Assessment and roadmap for the digital transformation of the energy sector towards an innovative internal energy market

Final Report

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Contact: Manuel Sanchez Jimenez

E-mail: manuel.sanchez-jimenez@ec.europa.eu

European Commission
B-1049 Brussels

Assessment and roadmap for the digital transformation of the energy sector towards an innovative internal energy market

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List of authors: Simona Benedettini (PwC), Guglielmo Brugnetta (Tractebel), Franco Fumiatti (Tractebel), Paolo Gentili (PwC), Giulia Ghiglione (PwC), Vincenzo Giordano (Tractebel), Aviv Gidron (Tractebel), Gerd Küpper (Tractebel), Pavla Mandatova (Tractebel), Roberta Masci (PwC), Alessandro Rubino (PwC).

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"The transition to a smart, secure and sustainable energy system is no longer a choice for Europe; it is a responsibility towards all citizens, our future generations and the planet. This transition represents a real economic opportunity and requires first and foremost bridging energy and digital economy."

Dominique Ristori (former Director-General, DG ENER),

Roberto Viola (Director-General, DG CNECT)

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List of Acronyms

Abbreviation	
5G	Fifth Generation
ACER	European Union Agency for the Cooperation of Energy Regulators
ACM	Authority for Consumers and Markets (Autoriteit Consument & Markt)
ADP	Active Digitalisation Policy
AESA	Spanish Aviation Safety and Security Agency
AI	Artificial Intelligence
AIOTI	Alliance for Internet of Things Innovation
AMI	Advanced Metering Infrastructure
AP	Access Point
API	Application Program Interface
APM	Asset Performance Management
B2B	Business-to-Business
B2C	Business-to-Consumer
BAU	Business-As-Usual
BEM	Building Energy Management
BEREC	Body of European Regulators for Electronic Communications
BEUC	European Consumer Organisation
BIM	Building Information Modelling
BM	Business Model
BRP	Balance Responsible Party
C&I	Commercial and Industrial
CAPEX	Capital Expenditure
CAPS	Collective Awareness Programs for Sustainability and Social Awareness
CBA	Cost Benefit Analysis
CCR	Capacity Calculation Regions
CEER	Council of European Energy Regulators
CEF	Connecting Europe Facility
CEP	Clean Energy Package
CG	Consistent Governance
CGM	Common Grid Model
CHP	Combined Heat and Power
CPO	Charging Point Operator
CRE	Energy Regulatory Commission
CRM	Customer Relationship Management
CSIRT	Computer-Security Incident Response Team
CSPN	Certification de Sécurité de Premier Niveau
DAM	Day-Ahead Market
DEI	Digitising European Industry

DEP	Digital Europe Programme
DER	Distributed Energy Resource
DLMP	Distribution Locational Marginal Prices
DLT	Distributed Ledger Technologies
DPA	European Data Protection Authority
DPIA	Data Protection Impact Assessment
DPP	Digital Power Plant
DR	Demand Response
DSI	Digital Service Infrastructure
DSM	Digital Single Market
DSO	Distribution System Operator
EaaS	Energy-as-a-Service
EASA	European Aviation Safety Agency
EBP	European Blockchain Partnership
EBSI	European Blockchain Services Infrastructure
EC	European Commission
EED	Energy Efficiency Directive
EEFIG	Energy Efficiency Financial Institutions Group
EE-ISAC	European Energy–Information Sharing Analysis Centre
EFSI	European Fund for Strategic Investments
EIC	European Innovation Council
EIP-SCC	European Innovation Platform Smart Cities and Communities
EIT	European Institute of Innovation and Technology
EM	Energy Management
EMS	Energy Management System
ENISA	European Union Agency for Network and Information Security
ENTSO-E	European Network of Transmission System Operators - Electricity
EPBD	Energy Performance of Buildings Directive
ESCO	Energy Service Company
ESMIG	European Smart Metering Industry Group
ETIP	European Technology and Innovation Platforms
ETPA	Energy Trading Platform Amsterdam
ETSI	European Telecommunications Standardisation Institute
EV	Electric Vehicle
FCR	Frequency Containment Reserve
FIT	Feed-in-Tariff
FSP	Flexibility Service Provider
GDPR	General Data Protection Regulation
GHG	Greenhouse Gases
GIS	Geographic Information System
GO	Grid Operator
HAN	Home Area Networks
HEM	Home Energy Management
HEMS	Home Energy Management System
HVAC	Heat Ventilation Air Conditioning

I/O	Input/Output
iBMS	intelligent Building Management System
iBPM	intelligent Business Process Management
ICT	Information and Communication Technology
IEA	International Energy Agency
IEM	Internal Energy Market
IIC	Industrial Internet Consortium
INATBA	International Association for Trusted Blockchain Applications
IoT	Internet of Things
IP	Internet Protocol
IPR	Integrated Planning and Reporting
ISMS	Information Security Management System
IT	Information Technology
ITER	International Thermonuclear Experimental Reactor
JRC	Joint Research Center
KORRR	Key Organizational Requirements, Roles and Responsibilities
KPI	Key Performance Indicator
LEED	Leadership in Energy and Environmental Design
LEIT	Leadership in Enabling and Industrial Technologies
LV/MV	Low Voltage/Medium Voltage
M2M	Machine-to-Machine
MFF	Multiannual Financial Framework
mFRR	Frequency Restoration Reserve market
MRL	Market Readiness Level
MS	Member State
MSP	Moblity Service Provider
NABEG	National Grid Expansion Acceleration Act
NC DCC	Network Code Demand Connection
NC HVDC	Network Code High Voltage Direct Current Connection
NC RfG	Network Code Requirements for Generators
NECP	National Energy & Climate Plan
NILM	Non-Intrusive Load Monitoring
NIS	Network and Information Systems
NRA	National Regulatory Authority
NZEB	Nearly Zero-Energy Building
O&M	Operation and Maintenance
OCPI	Open Charge Point Interface
OEM	Original Equipment Manufacturer
OES	Operators of Essential Service
OIC	Open Internet Consortium
OPEX	Operating Expenditure
OSCP	Open Smart Charging Protocol
OT	Operational Technology
OTT	Over-the-top Technology
P2P	Peer-to-peer

PaaS	Platform-as-a-Service
PEB	Positive Energy Block
PED	Positive Energy District
PEER	Partnership for the Enforcement of European Rights
PPA	Power Purchase Agreement
PPP	Public Private Partnership
PSI	Public Sector Information
PV	Photovoltaic
R&D	Research and Development
R&I	Research and Innovation
RAB	Regulatory Asset Base
RE	Renewable Energy
RED	Renewable Energy Directive
RES	Renewable Energy Systems
RFID	Radio-Frequency Identification
RL	Reinforced Legislation
ROI	Return on Investment
RSPP	Radio Spectrum Policy Programme
SaaS	Software-as-a-Service
SAREF	Smart Appliances Reference ontology
SDO	Standard Development Organisations
SET	European Strategic Energy Technology
SME	Small and Medium Enterprise
SO GL	System Operation Guideline
STF	Specialists Task Force
ToU	Time-of-Use
TRL	Technology Readiness Level
TSO	Transmission System Operator
UAS	Unmanned Aircraft Systems
UAV	Unmanned Aerial Vehicles
UC	Use Case
UDP	Urban Data Platform
V1G	Vehicle-to-Grid (Unidirectional power flow)
V2B	Vehicle-to-Building
V2G	Vehicle-to-Grid (Bidirectional power flow)
V2H	Vehicle-to-Home
VPP	Virtual Power Plant
VR	Virtual Reality
WACC	Weighted Average Cost of Capital
WPS	Wi-Fi Protected Setup

Executive Summary

Why this study?

Thanks to the European Union's policy pressure, the EU energy system is going through increasing decentralisation and decarbonisation processes. Digitalisation, in this context, is a key enabler, as it unlocks opportunities for actors across the value chain (i.e. consumers, prosumers, retailers, traders, producers, network operators), providing them with new solutions.

At the moment, digital technologies are already playing an important role in the energy sector. Internet of Things, Artificial Intelligence, Big Data, Cloud, 5G and Blockchain technologies are influencing changes both in energy companies' value creation strategies and in customer behaviour. They are expected to have an impact on long-time established roles, particularly by creating trust and empowering consumers.

In addition to this, digital technologies also provide the opportunity to integrate more renewable energy into grids and use energy more efficiently in households, industry and the whole system. They thus contribute to the creation of favourable conditions for tackling the sustainable low carbon economy challenge.

To support policy making, this study assesses in which way and to what extent are digital solutions affecting the energy transition. It does this firstly by analysing ten specific use cases which provide, altogether, a good coverage of what is happening in representative segments of the energy value chain; and secondly, thanks to such a comprehensive view, by proposing a Roadmap for future EU and MS actions aimed at removing existing barriers to the digital transformation and its opportunities unlocking potential.

Such a Roadmap presents a list of short-term actions able to remove those barriers and accelerate the implementation of the most relevant provisions of the Clean Energy Package. At the same time, looking forward, the recommended policy measures at EU and MS level are consistent with two of the six priorities of the new Commission, namely the "European Green Deal" and "Europe fit for the Digital Age", confirming the continuity of the EC's action in support of the energy transition.

Scope of the study

The study focuses on an overview of the European Commission's digitalisation policies, on the assessment of ten selected use cases which can be enabled by further actions removing hampering factors, on the design of four policy scenarios depicting such further actions and, finally, on a roadmap identifying timelines for both actions and implementation.

The main questions that this study addresses are: why do we need digitalisation in the energy sector, whether it is worth paying for it, and who shall pay for it. To respond to such questions, the study goes through five tasks, whose main objectives are to provide:

1. A description of the most relevant future business cases in the energy sector which are dependent on the digitalisation of the sector, identifying existing barriers to their development;
2. The design of four realistic scenarios for the digital transformation of the energy sector by 2030;
3. The evaluation of synergies among different policy making areas in view of a wider "digitalised energy sector" and the regulatory challenges stemming from the rising need for cross-sectoral cooperation among different policy areas, at the EC and MS level;
4. The indication of a preferred policy scenario with actions to take and objectives to be pursued;
5. A comprehensive policy roadmap (2020-2025-2030) and the related recommendations to implement the identified measures.

Policy Context

The digitalisation of the power sector calls for a coherent policy making in the Energy and ICT domain, namely in the implementation of the Energy Union and the Digital Single Market (DSM) strategies. The implementation needs to ensure coherence and develop synergies, in order to create the most suitable conditions for consistent public regulation and public/private investments on smart energy products and services across Europe. To this purpose, it is of paramount importance to apply consistency in the regulation of several cross-cutting issues – such as security, privacy, interoperability - and also in all the sectors involved (Energy, ICT, Transport, etc.).

The study analyses the relevant EU policies and investment programmes, with a focus on those bridging the Energy and Digital portfolios, and in line with the bond established by the new EC's priorities between the "European Green Deal" and "Europe fit for the Digital Age". On the policy side, the most notable are the Clean Energy Package, the Free Flow of non-personal Data Regulation, the Network and Information Systems Directive (NIS Directive), the Cybersecurity Package, the General Data Protection Regulation (GDPR) and the New Deal for Consumers. On the investments side, the study takes into consideration the information available on the new Multiannual Financial Framework 2021-27.

As a result, the study assesses the capacity of both public policies and investments to facilitate the penetration in the Energy sector of Big data and data analytics, AI, IoT, 5G and Blockchain. All of these are technologies with a significant potential to improve productivity, efficiency, competition and sustainability in energy systems, to deliver value to every segment of the power sector, and also to unlock opportunities for job creation.

Use Cases Analysis

Digitalisation has a barrier-removing effect along the entire energy value chain. To analyse the opportunities that digital technologies can create for energy businesses and consumers, ten use cases (UCs) relevant for the digitalisation of the power sector have been selected.

The ten UCs span the entire energy value chain to capture the full potential of digitalisation. They cover the following areas: smart homes, digital customer engagement, wholesale energy markets, smart cities, digital power grids, smart EV charging and digital power plants.

The starting point of the UCs analysis is the identification of opportunities that digitalisation can unlock for customers and society more widely, resumed in the following table for each UC.

Use Cases	Opportunities for Customers	Opportunities for Society / Energy System
1. On-site optimisation for C&I and residential buildings	• Cost savings (bill reduction) • Customers empowerment Improvement of buildings maintenance in terms of performance and costs (predictive maintenance, early identification of faults)	• Contribution to the EU energy efficiency targets through enabling Nearly-Zero Energy Buildings • Increase of energy system flexibility • Improving distributed RES integration Support to EV integration
2. Smart Districts	• Reduction of energy bills for final users • Development of e-mobility thanks to the increased availability of charging stations at district level Improvement of buildings maintenance in terms of performance and costs	• GHG emissions reduction due to the increase of distributed generation from RES • Enhanced innovation push due to new forms of energy management solutions Improved life quality thanks to improved district service availability
3. Energy Aggregators	Valorisation of customers' flexibility, enabling reduction of the energy bill	• Lower balancing, energy and peak capacity costs Better RES integration
4. Customer Data Analytics	• Improved customer experience • Cost savings (bill reduction) Familiarity with market dynamics and energy efficiency programmes	• Optimising (reducing) energy consumption • Changing behaviour as a cost-effective way of cutting carbon emissions
5. Smart EV Charging and Charging Management	• Energy cost savings (off-peak charging) • Additional revenue streams by providing ancillary services to TSOs and local services to DSOs • Backup power source & resilience • Access to electric mobility via sharing	• Energy cost savings • Avoidance of local grid issues • Higher RES shares through better integration • Provision of flexibility
6. Urban Data Platforms	• Access to integrated energy services • Improved mobility services • Lower taxes due to reduced bills for public energy consumption • Efficient public lighting, waste management, traffic monitoring, etc.	• Air quality monitoring and prevention actions • Advanced traffic planning and management (both public and private transport) • Predictive maintenance on city infrastructures • Security/safety planning and management

Use Cases	Opportunities for Customers	Opportunities for Society / Energy System
7. Energy Communities	• More consumers can actively participate in the energy transition (e.g. tenants in a building, low-income or vulnerable household) • Reduction of the energy bill	• Supporting RES development through better access to financing and self-consumption • Possibility to address local grid issues • Better allocation of RES support, towards the ones willing to pay for more local and green energy
8. RES Origin Tracking	• Choose the origin of the energy in an easier and more transparent way • Lower transaction costs	• Improved access to PPAs will support the acceptability and further development of RES • Cost saving because of administrative simplification
9. Improved O&M	• High efficiency (optimizing performance while minimizing operational costs) • Lower costs for power plant start-ups • Increased revenue through fewer outages • Portfolio optimization	• Optimisation of transmission and distribution grid management in terms of availability, reliability and flexibility • Lower carbon emissions from power plants thanks to improvement in their performance
10. Flexibility Market Platforms	• Valorisation of customers' flexibility • Lower grid charges through better coordination between TSOs and DSOs and better resource planning for (local) congestion management	• Better resource planning through coordination and local congestion management, reducing overall system cost • More efficient RES integration, through local price signals

For each UC, the study identifies key issues by analysing major Business Models (BM) through a technical, market and regulatory feasibility assessment. Such key issues, listed in the table below, highlight market and regulatory barriers that need to be addressed via targeted policy actions (or in some cases, they have already been addressed, though partially).

Use Cases	Business Models	Key Issues
1. On-site optimisation for C&I and Residential buildings	Building Energy Management (BEM) Home Energy Management (HEM)	1. Customer privacy and data protection
		2. Cybersecurity of ICT products
		3. Interoperability between connected devices
		4. Lack of customer engagement
2. Smart Districts	Positive Energy District (PED)	1. Role of prosumers
		2. Interoperability between connected devices (IoT)
		3. Detachment from EU incentives??
3. Energy Aggregators	Aggregator = Supplier Independent Aggregator	1. Difficult market access by independent aggregators
		2. Limited access to consumption and production data
		3. Limited or uncertain market potential and difficulty to stack revenues
		4. Prequalification & product design requirements

Use Cases	Business Models	Key Issues
4. Customer Data Analytics	B2C Customer engagement solutions B2B Customer engagement solutions	1. Customer privacy and data protection 2. Cybersecurity of ICT products 3. Data monetization 4. Lack of customer engagement
5. Smart EV charging and charging management	V1G' Smart Charging V2G or V2X' Smart Charging	1. Lack of certification for power quality and standardisation for V2G 2. Customer acceptance of EVs, smart charging and car sharing 3. Double taxes, levies and network charges for storage 4. Absence of e-roaming & charging interoperability
6. Urban Data Platforms	Vertical Platform Horizontal Platform	1. Customer privacy and data protection 2. Cybersecurity of ICT products 3. Interoperability between connected devices (IoT) 4. Lack of business models on data access
7. Energy Communities	Peer-to-Peer (P2P) trading Collective self-consumption	1. Sharing of consumption and production data jeopardizing the contractual relationship of P2P trading business models 2. Dependence of collective self-consumption business models on behind the meter advantages 3. Definition of community's self-consumption when not everyone joins the community
8. RES Origin Tracking	Smart PPAs	1. Acceptance & sustainability of blockchain technology
9. Improved O&M	APM-Digital Power Grid APM-Digital Power Plant Platform-as-a-Service	1. Drone use regulations and constraints created by their limitation 2. Risk of cyberattacks and threats to a digitised energy critical infrastructure 3. Need for APIs and interoperability standards for integrated platforms
10. Flexibility Market Platforms	Grid congestion management platform Single platform for energy trading and ancillary services	1. Low incentive for DSOs to procure market-based flexibility services 2. Insufficient TSO-DSO-Market coordination in the procurement of flexibility services 3. Absence of products reflecting "local" needs

In addition, for each UC, specific cases developed in nine selected EU countries are presented to illustrate the existing business models and the current issues for their full development.

Policy Scenarios

The study proposes targeted policy actions which tackle the most relevant and recurring key issues identified in the UCs analysis. The study considers various levels of intervention (legislative, regulatory, non-legislative measures) and levels of governance (EU, MS and industry). Key issues are grouped into four policy areas of intervention with the greatest potential to foster the digital transformation of the power sector: Flexibility services at the distribution level, Privacy and Data Protection, Cybersecurity, Interoperability and Standardisation.

The combination of the suggested policy actions defines the four policy scenarios for the digital transformation of the energy sector, namely the Business As Usual (BAU), Consistent Governance (CG), Reinforced Legislation (RL) and Active Digitalisation Policy (ADP) scenarios. For each scenario, the study identifies specific timelines (2020, 2025, 2030) for implementing the proposed measures.

The Business As Usual scenario foresees the full implementation of the already adopted provisions under the Energy Union and the Digital Single Market strategy, i.e. Clean Energy Package, GDPR, Free Flow of Data, Cybersecurity Package, NIS Directive and New Deal for Consumers.

The Consistent Governance scenario envisages the adoption of targeted policy actions addressing the key issues identified in the UCs analysis and aiming to safeguard consistency between different areas of sectoral regulation. This scenario entails technical and timely measures as well as binding guidelines and implementing acts to be made, mostly at the MS level, to accelerate the digitalisation strategy designed by the Commission. In this scenario, the Commission shall oversee the process and ensure homogeneous application of the current Directives and Regulations, by best practices sharing among NRAs and main market actors.

The Reinforced Legislation scenario foresees the adoption of additional regulatory measures to fully overcome the key issues, requiring an additional effort to the European Commission. To inform this additional effort, the scenario suggests new legislative provisions which will address potential future changes in the market design and operations brought by P2P and VPP and on the ground of already well-established and mature regulatory frameworks for the integration of resources connected at the distribution level.

The Active Digitalisation Policy scenario incorporates the investments foreseen for 2021-2027 in the next EU budget which will have a direct impact on the key issues strictly related to energy infrastructure and digital technologies. The study proposes the Active Digitalisation Policy to be shaped as a combination of the Consistent Governance scenario reinforced with the investments foreseen by the EU budget 2021-2027.

For each key issue, only a few policy actions are selected among those proposed in the policy scenarios and in that way the study seeks to indicate a preferential path for the digitalisation of the power sector by 2030. Such policy actions are expected to overcome in the fastest and most effective way the key issues identified in each policy area, while best exploiting the new opportunities offered by digitalisation.

Synergies between different sectors will be crucial to stimulate joint investments and coherence in regulatory frameworks, in a way to identify cross-fertilisation solutions in areas of interoperability, common standards, access to data, data processing and

cybersecurity. In this context we suggest a cross-sectoral approach to breaking down sectoral silos. Policy actions that most effectively capture the cross-cutting nature of digitalisation are, thus, selected as preferred actions.

Such actions are represented in the CG scenario, which is composed of sectoral or horizontal measures aiming at safeguarding consistency between for energy and digital economy sector regulation. Moreover, the CG scenario foresees the application of common horizontal measures. The added value of policies concerned by the CG scenario also relies on the technical and punctual measures it entails. Guidelines and implementing acts contained in the CG scenario may promote a more effective, straightforward and harmonised implementation of actions to encourage digitalisation in Member States.

In addition to these actions, the ADP scenario roadmap incorporates the foreseen investments for the next EU long-term budget 2021-2027. These investments will provide vital support to current and future digitalisation-enabling policies and will contribute to significantly boosting the digital transformation of the power sector.

The resulting actions of this ADP scenario (CG plus Investments) are, then, assigned to different time horizons to outline the roadmap to 2030 for the digital transformation of the power sector.

Compared to the picture sketched in the inception phase of the study, the need to include a 2025 deadline arose from the analysis, as reported in the Roadmap. In such a scenario, the Commission will create suitable conditions for the digitalisation of the power sector by capitalizing on the strategy-setting and market design effort made so far, by complying with the need for empowering customers, by enhancing competition and by creating new opportunities for the EU industry in the short term.

Roadmap

The roadmap starts with the full implementation of the policies that are either in force or will be adopted in 2020 at the latest. The roadmap consequently considers an intermediate deadline (2025) by which the most urgent policy actions shall be implemented by the MSs to be compliant with the current legislative framework. Finally, in the time horizon 2025-2030 the roadmap identifies measures which are considered to be more effective in fully addressing the key issues emerged in the analysed UCs.

To deliver the digitalisation opportunities to the energy market, it is essential to address, in a timely manner, the emerging issues with respect to market design and operations that may affect the provision of flexibility services at the distribution level.

To this purpose, it appears desirable that Member States adopt all the necessary actions to comply with the current legislation, i.e. the Regulation (EU) 2017/2195, the recast Electricity Directive (EU) 2019/944 and the Electricity Regulation (EU) 2019/943. In addition, to enhance and support compliance by MSs, it is recommended that the latter implement the actions presented in the CG scenario, which mostly refer to the adoption of binding EU guidelines.

The choice of the CG scenario as the preferred one, is justified by the opportunity this scenario offers to address the harmonisation of MSs' regulatory framework by means of timely and binding rules. For example, regulations introducing network codes are

effective as they provide detailed technical and operational rules to make electricity markets more functional, by assigning roles and responsibilities to the actors involved in these markets, ensuring compliance with the principles established by Directives or other Regulations.

Concerning digital-related policy areas, one of the key priorities is to build trust and acceptance of digital technologies among energy consumers. To this extent, the issues related to consumer concerns about their data protection, privacy and security need to be addressed in a timely manner.

A robust regulatory framework is already in place both in the field of data protection and cybersecurity. The former sees the General Data Protection Regulation (GDPR) and the Free Flow of non-personal Data Regulation in force and the e-Privacy Regulation expected to be adopted in the next months, while the latter can rely on the NIS Directive and the Cybersecurity Package implementation.

Therefore, actions mostly referring to the adoption of binding EU guidelines are needed, which are presented in the CG scenario.

Recommendations

The EU climate and energy goals to 2030 offer the most suitable framework to identify the objectives of the digitalisation of the energy sector.

The growing share of distributed generation, together with the increasing engagement of customers, may unlock unprecedented benefits for the energy system. All else being equal, the most significant benefits may arise from the provision of flexibility services by resources connected to distribution networks. The possibility to modify consumption and generation patterns at that level, in response to an external signal (e.g. electricity prices), may facilitate the integration of renewable generation sources while mitigating the costs for congestion management, grid and capacity reinforcement.

To make such benefits a reality it is essential to address in a timely manner emerging issues related to market design and operations, which may affect the provision of flexibility services at the distribution level.

In the following paragraphs, we provide recommendations for each of the key issues concerning the provision of flexibility services at the distribution level.

Flexibility services at the distribution level

Cooperation between TSOs and DSOs

To promote the efficient provision of flexibility services from distribution-connected demand and power generating facilities the cooperation between DSOs and TSOs is essential with respect to a wide range of aspects, as emerged from UCs and the review of the legislative framework in place.

To this purpose, the following actions are recommended:

- Member States' NRAs shall adopt the decisions discussed in the CG scenario to enforce in a timely manner the Electricity Regulation with respect to the monitoring of implementation of the network codes and guidelines and the planning and

operation of networks. The definition of common rules in the development, operation and functioning of networks is a prerequisite for the development of an effective model for the procurement of flexibility services at the distribution level. The provision of flexibility services from distribution-connected resources cannot disregard, indeed, a coordinated access of TSOs and DSOs to demand and distributed power generating facilities.

Such actions shall be undertaken in 2020.

- Member States' NRAs shall adopt the decisions discussed in the CG scenario to enforce the operational requirements of KORRR and make the data exchange effective in a timely manner. Making data exchange effective and clarifying the role and responsibilities of TSOs and DSOs to this aim can promote flexibility services at the distribution level without prejudice to system security and stability.

  Such actions shall be undertaken in 2020.

- The EC shall consult with relevant stakeholders and to organise expert panels to acquire knowledge on possible models of coordination between TSOs and DSOs implemented or under scrutiny across Member States. Such actions shall develop guidelines for:

  - the development of a coordinated approach between TSOs and DSOs in the procurement of flexibility services at the distribution level, according to different possible models by ensuring harmonisation across Member States without prejudice to national specificities;
  - the definition of guidelines for the development of pilot projects at the Member State level concerning the procurement and provision of flexibility services at the distribution level;
  - the acquisition of knowledge and the development of guidelines with respect to the development of flexibility platforms.

  Such actions shall be completed by the end of 2021.

- The EC shall use the results of the consultation process and of the expert groups to adopt an implementing act concerning the design and operation of possible models of interaction between DSOs and TSOs with respect to the procurement of flexibility services at the distribution level. The implementing act will ensure a timely and harmonised enforcement by Member States of the provision of the Electricity Regulation and Directive concerning the role of TSOs and DSOs in the provision of flexibility services at the distribution level.

  Such action shall be completed by the end of 2022.

- Implementation of the Horizon Europe framework and CEF programmes. The implementation of the Horizon Europe framework to promote R&I in the field of AI and Data Analytics to foster the coordination and synergies between TSOs and DSOs may provide, in addition to regulatory measures, also an important contribution to the development of flexibility services at the DSOs level. Such funds may help the development of projects aimed at increasing network observability and security as well as the development of platforms for the trading of flexibility services at the distribution level. In addition, the utilization of CEF funds to develop e.g. digital

platforms aimed at facilitating interactions between DSOs and TSOs can represent an effective add-on to this aim.

Characteristics of the products for flexibility services

The characterization of the products for flexibility services at the distribution level is an essential aspect for the provision of flexibility services. Such products, indeed, defines the characteristics of the services to be provided, rights and obligation of the providers of such services, the needed technical requirements and the roles and responsibilities of the TSOs and DSOs involved in the procurement of the services.

To ensure a proper characterisation of the products for flexibility services the following actions are recommended.

- Member States enforce by means of NRAs the provisions of the Electricity Directive with respect to aspects emerged in the BAU scenario. NRAs shall define the prequalification criteria necessary to provide flexibility services and develop a market design for the provision of flexibility at the distribution level which fulfils the non-discriminatory treatment of all market participants as suggested by the Electricity Directive.

  Such actions shall follow consultations with DSOs and TSOs and shall be implemented before 2025.

- Further secondary legislation amending Regulation (EU) 2017/2195 (Balancing Guideline). To ensure a harmonised and timely development of the products for flexibility services, amendments at the current Balancing Guideline appear desirable. The Guideline should encompass the definition of the principles set in the CG scenario with respect to the characterisation of the products for flexibility services.

  Such intervention shall be adopted no later than 2023.

More active role of DSOs in the provision of flexibility services

Network investments at the distribution level are an essential condition for a smarter role of distributors and customers and, consequently, for unlocking the opportunities of digitalisation.

To ensure that the most valuable investments and operations are undertaken to promote flexibility at the distribution level the following actions are recommended.

- Adoption of NRAs' decisions shaping the regulatory methodology for the remuneration of DSOs in the operation and development of their network according to the provisions of the Electricity Regulation. Such decisions shall encompass the adoption of an output-based regulation based on incentives and penalties to promote the development and management of smart grid able to promote the provision of flexibility services at the distribution level.

  In addition, NRAs' decisions should also adopt a long-term approach by imposing, in compliance with the Regulation, the development by DSOs of network plans encompassing a five to ten year time-horizon.

  Such plans shall become the base according to which NRAs assess the compatibility of network investments and operations with respect to the outputs set by national

Regulators, over a given regulatory period, also with reference to the promotion of flexibility. It is thus recommended that network plans are developed and subject to the NRAs' assessment before the starting of each regulatory period to allow for a forward-looking approach to the operation and development of the network.

NRAs' decisions shall by adopted before 2025.

- Implementation of the CEF and Horizon Europe programme. The exploitation of the CEF and Horizon Europe programme can represent an additional lever to support investments in smarter and digitalised distribution networks to allow for the provision of flexibility services at the distribution level. It is thus recommended to consider a proper funding of such programmes in order to allow an adequate support to innovative projects in the digitalisation of the distribution network.

  All these actions shall be implemented in a timely manner and before 2025.

- Adoption of Guidelines on the regulatory approach for distribution (and transmission network). Despite being binding, the Electricity Regulation only sets general principles with respect to the regulatory framework that DSOs shall put in place for DSOs. Therefore, heterogeneity across Member States can be expected with respect to the timely and uniform implementation of the recommendations set in the Regulation. In order to make sure that DSOs across MSs are engaged to the same extent and at the same pace in the promotion of flexibility, and smarter grids more in general, the Commission could adopt a Regulation establishing guidelines for detailed technical and operational rules to promote a forward looking and output-based regulation for distribution networks across Member States. A greater harmonisation of the regulatory approach for distribution networks will ensure that any Member State lagging behind in the development of smart grids is able to promote a more active role of demand with benefits for demand itself and the energy system as a whole.

  This action shall be undertaken before 2030.

The role of aggregators in providing flexibility services

Given the distributed nature of demand and the increasing role of digitalisation to empower customers, independent aggregators may play an important role to unlock the great potential of demand in contributing to the delivery of the energy transition. Aggregation of demand may, indeed, overcome several market failures which are currently preventing demand to deliver greater value to the energy system. Transaction costs, information asymmetry and lack of appropriate knowledge may deter demand from entering PPAs or providing flexibility services.

- Adoption of NRAs' decision to encourage the participation of independent aggregators to electricity markets according to a level playing field. The Regulation and the Directive on the IEM establish the adoption by MSs of a regulatory framework aimed at encouraging a non-discriminatory participation of aggregators in electricity markets. It is thus recommended that Member States comply with the provisions set in the Regulation and the Directive on the IEM by adopting NRAs' decisions promoting a non-discriminatory participation of independent aggregators in electricity markets at the level playing field with other market operators.

- In addition, it appears desirable that NRAs encompass the obligations of TSOs and DSOs in promoting the participation of independent aggregators in electricity markets as well as of electricity suppliers. The latter, in particular, shall avoid practices preventing customers to stipulate contracts with independent aggregators.

  All these actions shall be implemented before 2025.

- Implementation of the CEF programme. The CEF programme can provide an important contribution to the role of aggregators by promoting e.g. the development of platforms connecting the different stakeholders of the energy system involved by the provision of flexibility services and encouraging synergies between digital and energy infrastructures.

  The employment of the CEF programme shall be performed in 2021.

- Adoption of Guidelines on independent aggregators. To ensure the integration and harmonisation of electricity markets, Member States shall establish consistent and harmonised regulatory frameworks to allow the participation of independent aggregators in progressively more integrated regional electricity markets. For this reason, and given the emergent nature of independent aggregators, the adoption of binding EU guidelines on independent aggregators (as suggested in the CG scenario) is recommended. Guidelines may support Member States in the implementation of consistent and exhaustive technical and operational rules for the participation of independent aggregators in electricity markets and in particular in the provision of flexibility services.

  Guidelines should be implemented before 2025.

The access to consumption and production data

The Directive on the IEM establishes the right for customers and third eligible parties to access consumption and production data in order to promote an active role of demand in fostering the transition through renewable generation and the provision of flexibility services. In addition, the Directive affirms the necessity to promote interoperability for data access. In particular, the EU encourages interoperability to foster the realization of an integrated internal market increasingly based on digitalisation.

- Adoption of NRAs' decision to promote customers' right to access data. NRAs shall adopt decisions aimed at promoting customers' empowerment by ensuring their right to access their consumption and production data upon request and in an understandable format. Such regulatory provisions shall be adopted as soon as feasible to allow for a responsible participation of customers in electricity markets according to the principles established in the Electricity Directive. The possibility for customers to access to their metering data is, indeed, an essential condition to allow them to benefit from competition in the retail electricity markets as well as to engage them in more sophisticated activities such as the provision of flexibility services with opportunities for customers themselves and the energy system as a whole.

  NRAs' decision shall be adopted by the end of 2021.

- Adoption of binding interoperability standards. The Commission shall consult with ACER, ENTSO-E, NRAs and the EU DSO-entity in order to establish binding guidelines for the adoption of interoperability requirements. As data will increasingly shape the development of electricity markets - in terms of both customer empowerment and

the development of new tariffs, new figures such as aggregators will also impact, consequently, the integration of electricity markets. Therefore, it is important that binding and harmonised interoperability requirements are developed across Member States.

These actions shall be implemented by the end of 2023.

Privacy and Data Protection

The Electricity Directive promotes the adoption of a regulatory framework for data protection of smart meters, embedding relevant GDPR provisions and tailoring those to the needs and specificities of smart meters' implementation and functioning.

To this purpose, the following actions are recommended:

- MSs shall comply with the provisions set in the Electricity Directive by adopting a data management model for smart meters in order to ensure efficient and secure data access and exchange. Independently of the adopted data management model, each MS shall authorise, certify or, where applicable, supervise the parties responsible for data management.

- MSs shall carry out the collection and processing of personal data coming from smart meters in accordance with the GDPR. In line with customer-centric policies aiming at increasing energy consumer engagement and empowerment, MSs shall ensure that, prior to or at the time of installation of smart meters, final customers are duly informed about their energy consumption.

Given the high priority of addressing privacy concerns expressed by consumers over their personal energy-related data treatment, all these actions shall be adopted in a timely manner - and no later than 2022 - in order to build trust in more digitally engaged consumers.

Finally, to facilitate the large-scale deployment of smart metering systems across all MSs, the Commission shall develop EU guidelines on principles that need to be complied with by all data management models for smart meters in place or currently under design.

Cybersecurity

Cybersecurity of ICT products

The NIS Directive proposes a set of measures to boost the level of cybersecurity of network and information systems in Europe in order to increase resilience and enhance cybersecurity preparedness in Europe.

To this purpose, the following actions are recommended:

- MSs shall improve their national cybersecurity capabilities by designating one or more national competent authorities on the security of network and information systems, who shall monitor the application of the Directive at national level and shall coordinate with ENISA.

- MSs shall establish Computer Security Incident Response Teams (CSIRTs) to deal with incidents and risks and ensure efficient cooperation at EU level between the MSs. ENISA shall intervene when MSs have not developed national CSIRTs.

  MSs should have complied with such provisions by May 2019.

Over the recent years, the Commission carried out consistent work on cybersecurity certification schemes in order to tackle security concerns expressed by consumers about the cybersecurity risks associated with the ICT products and servers storing their personal data.

The Cybersecurity Act is the greatest expression of this work, as it sets up an EU cybersecurity certification framework for ICT products, services and processes. The proposed framework creates a comprehensive set of rules, technical requirements, standards and procedures to agree each scheme.

To this respect:

- The EC shall define a roadmap to deliver in a timely manner a common certification scheme for each relevant EU area and proceed with consultations with national competent authorities to harmonise with existing standards at the national level. By doing so, it would be possible to align efforts towards the identification of common certifications for the main European Industries. In tandem with developments on the proposed Cybersecurity Act, there will be supports for repositories, tools for awareness raising and assistance for security certification of digital products and services.

As the proposed EU cybersecurity certification schemes are not mandatory, but will be on a voluntary basis:

- The EC shall adopt a new EU Regulation on Cybersecurity defining the creation of EU cybersecurity certifications for different areas with mandatory standards and sanctions in the case of incompliance with set requirements. For example, the creation of ad hoc minim requirements for relevant operators and a clear definition of the role of the National competent authorities and CSIRTs. ENISA shall be enabled to make random checks of compliance and to request National authorities to provide information at any time.

The Cybersecurity Act also reinforces the role and responsibilities of ENISA. In order to better define areas of intervention of ENISA and its coordination with national authorities, the Commission shall envisage a series of provisions in an Implementing Act to efficiently tackle common challenges and bring forward best practices of MSs.

The combined effect of these actions will result in increased cyber-resilience and consumer trust in digital products and services. The investments proposed in the framework of the Digital Europe Programme for 2021-2017 will reinforce capabilities and ensure that the Union has technological and industrial capacities to secure its economy, society and democracy.

Cybersecurity of energy critical infrastructures

The NIS Directive aims to build and spread a culture of security across sectors that are vital for EU economy and society, where a cyberattack could disrupt an essential service, and rely heavily on ICTs, such as energy and digital infrastructure.

To this purpose, the following actions are recommended:

- Each MS shall identify Operators of Essential Services (OES) among key economic actors and businesses in these sectors, which will have to take appropriate security measures and to notify serious incidents to the relevant national authority. Under the Directive, also key Digital Service Providers (DSP), such as search engines, cloud computing services and online marketplaces, will have to comply with the security and notification requirements.

- The EC shall adopt new cybersecurity guidelines to set procedures for essential operators notification requirements, including deadlines, responsible bodies (stronger role of ENISA), format, definition of a common standard at the European level with respect to the information to be exchanged. Moreover, the new cybersecurity guidelines should define the modalities of collaboration between the EU DSO with National Competent authorities, CSIRTs and ENISA.

  The Commission shall adopt these guidelines no later than 2022.

The Electricity Directive establishes that MSs shall implement smart metering systems in accordance with European standards on security in order to ensure the highest level of cybersecurity protection while bearing in mind the costs and the principle of proportionality. To this regard:

- MSs shall follow the "security by design" principle when proceeding with the deployment of smart meters.

Following the Electricity Regulation:

- The EC shall adopt delegated acts in the form of network codes on cybersecurity to provide indications on minimum requirements to guarantee data security of smart meters.
  The Commission shall adopt these network codes no later than 2023.

Interoperability and standardisation

The Electricity Directive envisages smart metering systems interoperability as a fundamental requirement to promote the active participation of consumers in the electricity markets.

In the deployment of smart metering systems:

- MSs shall promote and adopt relevant available standards, including standards that enable smart meters interoperability on the level of the data model and the application layer and best practices. To this extent, MSs shall consider future and innovative energy services and the importance of the development of data exchange, smart grids and the internal market for electricity.

- MSs shall facilitate the full interoperability of energy services within the Union in order to promote competition in the retail market and to avoid excessive administrative costs for the eligible parties.

In line with the provisions of the Electricity Directive:

- the EC shall adopt Implementing Acts to determine interoperability requirements and non-discriminatory and transparent procedures for access to metering data,

consumption data, as well as data required for customer switching, DR and other services.

- MSs shall ensure that electricity companies comply with requirements which are yet to be developed by the Commission taking into account existing national practices.

  Such actions shall be taken no later than 2023.

In order to enable interoperability in the smart appliances' domain relevant for energy:

- the EC shall promote the adoption of the SAREF family of standards (reference ontology) by widespread dissemination actions to support their wider diffusion across all Europe.

  This action shall be taken as soon as possible.

Roadmap to 2030

Key	2020	2020 - 2025	2025 - 2030
Cooperation between TSOs and DSOs	Full implementation of the Regulation on the IEM to enhance the cooperation between TSOs and DSOs in the implementation of network codes and guidelines, network planning and operation and the procurement of flexibility services at the distribution level.	Full implementation of the Balancing Guideline with respect, in particular, to the obligation to consults on the implementation of the Guideline itself; the definition of a joint methodology for the allocation of costs related to the provision of active power reserves. Full implementation of the Regulation on the internal market for electricity with respect to: the monitoring of implementation of the network codes and guidelines; the network planning and operation. Adoption of NRAs' decisions for the enforcement and operational implementation of the KORRR. Consultation processes and creation of expert panels at the EU level to develop guidelines for the promotion of the provision of flexibility services at the distribution level by means of coordination between TSOs and DSOs and flexibility platforms. Exploitation of the Horizon Europe framework to promote R&I in the field of AI and Data Analytics to achieve greater coordination and synergies between TSOs and DSOs in the planning and operation of networks and develop pilot projects for the provision of flexibility services at the distribution level. Implementation of the CEF programme to promote synergies between digital and energy infrastructure to support e.g. the development of digital platforms aimed at facilitating the interactions between the different actors of the energy system including TSOs and DSOs.	Adoption of an Implementing act on flexibility services from distribution-connected demand and power generating facilities Adoption of a new Directive on the internal market for electricity to address emerging issues in market design arising from the development of P2P trading and VPP and the procurement of flexibility services at the distribution level
	Compliance by Member States with the Regulation (EU) 2017/2195 with respect to the obligation of TSOs and DSOs in the implementation of the guideline on electricity balancing.		
Specifications of the products for flexibility services	Full implementation of the Regulation on IEM to promote the obligation for TSOs and DSOs to adopt market-based mechanisms for re-dispatching.	Adoption of a further secondary legislation amending the Balancing Guideline and aimed at regulating issues as: characteristics of products for flexibility services; guideline concerning actions for the mitigation of the	

	Full implementation of the Directive on the IEM to establish the obligation for TSOs and DSOs to define the technical requirements for the provision of flexibility services by resources connected at the distribution level (also through aggregators).	impact of congestions and redispatching measures; prequalification technical and non-technical criteria for the provision of flexibility services.	
More active role of DSOs in the provision of flexibility services	Full implementation of the Regulation on the IEM to promote the implementation of incentive- and output-based regulatory frameworks for electricity distribution networks.	Full implementation of the new Regulation on the IEM with respect, in particular, the adoption of incentive-based and consistent regulatory frameworks acknowledging the new role of distribution networks. Exploitation of both the Horizon Europe and CEF programmes to complement national regulatory approaches in promoting network investments and encouraging a smarter and more active role of DSOs.	Adoption of Regulation (EU) establishing guidelines on the remuneration of distribution networks
The role of aggregators in procuring flexibility services	Full implementation of the Directive on the IEM to promote the adoption of a regulatory framework at the Member States' level aimed at encouraging the development of independent aggregators, and their non-discriminatory participation to electricity markets. Full implementation of the Regulation on the IEM to establish obligations aimed at deterring electricity suppliers from hampering the right of customers to stipulate contracts with independent aggregators.	Full implementation of the new Regulation on the IEM with respect, in particular, the promotion of independent aggregators' participation to electricity markets. Utilization of the CEF programme to promote e.g. the development of market platforms aimed at fostering an active role of aggregators and their interactions with other stakeholders of the energy system.	Adoption of Regulation (EU) establishing guidelines on independent aggregators
The access to consumption and production data	Full implementation of the Directive on the IEM to establish the right of customers and third eligible parties to receive all relevant consumption and production data, in an understandable format able; the development of interoperability requirements at the EU level.	Full implementation of the new Directive on the IEM with respect, in particular, the access and exchange of customers' consumption and production data. Development of EU recommendations/guidelines on interoperability standards at the EU level.	Adoption of binding (EU) interoperability requirements
Customer privacy and data protection	Full implementation of the Directive on the IEM including the provisions related to data protection of smart meters' data in the smart metering system deployment.	Full implementation of the new Directive on the IEM with respect to smart meters data management model.	Development of EU recommendations/guidelines for setting principles that need to be complied by all data management models for smart meters in place or currently under design.

Cybersecurity of ICT products	Designation one or more national competent authorities on the security of network and information systems.	Definition of a roadmap to deliver common certifications for each relevant EU sector. Adoption by the Commission of a series of provisions in order to efficiently tackle common challenges and bring forward best practices of MSs.	Adoption by the Commission of a New EU Regulation on Cybersecurity: ▪ defining the creation of EU cybersecurity certifications for different areas with mandatory standards and sanctions in the case of incompliance with set requirements ▪ including a cybersecurity network code for critical infrastructures, in order to address roles and responsibilities of the European DSO in guaranteeing cybersecurity of critical infrastructure.
Cybersecurity of energy critical infrastructures	Full implementation of the Regulation on the IEM to establish a European entity of distribution system operators in the Union ("EU DSO entity") in order to raise efficiencies in the electricity distribution networks in the Union and ensure close cooperation with transmission system operators and ENTSO for electricity.	Adoption by the Commission of new cybersecurity guidelines to define the modalities of collaboration between the EU DSO and National Competent authorities, CSIRTs, and ENISA. Adoption by the Commission of a cybersecurity network code for critical infrastructures. Implementation of the CEF programme to improve MSs compliance with the NIS Directive and higher levels of crisis response.	
Interoperability between connected devices	Full implementation of the Directive on the IEM to define smart metering systems interoperability as a fundamental requirement to promote the active participation of consumers in the electricity markets.	Adoption by the Commission of common guidelines to MSs for the adoption of standards and best practices for smart metering systems interoperability. Adoption by the Commission of Implementing Acts to determine interoperability requirements and non-discriminatory and transparent procedures for access to data.	Adoption of binding (EU) interoperability requirements supported by the introduction of relevant parameters (KPIs) for products and parts.

1 Introduction

1.1 General Background

Thanks to the European Union's policy pressure, the EU energy system is going through increasing decentralisation and decarbonisation processes. Digitalisation, in this context, is a key enabler, as it unlocks opportunities for actors across the value chain (i.e. consumers, prosumers, retailers, traders, producers, network operators), providing them with new solutions.

At the moment, digital technologies are already playing an important role in the energy sector. Internet of Things, Artificial Intelligence, Big Data, Cloud, 5G and Blockchain technologies are influencing changes both in energy companies' value creation strategies and in customer behaviour. They are expected to have an impact on long-time established roles, particularly by creating trust and empowering consumers.

In addition to this, digital technologies also provide the opportunity to integrate more renewable energy into grids and use energy more efficiently in households, industry and the whole system. They thus contribute to the creation of favourable conditions for tackling the sustainable low carbon economy challenge.

To support policy making, this study assesses in which way and to what extent are digital solutions affecting the energy transition. It does this firstly by analysing ten specific use cases which provide, altogether, a good coverage of what is happening in representative segments of the energy value chain; and secondly, thanks to such a comprehensive view, by proposing a Roadmap for future EU and MS actions aimed at removing existing barriers to the digital transformation and its opportunities unlocking potential.

Such a Roadmap presents a list of short-term actions able to remove those barriers and accelerate the implementation of the most relevant provisions of the Clean Energy Package. At the same time, looking forward, the recommended policy measures at EU and MS level are consistent with two of the six priorities of the new Commission, namely the "European Green Deal" and "Europe fit for the Digital Age", confirming the continuity of the EC's action in support of the energy transition.

1.2 Purpose and structure of the document

Digital transformation and advanced technologies deployment represent enormous growth potential for all types of business, including those of the energy sector. companies' business models, customer engagement strategies and interaction methods.

Digital transformation brings great opportunities for EU businesses and consumers. Therefore, the digitalisation process is at the core of all major EC initiatives aiming at creating an enabling environment to facilitate the digital transformation of society.

The objective of this document is to describe in detail the results of the study entitled '*Assessment and roadmap for the digital transformation of the energy sector towards an innovative internal energy market*'.

After this first introductory section and a second section highlighting the scope and objectives of the study, the third section describes the policy context and the relevant legal framework for the digitalisation of the power sector. It briefly includes the current legislation at EU level relevant for this study. The analysis of the regulatory framework is indeed essential to better understand the state of play of the legislative process of the energy and digital sectors and the direction of the European Union on the digitalisation path.

The fourth section describes in detail the methodological approach followed in the activities carried out in each task of the study.

The fifth section analyses the 10 selected use cases going through a technical, market and regulatory feasibility assessment. The outcome of the use case analysis is the identification of the key issues highlighting any technical issue, market barrier or regulatory gap that still needs to be overcome (or in some cases that has already been addressed). To this extent, targeted policy actions have been proposed in order to tackle the identified key issues and thus remove the existing barriers hindering the full deployment of the use cases.

The combination of the suggested policy actions will build up the four policy scenarios by 2030 for digital transformation of the energy sector that are presented in the sixth section of this report (Business As Usual, Consistent Governance, Reinforced Legislation and Active Digitalisation Policy scenario). The four policy scenarios encompass regulatory policy at EU and MS level, focusing on the power sector and synergies between power and other sectors.

The final section of the study sets a comprehensive roadmap and a combination of recommendations on how EC and Member States can foster the digitalisation process of the power sector, removing existing barriers and hampering developments in order to achieve EU's policy objectives. Such a roadmap shall describe actions to be implemented at Member States level by 2020 and at EU and Member States level by 2030. Furthermore, the roadmap includes an intermediate step to 2025 to deal with all those actions that have a field of application of less than 10 years.

1.3 Scope of the study

As Digital transformation represents a great opportunity for EU businesses and society and for this reason, the digitalisation process is at the core of all major EC initiatives aiming at creating an enabling environment to facilitate the digital transformation of our societies.

The energy sector represents no exception to this irreversible process. Digitalisation is one of the driving forces of change on energy systems giving rise to new business models and imposing a significant pressure for radical transformation of the industry.

It shall help the decarbonisation process, while making energy more competitive and affordable, without neglecting our high standards of security of supply.

In this context, the Clean Energy Package has been launched to shape modern energy systems in the EU in the framework of the EU long-term strategy defined in the Energy Union. Their combined scope is to achieve a progressive decarbonisation of the EU energy sector with a consumer-centric approach.

In order to create an integrated energy market where consumers have access to secure, sustainable and affordable energy, measures leading to increased deployment of digital technologies, among others, have been implemented and currently planned. Such technologies offer many promises in making the system more productive, accessible and safe. Nevertheless, it is still necessary to better analyse the challenges and needs of the energy sector in the digitalisation field.

The main questions that this study addresses are: why do we need digitalisation in the energy sector, whether it is worth paying for it, and who shall pay for it. To respond to such questions, the study goes through five tasks, whose main objectives are to provide:

1. A description of the most relevant future business cases in the energy sector which are dependent on the digitalisation of the sector, identifying existing barriers to their development;
2. The design of four realistic scenarios for the digital transformation of the energy sector by 2030;
3. The evaluation of synergies among different policy making areas in view of a wider "digitalised energy sector" and the regulatory challenges stemming from the rising need for cross-sectoral cooperation among different policy areas, at the EC and MS level;
4. The indication of a preferred policy scenario with actions to take and objectives to be pursued;
5. A comprehensive policy roadmap (2020-2025-2030) and the related recommendations to implement the identified measures.

2 Policy context

2.1 The relevant legal framework for the digitalisation of the power sector

According to the European Commission, "the transition to a smart, secure and sustainable energy system is no longer a choice for Europe; it is a responsibility towards all citizens, our future generations and the planet". At the same time, this transition represents a real economic opportunity as it will bring new investments, jobs and growth and will empower consumers to actively participate in the market and benefit from new technologies.

In this context, the electricity system is becoming more decentralised and more decarbonised, and it needs to become more digitalised to keep EU electricity supply competitive and affordable, and maintain EU high standards of security of supply.

Synergies should, therefore, be developed between the energy and ICT sectors in order to stimulate joint investments and coherence in regulatory frameworks. From the policy making side, the Energy Union and the Digital Single Market agenda present strong convergences. Energy and digital will come together most closely if European companies are enabled to deliver energy intelligent products and services across Europe and if the energy sector actively contributes to horizontal Digital Single Market policies.

The so-called three "Ds" - Digitalisation, Decarbonisation and Decentralisation - are shaping energy transition at the global level in an unprecedented manner. While the EU and MSs have already put in place policy actions to acknowledge the challenges triggered by Decarbonisation and Decentralization, Digitalisation in the power sector represents quite a new issue for the regulatory and legislative framework at both the EU and the national level.

Among the three "Ds", Digitalisation has the additional characteristic to create a bridge between the other two. Consumers stand at the centre of this bridge, being the heart of the energy transition. Digitalisation, indeed, is the driving force for more active and aware customers whose role will be restricted no more to only withdraw electricity from the grid but they will be able to produce their own electricity, to feed it into the grid, to provide balancing services and, last but not least, to consume energy more efficiently.

At the same time, for the power sector to benefit from digitalisation, a number of issues - as security, privacy, interoperability - shall be addressed across different industries. To this purpose, consistency in policy making at all levels and in all the sectors involved (energy, ICT, transport, etc…) is key.

The following paragraphs discuss the current EU policy context and foreseen investment programmes relevant for this study, with a particular focus to those policy measures and investments creating a bridge between energy and digital.

Starting from the Energy Union and the Digital Single Market Strategy, the following part will give an overview on the state of play of legislation, including measures such as the Clean Energy Package, the General Data Protection Regulation (GDPR) and the Cybersecurity package.

For further information on the subject, Annex I provides a detailed and comprehensive review of all the relevant legislative and non-legislative initiatives presented by the European Commission under the Energy Union and the Digital Single Market strategies since 2015.

Furthermore, future European investment programmes have been analysed and presented below focusing on those investments foreseen in the next long-term EU budget (MFF 2021-2027) that will boost the digital transformation of the energy sector and the EU economy and society in general.

2.2 The Energy Union and the Digital Single Market strategy

As said, the digitalisation of the power sector calls for a coherent policy making in the energy and ICT domain, namely in the implementation of both the Energy Union and the Digital Single Market strategy.

Smart grids are a clear example of digital meeting energy, as they are about information exchange and making necessary data available to interested parties.

They are part of the solution for managing electricity grids in times of increasing shares of renewables, decentralised generation and new loads, such as EVs, but also for creating new services and products. Smart grids are also part of an innovative and competitive Energy Union. They provide an important opportunity for European manufacturers to develop attractive smart solutions and boost their global competitiveness. All these solutions require digital instruments to steer the optimisation.

On the Energy side, under the Energy Union, three key targets have been established within the 2030 climate and energy framework: 40% cut in greenhouse gas emissions; 32% share for renewable energy; 32.5% improvement in energy efficiency.

On 30 November 2016, the European Commission presented a package of eight measures – the Clean Energy Package for All Europeans – to keep the European Union competitive as the clean energy transition changes global energy markets. Since then all eight measures have been progressively adopted up until the adoption of the last four measures (including the recast Electricity Directive and Regulation) in June 2019.

The package promotes the goals of the Energy Union strategy by revising the current regulatory and legislative framework in the light of game changers as digitalisation and decentralization in shaping energy transition. It builds upon three main pillars:

- putting energy efficiency first;

- achieving global leadership in renewable energies;
- providing a fair deal for consumers;

The package also builds bridges between the Energy Union and the Digital Single Market. Good examples are the proposed framework to incentivise dynamic price contracts and smart metering, to promote the demand side flexibility, and to set up EU-wide principles for data management for easy and non-discriminatory access to metering and consumption data by market actors.

On the Digital side, the Digital Single Market (DSM) strategy was adopted on 6 May 2015 and includes 16 specific initiatives delivered by the Commission by January 2017. They focus on areas where the EU can bring specific added value, concentrating on European digital projects whose scope and scale cannot be realised by individual countries alone.

The DSM Strategy is built on three pillars:

- *Breaking down online barriers that prevent people from enjoying full access to all goods and services being offered by businesses in the EU*;
- *Right environment for digital networks and services*: creating the right conditions and a level playing field for digital networks and innovative services to flourish;
- *Economy and society*: maximizing the growth potential of the digital economy

Under the DSM strategy, with the aim to reach an open market where it is easy for businesses and people to operate effectively, the Commission has given the impulse to the development of a set of policy instruments and funding opportunities to support Member States in the digital transformation process.

As of 1 May 2019, the European Commission presented 30 legislative initiatives under the DSM strategy. Of these legislative initiatives, 29 have been politically agreed or finalised by the European Parliament and the Council of the European Union, with only one legislative initiative (e-Privacy) still on the table.

The 30 legislative proposals fall under five main areas: *Connectivity*, *e-Commerce*, *Data*, *Media/copyright*, *Trust (Cybersecurity)* and *e-Gov.*

Among these 30, the legislative initiatives with the highest relevance and impact on the digitalisation of the power sector fall under the following areas:

- *Connectivity:* European Electronic Communications Code
- *Data*: Free Flow of non-personal Data Regulation, Public Sector Information (PSI) Directive, e-Privacy Directive
- *Trust (Cybersecurity)*: Network and Information Systems Directive (NISD), Cybersecurity Act, European Cybersecurity Competence Network

In this report, synergies between energy and digital policy measures will be widely discussed as necessary to tackle and solve the key issues identified in the use case analysis.

2.2.1 Digital technologies in the energy sector

Digital technologies already play an important role in the energy sector. This holds particularly true for smart metering systems, smart home appliances, smart charging

solutions for EVs and smart cities solutions/services. They foster a secure and more efficient integration of renewables into the electricity system as they enable solutions that can flexibly adapt device and system operations in an increasingly dynamic and fast changing environment. In all these areas, digital technologies create various opportunities, including the active participation of the consumer to the energy market and the more efficient use of energy.

In the next future, big data analytics, 5G, artificial intelligence (AI), Internet of Things (IoT) and blockchain have great potential to improve productivity, efficiency, competition and sustainability of energy systems delivering value to each segment of the power sector as wholesale and retail markets, transmission and distribution networks.

2.2.1.1 5G

In the near future, the EU digital economy and society will be based on 5G, the "fifth generation" of telecommunication systems. 5G will provide connectivity not only to individual users but also to connected objects and will serve a wide range of applications and sectors, including energy.

In the energy sector, 5G technologies facilitate energy efficiency solutions as well as renewable energy and distributed generation integration, playing a fundamental role for balancing activities. Moreover, they enable the connection between smart home devices and smart grids, and offer advanced connectivity infrastructure for smart city initiatives.

In 2013, the European Commission established a Public Private Partnership on 5G (5G PPP) to accelerate research and innovation in 5G technology. The Horizon 2020 Programme has been supporting this activity with a public funding of EUR 700 million, with a great impact on EU industry.

More recently, in 2016, the Commission adopted a 5G Action Plan for Europe, to launch 5G services in all EU Member States by end 2020, and launched the monitoring tool "European 5G Observatory" to report on the spectrum auctions and national 5G strategies elaborated by MSs.

2.2.1.2 Artificial Intelligence

Artificial Intelligence (AI) will be one of the key drivers of economic and productivity growth in the future and the energy sector has great potential to embrace it for several interesting applications in both retail and trading areas, all linked to AI-enabled predictability (e.g. load forecasting, demand management, energy trading, etc.).

The European Union has been supporting research in AI for years and the energy sector is one of the Commission's priorities when it comes to AI research and deployment.

In December 2018, the Commission presented the "Coordinated Plan on Artificial Intelligence", in order to promote the development of AI in Europe. The Coordinated Plan contains a list of actions to be undertaken in order to make the most

of the opportunities offered by AI, ensure the respect of European values and address new challenges brought by AI through cooperation between MSs.

The Commission plans to further increase its investment in AI, in the framework of the next Horizon Europe and Digital Europe Programme. Within the latter, the EC is planning to set up large-scale testing and experimentation facilities for AI deployment in a number of strategic sectors, such as healthcare, autonomous and automated driving, as well as in energy.

2.2.1.3 Internet of Things

According to European Commission, the market value of the Internet of Things (IoT) in the EU is expected to exceed one trillion euros in 2020. The IoT has already started to make a clear impact in the energy sector by creating more connected homes and buildings leading to energy savings and increased safety levels and by cutting O&M costs through system modernisation and predictive maintenance models.

The availability of cheap connected IoT sensors is the basis for more refined and decentralised real-time monitoring. It enables accurate measurements and forecasting and contributes to the adoption of renewable energy, which requires controls with faster reaction times and needs to be balanced with flexibility of generation, active demand and storage.

In March 2015, the Commission launched the Alliance for Internet of Things Innovation (AIOTI), the largest European IoT Association, to work closely with all IoT stakeholders and actors involved in the establishment of a competitive European IoT market. Since 2015, the Commission adopted a set of supporting measures to accelerate the integration of IoT for the benefit of European citizens and businesses.

Security, liability, privacy and data protection are critical challenges for IoT deployment, with users' trust for private, business or governmental use the biggest challenge for IoT acceptance. In response to such emerging challenges, operators using the IoT should adopt trusted IoT label as a demonstration of compliance to the NIS Directive's requirements for consumer products, providing transparency about different levels of privacy and security.

2.2.1.4 Blockchain

Blockchain technology allows for timely and secure transactions and has the potential to change the way consumers and the IoT interact with the energy system, by providing a secure and trustworthy way to integrate actions, as for example solar panels or electric car batteries able to inject energy into the grid.

In the energy sector, by reducing transaction time and costs, blockchain technology has the potential to optimise energy processes, improve energy security, and promote renewable generation and low-carbon solutions. It also has the potential to empower prosumers, creating a customer empowered energy system and enabling peer-to-peer (P2P) trading and facilitate new models for energy market design. For grid operators (TSOs and DSOs), the use of blockchain can enhance their capacity to record more precisely the use of their network, allowing the exact collecting of

network fees, and providing peer-to-peer transactions data to better manage the capacity and power flows on their network.

In February 2018, the European Commission launched the EU Blockchain Observatory and Forum, which monitors technology developments and aims to accelerate blockchain innovation and the development of the blockchain ecosystem within the EU.

2.2.2 Towards a digitalised European industry

The digital transformation of industry has been high on the Commission political agenda since years. To support this transformation, in April 2016 the European Commission launched the first industry-related initiative of the Digital Single Market (DSM) strategy, the "Digitising European Industry" initiative.

The initiative envisions different policy instruments, financial support schemes, coordination and legislative powers to trigger further public and private investments in all industrial sectors and create the framework conditions for the digital industrial revolution. The initiative aims to reinforce the industrial and innovation pillar of the DSM strategy, enhancing EU competitiveness in digital technologies.

2.2.2.1 ICT standardisation and interoperability

In the area of smart energy, more than 70% of standards are ICT standards. Their implementation would empower consumers and ensure more transparent and competitive retail markets. Building on and completing the various national initiatives, the Commission put forward concrete measures to speed up the development of common standards in priority areas. In particular, the Commission identified five priority areas as the essential building blocks of the DSM: *5G communications*, *Cloud Computing*, *Internet of Things (IoT)*, *Big Data technologies and Cybersecurity*.

The 5G standardisation process should be inclusive of vertical industries though each vertical industry typically has its own standard body and association. This is needed to ensure a globally applicable and consistent set of 5G mobile communication standards that can benefit all industrial sectors at large.

Standardisation is the critical element to deliver a single market for IoT, by facilitating interoperability, compatibility, reliability, security and effective operations. IoT standards, in fact, may support the emergence of business models unleashing the commercial capabilities of systems and device integration.

A large number of proprietary or semi-closed solutions to address specific needs have emerged, leading to high fragmentation and to the creation of non-interoperable applications, based on different architectures and protocols. As opposed to proprietary solutions, open standards are considered a solution in the IoT landscape, because of their net positive effects as regards large scale deployment, widespread adoption and preventing lock-in situations.

The European Union needs open standards that support the entire value chain, integrating multiple technologies, based on streamlined international cooperation. Several standardisation initiatives currently co-exist, in individual Standard Development Organisations (SDOs) or partnerships (e.g. ETSI SmartM2M, ITU-T,

ISO, IEC, ISO/IEC JTC 1, oneM2M, W3C, IEEE, OASIS, IETF, etc.) and also in conjunction with a number of industrial initiatives (e.g. All Seen Alliance, Industrial Internet Consortium (IIC), Open Interconnect Consortium (OIC), Platform Industrie 4.0 etc.).

In the energy sector, ensuring interoperability between different smart appliances is crucial for allowing them to communicate and make decisions on their energy consumption. With the aim to create a shared semantic model of consensus to enable interoperability in the smart appliances domain relevant for energy, the development of a reference ontology was targeted as the main interoperability enabler. This resulted in the definition of the Smart Appliances REFerence ontology (SAREF), which, in 2015, became a standard of European Telecommunications Standardisation Institute (ETSI) and the Global Initiative for Internet of Things standardisation (OneM2M).

The EC is progressively extending this standard to other relevant domains, such as energy, smart cities, automotive, water, manufacturing, agriculture, etc. In 2017, a new version modular and domain independent, allowing the incorporation of different modules (extensions) for the different domains. The first three extensions that have been standardised are: SAREF for Energy (SAREF4ENER), SAREF for Environment (SAREF4ENVI), SAREF for Buildings (SAREF4BLDG).

In July 2019, ETSI SmartM2M Technical Committee released three new specifications for smart cities (SAREF4CITY), industry and manufacturing (SAREF4INMA), and smart agriculture and food chain (SAREF4AGRI) domains. Finally, ETSI TC SmartM2M is working on new extensions for automotive, water, health and wearables, and on the development of an open portal to gather direct contributions to SAREF to be completed by 2020.

The SAREF family of standards enable interoperability between solutions from different providers and among various activity sectors in the Internet of Things (IoT) and therefore contribute to the development of the digital single market. These standards are designed to run on top of the oneM2M system, the global IoT partnership project of which ETSI is a founding partner. OneM2M provides the communication and interworking framework to share the data among applications; SAREF provides the semantic interoperability necessary to share the information carried by the data.

The Commission has used its Horizon 2020 and Connecting Europe Facility funds to strengthen existing and deploy forward-looking standardisation activities, with H2020 putting a particular focus on promoting open standards.

Moreover, since such implementations require close cooperation between different industry sectors like digital, energy, telecoms, and home automation, the EU provided more than 400 M€ funding under Horizon 2020 through large-scale pilots in the focus area 'Internet of Things' to cross-sectoral platforms, which aim to accelerate the market up-take and to achieve economies of scale.

Ultimately, all those promote the development of new energy services for or by different actors (DSO, TSO, suppliers, aggregators, and consumers), enable the integration of RES, improve energy efficiency, maintain security of supply and provide benefit to consumers.

2.2.3 European data economy

In a more and more connected world, data has become an essential resource for economic growth, job creation and societal progress. This global trend holds enormous potential in almost all fields, climate, energy and smart cities included.

As announced in the DSM strategy, the Commission's objective is to create a clear and adapted policy and legal framework for the "data economy", by removing remaining barriers to the movement of data and addressing legal uncertainties created by new data technologies.

The "data economy" concept is characterised by an ecosystem of different types of market players collaborating to ensure that data is accessible and usable. This enables the market players to extract value from this data, by creating a variety of applications with a great potential to improve daily life (e.g. home comfort and security, traffic management, etc.).

To fully unleash the data economy benefits, the Commission intends to unlock the re-use potential of different types of data and facilitate its free flow across borders to achieve a European digital single market.

In September 2017, the Commission proposed a new Regulation aiming at removing the four main obstacles to the free flow of data within the EU:

- Unjustified data localisation restrictions by Member States' public authorities,
- Legal uncertainty about legislation applicable to cross-border data storage and processing,
- Lack of trust in cross-border data storage and processing linked to concerns amongst Member States' authorities about the availability of data for regulatory scrutiny purposes
- Obstacles to movement of data across IT systems due to vendor lock-in practices.

The free flow of non-personal data Regulation (Regulation 2018/1807) was adopted on 14 November 2018 and entered into force on 28 May 2019. This Regulation establishes the free movement of non-personal data across MSs as the General Data Protection Regulation (GDPR) does for personal data, thus ensuring a comprehensive and coherent approach to the free movement of all data in the EU.

The proposed measures will create a common European data space without unjustified or disproportionate national rules restricting companies' location choices for data storage and processing. As a result, Europe's data economy could double its value to 4% of GDP in 2020 and create more than €1.9 billion additional revenue in the manufacturing sector.

Data should be available for re-use as much as possible, as a key source of innovation and growth. In the EU, the public sector is one of the most data-intensive sectors. The vast amounts of data it holds, known as Public Sector Information (PSI), range from anonymised personal data on household energy use to general information about national education. The re-use of these data can contribute to the growth of the European economy, with a great impact on the energy sector.

For this reason, on 22 January 2019, the PSI Directive was adopted making public sector and publicly funded data re-usable. The PSI Directive is built around two key

pillars of the internal market, that is transparency and fair competition, and focuses on the economic aspects of the re-use of information rather than on access to information by citizens. Any re-use of personal data under the PSI Directive must be in full respect of the rights and obligations contained in the GDPR.

One of the objectives of the DSM Strategy is to increase trust and security of digital services. The reform of the data protection framework, and in particular the adoption of the General Data Protection Regulation (GDPR), was a key action to this end. In September 2017, the Commission proposed the review of the e-Privacy Directive in order to provide a high level of privacy protection for users of electronic communications services and a level playing field for all market players. Since then, the EU Council published several redrafts of the proposal, which is still on the table for the European Parliament and the Council of the European Union to adopt.

The sector's ability to gain from innovative data solutions will depend on the willingness of energy companies to cooperate with other sectors, in particular the digital sector, to support the testing and application of innovative data-led services.

2.2.4 Cybersecurity

The more devices are getting digitally connected to the power system, the more they expose such a very critical infrastructure to the risk of cyberattacks. Likewise, in the smart home ecosystem, poor security measures in the design of connected devices may expose them to cyberattacks causing important issues related to security and data protection. Cybersecurity is thus becoming a notably challenge for many stakeholders of the energy sector.

At EU level, a cybersecurity framework is set by the Network and Information Systems Directive (NIS Directive), adopted in July 2016, which is the cornerstone for strategic cooperation among Member States and for improving resilience of critical sectors including energy and transport. Consistent implementation of the directive across different sectors and MSs is provided by the NIS Cooperation Group, which decided to establish a dedicated work stream on cybersecurity in the energy sector in 2018. The purpose of this dedicated work stream on energy is to provide support to Member States on identifying the particular characteristics of the energy sector, when implementing the NIS Directive.

In addition to the NIS Directive, the recently adopted Commission Package on Clean Energy for All Europeans, includes provisions for the adoption of future technical rules for electricity such as a Network Code on Cyber Security.

In September 2017, the Commission presented the so-called "Cybersecurity Package" under the DSM strategy, which builds upon existing instruments and presents new initiatives to further improve EU cyber resilience and response. As part of the package, the Commission presented a legislative proposal, the "Cybersecurity Act", including:

- Reform proposal for strengthening ENISA's role, giving the EU Cybersecurity Agency a permanent mandate, more tasks and adequate resources to assist MSs in dealing with cyber-attacks.
- Set up of an EU cybersecurity certification framework for ICT products, services and processes.

The reformed ENISA will provide support to Member States, EU institutions and businesses in key areas, including the implementation of the NISD and the proposed cybersecurity certification framework.

The proposed EU-wide ICT certification framework creates a comprehensive set of rules, technical requirements, standards and procedures to agree each scheme. A certificate will attest that ICT products and services that have been certified in accordance with such a scheme comply with specified cybersecurity requirements. The resulting certificate will be recognised in all Member States, making it easier for businesses to trade across borders. The schemes would be voluntary and would not create any immediate regulatory obligations on vendors or service providers.

The "Cybersecurity Act" is expected to entry into force in June 2019, with the development of certification schemes for critical or high-risk applications among the priority areas.

Moreover, the Commission has been active in tackling cybersecurity challenges which acknowledges the importance of specificities of different sectors. It is, therefore, indispensable to look at the particularities of the energy sector that create challenges in terms of cyber security: (1) real-time requirements, (2) cascading effect; and (3) the combination of legacy systems with new technologies.

Last year, the NIS Cooperation Group, which gathers national competent authorities responsible for cybersecurity under the Directive on Security of Network and Information Systems (the NIS Directive), has set up a work stream on the cybersecurity of the energy sector. This is the first example of sector specific work stream within the Cooperation Group and is a testimony of importance that all members (Member States, Commission and ENISA) attach to ensuring the cyber-resilience of the energy sector.

This work has already delivered the recent adoption Commission Recommendations for cybersecurity last 3 April 2019, which are focused on the specificities of cyber security in the energy sector at EU level and will help give them the required attention also under the next Commission. There will be more to come in the near future, such as the NIS Co-operation group work stream 8, network code on cyber security, stakeholder conferences, cooperation with the EE-ISAC (European Energy–Information Sharing Analysis Centre) which helps utilities improve the cybersecurity and resilience of their grid by enabling trust-based data and information for sharing, etc.

The Commission is confident that all these measures will contribute to the creation of a cyber-secure environment, which will allow EU consumers to benefit from an increasingly digitalised consumer-centric energy system.

2.3 The role of investments in the digitalisation of the power sector

For digital transformation of the power sector to happen, public support from the Union will play a crucial role. The EU budget has long been a source of growth-enhancing investment for the whole Europe and the next long-term budget for 2021-2017 – the Multiannual Financial Framework (MFF) – will continue to be that.

The substantial budget allocated to MFF 2021-2027 areas such as Research & Innovation, Strategic Investments, digital transformation and the Single Market witnesses that the Commission acknowledges that stepping up investment now in such areas will be key to unlocking future growth and tackling common challenges, including those related to the energy sector.

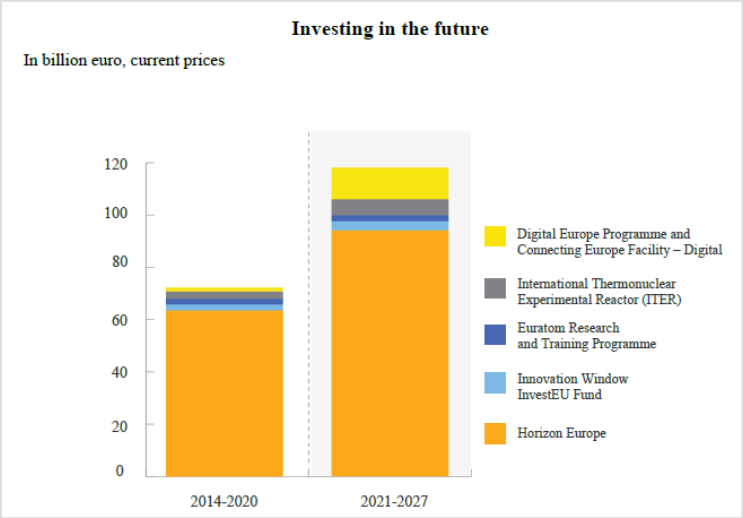
2.3.1 European Investment Programmes – Multiannual Financial Framework 2021-2027

On 2 May 2018, the Commission proposed the next long-term budget for the EU-27, starting on 1 January 2021, in its Communication "A modern budget for a Union that protects, empowers and defends" (COM 2018/321).

The new Multiannual Financial Framework (MFF) 2021-2027 has a structure and programmes that are fully in line with the agenda of the Union post-2020. Programmes are arranged around the main thematic spending priorities, which correspond to the headings in the formal budget structure. Within each priority, programmes are grouped in policy clusters in order to provide greater clarity on how they will contribute to policy goals.

In the new MFF, the budget allocated for the EU priorities specifically treated in this study falls under Heading 1 "Single Market, Innovation and Digital", which represents almost 15% (€187.4 m) of the total budget proposed by the Commission. In particular, it covers four policy areas: Research and Innovation, European Strategic Investments, Single Market and Space.

The figure below shows the increased relevance of digital in the proposed MFF 2021-2027 compared to the MFF 2014-2020 at EU-27. In the next MFF, a much higher budget is allocated to digital under the new Digital Europe Programme and the new Connecting Europe Facility (CEF) programme entirely dedicated to Digital.



(Source: European Commission)

Research and Innovation

2.3.1.1 Horizon Europe

On 7 June 2018, the Commission adopted its proposal for Horizon Europe - the Framework Programme for Research and Innovation for the period 2021-2027 (COM 2018/435) - that will succeed Horizon 2020. The European Parliament endorsed the provisional agreement on 17 April 2019.

Its general objective is to deliver scientific, technological, economic and societal impact from the Unions investments in research and innovation so as to strengthen the scientific and technological bases of the Union as a whole, to strengthen the European Research Area and foster its competitiveness in all MSs.

As part of the general Union objective of mainstreaming climate actions into EU sectoral policies and EU funds, it is set that actions under this Programme shall contribute at least 35% of the expenditure to climate objectives where appropriate.

Horizon Europe, with a budget of €120 billion (proposed by the EU Parliament), is the biggest ever research and innovation funding programme and is designed around three pillars:

- Pillar I: '*Excellent and Open Science*' supporting researchers through fellowships and exchanges as well as funding to projects defined and driven by researchers themselves;
- Pillar II: '*Global Challenges and European Industrial Competitiveness*' supporting research relating to societal challenges, setting EU-wide missions with ambitious goals. It is composed by 5 different clusters: Health; Inclusive and Secure Creative Society; Digital, Industry and Space; Climate, Energy and Mobility; Food, Natural Resources and Agriculture;
- Pillar III: '*Innovative Europe*' aiming to make Europe a front runner in market-creating innovation. A European Innovation Council will offer a one-stop shop for high potential and breakthrough technologies and innovative companies with potential for scaling up;

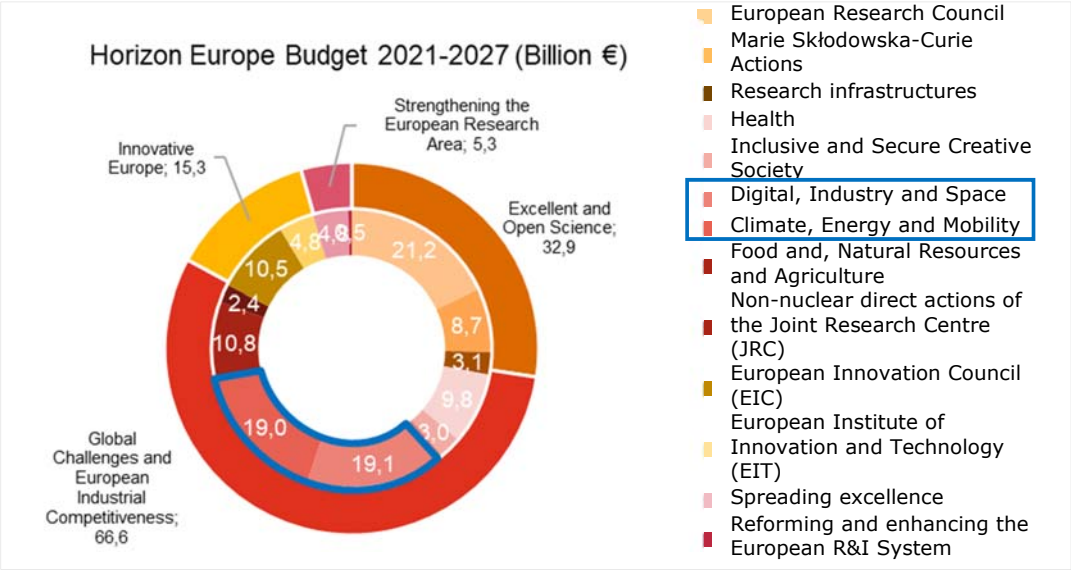
As shown in the figure below, the highest shares of Pillar II budget are allocated to the clusters 'Digital, Industry and Space' and 'Climate, Energy and Mobility' (about €19 billion each), which gives evidence of the EU efforts to promote future R&I activities in these two fields.

In particular, R&I activities within the cluster *'Digital, Industry and Space'* have the scope of reinforcing capacities and securing Europe's sovereignty in key enabling technologies for digitisation and production, and to build a competitive, digital, low-carbon and circular industry. Areas of intervention: Manufacturing technologies, Advanced materials, Next generation internet, Circular industries, Space, Key digital technologies, Artificial intelligence and robotics, Advanced computing and big data, and Low carbon and clean industry.

R&I activities that are part of the cluster *'Climate, Energy and Mobility'* include fighting climate change by better understanding its causes, evolution, risks, impacts and opportunities, by making the energy and transport sectors more climate and environment-friendly, more efficient and competitive, smarter, safer and more resilient, and by promoting the use of renewable energy sources and energy efficiency. Areas of intervention: Climate science and solutions, Energy systems and

grids, Communities and cities, Industrial competitiveness in transport, Smart mobility, Energy supply, Buildings and industrial facilities in energy transition, Clean transport and mobility and Energy storage.

The Commission has envisioned several synergies between Horizon Europe and other programmes, in particular with the Connecting Europe Facility (CEF) and the Digital Europe Programme (DEP).



(Source: European Commission)

European Strategic Investments

2.3.1.2 Digital Europe Programme

Technological change and digitisation are changing European and global industries, societies, jobs and careers, as well as education and welfare systems. In this context, in order to bridge the current digital investment gap, on 6 June 2018 (COM 2018/434) the Commission proposed to establish a new Digital Europe Programme to shape and support the digital transformation of Europe's society and economy. The new programme will help to complete the Digital Single Market, by supporting strategic projects in five frontline areas. The Commission proposed a combined increase of 64% in R&I and digital investment under direct management in the next MFF.

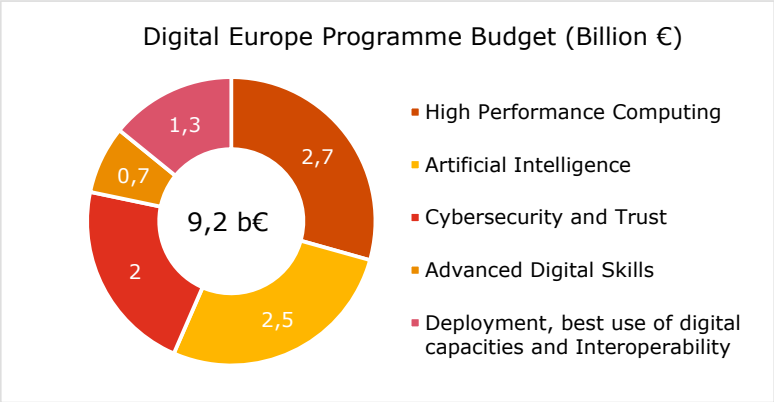
The programme will be based around five interdependent and mutually reinforcing pillars.

1. High performance computing and data processing infrastructures will be procured jointly to build an integrated European supercomputers ecosystem (including hardware, software, applications), used in particular in areas of public interest;
2. Cybersecurity capacities for both public administration and businesses will be enhanced via (i) procurement of advanced solutions, equipment, tools and

data; (ii) increasing access to testing and certification facilities; and (iii) provision of technical assistance and expertise;

3. Open platforms and "common data space" for Artificial Intelligence will be acquired and made available widely across the EU in Digital Innovation Hubs, providing testing facilities and knowledge to small businesses and local innovators;
4. The Advanced Digital Skills pillar will offer students and technology experts the opportunity to pursue training in advanced digital technologies (data analytics, robotics, artificial intelligence, blockchain, cybersecurity, high performance computing, quantum etc.), specialised courses and internships in companies deploying advanced technologies;
5. Large-scale deployment projects will assist the transition of areas of broad public interest to the digital age. They will align investments of Member States and the EU to ensure wide availability and interoperability of the resulting solutions, continuing actions and services provided under the predecessor programmes.

As well as supporting the delivery of the Digital Single Market more widely, the Digital Europe Programme will provide the digital capacity-building and large-scale deployment needed by a number of other EU programmes. In many areas such as health, public administration, justice and education, the Programme will contribute to the EU's work to promote effective and modern public services. Support for a dynamic economic sector will also reinforce growth-focused programmes and industrial policy. The Programme will in turn benefit from research and innovation breakthroughs under the Horizon Europe Programme, progressively mainstreaming them in areas of public interest and contributing to their commercial exploitation. The Connecting Europe Facility will support the physical connectivity infrastructure needed for the services delivered under the Digital Europe Programme.



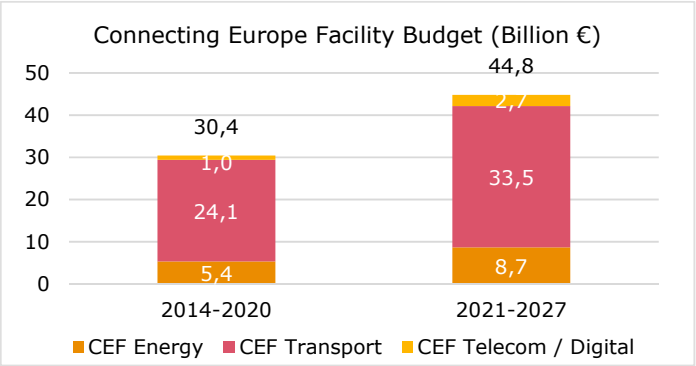
2.3.1.3 Connecting Europe facility (CEF)

With a proposed budget of €44.8 billion for seven years (2021-2027), the reformed Connecting Europe Facility (CEF) will support infrastructure projects connecting the EU and its regions. In particular, 60% of the CEF budget will contribute to climate objectives in line with the EU's commitments under the Paris Agreement.

Cross-border infrastructure is the backbone of the Single Market, helping goods, services, businesses and citizens to move freely across borders. Through the new CEF**,** the Union will continue to invest in trans-European transport, digital and energy networks, which are strategic to implement the Energy Union and the Digital Single Market.

The future programme will better exploit the synergies between transport, digital and energy infrastructure, for example through developing alternative fuels infrastructure or sustainable and smart grids underpinning the Digital Single Market and the Energy Union. For this purpose, the CEF supports projects with high added-value at European scale and helps leverage further investment from other sources, in synergy and complementarity with InvestEU and other Union programmes.

As shown in the figure below, compared to the CEF 2014-2020, the reformed CEF has a more consistent total budget, while the CEF Telecom has been replaced with CEF Digital, given the increasingly high relevance of digitalisation in the coming years.



The CEF is hence divided into transport, energy and digital sectors, as it aims to better integrate the three sectors in order to accelerate the digitalisation and decarbonisation of the EU's economy.

- CEF Energy, with a budget of €8.7 billion, will help complete the Energy Union and support Europe’s clean energy transition following the Clean Energy for all Europeans package.
- CEF Transport, with a total budget of €33.5 billion, will finance strategic transport projects.
- CEF Digital, with a budget of €2.7 billion, will finance digital connectivity infrastructure, essential for the success of the Digital Single Market.

3 Methodological approach

3.1 Overview

The main scope of this study can be summarized as a first fundamental step to answer the following overarching questions:

1. Why do we need digitalisation in the energy sector?
2. Who shall pay for it?

To respond to such questions, the study has been carried out going through 5 tasks that broadly reflect the objectives outlined in the previous chapter.

As a preliminary step, the Commission asked the Contractors to identify 10 Use Cases (UCs) that are relevant for the digitalisation of the power sector. The 10 selected UCs are listed in the table below, and, as shown in Figure 1, they span the entire energy value chain in order to capture the full potential of digitalisation, which is abating traditional barriers.

UC#	Use Cases
UC1	On-site optimisation for C&I and Residential buildings
UC2	Smart Districts
UC3	Energy Aggregators
UC4	Customer Data Analytics
UC5	Smart EV charging and charging management
UC6	Urban Data Platforms
UC7	Energy Communities
UC8	RES Origin Tracking
UC9	Improved O&M
UC10	Flexibility Market Platforms

Furthermore, a set of Member States where to focus the study was preliminary selected based on the following relevant criteria:

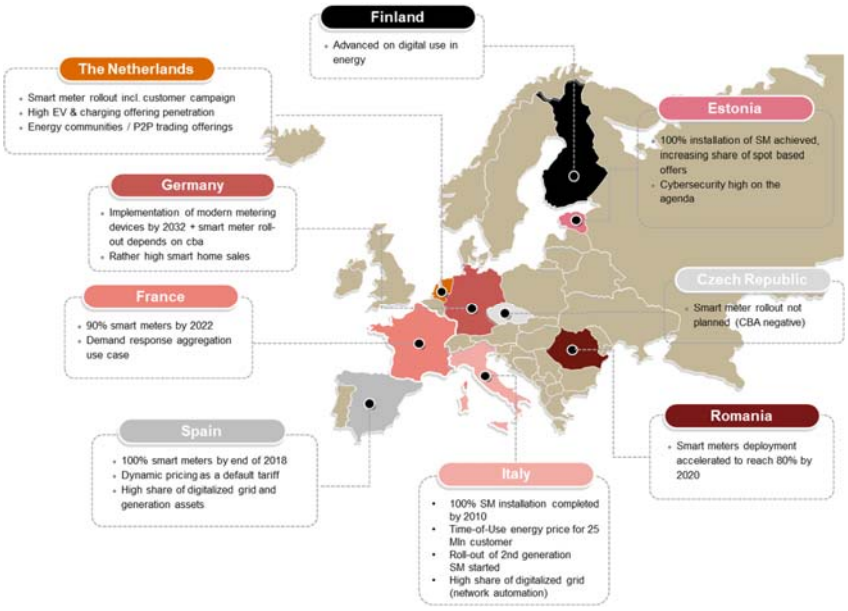
- Geographical representation to reflect:
  - Different consumption patterns
  - Energy mix composition
- Level of energy sector digitalisation, including customer acceptance of digital-enabled services:
  - Level smart meters installation today (as a proxy)
  - Communication to customers and implementation of commercial offers
- Use cases availability in the market

- Diverse selection of Countries in terms of penetration of analysed services (smart home IoT, EVs, aggregation, energy communities, etc.) to allow for comparison of countries with and without the use case

After a consultation process between the Contractors and the Commission, the choice fell on the 9 EU countries shown in Figure 2: Czech Republic, Estonia, Finland, France, Germany, Italy, the Netherlands, Romania and Spain.

Figure 1 – The 10 Use Cases testifying the disruptive effect of digitalisation along the energy value chain

Figure 2 - The selected set of 9 Member States



In the sections below, we describe in detail the approach developed along the activities of this study.

3.2 Main tasks

Task 1

Objectives

The first objective of Task 1 has been to validate the 10 use cases at EU level, going through a technical, regulatory and market potential assessment. At this stage, the regulatory analysis focused on EU legislation and standards and we looked at EU markets. The technical feasibility is here considered to be use case-specific rather than country-specific, as the maturity level of each enabling technology is assumed to be country-independent at EU level.

The second objective of Task 1 has been to identify where, in the 9 Member States selected for the study, there is a specific interest to develop each use case. The purpose was to simplify the "10 use cases-9 Countries" scheme, trying to get to a more manageable sample of "use case-Country" couples (one case in two or maximum three countries) where to develop the qualitative analysis of each use case at MS level.

The geography-use case combinations determined in this first stage of the study constituted the basis for the in-depth qualitative analysis (Task 3) and has been further validated during a workshop that took place in Brussels on March 19th, where further feedback was acquired by the participants to the event.

This activity resulted in 10 storyboards reporting the main output of this qualitative assessment at EU level.

Approach

The 10 UCs have been screened along three main feasibility dimensions (technical, regulatory, market) in order to identify the key issues, which have been determined at the outset of our study, following different activities.

Firstly, via a desk research drawn from the academia, industry reports and previous studies carried out from the Contractors. Then, we moved to countries selection, identifying, for each use case, a subset of 2-3 countries out of the preliminary selected 9 Member States, through a multicriteria analysis. We proceeded with the methodological approach illustrated in Figure 3.

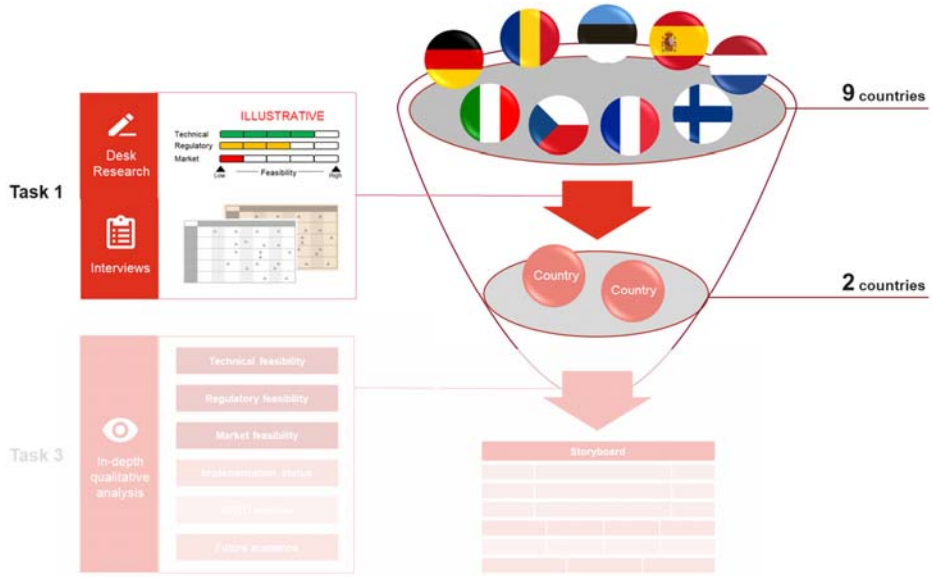
The country selection criteria mostly focused on market and regulatory variability among the Member States. We looked at the most relevant cases of market maturity/barriers and regulatory maturity/gaps, so as to identify and analyse the 10 use cases that span a diverse range of feasibility level in the countries considered. The scope of distinguishing between diverse level of feasibility is to improve the explanatory value of this analysis and to answer two main questions:

1. What regulatory and market barriers/obstacles are currently present for this use case?
2. What future developments are expected?

Implementation time and level of diffusion of each use case in the nine Member States will also be considered as relevant criteria in the country selection. Geographical coverage and country representativeness will be used as correction factors should the

other criteria be excessively concentrated in a limited number of countries, jeopardizing the geographic scope identified at the kick off meeting.

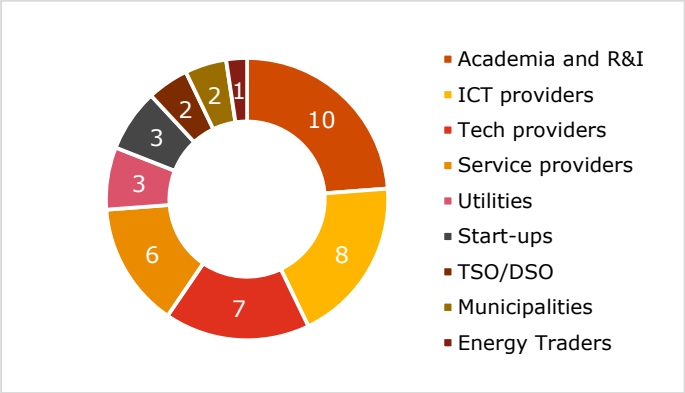
Figure 3 –The methodological approach for the country selection applied to each use case (Task 1)



Finally, the use case assessment has been validated by carrying out interviews with 42 energy experts belonging to various organisations and playing different roles in the energy digitalisation process across the selected EU countries.

The interviewee list covers the entire spectrum of the UCs considered along the following composition of stakeholders: 10 interviewees come from academia and R&I; 8 from ICT providers; 7 from technology providers, 6 from service providers, 3 from start-ups; 3 from utilities; 2 from TSO/DSO; 2 from Municipalities and 1 from energy traders (see Figure 4). The gathered information, while non-exhaustive, offered a wide and comprehensive overview of the process from different angles and perspectives.

Figure 4 – Interviewees composition



In order to assess the feasibility levels, the interviewees were asked to give a score *low-medium-high* to each feasibility (technical, market and regulatory) according to the definitions illustrated in Figure 5.

Figure 5 – Score criteria for Feasibility levels

Feasibility level	Low	Medium	High
Technical feasibility measures the technology readiness level (TRL) and assess the maturity of a technology being developed by a project.	The technology solution is at formulation level. There is a concept and possible applications defined.	The technology solution is at prototype stage and can be tested in pilot projects	The technology is at production stage and there is a clear market application
Market feasibility assess the commercial readiness of a technology offering and provide indication on the commercial traction.	There are no offerings in the market for this service and no evident business cases	The service is viable under specific circumstances/ incentives schemes and with early adopters	There are offerings in the market for this service and successful business cases
Regulatory feasibility assess the regulatory conditions* enabling the business models of a technology/service offering in the market.	Refer to the absence of the appropriate regulatory conditions enabling the technology/service offering in the market	The regulatory framework allows only a limited number of new services to be provided in the market	The regulatory framework fully supports the implementation of new/ innovative services/ product in the market.

(*) Regulation here refers to the complex of specific sector(s) regulation, by laws, EU level legislation (Directives, Regulations) and standards existing in the markets defined in the use case considered. Might include the combined regulatory framework of different sectors such as energy, transport and TLC.

Task 2

Objectives

Task 2 aims at identifying the data needed to enable the 10 use cases to run. The fist activity consisted in defining which data are indispensable to enable the business model, disregarding the specific environment they can be located.

Approach

The use cases and associated business models have different requirements in terms of data quality, communication channels and access of various stakeholders. Data quality refers to the type of data needed to enable the use case:

- Validated or non-validated data;
- Real-time and/or historical data, including the provision of forecasted data;
- The time granularity;
- Aggregated data on consumption or on specific usages.

Furthermore, uses cases require different communication channels and linkages with several groups of data:

- Consumption data will have to be linked with market data (prices) and/or grid data;
- Customers' behaviour may have to be influenced directly or indirectly by the service provider.

Based on our internal experience, discussion with stakeholders as well as web-based research, we identified the minimum data quality requirements to allow for the

implementation of the use case. They represent requirements that are common for all countries at this stage.

As Task 1 defines stakeholders involved in the various use cases, we checked where the required data is located and to what extent stakeholders can access and exchange these data. Note that "location" of data refers to the point where data can be accessed: direct access to the data stored in the smart meter, or access via DSO, supplier or third-party websites. On the other hand, we did not consider possible barriers that might exist for moving data between Member States (regulation on the free flow of non-personal data) since it is out of scope.

To this end, we mainly relied on the insights and information gathered during our recent study on electricity data format, access and exchange in the Member States (study finalized in 2018) and the smart meter benchmark study (ongoing). From those studies, we assessed that access to data for emerging energy and flexibility services is not straightforward and not uniformly organized across Member States.

In particular, in the study on data format, access and exchange, we concluded that:

- The level of smart meter coverage varies widely;
- Smart meters being rolled out do not necessarily comply with the 10 common minimum functionalities recommended by the EC and particularly with those that support dynamic pricing and the provision of frequent data (even in near real time) to consumers and/or third parties of their choice;
- Consumption data access opportunities by customers and third parties between countries are heterogeneous (partially linked to SM coverage and functionalities);
- A fully transparent mechanism for giving and revoking consent is usually not implemented yet.

The ongoing smart meter benchmark allows for a refined view on the possibilities that smart meters offer in the Member States.

Figure 6 – Example of consumption data requirements for a Use Case

Electricity consumption data							
	Consumption Data Requirements for Use Case X						
	Stakeholder access	Validated (V) or non-validated (NV) data	(Near-) real time (RT) or historical (H) data	History	Granularity	Aggregated data (A) or by usage (U)	Communication requirements
Data Accessibility	☑ Customer ☑ ESCO ☐ Other Specify: …	☑ V ☐ NV	☑ RT ☐ H	☐ hours ☐ days ☐ months ☐ years ☑ not specific	☐ every minute ☑ every 15 minutes ☐ hourly ☐ daily ☐ monthly ☐ yearly ☐ not specific	☐ A ☑ U Usages: *EV charging*	☐ Direct influence on customer's behavior ☑ Need to link with market data
Local Access to Smart Meter	*All Stakeholders have access*	*Validated data is not available locally*	*Real-time data available*		*Required data only available if customer pays for the smart meter functionality*	*H2 interface planned but not implemented yet*	*Smart meter does not foresee this functionality (in the near future at least)*
Central Data Management system	*Only ESCOs have access*	*Etc.*					
Behind-The-Meter Devices							

Task 3

Objectives

Task 3 consisted in carrying out a country-specific qualitative assessment of each use case in the 2-3 countries selected in Task 1.

Approach

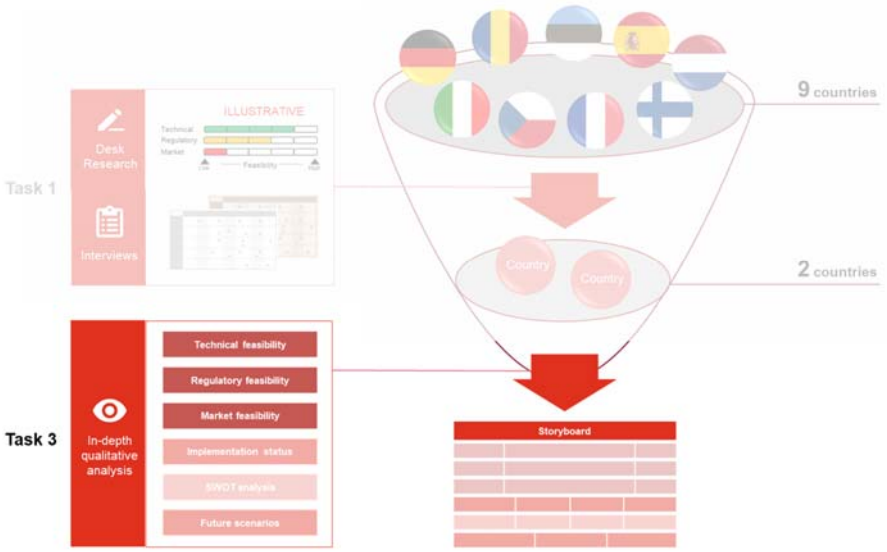
The assessment of each use at MS level will consist of the same activities carried out in Task 1 at EU level, following the methodology illustrated in Figure 7, and will especially take into account:

a) **Regulatory gaps** for use cases implementation

b) **Market barriers** for use cases implementation

c) **Country legislation** whereby national regulation, legislation and business practices are assessed to identify national specific barriers/opportunities.

Figure 7 - The methodological approach for the country selection to be applied to each use case (Task 3)



In order to further corroborate or correct the initial assessment on the technical, market and regulatory feasibility of the 10 use cases, the preliminary findings resulting from the activities carried out in Tasks 1-2-3 were presented during a Workshop held in Brussels on 19 March 2019. The Workshop was hosted and organized by the Commission and saw the participation of relevant EU stakeholders of the energy sector.

The Workshop was structured in two different sessions; a panel discussion (Session 1) and a stakeholders' viewpoint discussion (Session 2), with the following three main objectives:

1. Discuss with the invited speakers the interim results presented in the discussion document to acquire their informed opinion on the main evidence collected so far (Session 1)

2. Gather stakeholders' viewpoints on the main technical, market and regulatory aspects influencing the 10 use cases assessment and their maturity level (Session 2)
3. Gather invited speakers and stakeholders' views on the foreseen developments of the 10 use cases in the next decades (Session 1 and 2)

All evidence and results of the discussion that emerged during the workshop provided further elements for the study as well as a clearer picture of the digitalisation process so far. All collected contributions helped concluding the first phase of the study (Tasks 1-2-3). The provided overview of the new trends, opportunities and challenges emerging in the digitised energy sector have been used as input for the second phase of the study (Tasks 4-5), consisting in the definition of a European roadmap of policy and regulatory recommendations for different time horizon (2020, 2030 and 2050).

The views collected during the workshop have been further enhanced with the outcome arising from the online survey we distributed to all the participants. We collected a total of 102 responses from stakeholders operating mainly in the following countries: the Netherlands, Germany, Italy, Spain, Romania and France.

The highest shares of survey participants came from Utilities, Service providers, Technology providers, Network Operators (TSO/DSO) and Academia/R&I institutions. A minor though relevant participation came from Consultants and Public Entities/Institutions (including regulators).

In particular, 10 surveys have been distributed, one survey for each use case, in order to allow experts to give their opinion on the use case best fitting their experience and expertise. This approach allows a greater ownership of the outcome of our analysis from the actors that will positively contribute to the progressive digitisation of the energy markets and provide the opportunity to consolidate a shared view of the trends emerging in the energy systems.

Thanks to the survey we collected further information on any specific regulatory provision impacting Use Cases implementation at both EU and MS level or any missing key issue from those we had preliminary identified. Moreover, we submitted to expert judgment the scoring (*low-medium-high*) of the three feasibility levels in order to have a much stronger validation of the scores.

All the activities carried out in Task 1-2-3 resulted in the definition of a precise identikit of each use case. Such identikits have been reported in a *storyboard* gathering all the information elaborated on the use cases at EU and MS level. For each use case, we went through technical, regulatory and market feasibility assessments that led to the identification of the key issues of each use case. Such analysis resulted in a snapshot of the use case current implementation status at EU and MS level and in a SWOT analysis, from which we build possible future scenarios in Task 4.

In essence, the use cases' storyboards collect the evidence and analysis gathered during the first phase of the project, by summarising the results of a comprehensive desk research, literature and case study review, coupled with dedicated interviews with experts, project coordinators and researchers actively operating in the development of digital services in the energy sector.

Figure 8 is a summary table indicating how storyboards of each Use Case will be formulated.

Use Case (UC#)	Storyboard			
Technical feasibility	Service provided: Exist / does not exist	Technology maturity level of each enabling technology KPI: Technology Readiness Level (TRL from 1 to 9)		Data availability
Regulatory feasibility	EU legislation implementation	National level legislation		Regulatory gaps
Market feasibility	Market analysis	Market maturity level KPI: Market Readiness Level (MRL from 1 to 9)		Market barriers
Implementation status	Preparation	Trial	Evaluation	Scaling-up
SWOT analysis	Strengths	Weaknesses	Opportunities	Threats
Future scenarios	2020 scenario	2030 scenario	2050 scenario	
Roadmap and policy recommendations	General recommendations for fast implementation	Synergies between energy and digital sectors		
		Technology	Regulation	Finance

Figure 8– Use Case Storyboard

Task 4

Objectives

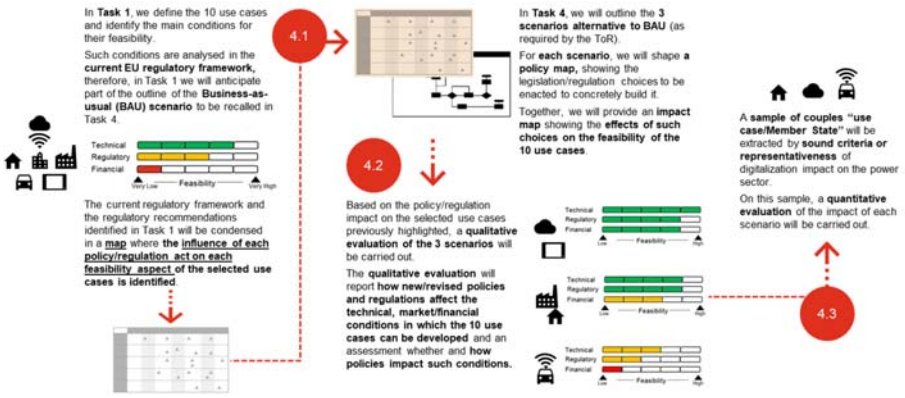
The main objective of Task 4 is to carry out an evaluation of the digitalisation of the power sector, assessing four different scenarios in which the policy making can push the digitalisation transformation with different intensity, by 2030.

The main outcome is, therefore, to outline these scenarios with proper assumptions on policy making at EU, Member States and Industry level (e.g. standardization rules). Evaluation results will be the starting point to deliver policy recommendations in Task 5.

Approach

We shaped the four scenarios proposed by the ToR, following an approach that reflect a simplified Impact Assessment methodology. To this purpose, the results of Task 1, 2 and 3 were the input for our scenario analysis. In particular, the most relevant key issues identified for the use cases provided the basis to further elaborate on how the 10 use cases, and the related business models previously identified, can be influenced by reinforced and more active policy efforts on a medium and long-term perspective.

Figure 9 –Process flow of Task 4 activities



This exercise, considering the cross-sectoral nature of the study, implied mapping of both existing and upcoming legislation and regulation activities at all levels (EU, MS, Industry), the related implementation measures, their economic, social and environmental effects and the actors affected by them. It also included assessing the impact of implementation of additional regulatory measures based on the recommendations defined in Task 3.

We additionally explored, how greater consistency of regulatory policy and speed of implementation will impact on the selected use cases examples defined in Tasks 1 to 3. The main question that we aim to answer is: "Why the EC should play an active role to foster the digital transformation?"

Task 5

Objectives

The objective of Task 5 is to draft a comprehensive roadmap and regulatory recommendations on how EC and Member States can foster the digitalisation of the power industry in order to remove the existing barriers hampering developments which can help achieving EU's policy objectives.

Such a roadmap shall describe actions to be taken at Member States level by 2020, at EU and Member States level by 2030 and, finally, at EU level by 2050, in view of the long-term goals on decarbonisation.

Approach

Starting from the baseline scenario identified in Task 4 and by comparing the alternatives foreseen by the ToR, the required roadmap will further develop the considerations made in Task 4 about who shall take action, when and how, identifying conflict and synergies with other EC's initiatives and ways to mitigate the first and maximize the latter.

Energy and Digital policy measures, including legislative and non-legislative measures at EU and Member States level, and intervention on industry standards, have been detailed especially in the short to mid-term (2020, 2030). Synergies between energy and other sectors policies have been envisioned, considering the ever-increasing integration with other sectors like Transport and ICT.

We drafted the Roadmap required by the ToR as a series of gradual intervention involving EU Institutions, Member States and any regulatory bodies whose decisions affect the development of the digitalisation of the power sector.

4 Analysis of the selected use cases

4.1 On-site optimisation for C&I and Residential buildings

General description

On-site energy optimization processes for Commercial & Industrial (C&I) and Residential buildings can be achieved by Energy Management (EM) solutions relying on digital technologies.

By using near real-time information obtained from ambient and consumption monitoring devices (hardware) and control systems (software), EM systems enable the optimization of energy flows and the reduction of energy consumption, with the related cost savings.

Digital EM solutions are relevant in the energy system management as they enable efficiencies at distributed level with a high impact on the overall energy consumption, supporting the achievement of EU energy efficiency objectives.

If framed in a wider context, these systems can play a role to support demand-side management and unlock demand-side flexibility with dynamic contracts based on either the consumer's reaction to price signals (implicit demand response) or aggregation contracts entailing the involvement of an aggregator (see UC3) directly managing the consumer's consumption (explicit demand response).

Opportunities

EM solution for C&I can offer a number of opportunities to building users, owners and the energy system more widely. By analysing data provided by individual building systems and sensors, the EMS optimises the energy flows of the building to reduce operating expenditure, to run it more sustainably and to enhance the experience of occupants. Smart technologies that enable buildings to be net contributors of energy, rather than consumers, positively contribute to occupiers' sustainability goals. The building energy performance can be carefully monitored and controlled by the EMS, allowing identifying any issues and automatically scheduling maintenance when needed.

The deployment of EM solutions for residential buildings relies on consumers perceiving clear opportunities in terms of energy savings and improved comfort, resulting in better energy services. A decrease in energy consumption followed by a potential reduction of the household's utility bill is one potential opportunity, along with feedback on consumption behaviours and suggestions on how to optimise energy

uses (see UC4). Load shifting from peak to off-peak hours can bring additional opportunities, if home automation is linked to dynamic or time-of-use tariffs.

Customers	Society / Energy system
• Energy volumes and cost savings (bill reduction) • Customers empowerment • Improvement of buildings maintenance in terms of performance and costs (predictive maintenance, early identification of faults)	• Contribution to the EU energy efficiency targets through enabling Nearly-Zero Energy Buildings • Increase of energy system flexibility • Increase of distributed RES integration Support to EV integration

Business models

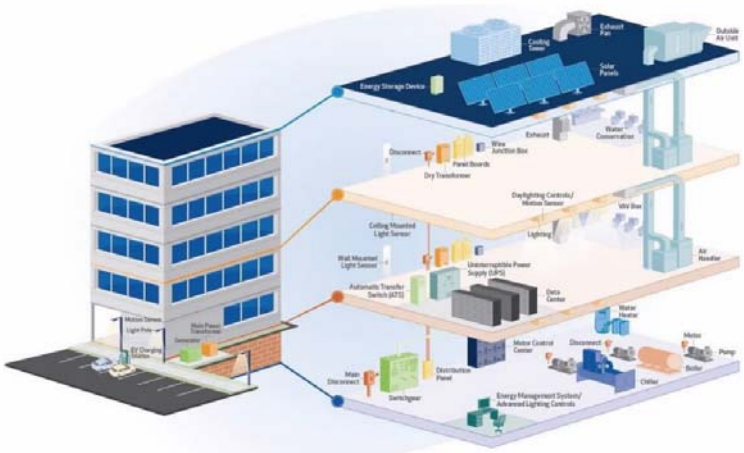
Energy Management solutions can have different applications for C&I and Residential buildings, changing their application scale and type of end-users. Therefore, Building Energy Management (BEM) and Home Energy Management (HEM) models have been assessed for businesses (1) and households (2) respectively.

	1 Building Energy Management (BEM)	2 Home Energy Management (HEM)
Description	• Building Energy Management (BEM) systems are a combination of the latest building technologies with advanced analytics and digital services capabilities to deliver high levels of building performance maximizing efficiency, minimizing operating costs and reducing environmental impact	• Home Energy Management (HEM) provides home-owners digital solutions to efficiently monitor and reduce their energy consumption via behind-the-meter services.
Key actors	• Building owners and managers (e.g. Real estate companies) • Utilities / Energy suppliers / Retailers • Building automation companies • EM service providers • ICT providers / Control companies • HVAC manufacturers • ESCOs	• Consumers / Prosumers • Utilities / Energy suppliers / Retailers • EM service providers • ICT providers / Control companies • HVAC manufacturers

BM1 – Building Energy Management (BEM)

Energy management in C&I buildings allows to predict, measure and monitor the energy performance of buildings thanks to multiple interconnected smart building technologies. These include all smart building appliances and electric heating and cooling with smart thermostats that can be integrated with rooftop PV panels, smart EV charging and battery storage.

The combination of the latest building technologies with advanced analytics and digital services capabilities can deliver high levels of building performance. Moreover, digitalisation changes the way buildings are planned and automated. A significant example is the advent of Building Information Modelling (BIM) systems, which consist in digitally supported processes for planning, constructing and operating buildings embracing the 'energy efficiency by design' concept. BIM helps realizing buildings with less construction time, precisely defined tasks and increased efficiency over the entire building lifecycle.



(Source: Landscape - Smart Building challenges, 2018)

An Energy Management System (EMS) is the essential component of a smart building, as it allows to give unprecedented insight on its performances by integrating building systems and utilizing advanced analytics in order to monitor, measure and manage it in the most efficient way (BPIE, 2016). Intelligent BEM solutions allows to:

- enhance the integration between on-site renewable energy generation, energy storage, EV;
- empower building users and occupants with control over the energy flows;
- recognize and react to users' and occupants' needs in terms of comfort, health, indoor air quality, safety as well as operational requirements.

BM2 – Home Energy Management (HEM)

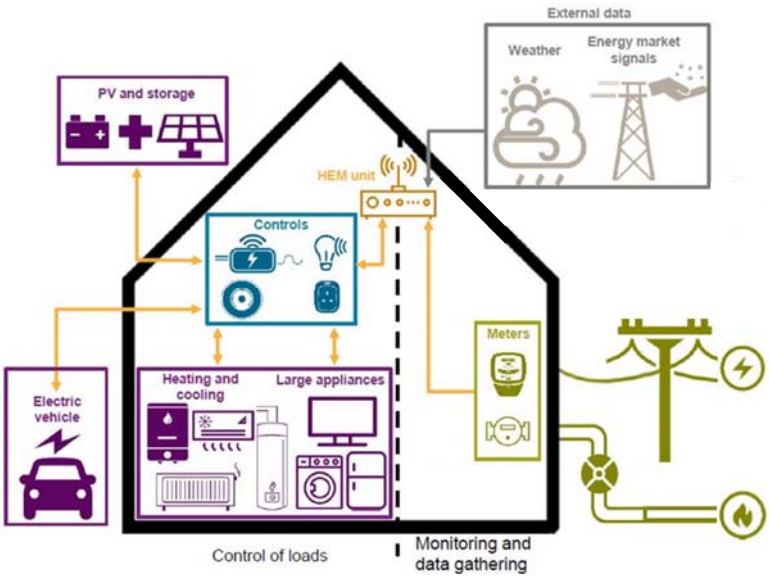
A Home Energy Management System (HEMS) is a technology platform comprised of both hardware and software that allows the user to monitor energy usage and production and to manually control and/or automate the use of energy within a household. Users can connect and interact with HEMS via an online dashboard (or interface) or through an app on their smartphones. HEMS range from simple plug-in devices that can measure and control an appliance's electricity use at the power point, to sophisticated systems that manage and integrate home's energy use in line with the fluctuating price of electricity in the market and predicted weather conditions.

Behind-the-meter devices can trigger different energy management services depending on whether the final customer is a household consumer or prosumer.

Residential consumers can use HEMS for **energy consumption optimization**, resulting in lower electricity bills. For example, consumers can remotely monitor energy use of appliances and electronic products and remotely switch them on or off to increase their comfort (i.e. turn on heater or air conditioner from work when going back home).

When used by prosumers, HEMS combined with decentralized energy devices like rooftop solar PV, battery storage, electric vehicle charging, and heat pumps or storage heaters allow for **self-consumption optimization.** A platform integrates all the smart energy devices, communicates with their controls and coordinates them with

information regarding the households energy demand and external information such as weather data or price signals (most advanced applications).



Source: DELTA-ee, 2017

In both cases, HEMS can be combined with smart meters and connected to the smart metering signals via Home Area Networks (HAN). In this way, HEMS can process the energy information coming to and from home through the smart meter, allowing house owners to view it in a user-friendly format on mobile devices and to better understand their home energy usage patterns (see UC4).

Technical maturity

The technical maturity of the use case is assessed as high (TRL=8) since both building and home energy management solutions are based on existing and mature digital technologies, but they still have to reach full market maturity. Moreover, interviewed experts gave evidence that very low technical risks are associated with the deployment of this use case.

BM1 – Building Energy Management (BEM)

In buildings, digitalisation is bringing new energy services to consumers thanks to digital technologies, such as smart thermostats, occupancy sensors, remote control and enhanced safety features. According to IEA, these technologies could cut energy use by about 10% by using real-time data to improve operational efficiency (IEA, 2017). For example, smart thermostats can anticipate the behaviour of occupants (based on past experience) and use real-time weather forecasts to better predict heating and cooling needs.

Leveraging and combining the latest digital technologies with EMS is essential to unleash the opportunities provided by EM solutions to building users and owners. Emerging technologies, such as IoT, the next generation of intelligent Building

Management Systems (iBMS), Building Information Modelling (BIM) and new device protocols, are fundamentally changing how buildings are designed, built and operated (Schneider Electric, 2017).

The installation of connected devices in buildings is one of the key applications of IoT technology. The commercial buildings of the near future will have hundreds of thousands of sensors installed, monitoring many parameters from the performance of individual light fittings to the health and wellbeing of employees. The office building "The Edge" in Amsterdam (considered the world's smartest building) has about 28.000 sensors tracking the movement of people through the building (see case study below).

New standards for cabling are being implemented in smart buildings to allow more effective information exchange. Power over Ethernet (PoE) is an electrical standard that can be used to transmit electrical power and data over Ethernet cabling. One of the key advantages of PoE is that it enables the monitoring and control of power consumption at the device level, meaning that individual devices can be remotely controlled or shut down when not in use. In lighting systems, PoE also enables the deployment of other communication and location-based technologies on top of lighting, which, for example, enables building users to adjust lighting levels to their preferred level via an app.

Intelligent Building Managament Systems (iBMS) can be seen as the next generation of EMS that will power smart buildings in the near future. An iBMS, connects to all building systems and services over an Internet Protocol (IP) network, thus functioning like the operating system of a building, with data from individual systems and devices transmitted back to the iBMS. Using this data, an iBMS can make informed decisions and actions that improve the operation of the building. Furthermore, iBMS control software provides a simple, visual solution that brings all building systems together on one user interface, allowing building managers to monitor, adjust and reconfigure devices on lighting, security, HVAC, elevator, power and other building systems as needed.

Finally, the massive adoption of IoT, data analytics and machine learning in smart building applications has paved the way for the digital twin technology. Digital twin is the virtual representation of the physical building embedded with rich information about spaces and assets that can enable owners and operators to manage assets, energy, space and comfort in a free-flowing manner inside of a building.

One of the major inhibitors to the adoption of smart building technology has been the lack of interoperability between different building systems (**Key Issue #3**). Currently building control system manufacturers have begun to adopt open protocols, such as LonWorks or ASHRAE's open-source BACnet, that allow all systems to communicate in a common protocol language. These common protocol languages define the arrangements under which devices and systems interact and communicate with each other.

One key advantage of open standards architecture and open protocol systems is that they enable the integration of new devices, IoT sensors and systems, as long as these devices also communicate using an open protocol language. A building that adopts open architecture standards is, therefore, effectively 'future-proofed', as new

functions and devices can be easily installed when enabling technologies are developed.

BM2 – Home Energy Management (HEM)

HEMS hardware is generally composed of a central control unit (hub/gateway) connected to the Internet, which the heart of the system and from which a large number of networked devices can be connected with one another, such as smart thermostats/sensors, smart lighting / lighting controls, smart plugs, smart appliances, in-home display and indoor air quality monitors. Households can control all such connected components for energy consumption management from the PC, smartphone or tablet. Common wireless standards such as Wi-Fi, Bluetooth, ZigBee or Z-Wave are used for communication or controlling devices.

For example, a smart thermostat enables the consumer to change the indoor temperature from a device (smart phone, computer, tablet or smartwatch) as well as to set the thermostat to automatically lower the temperature during the night or when residents leave home. The automatic changes in temperature can be linked to the customer's smart phone location and can also be affected by programming set by the customer. In a similar way, with sensors, smart plugs and switches can automatically turn on and off the lights in accordance with a pre-programmed schedule or the customer's location.

In order to fully interact with the wholesale energy market, a HEMS would require a smart meter. While most EU Member States have initiated (and some already completed) a systematic roll-out, other MSs have not because of negative CBAs or not even offer it at all, which raises an issue on who will bear associated costs.

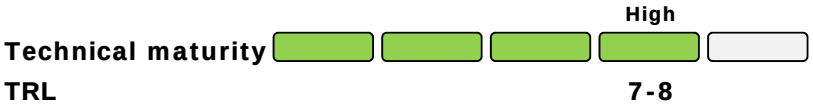
Interoperability between different smart appliances (smart sensors, thermostats, etc.) integrated in a single EMS is still seen as one of the big challenges for the development of this use case, (**Key Issue #3**).

To this extent, the European Commission, in close collaboration with industry and ETSI (European Telecommunications Standards Institute) created the Smart Appliances REFerence (SAREF) ontology, which became an EU standard in 2015. The standard creates a reference language for energy-related data, to be used by home devices (from lamps and consumer electronics to white goods like dishwashers) allowing them to exchange information with any energy management system, which could physically be in the home or in the cloud (see Section 5.4.1.1).

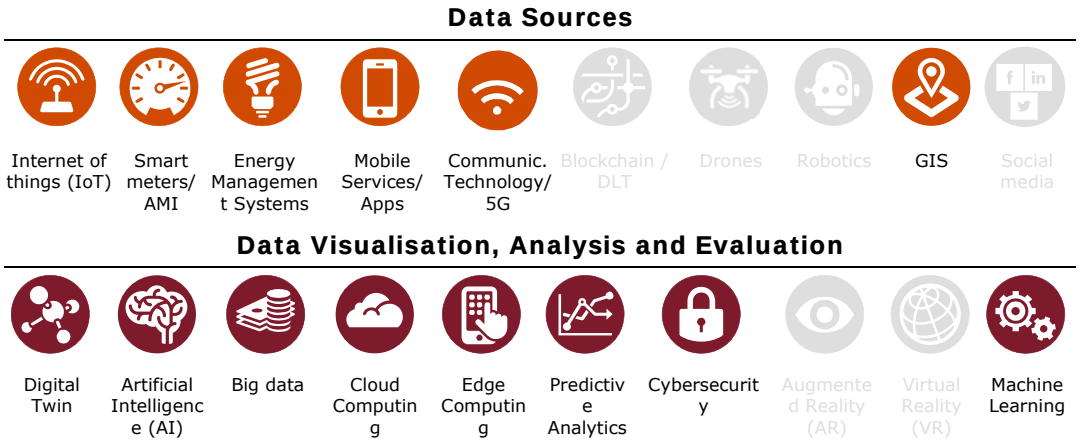
SAREF cretes a reference language (ontology) which can be adopted by different communication protocol standards (e.g. Wi-Fi, Bluetooth, ZigBee or Z-Wave).

Currently, the market is pulling towards the adoption of communication protocols used by the Over The Top companies (Google and Amazon) dominating the connected home markets. European manufacturers prefer to adapt to these market standards in order to enter more rapidly in the market, as it is most likely that customers having Google Home and Amazon Echo in their homes would buy products compliant and interoperable with those home automation devices. This trend is creating a market convergence towards Google and Amazon communication protocols standards, which are becoming standards *de facto*.

Due to the analysis reported above, the technical maturity of EMS for on-site optimisation can be considered high.



Key enabling digital technologies



Others: Building Information Modelling (BIM)

Data management

In this use case, energy related data include measurements from meters, boilers, thermostats, solar PV, batteries, and electric vehicles. Overall, data collected by connected devices can go beyond energy consumption values and can also encompass all manner of variables such as personal details, building or household metrics and other consumer sensitive information.

Data reliability and accuracy issues are mainly related to weather forecasting data of local and rural contexts, coming from public open meteorological services (more accurate for big cities) and used to optimize self-generation (rooftop PV and storage).

In both BMs, non-validated near real-time consumption data collected from connected devices are used for energy management services. The most technologically advanced devices can provide a very high data granularity, down to the level of microsecond measurements of power consumption patterns and actions.

In BM2, when HEMS are linked to smart metering systems, smart devices are connected together and linked to the smart metering signals via Home Area Networks (HAN). In this case, the maximum time granularity of available smart meter readings determines what potential is at the disposal of consumers to optimise their consumption patterns. Indeed, the granularity determines the type of time-of-use products that can be offered to consumers. The maximum time granularity for consumption data stored in the smart meter varies across MSs. The most commonly used granularity is 15 mins, followed by 30 mins and few MSs where it is 1 hour.

Such digitally interconnected energy systems also introduce risks, from concerns around data privacy, protection and ownership (**Key Issue #1**) and cybersecurity (**Key Issue #2**). While in buildings major concerns are about security, as building energy managers mainly dealt with non-personal data and energy flows, households are more affected by privacy concerns, as smart connected devices could indeed represent the entrance gate to get a privileged access to the customer private life.

To address privacy concerns (**Key Issue #1**) expressed by consumers over their personal energy related data treatment, it is in fact essential that energy suppliers provide consumers with clear and transparent information on privacy matters. Evidence was made that, due to recent entering into force of the GDPR (May 2018), most energy suppliers still need to be fully compliant with GDPR provisions. Non-privacy-friendly terms and conditions of new energy contracts have been spotted (BEUC, 2019).

As for security issues (**Key Issue #2**), consumers expressed concerns about the risks associated with the cybersecurity of the servers storing the information or personal data stored in third-party clouds, which could be used to identify a natural person. Cybersecurity certification schemes should be adopted in order to ensure the security of these devices. Certifications shall include not only ICT products and services, but also data management processes, looking at the whole service provision life-cycle (see Section 5.3.2.1).

Consumption data requirements

BM1 – Building Energy Management (BEM)

Stakeholder access to data	Validated (V) or non-validated (NV) data	Near-real time (RT) or historical (H) data	Granularity	Aggregated data (A) or by usage (U)	Communication requirements
☒ Customer ☒ Supplier or ESCO ☒ DSO ☐ Other	☐ V ☒ NV	☒ RT ☐ H	☒ minute or less ☒ 15min ☐ hourly ☐ more	☐ A ☒ U	☒ 2-way ☐ link with market data ☐ none

BM2 – Home Energy Management (HEM)

Stakeholder access to data	Validated (V) or non-validated (NV) data	Near-real time (RT) or historical (H) data	Granularity	Aggregated data (A) or by usage (U)	Communication requirements
☒ Customer ☒ Supplier or ESCO ☒ DSO ☐ Other	☐ V ☒ NV	☒ RT ☐ H	☒ minute or less ☒ 15min ☐ hourly ☐ more	☐ A ☒ U	☒ 2-way ☐ link with market data ☐ none

Market maturity

EM solutions rely on mature building and home digital technologies, with many solutions available on the market. Market feasibility of this use case is therefore high (MRL=7-8), but with some market barriers still to be overcome, which differ for C&I and residential applications.

BM1 – Building Energy Management (BEM)

Among large energy consumers, significant assets exist that can be managed, smart metering is in place (including sub-metering) and their scale makes the financial transactions simpler and more direct. ESCO model usually applies to large commercial and industrial customers (with extension to demand response) to provide value-adding services.

The market is driven by top industrial manufacturing companies (GE, Schneider Electric and Siemens) offering their building technologies solutions and integrated platforms that go beyong energy management (Platform-as-a-Service (PaaS) such as Siemens Desigo CC).

Combining products and services has proven to be an effective way to encourage BEMS adoption. For instance, relevance was made that commercial and industrial customers often want multisystem integration that incorporates energy storage systems into their operations. Energy providers can engage those customers who are looking for more than a single product, by connecting different lines of services.

In this regard, some solutions of integrated energy management platforms can be found on the market. A good example is the 'EnnexOS' energy management system from SMA Solar Technology (Germany), which links together data coming from solar PV, battery storage, gas, electric vehicles into one single platform (see case study).

E.ON developed E.ON connecting Energies provides an end-to-end service that integrates energy efficiency solutions, on-site generation and flexible solutions for its B2B customers. On the supply side, electricity can be generated directly at the client's site, supported by a virtual power plant, with communication triggers back to the trading team to trade oversupply at optimum times. On the demand side, its energy management capabilities include online reporting of live energy usage, identifying and implementing energy conservation measures, and designing and installing larger capital investment projects.

Finally, introducing the concept of "smart-ready built environment", BPIE conducted an analysis on the readiness of EU markets to transition to smart buildings (BPIE, 2017). A smart-ready built environment is where citizens and businesses are empowered by the control of their own energy system, producing, storing, managing and consuming energy – whether passively or actively. The analysis concludes that no Member State is fully prepared to take advantage of the opportunities smart buildings will entail. However, the leading countries in terms of a smart-ready environment are Sweden, Finland, Denmark and the Netherlands. Even in these cases, there is still ample room for improvement.

BM2 – Home Energy Management (HEM)

Considering the increased potential of behind-the-meter services in a decentralised energy system, utilities are focusing more on selling services to customers, shifting from 'Electricity providers' selling kWh to 'Service providers'. Far-sighted European utilities have already adopted innovative customer-centric business models, such as the Energy-as-a-Service (EaaS) model. Examples of EaaS can be found in France (Engie), Germany (E.ON) and Italy (Enel X).

Consumers are starting to expect choice, reliability and personalized service that extends beyond the meter. A growing number of blue-chip vendors, such as Amazon, Apple, Google and Samsung, are partnering with incumbent hardware and software providers to develop an integrated customer service, i.e. Amazon Echo, Apple HomeKit, Google Home, Samsung Smart Things. These players are well positioned to offer a seamless consumer experience across channels, and are challenging the traditional utility-customer model.

A well-cited example is that, in 2014, Google acquired Nest, a leading company in the connected home market, which signaled a move by Google toward developing a more integrated experience in the home. Nest and Google have continued this process by establishing a number of partnerships with lifestyle and home-product brands that extend far beyond the original Nest thermostat.

Energy companies will start to play a bigger role in how consumers optimize the home energy flows, choose tariffs, manage consumption and payments, and embed self-generation. The value from self-consumption of on-site generation (mostly rooftop PV) is currently one of the main drivers for HEM systems deployment in European markets (DELTA-ee, 2017). The value from this application for prosumers is expected to grow as feed-in tariffs for residential rooftop PV are being phased out in many Member States.

Digitally engaged customers have higher potential value to utilities, as they are more likely to participate in energy-management programs and to trust as well as be satisfied with the service they receive. Success in this market will be driven by the ability to provide customers with solutions that give them the flexibility to control, monitor and switch between different energy sources.

From our analysis, residential consumers willingness to engage with HEM systems emerged as the major market barrier for the deployment of these solutions (**Key Issue #4**), being it influenced by several factors:

- **High investment costs** associated with harware installation for energy/ambient monitoring (many smart sensors/thermostats and HVAC controllers, with the central hub/gateaway being the most expensive)
- **Limited perceived opportunities** (low return on investment), if the system is evaluated only against energy/cost savings. Marketing strategy would surely need to include and promote collateral safety and comfort features of the system, difficul to monetize. In this regard, HEMS can be more broadly part of a conneted home, combined with home automation systems and home assistant products. Collaborations between utilities and OTT players are entering the market, such as Innogy SmartHome integration with Google Home Assistant (Germany) and Sorgenia (Italy) with Amazon's Alexa (see 1.8).
- **Home-owners need not only "buy-in" to the HEM systems, but to lead it**. This requires the availability of economically viable solutions and services for consumers that must be simple, user-friendly and effortless. Consumers do not look for sophisticated solutions proving them with hundreds of data to manage their consumption, but rather for very simple ones. Energy consumption per se is not a priority in their daily lives, while high energy bills and technical problems are.

- **Consumer segmentation**: various consumer segmentations can be distinguished, based on demographics, interests, priorities, and technical capabilities. More informed and proactive users are more likely to be enrolled in behavioural energy efficiency programmes. Seniors, families with young children and less proactive users found it more difficult to adjust their consumption behaviour than other demographic groups. In this case, automation (AI) learning from their behaviour and automatically adjusting to preferred settings and taking decisions for them, while increasing their comfort and energy efficiency, can be a more suitable solution.
- **Households are also more likely to change their energy behaviour** if they compare themselves against their neighbours, similar households or when they set themselves targets and challenges to reduce their energy consumption (DELTA-EE, 2019). This requires accurate and timely feedback which smart meters enable. Making energy savings into a game has also been used in research trials (see case studies) to increase energy savings by challenging individuals or groups of people to use less energy.

To overcome these issues, there are mainly two ways that allow to redefine the customer experience and get greater customer engagement with EM solutions: create a seamless customer experience by overcoming complexity or shift the customer experience by combining multiple services (WEF, 2017).

Complexity will hinder adoption in any industry, especially in this industry where customers may not fully understand the technology behind the products and services. Successful products make it easy for customers to engage, offering simple customer interfaces that incorporate automation, self-learning and multi-device applications. Customers want experiences that are fast, intuitive, simple and effortless, and smooth and consistent. Customer choice is important, but opt-in schemes create obstacles for new technologies. Opt-in programmes that encouraged customers to buy their own smart thermostats or join time-of-use programmes have experienced lower participation rates.

Energy providers can engage customers who are looking for more than a single product, by combining products and connecting different lines of services. Residential customers can be very interested in "beyond-the-electron" services such as home security, which have proven successful. For some customers, for instance, EVs can be a gateway to a new relationship with the electricity system, spurring the uptake of other products like electricity storage (in the form of large home batteries). While for other customers, bundling energy management technologies with car, media and entertainment services (for example, in connected homes) can create new value.

BM	Presence on the market	Countries	Enablers / Barriers		Area
1	Service available on the market (best practice)		In Finland, buildings can already sell demand-side flexibility services on the reserve markets, by offering up and down regulating bid without the need of a license. They provide flexibility services directly to the TSO Fingrid, without having utilities or energy retailers as intermediaries. TSO Fingrid and Finnish Government invested several millions thanks to incentives related to innovation in the energy sector - energy efficiency and CO2 abatement emission potential is remunerated via certificate schemes in Finland.	+	
	Service available in the market		Finland and the Netherlands are among the smart-ready countries for building environment (BPIE, 2017). Such achievement was the result of having implemented more progressive and holistic approaches to decarbonise the energy system, including taxes, subsidies and stringent building regulations.	+	
2	Service available on the market		In Germany and Italy value from self-consumption (almost €0.20/kWh) can be very attractive. Both markets have high electricity prices for residential customers and feed-in tariff schemes that are close to being phased out completely (Germany) or replaced with a support scheme that incentivises self-consumption (Italy).	+	
	Low penetration level		In France some value from self-consumption of on-site electricity can be obtained, but the financial incentive is not sufficient to create an attractive proposition and the current feed-in-tariffs are high for PV. On the other hand, France has been one of the most progressive countries in opening up the market for DR (see UC3).	−	
	Limited market viability		Service providers are allowed to offer a very limited number of energy related services, as the Dutch Telecom Act gives a very narrow definition of what services can be considered energy related services.	−	

Leveraging the considerations made in this paragraph, the market maturity of the systems under scrutiny can be considered as high.

			High		
Market maturity					
MRL			**7-8**		

Regulatory feasibility

Overall, the regulatory feasibility of this use case can be assessed as high since there are no specific regulatory barriers hindering its development. Interviewed experts confirmed such evidences.

Both BMs are affected by cybersecurity concerns related to ICT products. Currently, a number of national certification schemes exist, as for many years each Member State has been developing and improving its own ones. This issue has already been tackled in the **Cybersecurity Package** adopted by the Commission in September 2017, which proposes the creation of a common European cybersecurity certification framework in its 'Cybersecurity Act'. However, the use of the EU cybersecurity

certification schemes will be on a voluntary basis as they are not mandatory (see Section 5.3.2.1).

BM1 – Building Energy Management (BEM)

Current regulatory framework is well on track to prepare the ground for a fast spreading of smart buildings. The revised **Energy Performance on Buildings Directive (EBPD)** entered in force on May 2018 bringing significant changes: stronger long-term renovation strategies for Member States aiming at decarbonisation by 2050, targeted support to e-mobility infrastructure deployment, enhanced transparency of national building energy performance calculation methodologies, etc.

Furthermore, the Directive introduces a '*Smart Readiness Indicator*' to rate buildings' capacity to adapt to the needs of the occupant (performance optimisation) and to adapt their operation in reaction to signals from the grid (energy flexibility). This tool should encourage behavioural changes needed to support smart buildings deployment, as it will raise awareness of building companies and occupants on actual savings deriving from building automation and electronic monitoring of technical building systems. By mid-2020, the Commission will adopt a delegated act supplementing this Directive by establishing an optional common Union scheme for rating the smart readiness of buildings. Such instrument reflects the aim of the Directive to keep promoting smart building technologies.

For what concerns non-personal data, the **Free-flow of non-personal data Regulation** 2018/1807 will be entering in force in May 2019 and will ensure that transparency principles are adopted, while data economy opportunities are unleashed. Companies and public administrations around Europe will be allowed to store and process non-personal data everywhere in the EU and competent authorities will have access to data with no geographical limitations and will be entitled to carry out regulatory control purposes.

BM2 – Home Energy Management (HEM)

Consumer data protection and privacy must be ensured to boost the development of EM solutions. Energy supplier must give proper guarantees on data protection and be transparent with customers about what they collect, why they collect it, and how they use it. In this regard, the EU has recently reviewed and updated its data protection laws, in the form of the **General Data Protection Regulation (GDPR),** which came into force on 25 May 2018. According to GDPR, end users must sign an agreement to give access to their private data (ambient and consumption monitoring). To limit the number of stakeholders who get in touch with the sensitive data, third parties that may have access to EM platforms should operate with anonymized data.

Concerning smart metering systems in particular, specific provisions on final customer data protection and security are given by the **recast Electricity Directive**. The Directive embeds relevant GDPR provisions in the new text and tailors those to the needs and specificities of smart meters' implementation and functioning. According to the Directive, MSs should take into account the best available techniques for ensuring smart metering systems and data communication the highest level of cybersecurity protection while bearing in mind the costs and the principle of proportionality (Article 20(b) and Annex II), when performing the economic

assessment of smart metering roll-out. This can be considered as clear reference to the 'privacy by design' and 'cybersecurity by design' concepts.

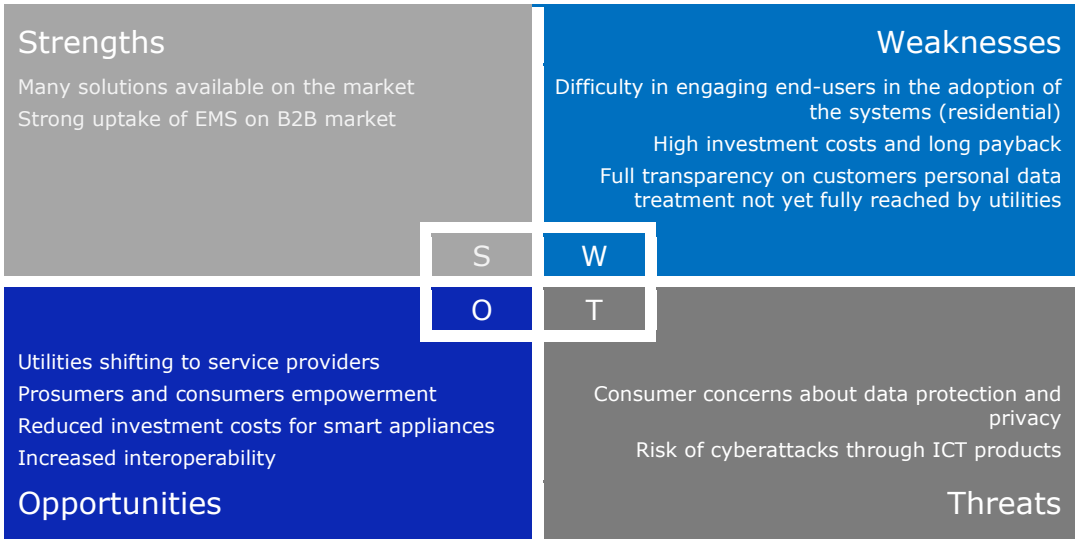
Regarding customer privacy, with the aim of guaranteeing a high level of privacy rules for all electronic communications, the Commission's proposal (COM (2017) 10) for an **e-Privacy Regulation** (Regulation on Privacy and Electronic Communications) is currently in the legislative process in the European Parliament and the Council. When entering in force, it will protect confidentiality of electronic communications and the devices. In particular, when communications include personal data, the general rules of the GDPR apply, unless the e-Privacy Regulation will lay down more specific rules (see Section 5.2.1.1).

Another crucial provision for this BM lies under Art.12 of the revised **Energy Efficiency Directive** (EED 2018/2002), which requires MS to adopt a range of instruments and policies to promote behavioural change in order to promote and facilitate an efficient use of energy by small energy customers. These may include fiscal incentives, access to finance, grants or subsidies, information provision, exemplary projects, workplace activities, ways and means to engage consumers and consumer organisations during the possible roll-out of smart meters through communication of cost-effective and easy-to-achieve changes in energy use and information on energy efficiency measures.

On April 2018, the Commission announced in the communication regarding the '**New Deal for Consumers'** proposals and initiatives that will bring clear opportunities for European consumers seeking choice and fairness in the whole Single Market. In this communication, the Commission commits to take steps to raise consumer awareness, improving knowledge about consumer rights and stimulating a new culture of compliance with EU consumer law.

Regulatory feasibility High

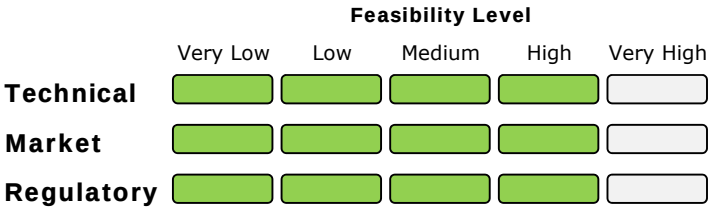
SWOT analysis



Overall evaluation of UC feasibility level and key issues

Summarising the assessments on three dimensions of EMS, we can conclude that the overall evaluation of such systems maturity is high.

Implementation status



Key issues

Key Issue	Description	Type of Issue

1. Customer privacy and data protection	• Privacy issues (transparency on information use by service providers)
	• Data protection challenges are mainly related to:
	  • Qualification of final customer energy related data
	  • Data management and allocation of responsibilities
	  • Rights of the data subject	

2. Cybersecurity of ICT products	• Costumer concerns on their security in terms of risk of cyberattacks through ICT devices	
3. Interoperability between connected devices	• Interoperability issues of energy management devices and communication protocols prevent providers switching and creating vendors lock-in	

4. Lack of customer engagement	• Lack of awareness/information, especially among residential consumers
	• Low end user willingness to engage with energy management systems due to limited perceived opportunities (low pricing/value perception):
	  • Services entry costs and payback
	  • High hardware installation costs
	  • User-friendliness of devices/solutions
	  • Supplier switching costs	

Preliminary identification of enabling policy / regulatory actions

From the use case analysis, it emerged that on-site optimisation services for C&I and residential buildings are mature and available on the market. However, there are still some key issues to be addressed in order to unlock the potential of the services enabled by EMS.

Key Issue #1: Customer privacy and data protection

Policy actions at EU level by 2030:

- *Consistent Governance scenario*: guarantee consistency between E-Privacy and the GDPR rules to secure a high level of privacy protection and legal clarity for businesses (see Section 5.2.1.2).

- *Reinforced Legislation scenario*: provide a common guidance for the allocation of GDPR roles and responsibilities to the actors involved in smart metering systems personal data processing (see Section 5.2.1.3).

Key Issue #2: Cybersecurity of ICT products

Although actions have been already taken to support the creation of a EU-wide cybersecurity certification framework in the 'Cybersecurity Act', further actions can be taken to support their implementation. According to the 'Cybersecurity Act', the use of such EU cybersecurity certification schemes is not mandatory, but will be indeed on a voluntary basis (see Section 5.3.1.1).

Policy actions at EU level by 2030:

- *Consistent Governance scenario*: make the European cybersecurity schemes for ICT products, services and processes mandatory and provide incentives to support the application of the schemes as well as sanctionatory measures in case of failure to adopt current legislation (as done by GDPR and Telecom Package) (see Section 5.3.1.2).

Key Issue #3: Interoperability between connected devices

Policy actions at Industry level by 2020 and 2030:

- *BAU scenario:* grant industry the necessary freedom to design innovative products, while keeping a good balance with progressive legislation (see Section 5.4.1.1).
- *Consistent Governance scenario*: Keep standardisation as the prerequisite to specify technical methods, such as measurement and product safety, and maintain the New Legislative Framework principle by listing standards under the respective legislation (see Section 5.4.1.2).
- *Reinforced Legislation scenario*: create legislation that is evidence-based, and regulating measurable, verifiable and relevant parameters, avoiding overlapping double regulation of products and parts (see Section 5.4.1.3).

Policy actions at EU level by 2030:

- *Consistent Governance scenario*: promote the use of the standard reference language SAREF by massive dissemination actions (see Section 5.4.1.2).
- *Reinforced Legislation scenario*: Address interoperability among smart home appliances for the implementation of Demand Side Flexibility at residential level (see Section 5.4.1.3).

Key Issue #4: Lack of customer engagement

Besides providing incentives for private tertiary buildings making investments towards energy efficiency, policy makers should include incentives for solutions based on changing/supporting end-user behaviour.

Policy actions at MS level by 2020:

- *BAU scenario:* conduce national awareness-raising programmes that can include communication campaigns providing customers with clear and accessible information, as suggested by the proposal for the New Deal for Consumers.

In addition to the policy actions to be taken to tackle the issues preventing the full deployment of EMS services per se, additional policy actions can be identified to guarantee preconditions to unlock implicit demand-side flexibility services, enabled by HEMS solutions.

Preconditions for implicit DR include the availability of short-term, market-related tariffs, the availability of short interval metering (i.e. smart meters with the necessary functionalities to support dynamic pricing offers), as well as the automation of consumption. Home automation, combined with dynamic or time-of-use tariffs, requires a market where consumers, or a service provider acting upon their behalf, can react to short-term price signals. This, in turn, would rely on the ability for the consumer to sign a dynamic or time-of-use contract. Consumers may earn from flexibility on the market by other means, such as accessing balancing markets through aggregators (see UC3).

Policy actions at MS/EU level by 2030:

- *Consistent Governance scenario*: create and include quantitative KPIs on Demand Response in the INCEPs track effective DR deployment in every MS (see Section 5.6)
- *Reinforced Legislation scenario*: adopt further regulation in order to remove barriers for consumers to achieve the financial from smart home technologies that results from price variations (see Section 5.7).

Case studies

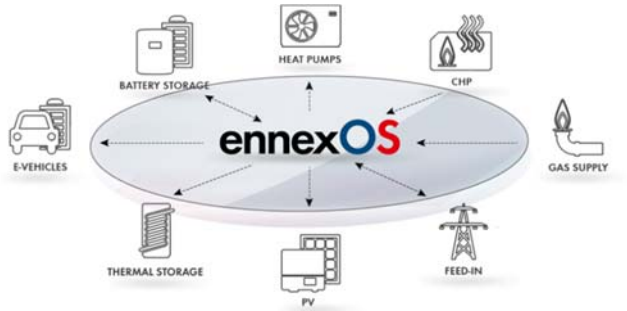
BM1 – Building Energy Management (BEM)

Case Study 1

Where	*What*	*Who*
GERMANY	ennexOS CROSS SECTOR ENERGY MANAGEMENT	SMA

EnnexOS from SMA Solar Technology is a cross-sector platform for holistic, intelligent energy management. With ennexOS, energy management processes can be digitised and automated, energy flows can be sustainably optimised and energy costs can be significantly reduced by interlinking various energy sectors such as heating, climate control, electricity and mobility.

EnnexOS can record all energy components across different sectors. All of the data relevant to energy generation, storage and consumption can be brought together into one system through I/O systems, measuring devices and interfaces. EnnexOS is modular in concept and will be developed further over several expansion stages. Along with local analysis, control and optimization, total energy industry solutions will also be available in the near future.



(Source: SMA Solar Technology)

Highlights

- EnnexOS provides a cost overview of building energy consumption through the holistic recording of energy flows, intelligent forecasting procedures and the support of individual tariff models
- All energy data can be called up at any time via secure access using a web browser—via a PC or mobile devices
- Customers can benefit from maximum transparency and clear analyses of all energy flows—from the complete system to the individual system or device

Case Study 2

Where	***What***	***Who***
THE NETHERLANDS	The Edge – The world's most sustainable office building	Schneider Electric

The Edge in Amsterdam is a leading example of a smart office building in Europe, demonstrating all of the characteristics of being part of a smart system. The building uses 70% less electricity than comparable office buildings. The smart design, lighting solutions and the level of connectivity make this office building a leader in the smart building field.

Highlights

- There are 28,000 sensors at The Edge, measuring everything from the occupancy of workstations to the cleanliness of bathrooms. Super-efficient LED panels built by Philips, for instance, are powered using Ethernet cables and packed with sensors that measure motion, light, temperature, humidity, and air quality.
- SmartStruxure, an iBMS built by Schneider Electric, analyses the data produced by the building's sensors, actuators and valves to optimise the operation of the building. Through its use of technology, The Edge is among the world's most energy efficient buildings.
- The building's entire south façade is fitted with solar panels, allowing the building to produce more energy than it consumes. A subterranean aquifer dug 130m beneath the building stores warm water in the summer and releases it when it is needed in the winter. Over 180 energy meters have

been installed around The Edge, with all the data fed back to the building management system.

- Easy-to-use dashboards allow the building's facilities managers to review and analyse all the data and make information-based decisions to enhance building operations and improve the experience of occupants.
- Employees based at The Edge can interact with building systems via a smartphone app, which they can use to find a space to work or track down a colleague. The app knows the lighting and temperature preferences of individual building users, allowing it to tweak the environment accordingly.

Case Study 3

Where	***What***	***Who***
FINLAND	SELLO Shopping Center – Buildings as an active part of the smart energy system	SIEMENS

Sello is the biggest shopping mall in Finland with 102,000 m2 of shopping space, 26 million visitors per year and over 170 shops. The shopping center needed to be modernized and its efficiency improved to secure ongoing LEED certification. In the near future, SELLO is going to be part of a Virtual Power Plant.

Highlights

Building Energy Management (BEM) solution:

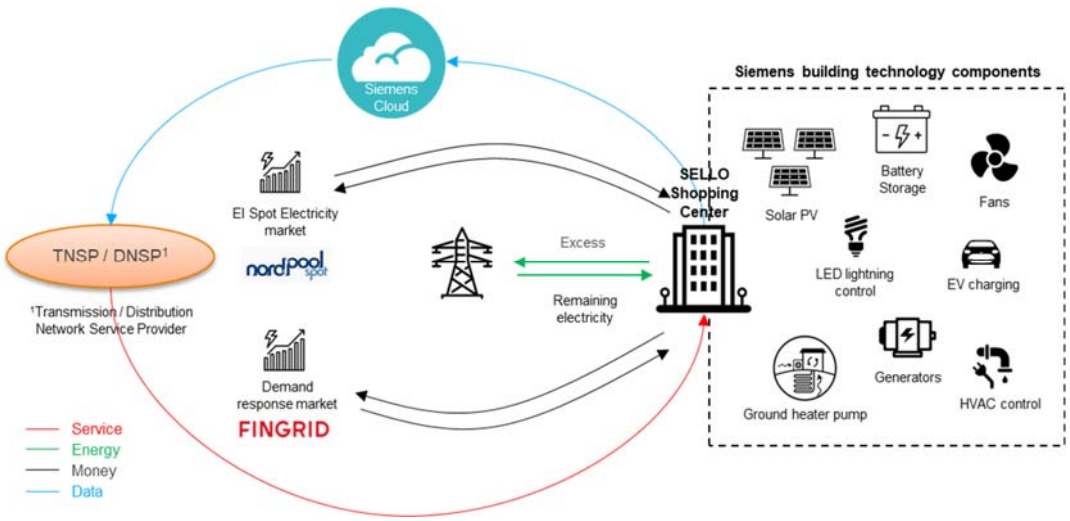
- Strong integration of different building technologies (main technical challenge)
- Digital platform: Analytics & Data visualization, Cloud, Open system offering, IoT / devices
- Digital services: Open application & partner ecosystem, Data driven maintenance, remote operations, Software-as-a-Service, Cyber Security services
- RES generation + Storage capacity: PV system (750 kWp), Battery storage (2MW / 2,1 MWh)

Opportunities

- Reduced operating costs
- Reputational opportunity: air quality as key factor for the overall quality of the shopping environment offered to the public

Best practice

- SELLO provides flexibility services directly to the TSO Fingrid, so that no utilities and energy retailers are involved. In particular, SELLO does not need a license for selling flexibility services on the reserve markets, typically offering demand side response (ability to rapidly increase/reduce demand) by offering up and down regulating bid. No initial investment for the customer: TSO Fingrid and Finnish Government invested money thanks to incentives related to innovation in the energy sector available in Finland - energy efficiency and CO2 abatement emission potential is to be remunerated via certificate schemes in Finland.



BM2 – Home Energy Management (HEM)

Case Study 1

Where	***What***	***Who***
FINLAND	COSY NORDICS	GEO Smarter energy

COSY NORDICS is an electric heating management system for the Nordic market introducing advanced controls, including integration with the Nord Pool Spot Market and the potential for "peak lopping". The Cosy system introduces simple controls to each room/zone controlled from an app together with a machine learning predictive heating engine.

Highlights

- Cosy combines energy efficiency and demand management: users programme what temperatures they want their rooms to be at and for which time period and the system then automatically calculates the minimum time it needs to heat the room, taking into account the Nord Pool spot prices.
- Nordic homes are usually well insulated and good at retaining heat so, where appropriate, the system will heat the room when prices are low or to avoid peak periods.
- Modelling suggests that using spot prices could deliver a further 10% totalling 25% - or around €500 - €750 per year
- Payback is currently estimated to be around 2 years, but is expected to be reduced significantly as volumes build and installation is simplified and codified.

Case Study 2

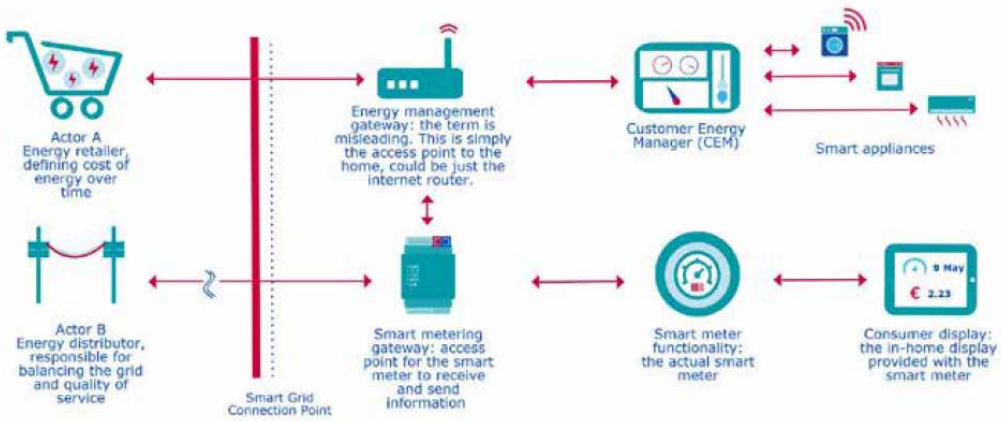
Where	***What***	***Who***
EU	INTEROPERABILITY OF SMART APPLIANCES FOR DEMAND RESPONSE	EEBUS, Energy@Home, APPLiA

Two not-for-profit associations, EEBUS and Energy@Home, developed SPINE, a platform-neutral message exchange standard, to allow all sectors of energy management in homes and buildings to communicate seamlessly for the efficient use of energy, closing the gap in standardisation between smart grids and the energy management in homes and buildings. SPINE is part of the EU-driven Smart Appliance Reference Framework SAREF4ENER and is included in EN5631, which is a smart appliance standard for white goods.

Highlights

The tool is an example of technical feasibility; an enabler for use cases, since interoperability is crucial for smart homes.

- Vision behind: One common language that every device and every platform can freely use – regardless of the manufacturer and technology
- Home appliances can speak the same language, communicate with energy managers, smart home systems
- and with each other in an integrated home ecosystem, providing the opportunities of smart energy management for consumers and allowing power suppliers and grid operators to check their customers' variable loads securely, anonymously and directly, and to control them over time.



(Source: Applia)

Case Study 3

Where	***What***	***Who***
Germany, Italy	HEMS combined with Home Assistant	Innogy with Google Home; Sorgenia with Amazon Alexa

InnogyHome with Google Assistant

In 2018, German utility Innogy linked its Innogy SmartHome service to the voice-based assistant Google Assistant as well as smart speakers just like Google Home. All functions that have been integrated into the Innogy system can be controlled: thermostats, lighting, dimmers, switches and devices that are connected via smart plugs. Google Assistant automatically translates the spoken words into instructions for the smart home control system. It is sufficient to simply say "OK Google, dim the living room ceiling light by 15 per cent" and the instructions are carried out within seconds.

- Google Assistant can switch to different predefined states. It is possible to check the situation at home at any time while being away via smartphone app and to display status information or issue new instructions. By linking the two, users can voice control their homes from anywhere.
- The functionality of Innogy SmartHome is updated and added to on an ongoing basis. In future, it will also be possible to integrate third-party devices.

Sorgenia with Amazon Alexa

Sorgenia, an Italian electricity and natural gas supplier, has developed a "skill" that will allow customers to ask Alexa for consumption, expenditure for the supply, tips for saving, smart home and e-mobility solutions and even to carry out the smart meter auto-reading.

Case Study 4

Where	***What***	***Who***
France	InBetween - ICT enabled BEhavioral change ToWards Energy EfficieNt lifestyles (EU project)	Consortium. Project Coordinator: RINA CONSULTING S.P.A.

InBetween project aims to create more energy efficient lifestyles towards a global process that foreseen assisting Users to identify energy wastes, learn how they can conserve energy and motivate them to act. Therefore, marketing strategy would surely need to include and promote collateral safety and comfort features of the system. Value proposition: Energy conservation and energy related cost reduction; Avoidance of energy wastes and optimization of energy supply and demand through real-time warning, manual and automatic actions; Comprehensive ambient/energy monitoring and/or advanced energy demand analytics (load disaggregation).

Highlights

- Comprehensive ambient/energy monitoring and advanced energy demand analytics (non-intrusive load monitoring - NILM) - Risks related to technical feasibility are perceived as low
- High hardware costs associated with energy/ambient monitoring; Switching costs for end users using similar products (Amazon Alexa, Apple HomeKit, Google Home Hub etc.);
- Low return on investment, if the system is evaluated only against energy/cost savings. The system has also considerable implications on security and comfort aspects, difficult to monetarize.

- End user willingness to engage with the proposed system is relatively high due to limited perceived opportunities, if only energy efficiency is considered

Case Study 5

Where	***What***	***Who***
SPAIN, ROMANIA	eTEACHER - end-users Tools to Empower and raise Awareness of Behavioural CHange towards EneRgy efficiency (EU project)	Consortium. Project Coordinator: CEMOSA

eTEACHER is a European project funded by Horizon 2020 that uses ICT solutions to encourage and enable behaviour change of building users towards energy efficiency. eTEACHER aims at developing an Information and Communication Technology (ICT) toolbox to motivate energy behavioural change of energy end-users in buildings, providing tailored interventions that result in significant energy savings and better productivity, health and comfort levels. The eTEACHER's project approach is demonstrated in schools, office buildings, healthcare centres and residential buildings located in Spain, UK and Romania, involving more than 5200 building users.

Highlights

- Comprehensive ambient/energy monitoring and advanced energy demand analytics (non-intrusive load monitoring - NILM) - Risks related to technical feasibility are perceived as low
- High hardware costs associated with energy/ambient monitoring; Switching costs for end users using similar products (Amazon Alexa, Apple HomeKit, Google Home Hub etc.);
- Low return on investment, if the system is evaluated only against energy/cost savings. The system has also considerable implications on security and comfort aspects, difficult to monetarize.
- End user willingness to engage with the proposed system is relatively high due to limited perceived opportunities, if only energy efficiency is considered

4.2 Smart districts

General description

Smart districts, that are emerging as a major part of the European sustainably agenda, are the perfect combination of these current trends. Such districts are city spaces designed or revitalised to reduce CO2 emissions cost-efficiently through an efficient use of energy through smart grids, district heating and cooling, distribution systems, e-mobility and ICT. In other words, smart districts are featured by interoperability among devices over heterogeneous networks to facilitate the interaction between smart buildings, streets, public lighting, mobility, etc.

Across Europe, many different projects exploring and demonstrating low energy districts have emerged. Under the EU research programme, there are currently 27 smart city projects involving 25 cities across Europe that through a sound technological development aim at promoting the large-scale replicability of innovative energy efficiency solutions for cities and communities. So far, these projects have displayed innovative approaches to buildings retrofitting: energy efficiency measures often involved the use of smart grids, monitoring platforms and wide range of ICT tools. The ultimate goal will be to develop automated and intelligent districts able to self-sustain themselves through their energy production.

In this regard, the role of empowered consumers is central, as it allows moving to (collective) self-consumption schemes and to peer-to-peer selling of the energy produced by final costumers. By putting the consumer at the centre, the Clean Energy Package of 2016 made an important step in this direction. However, as it will be discussed below, the success of these developments depends on advanced technologies (e.g. smart meters), business models promoting self-consumption, national regulatory framework and the legal relationships amongst the entities involved in the energy system.

Opportunities

Customers	Society / Energy system
• Reduction of energy bills for final users • Development of EV mobility thanks to the increased availability of charging stations at district level • Improvement of buildings maintenance in terms of performance and costs	• GHG emissions reduction due to the increase of distributed generation from RES and energy management systems • Increased essential utilities service level (energy/ICT/water/etc.) thanks to network integration

Business models

	Positive Energy District (PED)
Description	• Energy efficiency measures with the support of new technologies for energy management • Buildings (houses, commercial spaces...) take advantage of complementary energy consumption curves and optimise local renewable energy production, consumption and storage. • Sensors and smart appliances equip the environment • Automation technologies, smart adaptive lighting of streets, traffic adaptive installations and EV integrated infrastructure • Integration of RES through smart grids and systems of decentralised energy sources
Key actors	• Municipalities • Mobility providers • ICT companies • Network operators • Real estate developers • Energy providers • Prosumers

BM1 – Positive Energy District

The identified business model that will allow the deployment of smart districts is the Positive Energy District (PED), which represents the large-scale deployment of Positive Energy Blocks (PEBs) concept. These are developed in the context of the Marketplace of the European Innovation Platform Smart Cities and Communities (EIP-SCC) and have been passed into the H2020 Smart Cities and Communities' calls.

The EIP-SCC is an initiative supported by the European Commission bringing together cities, industry, SMEs, banks, research and other smart city actors and one of its main goals is to launch, by 2020, the deployment of 100 PEBs throughout EU and neighbouring countries, with at least 1 PEB per Member State.

PED realisation is foreseen by Horizon 2020 - Work Programme 2018-2020 through the PEDs Implementation Plan of the Temporary Working Group of the European Strategic Energy Technology (SET)-Plan on Action 3.2 "Smart Cities and Communities" which currently supporting the planning, deployment and replication of 100 'Positive Energy Districts' by 2025 for sustainable urbanisation.

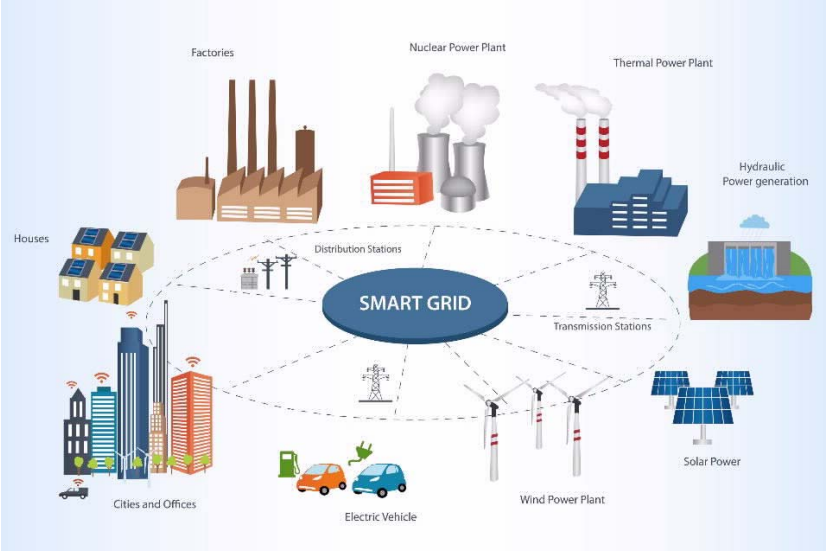
According to the definition elaborated in that context, PEBs are a group of at least three connected neighbouring buildings (new, retrofitted or a combination of both) that actively manage their energy consumption and the energy flow between them and the wider energy system, exchanging net self-production with the grid.

The PED's concept is an extension of it and represents a urban district where distributed energy production from RES plus energy management systems are able to feed buildings, EV, public lighting and other consumptions, exchanging net flows with the same grid. In this context, Information and communication technologies (ICT) play a pivotal role as they enable advanced controls of the whole district.

In this business model, buildings are active components in an integrated system involving not only the energy domain, but also all essential utilities and other services. Doing this requires the use of smart meters and the application for IoT technologies to a level able to grant highly scalable, connected, systems capable of sensing, acting, controlling, balancing and forecasting. PED makes optimal use of local RES, local

storage, smart energy grids, demand-response, innovative energy management (electricity, heating and cooling) and user interaction/involvement. Additionally, ICT platforms gather information about various parameters as, for instance, information about public transport (real-time location, utilization), traffic, air quality, energy consumption in public buildings, etc.

As a result, this configuration will include automation technologies such as smart adaptive lighting of streets, traffic adaptive installations and EV integrated infrastructure.



(Source: IEEE 2018)

Technical maturity

The technology readiness level is currently medium (5-6).That is because innovative ICT and energy technologies enabling the PED model are available but they have not been applied, yet, in real cases. Although different pieces of the puzzle are there (e.g. advanced building energy management, smart grid management, EV charging, storage solutions, smart lamppost), an integrated solution with a single point (or even a coordinated) management has never been applied. To this purpose, H2020 pilot projects shall provide applications.

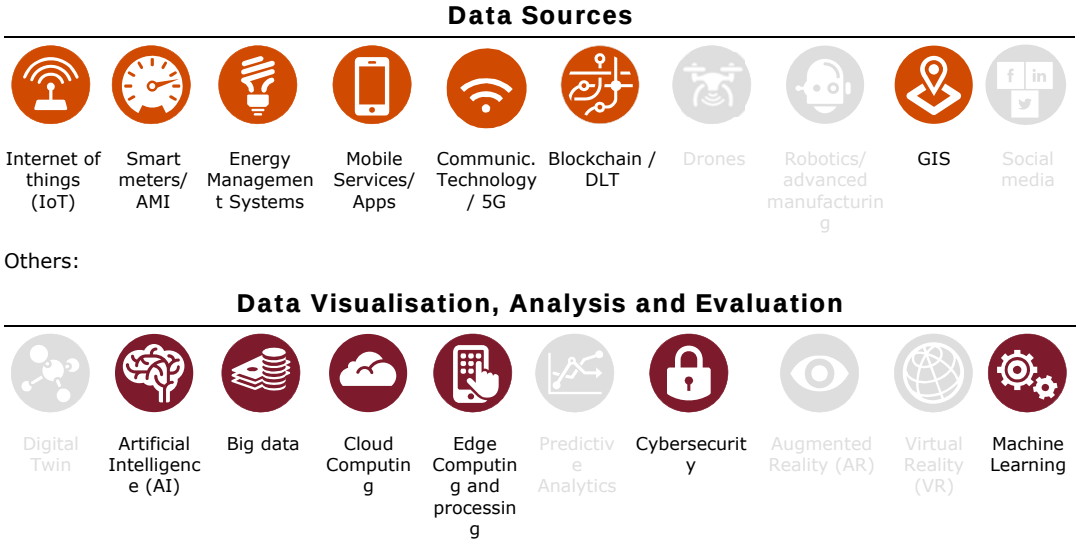
The role of R&D is still crucial, for example, in fostering the role of EV in electric load management, which is far from being mature. As well, energy storage technologies still lack the capacity to provide power availability (either short or long-term).

Furthermore, developing advanced EM systems sees interoperability as one of the big challenges for integrating different smart appliances in a single monitoring system. Interoperability is essential for the development of smart districts because it allows different systems and networks within the utility to connect. With the rolling out of smart grids, traditional systems unable to communicate are therefore inadequate.

The ongoing challenge is given by the presence of multiple devices, IoT infrastructure, APIs and data formats that are creating substantial interoperability issues. These problems are caused by the impossibility to develop cross-platform/cross-domains for IoT applications. There are many IoT platforms but their standards are not

compatible with other IoT structures and this leads to insulated ecosystems (silos). The industry is trying to address the interoperability problems through standardization (e.g. Amazon with AWS IoT and Microsoft with Azure IoT); nevertheless, these different solutions should be able to eventually work together. Under Horizon 2020, the European Union has been funding several research projects focused on the federation of IoT platforms, however, since it may take time to get common standards, some action to accelerate the process may be necessary.

Key enabling digital technologies



Data management

In the this model, data management is key as the PED manager tackles the challenge of gathering, elaborating and extracting information from the whole urban district environment. To this extent, the PED manager needs an effective urban data platform where IoT devices are placed in critical points of energy production, storage and use (to stick to the energy system only) and data are processed in real time to balance the system and ensure an effective liaison with the DSO.To this extent, the district manager profile can be assimilated to either a microgrid manager or a local aggregator.

In this context, the role of advanced meters is essential for data management and to guarantee a 2-ways communication actively involving consumers. Smart meters have a central role in the development of PEDs: they shall provide real time validated data to manage either the microgrid or the relationship with the DSO for balancing purposes. The same data shall be used to properly bill consumptions to final customers. Energy service companies use data collected from smart devices connected to the smart meter. These data are non-validated and time granularity varies from 15 minutes (most frequent) up to 1 hour, depending on the country.

However, the latest technologies can provide microsecond measurements on power consumption data. As it will be further explored in the UC4, the rolling out of smart meters in Europe has also raised concerns about data access and privacy of consumers.

Lastly, as previously highlighted, aggregated data raise issues in terms of standardisation and interoperability. For example, the fact that data are collected from different IoT structures inside the district together with the lack of common data formats currently represent a problem for data gathering.

Stakeholder access to data	Validated (V) or non-validated (NV) data	Near-real time (RT) or historical (H) data	Granularity	Aggregated data (A) or by usage (U)	Communication requirements
☒ Customer ☒ Supplier or ESCO ☒ DSO ☐ Other	☒ V ☐ NV	☒ RT ☐ H	☒ minute or less ☒ 15min ☐ hourly ☐ more	☒ A ☒ U	☒ 2-way ☐ link with market data ☐ none

Market maturity

This business model is not mature in Europe from a market viewpoint, mostly due to insufficient technology maturity and enabling regulation. As previously mentioned, energy storage is one of the biggest obstacles for the realization of PEDs. Finding ways to store energy all year long must become cheaper in order to make PEDs cost-effective, so they can compete with conventional buildings and districts. EV charging infrastructure could have positive impact in this regard but such solution is still encountering consistent technical and market barriers.

On the building side, deep retrofitting and new near-zero energy buildings are not cost effective based on today's energy costs, requiring new financing schemes, including optimized subsidies, particularly for the initial phase, in order to promote and accelerate the replication process and enable the construction industry to generate economies of scale among the whole value and supply chains.

The expensive part of a change in this regard, does not lie with the production of sustainable energy, but rather with the necessary change of the energy system. It is necessary to introduce new market models able to encourage local level participation and foster the role of prosumers. Currently, the wholesale market is distant from final customers: they are not incentivised to generate energy locally, provide flexibility and aggregate power generation.

BM	Presence on the market	Countries	Enablers / Barriers		Area
1	Pilot stage		Incentives for RES	+	
			National regulation foreseeing collective self-consumption	+	
	Not available on the market		High upfront capital costs for buildings retrofitting/construction	−	
			Low investments and high risk perception from involved stakeholders (investors, buyers, municipalities, constructors, etc)	−	
			Power markets for renewable energy are quite new and are governed by traditional large energy companies	−	
			Lack of communication protocols standardisation: no interoperability at the data layer	−	
			Role of collective prosumers is not regulated	−	

Regulatory feasibility

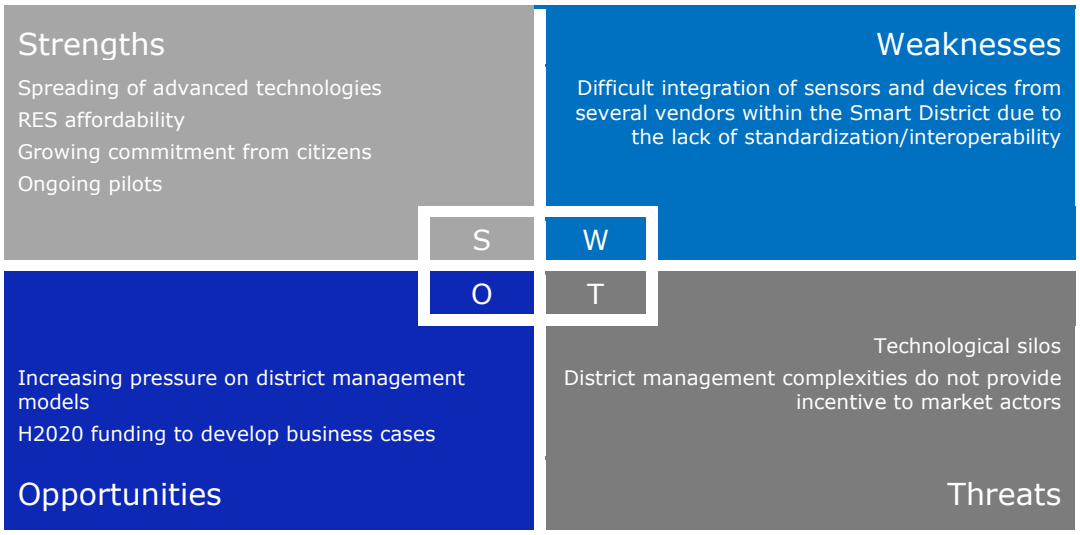
The development of smart districts is a key element for a successful clean energy transition promoted by the Clean Energy Package of 2016. As part of that Package, the most relevant piece of legislation for buildings is the Energy Performance on Buildings Directive that foresees the development of a smart readiness indicator to measure the capacity of buildings to use information and communication technologies and electronic systems to adapt the operation of buildings to the needs of the occupants and houses., to optimise operation and maintenance, and to enhance energy flexibility. The Renewable Energy Directive (as revised in 2018) instead has a broader area of intervention as it aims at spurring the development of the next generation of renewable-energy solutions in the heating and cooling, transport and electricity sectors.

The Clean Energy Package introduced also a very important aspect regarding the role of consumers: it recognised that consumers play a fundamental role in realising the full potential of the European energy market, and that the retail electricity market has to offer them the possibility to actively participate in the energy transition process. Hence, it must be taken into account that consumers are becoming active and central players of the future and will become prosumers. According to Art. 21 of the revised Renewable Energy Directive of 2018, MSs should guarantee both self-consumers and groups of self-consumers to: generate renewable energy for their own consumption, store and sell their excess production.

In Europe, there is a very fragmented situation related to compensation for feeding electricity into the grid. Regulation varies substantially depending on the country and in some cases, prosumers are still either not allowed or poorly incentivised to sell their energy. Collective self-consumption, which refers to PEDs (for both residential and commercial groups of buildings), is currently not feasible in most Member States. In order to overcome this problem and foster the deployment of PEDs, close cooperation between projects promoters and regulatory authorities is necessary to allow small-scale demonstrations.

Furthermore, consumers might not have the capacity to trade on the energy markets; they would rather require the services of an aggregator to help them participate. Aggregators pool many different loads of varying characteristics and provide backup for individual loads as part of the pooling activity, increasing the overall reliability and reducing risk for individual participants. They create one "pool" of aggregated controllable load, made up of many smaller consumer loads, and sell this as a single resource (See UC3).

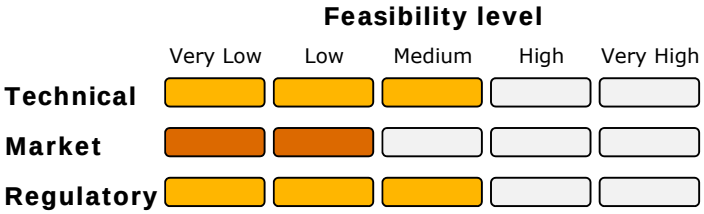
SWOT analysis



Overall evaluation of UC feasibility level and key issues

Summarising all the considerations made around this UC, the overall assessment, reported below, shows that positive energy districts are well on track in terms of technical maturity, while they suffer from market issues. Despite the current regulatory framework trying to addressing such problems, additional action may be necessary in order to accelerate PEDs development and achieve SET Plan's targets for 2025.

Implementation status



Key issues

Following the order of appearance of the key issues identified in our analysis, the table below presents a summary, which helps linking such issues with the policy/regulatory actions needed to overcome them and allow a wider development of the positive energy districts model.

Key Issue	Description	Type of Issue
1. Role of prosumers	• Lack of homogeneous regulatory approaches to regulate the market participation of prosumers	
2. IoT interoperability	• Advanced IoT platforms needed to manage communication among different energy production and consumption points (e.g. CHP or PV local plants, EV chargers, smart lighting poles)	
3. Detachment from EU incentives	• Old buildings: costs of renovation are mostly on households, which prevents dwellings from adopting energy efficiency measures. • New dwellings: energy efficient buildings with advanced energy management systems have higher costs of construction and high upfront purchase costs for buyers of purchase. These represent high risks for investors • The challenge is to build/ retrofit with no public funding	

Preliminary evaluation of the need for policy / regulatory actions

In order to address the challenge on the role of prosumers (**Key issue #1**), first, it should be established a clear and detailed definition of prosumer to be applied EU-wide. Secondly, specific guidelines on how to regulate collective self-consumption at the MS level (as foreseen in Art 21 of RED) should be provided.

As for IoT interoperability (**Key issue #2**), it is required to keep standardisation as the prerequisite to specify technical methods, such as measurement and product safety, and maintain the New Legislative Framework principle by listing standards under the respective legislation.

Finally, in order to encourage the detachment from EU incentives (**Key Issue #3**) it is necessary to mobilise private financing for energy efficiency and renewable in buildings. The following policy action could be taken at EU level by 2030:

- De-risking measures for PPP. It is crucial to work on risk perception of municipalities and investors. The Commission and the Energy Efficiency Financial Institutions Group (EEFIG) developed two instruments in this regard (a platform and a toolkit), but stronger action is necessary. The Commission could provide common mandatory steps to be followed by public entities and private investors to safeguard their interests and encourage projects development.
- Regulation introducing additional taxation for low energy efficient households
- Develop auditing tools to increase the capacity of local authorities in planning and implementing renovation strategies.

Case studies

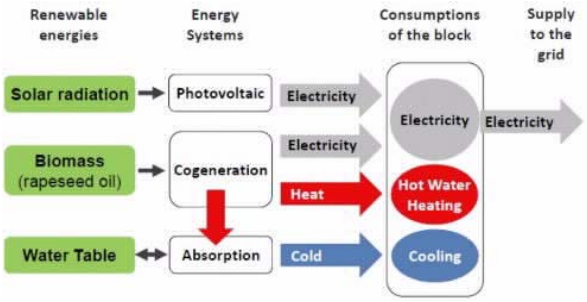
The first case study concerns the first pilot of Positive Energy Blocks realised in France in 2015, while the second case is a "sui generis" example of a whole village in Germany selling the surplus of electricity it generates.

Case Study 1

Where	***What***	***Who***
France	The Positive Energy Block (PEB) of HIKARI	NEXT Buildings

Located in Lyon, the Confluence District is part of the FP7 project NEXT Buildings. After an international design competition, the local public redevelopment company SPL Lyon-Confluence selected a group of real estate developers, Bouygues Immobilier and SLC, which are associated with the Japanese architect Kengo Kuma, who has designed a group of three buildings called HIKARI.

Commissioned in 2013, it is the pioneering best practice pilot is in operation in Europe. Hikari is a mix-use PEB of 12,300 m2 consisting of apartments, shops and offices. It uses various renewable energy sources (solar, geothermal, cogeneration) to provide electricity, heating and cooling solutions. The bioclimatic architecture optimizes the use of natural light and ventilation, in its first 18 months of activity, HIKARI had a positive generation of primary energy of 2kWh/m2/yr. Two more PEBs are planned in the same area to transition from prototype to sustainable business model.

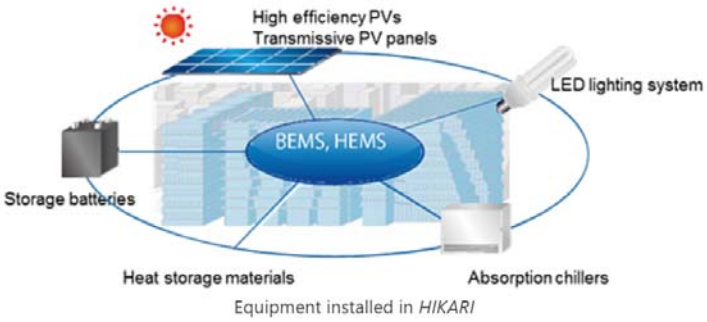


(Source: EIP-SCC 2017)

Highlights

- Hikari project gives priority to renewable energies. It is uses information technologies to optimise energy production, distribution and consumption. Installation of the latest sensors throughout the buildings gives the occupants access to all the data on their environment and enables them to interact with it;
- Including citizens in the early stages of development was key and is carried out through variety of actions – setting up the so-called *House of the project*, organising labs, providing the opportunity to participate in the prototyping. On one hand, this focuses on the involvement of local inhabitants (private groups of owners) in the eco refurbishment of their buildings. On the other, the inhabitants and the people working in the neighborhood are engaged in the management of their energy consumption by means of data collection;

- The project team encountered challenges with the access, collection and use of data from multiple public and private providers;
- Following the adoption of a series of legal and regulatory texts in 2016 and 2017, French law allows collective self-consumption for private parties. As a main French special feature, the collective self-consumption is designed as a virtual private network embedded in the public network. Thus, the role of the DSO (Enedis, operates 95% of the network) is key.



(Source: NEDO 2015)

Case Study 2

Where	***What***	***Who***
Germany	Plus energy village Wildpoldsried	Wildpoldsried

Wildpoldsried, is a Bavarian village of about 2,600 residents, that over the past 18 years has invested in a holistic range of renewable energy projects that include 4,983 kWp of photovoltaics, five biogas facilities, 11 wind turbines and a hydropower system. As a result, the village has gone beyond energy independence and it now produces 500% more energy than it needs and profits from sales of the surplus power back to the grid. With such a diversity of renewable energy sources, the town operates a smart grid that maintains the balance between energy production and consumption and keeps the power grid stable.

Highlights

- The Siemens lab is collaborating with the local grid operator to launch a project called Irene: for the Integration of Regenerative Energy and Electric Mobility.
- The project is currently supported by the German government through investments and subsidies.

Revenue creation source

Wholesale markets	TSO Ancillary services	Distribution network	Cost efficiencies	Subsidies	Behind the meter	Additional payment for green /local	ROIs

4.3 Energy Aggregators

General description

An aggregator combines multiple consumer loads or generated electricity for sale, purchase or auction in any electricity market (Art. 2 of the new Electricity Directive). Aggregators act as a facilitator, by bundling flexibility from different customers and generators and offering it to the different actors that need it (BRP/DSO/TSO).

This use case focuses on the market actors' perspective of flexibility aggregation of distributed demand and supply, valorised in the energy, capacity and ancillary services markets, the latter being proven to be particularly well-suited for DR valorisation. Owners of the flexibility (consumers and prosumers) benefit by receiving direct payments or bill reductions in exchange for altering their consumption and/or generation patters upon request, triggered e.g. by activation of balancing energy, differences in electricity prices or a constraint on the network.

This use case is closely linked to UC1, as advanced energy management services can provide pre-conditions for aggregation. Questions related to customers awareness and incentives are thus discussed there and not repeated here. UC10, on the other hand, can be seen as an application, since aggregation is expected to deliver services also to system operators.

Opportunities

Larger industrial electricity consumers sell their flexibility to the market directly. Smaller consumers, on the other hand, do not have a direct market access, but aggregation allows to bundle flexibility in order to reduce the peak demand as well as to shift load through time. Developing this flexibility potential contributes to a more efficient integration of increasing intermittent renewable energy sources. Flexibility can be delivered by controlling not only electricity consumption but also decentralized generation and storage.

Customers	Society / Energy system
• Valorisation of customers' flexibility, enabling reduction of the energy bill	• Lower balancing, energy and peak capacity costs • Better RES integration

Business models

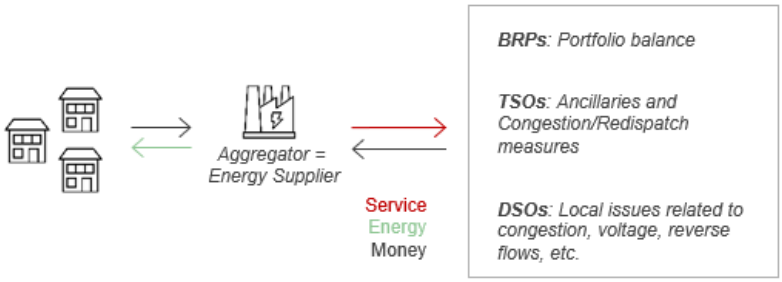
Business models around aggregation are currently evolving. They differ according to the roles and responsibilities of the aggregator. The standard situation is that of an energy supplier who also bundles the flexibility of its customers to value it in short term electricity markets, ancillary services markets or capacity markets. Independent aggregators, on the other hand, do not have an energy supply contract with their customers and intervene thus as a third party service provider next to the supplier. Independent aggregators can have their own balancing responsible party, or they contract with the supplier's BRP.

In practice, different models are conceivable to handle the relationship between the independent aggregator, the supplier and the BRP ((USEF, 2017); (Danish Energy Association; Danish Intelligent Energy Alliance; Energinet; Confederation of Danish Industry, 2017; PÖYRY, 2018).

	1 Aggregator = supplier	2 Independent Aggregator
Description	• The energy supplier bundles the flexibility of his customers to value it in short term electricity markets • Being a supplier, the aggregator is also balancing responsible for its customers	• The independent aggregator is not affiliated to the supplier of the customer providing flexibility, nor to the supplier's BRP • Role recognized by the New Electricity Directive, according to which an independent aggregator is also responsible for the imbalance he causes
Key actors	• Flexible consumers, producers and prosumers • Aggregator, supplier and BRP being one actor • TSO/DSO	• Flexible consumers, producers and prosumers • Independent aggregator • Supplier • BRP • TSO/DSO

BM1 – Aggregator = Supplier (Integrated Aggregator)

In the first business model, the energy supplier also values the flexibility of its customers in the energy markets. Services can be delivered to various stakeholders, including system operators and BRPs. The customer thus has a single contract with his supplier, bundling energy and flexibility services, i.e. aggregator and supplier are the same person who also is balancing responsible. The supplier can activate flexibility via behind the meter devices and the customer is remunerated via lower tariffs.



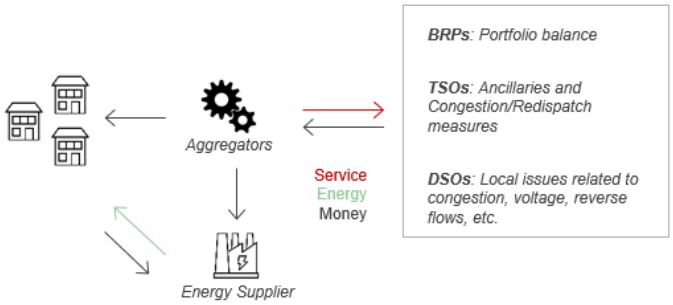
Revenue creation source

Wholesale markets	TSO Ancillary services	Services provided to DSOs	Cost efficiencies	Subsidies	Behind the meter	Additional payment for green /local	Others

BM2 – Independent Aggregator

The independent aggregator also bundles flexibility from a large number of smaller consumers and producers and values it in the energy markets. However, he is not

the energy supplier of its customers, i.e. when activating flexibility, the independent aggregator causes costs to the supplier: the supplier faces an imbalance he is not responsible for, while the energy actually consumed by the customer deviates ex post from the energy procured by the supplier ex ante in the energy markets (forward contracting, day-ahead market, intraday market). Some arrangements between the aggregator and the supplier need to be defined to address these issues. In particular, flexibility is about consuming or producing less or more, compared to a reference. Hence, a baseline is needed to measure the flexibility.



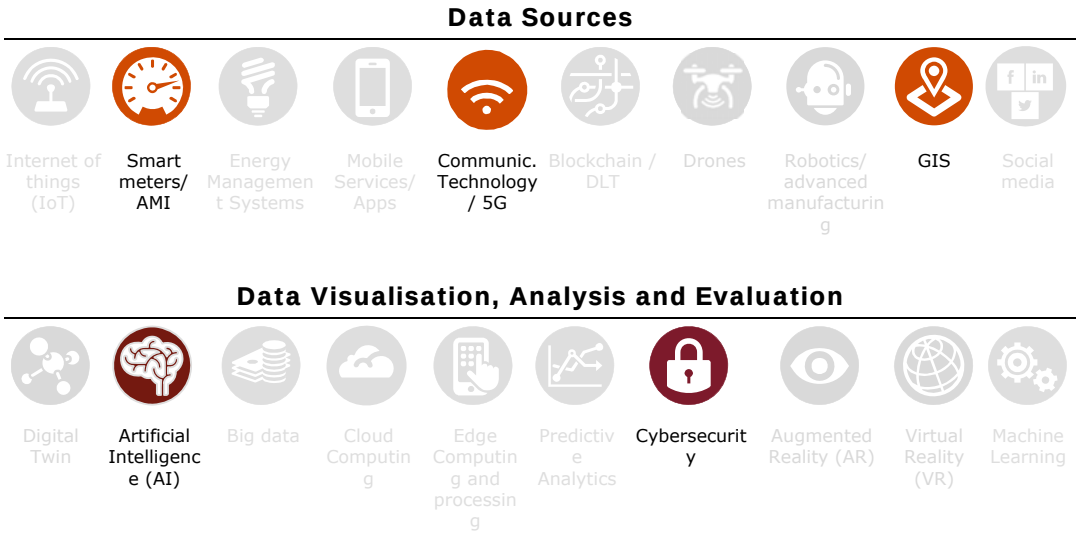
Revenue creation source

Wholesale markets	TSO Ancillary services	Services provided to DSOs	Cost efficiencies	Subsidies	Behind the meter	Additional payment for green /local	Others

Technical maturity

The TRL of the two business cases is assessed as medium to high. To activate flexibility, two-way communication between the aggregator and the consumer as well as the availability of near-real time consumption data are required. When the aggregation service is delivered by the supplier, behind the meter devices are sufficient and typcially provided by the supplier (see case of Fortum Spring in Finland). In case of independent aggregation, validation of provided flexibility is key for the settlement between the aggregator and the supplier. This might require the placement of a second meter, causing high costs for smaller flexibility providers. However, this is more a regulatory rather than a technical issue.

Key enabling digital technologies



Data management

Aggregation requires that the applications providing the flexibility can be activated up or down. Two-way communication and access to real-time data is therefore needed. Smart meters with the appropriate functionality and/or behind the meter devices are sufficient if the aggregator is also the energy supplier. On the other hand, independent aggregators need to rely on validated data in order to ease the settlement with the supplier for balancing and billing purposes. Some form of validation of activated flexibility together with the definition of a baseline is required (**Key Issue #1**). Validation can be achieved through the placement of a second meter, which can imply disproportional costs for smaller flexibility providers, or through standardization of devices deployed by the aggregator.

Easy access to accurate and timely data (through smart meter deployment) is a pre-condition for the emergence of flexibility and novel energy services. Before contracting, both the customer and the aggregator need to have a good view on the flexibility potential. To this end, access to historical data, in the appropriate granularity and possibly by application, is essential. This raises issues around data availability and customer consent. However, today, consumption data access opportunities by customers and third parties between countries are heterogeneous and a fully transparent consent mechanism is usually not implemented yet (**Key Issue #2**). Independent aggregators tend to be in a weaker position compared to energy supplier also providing aggregation services. Also, uncertainty with respect to what can be shared and what are the implications for new business of revoking the consent is reported by some interviewees, linked to GDPR and the upcoming e-Privacy regulation.

Consumption data requirements

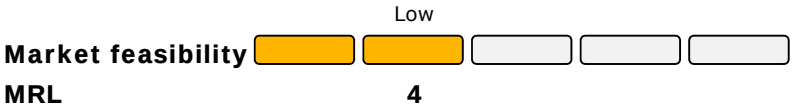
Data requirements are identical, whether the aggregator is integrated or independent. The granularity of the data depends on the service provided. Several options are thus possible.

Aggregator=Supplier and Independent aggregator:

Stakeholder access to data	Validated (V) or non-validated (NV) data	Near-real time (RT) or historical (H) data	Granularity	Aggregated data (A) or by usage (U)	Communication requirements
☒ Customer ☒ Supplier or ESCO ☐ DSO ☐ Other	☒ V ☒ NV	☒ RT ☒ H	☒ minute or less ☒ 15min ☒ hourly ☐ more	☐ A ☒ U	☒ 2-way ☐ link with market data ☐ none

Market maturity

The today's market maturity level is rather low. Next to the uncertain furture potential, independent aggregation is only in an early development stage and consumption data measurement and availability represent important market development barriers. The future outlook on ancillary services is highly uncertain. With growing shares of intermittent renewable generation, the need for flexibility closer to real time is expected to grow. On the other hand, supply of flexibility may increase as well: thermal plants will still be present in the market, larger renewable installations can provide flexibility directly, enhanced transmission capacity usage allows for cross-border sharing of flexibility, etc. Aggregation of smaller customers may therefore be limited to countries where there is sufficient potential (e.g. countries with a large share of electric heating and cooling like France or Finland) and where smart meters with the appropriate functionalities facilitate entry of (independent) aggregators. Next to the uncertain overall potential, further development of business models may be hampered by the difficulty to stack revenues from providing services to various stakeholders (**Key Issue #3**).



BM	Presence on the market	Countries	Enablers / Barriers		Area
1	Service available on the market		Behind the meter device	+	
	Service not available / low penetration level		Today: Technical requirements favor large industrial sites - Pilot in place to test solutions	−	
2	Service available on the market		Allowed since 2014, still difficult to access mFRR market.	+	
	Service not available / low penetration level		Low prices, excessive requirements for demand-side participants.	−	

Source: (Andres Pinto-Bello, smartEn, 2018)

Regulatory feasibility

Regulatory feasibility is assessed as medium thanks to the CEP and its upcoming implementation in the MSs. Its predecessor, the Third Energy package, did not yet foresee the role of an energy aggregator. Since then, aggregated demand side

flexibility has entered the electricity markets in some EU countries, while facing several barriers. The Energy Efficiency Directive of 2012 represented an important step in defining the framework for demand response in Europe. The barriers related to market access of demand side flexibility have been progressively addressed by adjusting the market framework to aggregators (also sometimes called flexibility service providers) in many European countries. However, there are number of regulatory challenges that still need to be addressed in order to facilitate this UC, including:

- Prequalification and product design requirements that were defined for conventional thermal power plants, but which are not adapted to new flexibility and demand side sources (**Key Issue #4**). On the one hand, the bids from all flexibility resources need to comply with the technical characteristics required for the delivery of the service. On the other hand, limitations applied to bids are not always justified. Although the quality of the service as such is not impacted, new flexibility sources including aggregation may not be able to deliver these services because of unjustified technical barriers, mainly related to minimum bid sizes and delivery periods. Similarly labelled products have different formats in the MSs. In addition, underlying technical regulation on measurement, validation and settlement of flexibility products needs to be defined both at European level (for instance through the upcoming network code on demand response) and at National level (European Smart Grids Task Force, EG3, April 2019).
- At the same time, the market entry of independent aggregators creates new issues around their roles and responsibilities (Key Issue #1 already identified above). The CEP, namely the recast Electricity Directive, goes further by clearly defining the role of independent aggregators. Integrated and independent aggregators should have the same rights and obligations once the new Directive is applied. When activating flexibility, independent aggregators create costs to the supplier being balancing responsible for the customers delivering flexibility. Compensations and/or mechanisms to adjust load forecasts need to be tackled by the regulator. At EU level, the new Directive recognizes the role of the aggregator, it enables the market entry of independent aggregators and defines principles for addressing the issues mentioned above. From a regulatory point of view, the further development of aggregation activities will depend on how the Directive is transposed into national law.

Lastly, the access to data (Key Issue #2), is a debated issue highly relevant for this use case. Access to granular demand information from smart meters and behind the meter devices, on 15 minutes intervals or even less for some services like frequency response, is necessary. Granular demand information allows for identification of a person and will thus likely to be classified as personal data according to art. 6 of the GDPR and thus only accessible to third parties subject to customers' consent (CEER, 2019). In addition, according to the upcoming e-Privacy regulation, consumers would need to give their prior consent to companies processing energy data from equipment installed in people's homes, i.e. not only personal data but also business and technical data, and revoke it at any moment, without advance notice (art. 8). The final legal interpretation and practical implementation of these rules will be decisive. On the one hand, end user right to privacy and confidentiality of communications must be respected. On the other hand, the possibility to use anonymised or pseudonymised

data for improvement of existing and/or development of new products and services using AI-based R&D to tap the opportunities of innovation in digital market is key.

Regulatory feasibility Medium

Key EU legislation provision	
Energy Union	**The Recast Electricity Directive** requires that: • Customer can engage with aggregators independently of their supply contract and without being subject to discriminatory technical and administrative requirements, procedures and charges by their supplier. Non-discriminatory & transparent data exchange rules should be also ensured (art. 12 & 13). • Aggregation can participate in electricity markets based on non-discriminatory technical treatment and data exchange rules. Aggregators are financially responsible for the imbalances that they cause in the electricity system and to that extent, they shall be balance responsible parties or shall delegate their balance responsibility. It also defines principles for calculation methods for compensations between BRP and aggregators (art. 17). • Member States shall ensure the interoperability of those smart metering systems, as well as their ability to provide output for consumer energy management systems (art. 19.3) **The Electricity Balancing Guideline (2017/2195)** allows the aggregation of demand facilities, energy storage facilities and power generating facilities in a scheduling area to offer balancing services (art. 18.4).
Digital	Subject to general **GDPR** provisions on the processing of different types of personal data (art. 6) and also upcoming **e-Privacy Regulation** (that will replace the ePrivacy Directive 2009/136/EC) provisions that focus on storage in and access to data in terminal equipment such as smart meters.

SWOT analysis

Strengths

The role of the aggregator is recognized by European legislation

Aggregation allows for participation of smaller consumers and producers in electricity markets

Weaknesses

Relationship between aggregators, suppliers and balancing responsible parties can be complex

Coordination of many small flexibility providers may be difficult (rebound effect)

S W

O T

Opportunities

With increasing shares of intermittent renewables and EVs, aggregation can unlock further flexibility

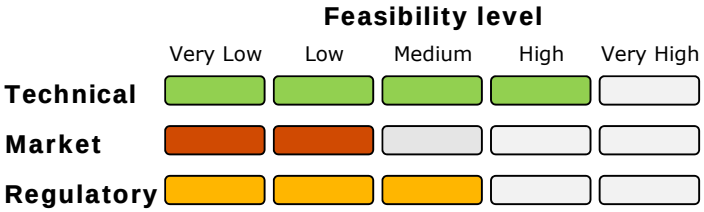
The 5G technology expected to facilitate aggregation of many flexibility sources

Threats

Potential may be limited to specific applications (heating and cooling) and services (e.g. Frequency Containment Reserve, with limited energy involved)

Overall evaluation of UC feasibility level and key issues

Implementation status



Key issues

Key Issue	Description	Type of Issue
1. Difficult market access by independent aggregators	When independent aggregators activate customers' flexibility close to real-time, they create an imbalance that is not caused by the supplier. Also the latter has contracted energy which he cannot sell (open energy position) or which he still hasn't procured (in case the aggregator is activating a load increase). The Recast Electricity Directive allows for participation of independent aggregators in the electricity market and specifies that they are financially responsible for the imbalances they cause. Appropriate national implementation will need to be ensured. Some form of validation of activated flexibility together with the definition of a baseline is required.	
2. Limited access to consumption and production data	Easy access to accurate and timely data is a pre-condition for the emergence of flexibility services. Before contracting, both the customer and the aggregator need to have a good view on the flexibility potential. During the contract, access to near-real time data and two-way communication is essential. Today, access conditions are very heterogeneous among Member States.	
3. Limited or uncertain market potential and difficulty to stack revenues	Aggregation activities may be concentrated in a few countries where typical applications like electric water boilers and electric space heating are wide-spread (e.g. Finland, France). Growing electrification (heat pumps, EVs, etc.) may change this view of course. Also, although one can expect a growing flexibility need with higher shares of internittent renewables, there are alternatives to aggregation (flexibility provided directly by large thermal and RES producers, implicit demand response, improved cross-border sharing of resources, etc.) that might limit further development. Finally, stacking revenues from providing several services to ensure a viable business case is not straightforward.	
4. Prequalification & product design requirements	Unjustified prequalification and product design requirements may be a barrier for DR if they are not adapted to the highest possible extent to the technical capabilities and limitations of demand response/aggregation. Examples include excessive frequency of metering and telemetry resolution required to demand-side resources to participate in ancillary markets in Italy or same requirements for battery storage as for hydropower for Frequency Containment Reserve (FCR) in Finland, currently addressed as a follow-up of the SO GL. This relates both to the initial prequalification and to an adjustment of the flexibility portfolio.	

Preliminary identification of enabling policy / regulatory actions

In order to address the identified challenges, some policy actions could be taken at EU level in the short term (2020) and by 2030.

With respect to the identified difficult market access by independent aggregators (**Key Issue #1**), the BAU scenario foresees the transposition of the recast Electricity Directive into national law. The BAU Scenario includes the risk is that national choices are heterogeneous, such that barriers to entry remain, inhibiting companies to become active in several Member States. In a Consistent Governance scenario, the Commission could therefore support secondary legislation, providing specific guidance on the definition of a baseline and best practices on transfer of energy/compensations/balancing responsibilities. Also, at industry level, standardization of sub-meters, allowing for favourable solutions for measuring flexibility provided by smaller customers, could be a way to facilitate the entry of independent aggregators.

As regards the limited access by independent aggregators to consumption and production data (**Key Issue #2**), the BAU Scenario could be characterized by Member States lagging behind in implementing clear consent mechanisms to allow independent aggregators to access the consumption data. Also, the quality of consumption data available in terms of history and granularity may be heterogenous. Furthermore, legal uncertainty remains related to some conflicting articles of GDPR and the upcoming e-Privacy Regulation. As a result, independent aggregators only develop in a few countries. Short term measures to address the issue can include in a Consistent Governance scenario:

- The EC closely controls the implementation of clear consent mechanisms to share data and defines best practices regarding consumption data history and granularity provided by smart meters;
- Conflicting articles in Privacy Regulation and GDPR are clarified, i.e. anonymised data or data collection serving legitimate purpose and not impacting end user privacy can be shared.

No particular policy actions are linked to the limited or uncertain market potential and difficulty to stack revenues (**Key Issue #3**). Uncertainty is part of a normally functioning liberalized market. As such it is not a market failure requiring policy action to support aggregation from a risk mitigation perspective, also because aggregation activities present a low CAPEX intensity. The ability to stack revenues from the provision of different services is a consequence of the product definition for the services considered. See Key Issue #4.

Finally, on the prequalification & product design requirements (**Key Issue #4**) the recast Electricity Regulation (Article 6) requires that prequalification processes and product design in balancing markets allow non-discriminatory access to all market participants, individually or through aggregation. The System Operation Guideline also mandates TSOs to define prequalification processes for frequency ancillary services. Still, in a BAU Scenario, there is no specific mandate or guidance on how the prequalification should be implemented at national level; as far as the product design is concerned, the Electricity Balancing Guideline provides a set of minimum features (e.g. minimum bid size, full activation time, product duration) for standard products for balancing; all TSOs are expected to draft by end 2019 a proposal for the

values for these standard products. Currently the initiatives TERRE, MARI and PICASSO (Trans European Replacement Reserves Exchange, Manually Activated Reserves Initiative and Platform for the International Coordination of Automated Frequency Restoration and Stable System Operation, respectively) are laying the grounds for the definition of the standard balancing products of the future European balancing markets.

Furthermore, the recast Electricity Directive (articles 31 and 32) defines a brand new framework aimed at incentivizing DSOs to procure flexibility services according to market-based procedures. To this end, DSOs will define - through a consultation process with all relevant stakeholders and under NRA supervision - the products they will procure mainly for congestion management and non-frequency issues. Waiting for the transposition of the Electricity Directive into National Law which is set by end 2020, products for new services to be delivered especially to DSOs are still missing. In the Consistent Governance scenario, secondary legislation or sharing of best practices for prequalification of aggregated portfolios could be a way to address the issue (see, for instance, (Energinet, 2018)). Furthermore, in a Reinforced Legislation Scenario, local issues not addressed by currently existing markets should be addressed, e.g. minimum standardization of products addressing these new needs, including especially a locational signal. This is closely linked to UC10. On the other hand, more locally defined products necessarily reduce the room for aggregation. There is thus a trade-off between more locally defined products and aggregation, leaving an open question about the right level of geographical granularity that still enables efficiently working markets.

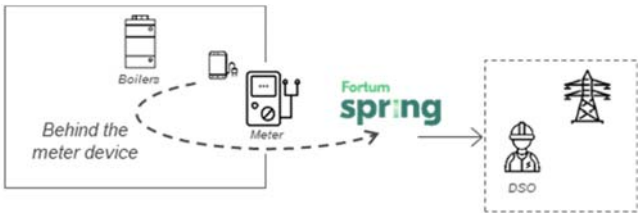
Case studies

BM1 – Aggregator = Supplier/BRP

Case Study 1

Where	***What***	***Who***
FINLAND	Operation of a virtual battery	Fortum Spring

With the Spring project, Fortum operates a virtual battery to deliver demand response services to DSOs and TSOs. Fortum aggregates the distributed assets owned by their customers, including water boilers, batteries and data centres.



Highlights

- Smart meters installed in Finland before 2010 do not provide real-time data on consumption. Two-way communication is ensured by a behind-the-meter device installed by Fortum Spring, providing real-time consumption

information (it reads the smart meter LED display) and allowing a direct control of the flexibility means;

- Today, communication is ensured via 2G and 3G technology. Ericsson is also testing 5G solutions. Because of the low latency and its high reliability, the 5G technology is expected to facilitate the aggregation and coordination of many flexibility sources.
- Since Fortum is also the supplier, there are no issues regarding the definition of the baseline and compensations.

BMs 1 & 2 – Aggregation in Spain

Case Study 1

Where	***What***	***Who***
Spain	Aggregation in Spain	Endesa, Som Energia

Aggregation in Spain is still in the preparatory phase. Currently, few demonstrations were launched under EU financed grants. Under the umbrella of the FLEXICIENCY project, Endesa put in place a demonstration in the city of Malaga from August 2015 until January 2019. Owning a microgrid a service provider was able to aggregately provide flexible services to the DSO. Another demonstration is in place by Som Energia under the FLEXCoop project (EU financed) is launching a platform to provide aggregation services.

Highlights

- In Spain, the ancillary service markets are quite competitive because of the large amount of flexible generation, so prices are relatively low;
- The only demand-side participation currently available in the Spanish market is through the so-called interruptible service, procured by the TSO via auctions, closed to very large customers;
- The TSO is currently in the process of implementing the Balancing Guidelines, contemplating the participation of demand only in the manual Frequency Restoration Reserve (mFRR) market. So far the considered participation is limited to individual demand, not to aggregation, with minimum bid size expected to be 1 MW.

BM 1 & 2 – Aggregation in Italy

Case Study 2

Where	***What***	***Who***
ITALY	Aggregation in Italy	Terna and DR providers

Aggregation is in the scaling up phase with full opening of Italian balancing and ancillary services markets expected in 2020. Following a decision of the Energy

Authority back in 2017, the Italian TSO (Terna) launched different pilot projects that will be substituted by a full operational market in the next future.

These projects were designed to include the contribution of aggregated consumption and production for providing flexibility services. Firstly, the TSO tested the opportunity of production only and consumption only assets to provide services. The UVAC program was launched in the second part of 2017 and it targeted consumption assets, while the UVAP one, operative at beginning of 2018, was realised to allow generation assets into the balancing market. These two programs are now closed, while the UVAM project, targeting consumption and production assets (including EV charging Infrastructure), has awarded the capacity able to participate to the balancing markets for 2019.

Highlights

- The national regulatory authority implemented a number of balancing markets pilot projects:
  - UVAC (not active anymore) enabled aggregated units of consumption as well as behind the meter generation including behind the meter CHP. The pilot projects included forward product provided as capacity payment in addition to the energy payment implemented in summer period of 2017, and a similar winter product implemented between 2017 and 2018. Units participating in this program should have been able to reduce consumption for at least three consecutive hours and react in 15 minutes at maximum;
  - UVAP enable purely generation product that could just gain energy payment and not capacity payments. Among the technical requirements foreseen by the implementing regulation, it is important to notice that units should have been able to reduce consumption for at least three consecutive hours and react in 15 minutes at maximum. On top, each unit should be equipped by an appliance that can provide validated data every 4 seconds;
  - The latest pilot project (UVAM) involves consumption, generation and storage (ARERA Decision 111/06);
  - In autumn 2018, regulator created rules to substitute with UVAM – possible to put industrial loads and behind the meter and also storage;
- The CRM design foresees aggregators participation to this market, as stated in its funding directives. However, it was designed possibly misunderstanding what DR can or cannot do. As a result, while on theory it foresees the participation of aggregators, in reality its technical requirements forbid it and they favour only large load from industrial sites.
- This market has been constructed on a prequalification procedure based on paperwork. TSO is required to acquire information on data flows and ex ante characteristics of the units. In this setting, customers would need a second SM to participate to DR, e.g. the appliance used by generation units in the UVAP to validate data.

4.4 Customer Data Analytics

General description

Energy companies are adapting to the current transformation of the retail market, from commodity sales to service-based offerings, towards customer-centric business models. Energy suppliers and utilities are starting to prioritise customer engagement, seen as a source of real competitive advantage allowing to accurately target customers with cross and up-sell offers and as the route to compelling commercial opportunities, such as customer acquisition, retention and the ability to predict customer churn before it happens.

Extensive customer engagement activities relies on generating intelligent and usable energy insights extracted from customer data, which are becoming the new assets for energy suppliers and utilities. Energy companies have an unprecedented opportunity to take value from the huge amount of data generated from the growing number of connected smart meters and behind-the-meter solutions (sensors, appliances and other devices) installed in commercial, industrial and residential buildings (see UC1).

In this context, energy companies are widely using data analytics to process their customer data to better understand their behaviours and evaluate how to engage with them. These techniques harness customer data, looking at constantly changing patterns of behaviour and predicting future outcomes. There are different types of data analytics, each one finding its specific application when applied to energy customer data:

- *Descriptive analytics* show periodic energy consumption patterns, presented in currencies or kWh, which can be disaggregated into electrical appliances. This can be presented as comparison data and drilled down into yearly, monthly, weekly, daily and hourly representation.
- *Diagnostic analytics* help users identify potential "energy leaks" and/or possible sources of energy theft. This type of real-time alerts allows immediate actions.
- *Prescriptive analytics* inform users of current consumption that is higher than average, and can highlight whether it may be feasible to upgrade or replace a device to achieve higher efficiencies. This allows personalised and targeted engagement with the user.
- *Predictive analytics*, when combined with external data such as weather forecast, can tell users that their energy consumption is likely to change. As a result, they allow to customise marketing communications to include recommendations of alternative energy savings to prevent high bill surprises.

Energy insights are important means to drive engagement as they are key to keep, acquire and grow the value of energy customers in a highly competitive market. In this regard, the digitalisation of the customer relationship is still at early stages in the energy sector, and lags behind other sectors like telecoms, retail and banking.

Providing insights into energy consumption will be a key element of the digitalisation of the customer relationship, while also being a must have for new energy service offers like Energy-as-a-Service (see UC1), EVs (see UC5) or peer-to-peer trading (see UC7).

Energy insights can be grouped into three main categories:

Behavioural insights providing customers with intelligence about how they use energy	Dynamic energy insights	Automated energy insights that automatically personalise home comfort and energy use
• Consumption/cost history/comparisons • Consumption/ cost forecasts • Appliance disaggregation • PV generation/exporting, Battery status, EV charging	• Personalised tariffs • Energy efficiency tips • Budgeting/High bill alert • Appliance fault warnings • Real-time temperature alerts • DR incentives	• Automated time-of-use tariffs • Automated DR • Automated heating • Automated tariff switching

In households where only a smart meter is installed (i.e. in the absence of energy management systems and smart sensors) energy disaggregation methods can be used to convert smart meters data into useful insights. Machine learning algorithms are applied to smart meter data readings to detect individual appliance energy demand. Among them, a commonly adopted method for energy disaggregation is Non-Intrusive Load Monitoring (NILM).

Opportunities

Energy businesses are puzzling over how to best manage and activate the wealth of customer data for their business and customer opportunities. If customers can see the opportunity of their data being used to provide enhanced services and experience, they are more likely to engage with them and accept their use.

It is commonly agreed that the major opportunity energy insights generate to customers is an improved customer experience, which embraces many opportunities for both customers and energy suppliers, mainly in terms of reduced costs and customer churn, namely:

- Greater transparency of energy consumption and spend leads to greater customer understanding and control, resulting in more positive brand sentiment. For instance, if a consumer can see the spend breakdown or how they compare to others, they are less likely to lay the blame of a high bill with the energy supplier
- More frequent and more positive customer experiences for those with energy insights propositions deepen customer relationships and raise the switching barrier
- Proactive communication from the supplier, such as high bill alert warnings, will reduce the risk of negative interactions (e.g. bill shock / first bill surprise).

Customers	Society / Energy system
• Improved customer experience and engagement • Cost and energy savings • Familiarity with market dynamics and energy efficiency programmes	• Optimising (reducing) energy consumption • Changing behaviour as a cost-effective way of cutting carbon emissions

Business models

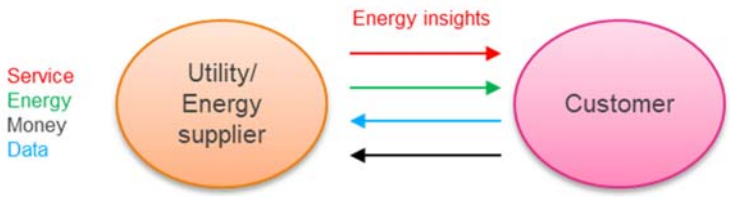
In order to extract the value of customer data for customer engagement, energy suppliers can either directly provide energy insights to customers (B2C) or have the service provided by energy data analytics companies (B2C). These two business model have been hence analysed.

	1 B2C customer engagement solutions	2 B2B customer engagement solutions
Description	• In-house platforms developed by energy suppliers or utilities in order to extract and provide customers with energy insights coming from their data	• Energy data analytics companies provide platforms and services to energy businesses to help them better harness customer data for energy insights • Software only solutions (Software-as-a-Service (SaaS)) or solutions with hardware provision
Key actors	• Consumers / Prosumers • Utilities / Energy suppliers / Retailers	• Consumers / Prosumers • Utilities / Energy suppliers / Retailers • Service providers

BM1 – B2C customer engagement solutions

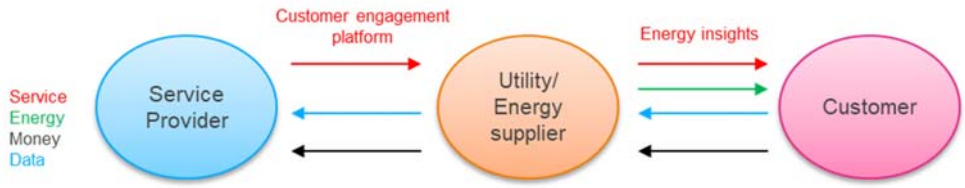
Some utilities and energy suppliers are using behavioral science and data analytics to develop solutions capable of exploiting the wealth of their customer energy consumption data. They provide customers with compelling energy insights as a service to improve customer experience and thereby achieve greater customer engagement, trust and loyalty. These most commonly include charts on energy use over time, disaggregated appliance information, and tailored tips to reduce consumption.

Some recent acquisitions of data analytics companies by large energy company groups demonstrate the strategic importance major energy businesses are placing on customer insight and analytics. A notable example is the Dutch energy company Eneco group that has recently acquired a small UK-based energy data analytics company ONZO.



BM2 – B2B customer engagement solutions

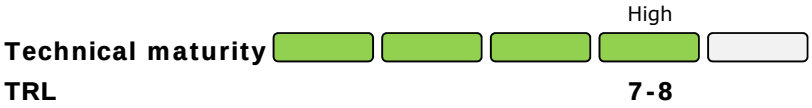
Some utilities are making the strategic decision to buy from external vendors platforms and services in order to provide customers with energy insights to drive better engagement. Over the last years, there has been a proliferation of dedicated platforms and services seeking to help energy businesses better harness customer insights. They mainly consist in solutions proposing both a software and hardware elements, or software only solutions (Software-as-a-Service (SaaS)).



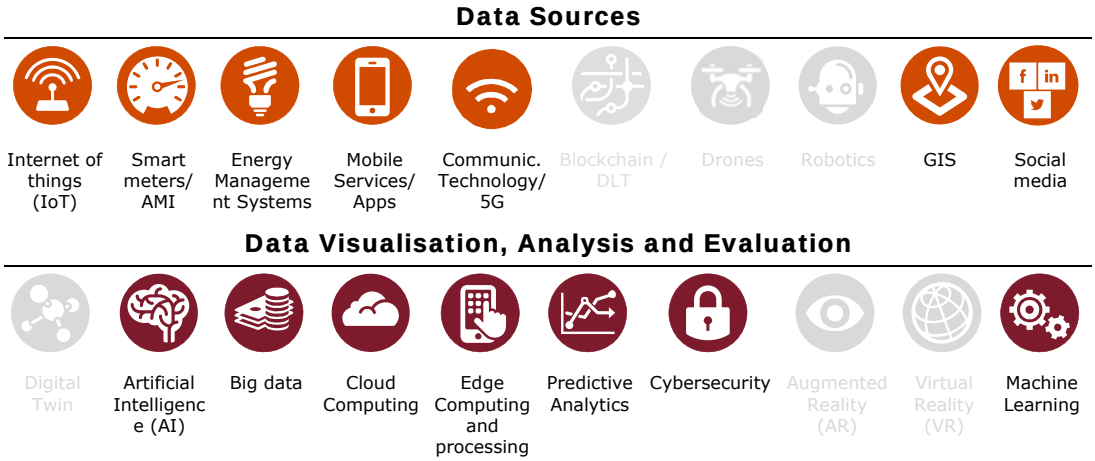
Technical maturity

Overall, the technical maturity of the use case is assessed as high (TRL=8), as the technical processess and systems to support BMs' commercial activity are in ready state, but still not on 'general availability' for all energy consumers (TRL=9).

Customers data used for data analytics are generated from smart meters, Energy Management Systems and IoT solutions. Data analytics can be combined with Artificial Intelligence (AI) using machine learning algorithms to provide advanced services.



Key enabling digital technologies



Data management

Customer energy related data includes measurements from meters, boilers, thermostats, solar PV, batteries, and even electric vehicles. Overall, there is potential for a great deal of customer data to flow into energy companies, encompassing all manner of variables such as personal details, household metrics, energy consumption values, and information collected by connected devices.

Energy service companies use non-validated near real-time consumption data collected from connected home devices to provide the services described in this use case. Smart devices are connected together and linked to the smart metering signals via Home Area Networks (HAN).

The maximum time granularity of available smart meter readings determines what potential is at the disposal of consumers to optimise their consumption patterns. Usually, the granularity determines the type of time-of-use products that can be offered to consumers. The maximum time granularity for consumption data stored in the smart meter varies across MSs. The most commonly used granularity is 15 minutes, followed by 30 minutes and few MSs where it is 1 hour.

On the other hand, the most technologically advanced home devices can provide a very high data granularity, down to the level of microsecond measurements of power consumption patterns and actions.

The spread of smart meters and other in-home connected devices makes customer privacy and their data protection and security big issues to be properly tackled with highest priority (**Key Issue #1 and #2**). These devices could indeed represent the entrance gate to get a privileged access to the digital domain of a household and to customer private life. In order to ensure the security of these devices, they should be certified under cybersecurity schemes. Certifications shall include not only ICT products and services, but also data management processes, looking at the whole service provision life-cycle (see Section 5.3.1.1).

Customer energy related data can be intuitively seen as personal data, having been harvested from within people's homes. Despite this consideration, a clear qualification of final customer energy related data and express definition of which customer energy related data has to be strictly regarded as a personal data and thus fall under the scope of GDPR is missing (see Section 5.2.1.1).

Managing customer data is critical to the creation of a personalised experience, but energy companies entering into those businesses should be careful when engaging with their customers, as there is a fine line between improving the way they interact with them and intrusion (**Key Issue #3**). In this respect, final costumers' trust and confidence are crucial, as without proper guarantees on data protection, consumers are likely to be reluctant to take risks. It is in fact essential that consumers are provided with clear and transparent information and have access to trusted mechanisms to manage their energy data and create value with it, while being in complete control of their private environment and behavioural habits. If customers can see the opportunity of their data being used to provide enhanced services and experience, they are more likely to accept its use.

This will necessitate energy companies to adopt a robust data management strategy with a clear allocation of responsibilities, which ensures all relevant data sources are captured, stored and analysed in a secure way.

Consumption data requirements

Stakeholder access to data	Validated (V) or non-validated (NV) data	Near-real time (RT) or historical (H) data	Granularity	Aggregated data (A) or by usage (U)	Communication requirements
☒ Customer ☒ Supplier or ESCO ☐ DSO ☐ Other	☐ V ☒ NV	☒ RT ☐ H	☒ minute or less ☒ 15min ☐ hourly ☐ more	☒ A ☒ U	☒ 2-way ☐ link with market data ☐ none

Market maturity

Over the last years, some far-sighted energy suppliers have been investing in energy insight tools, while some large energy company groups have made recent acquisitions of data analytics companies. From our analysis, evidence was made that at least one energy insight tool is now available in several European markets (e.g. France, Spain, Germany, Estonia and Netherlands) with a maximum of 2-3 suppliers offering it. For this reason, the market maturity of both BMs can be assessed as high (MRL=8).

European energy retailers are quite active in improved customer profiling for retention, upsell or loyalty programmes, or using smart meter data in customer engagement programmes (e.g. E.ON, Endesa, Enel, Iberdrola). More could be done in generating bill itemisation through disaggregation, step changes in fraud detection programmes, and integrating smart meter data with customer service initiatives

Moreover, in both BMs, customer engagement solutions need a smart meter as essential condition for the service to be provided, so that their penetration in European markets strongly depends on the status of electricity smart meters deployment across the Member States.

Among MSs, Sweden and Finland were amongst the first European countries to complete their smart meter rollout. Swedish and Finnish energy suppliers provide advanced energy insights to their customers, by accessing hourly data from the smart meters. Italy was the other country to complete it but no clear proposition for energy insights has been spotted. In the Netherlands and France, instead, Eneco and Engie have decided to anticipate the Dutch and French smart meter rollout, by offering sub-metering devices. These are compatible with both traditional and smart meters and can provide relatively sophisticated analysis of their customers' energy consumption.

BM1 – B2C customer engagement solutions

Currently, a majority of medium and large energy suppliers have an app to allow customer to see and pay their bills and to enter their meter readings (e.g. EDF, Endesa, Eesti Energia). Some companies providing this app also provide some energy insights based on the meter readings. These are often very basic propositions,

comparing the monthly consumption and giving generic tips to save energy. For instance, EDF (France) has created an energy insights platform for their customers called 'e.quilibre' (see case study).

Newer and smaller suppliers (e.g. GreenYellow, Powershop) are more agile and provide a fully digitalised customer experience with energy insights at the heart of it. The remaining slow-starter energy suppliers are at least doing trials with energy insights.

From the BM analysis, it can be concluded that the sophistication of energy insight tools available in the European markets is still generally quite low, which means for major suppliers having to strongly compete to stay relevant in this dynamic sector, while means for large and smaller suppliers having still room to compete with those basic offers. In this context, new entrants can learn from early movers and compete on the sophistication level to leverage competitive advantages. The following energy insight propositions are currently the most sophisticated ones available on the European market (Delta-ee):

- Consumption forecast, sometimes on a daily basis (e.g. EDF France)
- Consumption comparison with similar homes or even sometimes with actual customers (e.g. E.ON)
- Tailored energy efficiency tips (e.g. Essent), although most propositions remain quite generic on these recommendations
- Budgeting features with alerts when the consumption is forecasted to be higher than budgeted (e.g. Fortum). In some rare cases, this is even linked to the smart thermostat to adjust the heating accordingly (e.g. EDF's Sowee)
- Disaggregation of appliances. Most of these features come from estimations based on stastistical models and a few customer inputs (e.g. Electric Ireland). The most advanced ones do provide an actual disaggregation tool by using load signature recognition (e.g. Engie, Iberdrola) or smart plugs (e.g E.ON, Vattenfall).
- Ability to monitor solar PV generation (e.g. Eneco), while Vattenfall goes beyond this and automates the lighting based on the excess of PV generation.
- Electric vehicles as a niche product today with high potential demand. EDP is already offering consumption monitoring for charging an electric car.
- New energy business models such as peer-to-peer-trading (e.g. Powerpeers) are offering energy insights as part of their solution (see UC7).

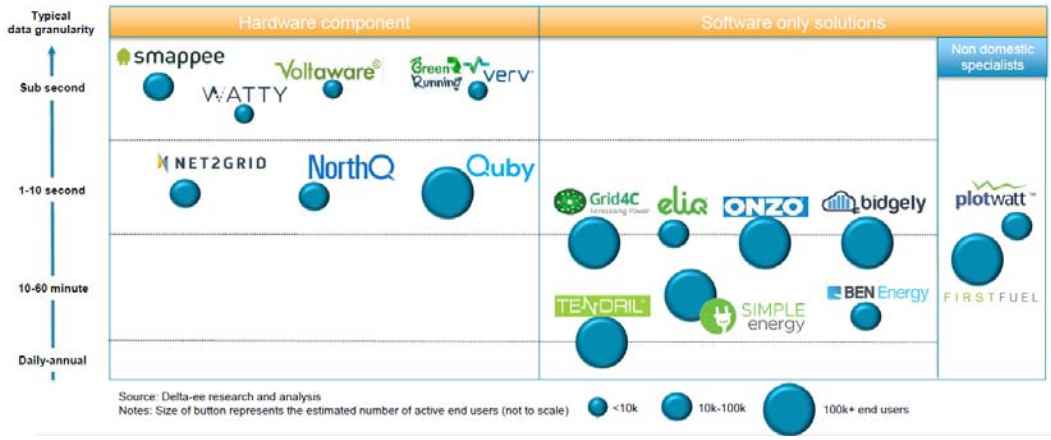
In this context, where customer data are becoming the new assets for energy suppliers and utilities, data monetization is becoming increasingly a critical topic for energy companies (**Key Issue #4**). Utilities may have significantly more and more opportunities to monetize the value of data, which can be grouped into mainly four strategic options, according to a study made by the research and consulting company Delta-ee (Delta-ee, 2018).They can be categorised by generating operational efficiencies, developing existing or new products and services, entering new markets or directly monetisation. Each of these forms of data monetisation can bring opportunities of cost reduction, operational opportunities and new revenues.

The BMs analysed in this use case use direct monetisation strategies. While these can offer regular revenue potential, there are significant legislative and data privacy challenges to overcome (see regulatory feasibility).

BM2 – B2B customer engagement solutions

In this BM, the service providers market is broadly split by hardware/software solutions and data granularity dimensions. Energy companies need to balance scale with sophistication in shortlisting a vendor's solution.

Software only solution (SaaS) shave greater market maturity and are scalable to an entire customer base. Solutions that contain a hardware element are likely to be better suited to paying or higher value end users, but the greater sophistication can open up more personalised engagement opportunities. Some of the software providers also work with more granular data, so a hybrid option becomes possible.



(Source: Delta-ee, 2018)

Some solutions require having a smart meter installed as a prerequisite/essential condition, like those offered by Net2Grid, Verv and BEN Energy, while other solutions do not need a smart meter installed to provide the service offered (e.g. Bidgely, Eliq and Onzo).

Among companies offering SaaS solutions to EU energy companies, notable examples include Bidgely, Onzo, Eliq and BEN Energy.

Bidgely is a global SaaS provider of residential customer engagement solutions to utilities, with personalised appliance disaggregation at the heart through machine learning. Bidgely has commercialised disaggregation technology to widescale deployment and its customer engagement platform allows energy distributors and retailers to increase customer satisfaction and meet energy efficiency and demand response goals.

The software company Onzo provides data analytics to utilities to help them providing advanced energy insights to residential customers with detailed bill breakdowns, personalised appliance-level energy advice with actionable tips on how to save energy & money and early identification of potential appliance faults (for more details see the case study).

Among companies offering hardware/software solutions, the Dutch company Net2Grid proposes a multiple-device solution to be connected to a smart meter. This solution includes both a hardware called 'SmartBridge' that pulls the correct information from the smart meter and shows it on an app and/or dashboard, and the online service Ynni, which analyses customer data and can measure how much energy

is consumed by individual appliances in the home (for more details see the case study).

Another example of hardware/software solution is provided by Quby (owned by Dutch utility Eneco), which has added a 'Waste Checker' feature in its application for their Toon smart thermostat. This feature uses smart meter data for demand disaggregation and offers personalised customer advice. Insights also highlight the savings available for replacing old inefficient appliances.

BM	Presence on the market	Countries	Enablers / Barriers		Area
1	Service available on the market		Electrification of heating	+	
	Low penetration level		Although Italy is among the first EU countries to have completed smart meter roll-out, no clear proposition for energy insights has been spotted on the market	−	
2	Service available on the market		Smart meters roll-out almost completed (expected by the end of 2020)	+	
	Service not available on the market		Smart meters roll-out still at early stage	−	

Considering what above, the market maturity evaluation is high.

Regulatory feasibility

From our analysis, customer data protection, privacy and security have been identified as the major issues to be tackled by energy companies, when treating data of their customers. They must take this responsibility seriously, and, in order to get customer trust, they need to give proper guarantees on data protection and be transparent with customers about what they collect, why they collect it, and how they use it.

In this regard, the EU has recently reviewed and updated its data protection laws, in the form of the **General Data Protection Regulation (GDPR),** which came into force on 25 May 2018. This regulation increases the obligations on businesses processing customer data, as well as significantly raise maximum penalties for non-compliance. In particular, the regulation will force companies to embrace the concept of 'privacy by design' and ensure data protection is considered at the earliest stage of any strategic project touched by customer data. Consequently, it is vital any energy business seeking to analyse personal data to improve customer experience is aware of and complies with these rules.

As for security issues related to ICT products, currently, a number of national certification schemes exist, as for many years each Member State has been

developing and improving its own ones. This issue has already been tackled in the Cybersecurity Package adopted by the Commission in September 2017, which proposes the creation of a common European cybersecurity certification framework in its 'Cybersecurity Act'. However, the use of the EU cybersecurity certification schemes will be on a voluntary basis as they are not mandatory (see Section 5.3.1.1).

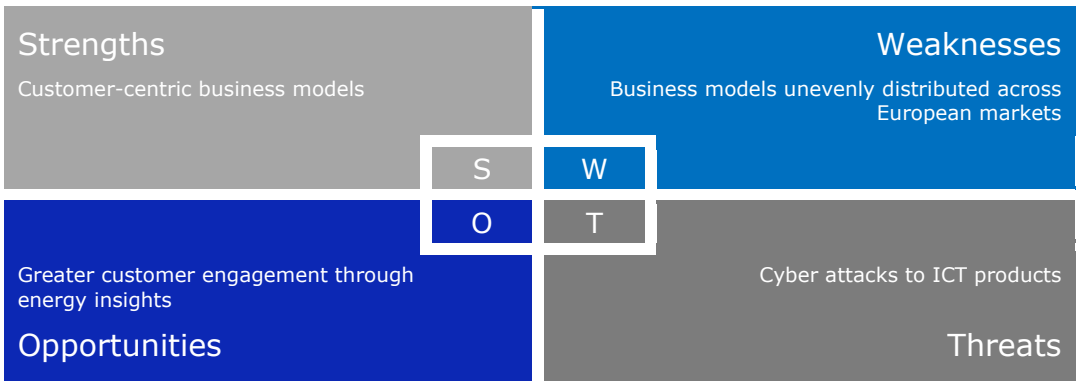
Concerning smart metering systems in particular, specific provisions on final customer data protection and security are given by the recast Electricity Directive (Directive(EU) 2019/944). The Directive embeds relevant GDPR provisions in the new text and tailor those to the needs and specificities of smart meters' implementation and functioning. According to the Directive, MSs should take into account the best available techniques for ensuring smart metering systems and data communications the highest level of cybersecurity and data protection while bearing in mind the costs and the principle of proportionality (Article 20(b) and Annex II), when performing the economic assessment of smart meters roll-out. This can be considered as clear reference to the 'privacy by design' and 'cybersecurity by design' concepts (see Section 5.2.1.1).

Regarding customer privacy, with the aim of guaranteeing a high level of privacy rules for all electronic communications, the Commission's proposal for an e-Privacy Regulation is currently in the legislative process in the European Parliament and the Council. When entering in force, it will protect confidentiality of electronic communications and the devices. In particular, when communications include personal data, the general rules of the GDPR apply, unless the e-Privacy will lay down more specific rules (see Section 5.2.1.1).

Regulatory feasibility is therefore assessed as medium since a European regulatory framework for data protection and privacy is in place, but due to the recent adoption of the GDPR, the majority of energy companies is still struggling to become fully compliant with them.

Regulatory feasibility Medium

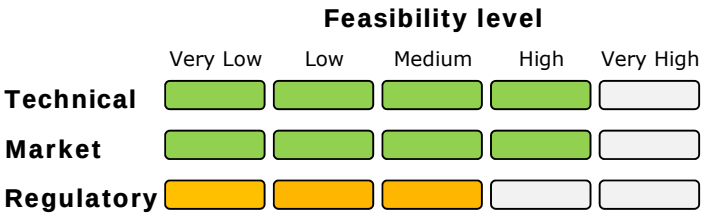
SWOT analysis



Overall evaluation of UC feasibility level and key issues

Summarising all the considerations made around this UC, the overall assessment, reported below, shows that customer data analytics business models could mainly suffer by privacy and cybersecurity issues the current regulatory framework is addressing, with the limits shown in the analysis, which may advice additional actions to be taken.

Implementation status



Key issues

Following the order of appearance of the key issues identified in our analysis, the table below presents a summary which helps linking such issues with the policy/regulatory actions needed to overcome them and allow a wider development of customer data analytics models.

Key Issue	Description	Type of Issue

1. Customer privacy and data protection	• Privacy issues (transparency on information use by service providers)
	• Data protection challenges are mainly related to:
	  • Qualification of final customer energy related data
	  • Data management and allocation of responsibilities
	  • Rights of the data subject	

2. Cybersecurity of ICT products	• Costumer concerns on their security in terms of risk of cyber attacks through ICT devices	
3. Lack of customer engagement	• Lack of awareness/information, especially among residential consumers • End user willingness to engage with energy management gaming systems is relatively low due to limited perceived opportunities	
4. Data monetisation	• If not used to feed other services (energy management, demand response, etc.), data are difficult to monetize, especially if customers do not allow to let them to third parties • Some market operators are launching offerings to share data monetization potential between customers and providers (e.g. Weople, People.io), which can help removing development barriers.	

Preliminary identification of enabling policy/regulatory actions

In order to address the identified different issues, the following policy actions could be taken.

Key Issue #1: Customer privacy and data protection

Policy actions at EU level by 2030:

- *Consistent Governance scenario*: the Commission could provide a clear definition of which energy related data has to be strictly regarded as a personal data and thus fall under the scope of GDPR to ensure a consistent interpretation across member States. Then, assess what are the implications on the energy market. (see Section 5.2.1.2).
- *Reinforced Legislation scenario*: the Commission could provide a common guidance for the allocation of GDPR roles and responsibilities to the actors involved in smart metering systems personal data processing. (see Section 5.2.1.3).

Key Issue #2: Cybersecurity of ICT products

As for customer concerns on their security, although actions have been already taken to support the creation of a EU-wide cybersecurity certification framework in the 'Cybersecurity Act', further actions can be taken to support their implementation. According to the 'Cybersecurity Act', the use of such EU cybersecurity certification schemes is not mandatory, but will be indeed on a voluntary basis.

Policy actions at EU level by 2030:

- *Consistent Governance scenario*: the Commission could provide incentives to support the application of the schemes as well as sanctionatory measures in case of failure to adopt current legislation (as done by GDPR and Telecom Package) (see Section 5.3.1.2).

Key Issue #2: Lack of customer engagement

Policy actions at MS level by 2020:

- *BAU scenario*: national awareness-raising programmes could be conducted including communication campaigns providing customers with clear and accessible information, as suggested by the proposal for the New Deal for Consumers

Case studies

BM1 – B2C customer engagement solutions

Case Study 1

Where	*What*	*Who*
FRANCE	Platform "e.quilibre"	EDF

EDF (France) has created an energy insights platform for their customers called 'e.quilibre'. The platform aims to help EDF customers understand and act on their consumption by providing breakdown analysis and encouraging engagement with regular notifications sent to a customer by email or text message. The notifications can help customers engage more to understand and act on their consumption.

Highlights

Customers are empowered to:

- Track their energy use by analysing their electricity consumption in kWh and in euros
- Compare their consumption to similar homes
- Get personal advice on which devices consume the most in order to make energy savings

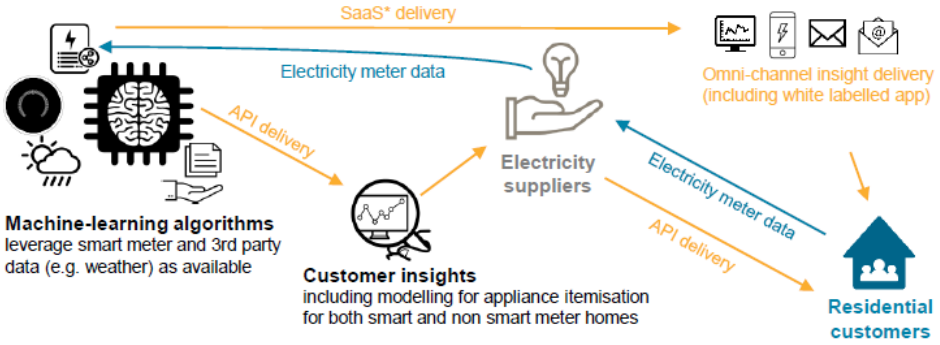
BM2 – B2B customer engagement solutions

Case Study 1

Where	***What***	***Who***
EU	SaaS solution offering B2B residential customer engagement solutions	bidgely

Bidgely is a global SaaS provider of residential customer engagement solutions to utilities, with personalised appliance disaggregation at the heart through machine learning. Bidgely has commercialised disaggregation technology to widescale deployment and its customer engagement platform allows energy distributors and retailers to increase customer satisfaction and meet energy efficiency and demand response goals. To do this, Bidgely is implementing an AI-based approach to help utilities harness their massive amounts of data and create a scalable, more personalized experience for their customers, starting from customers clustering.

Bidgely key clients in EU: E.ON, Innogy



(Source: Bidgely, 2018)

Highlights

- Software-only solution (SaaS) which applies machine learning to utility meter data to itemise the amount and cost of energy used by various home appliances to provide dynamic insight and personalised tips, alerts and forecasts
- It covers all homes including non-smart meters by enhancing meter data with models from smart meter home matching and (where available) customer survey input.
- No need for plug-level sensors or in-person audits
- Provides omni-channel delivery options to enable customisable end-user contact by utilities

Case Study 2

Where	***What***	***Who***
NETHERLANDS	SaaS solution offering B2B residential customer engagement solutions	

ONZO is a global leader in big data and analytics for utilities. ONZO delivers valuable insight from the analysis of big utility data and helps utilities apply this insight in transforming customer relationships, improving energy efficiency, shifting peak demand and offering new energy services while reducing operational costs.

ONZO provides a SaaS medium through which utilities can engage their customers, with capability to select and target message content to individuals, while providing useful information to the home owner about their energy use. Customers receive information that educates and informs them about their existing use and notifies them of changes to provide: Control, Comfort & Convenience.

Greenchoice are the leading energy supplier in the Netherlands who supply 100% renewable energy, which is sourced securely from local and traded generators.

ONZO are working with Greenchoice on their BOKS product which is transforming the way Greenchoice communicate with their customers in their mobile app. BOKS, using ONZO's analytics, helps their customer's identify which groups of appliances are using more energy than others and enables them to plan and take action to manage their energy bill better.

Highlights

Key Opportunities to the Utility

- Improve customer relationships & trust by delivering personalised content that explains and describes monthly expenditure, removing obscurity around bills.
- Increase communication uptake and relevance through targeted messaging for campaigns and services.
- Reduce cost to serve by providing self-service capability to customers to avoid bill shock and resulting in-bound calls.

Case Study 3

Where	***What***	***Who***
FRANCE	SaaS solution offering B2B residential customer engagement solutions	

Eliq is one of the pioneers in intelligent energy monitoring, providing solutions to help households fully understand and manage their energy consumption. Eliq provides a SaaS-based solution for monitoring and optimising electricity use to gain a better understanding of your customers' energy usage patterns. Eliq is already partnering with a number of progressive utilities in Europe, including Greenyellow in France.

Highlights

App (interface or platform) and cloud solution

- Eliq Energy Engagement App engages with utility customer by tracking their energy usage and generation based on data from electricity meters and Internet of Things (IoT) devices (e.g. sensors). The App collates meter readings, tariffs and customer billing information from the utility company, with weather and smart home data from 3rd party integrations. Eliq maintain and regularly update the App for optimum customer engagement;
- Delivered as a white label product enhances the perception of trust by the end-users. Features and design are also customisable within six weeks of implementation;
- Eliq use Microsoft Azure to create data-driven, intelligent apps in order to create new experiences that scale, and support deep learning, and real-time analytics on any shape and size of data.

Case Study 4

Where	***What***	***Who***
NETHERLANDS	Integrated end-to-end solution based on multiple devices (hardware and software)	NET2GRID

The Dutch company Net2Grid proposes a multiple-devices solution for energy insights to be connected to a smart meter:

- **SmartBridge:** hardware that pulls the correct information from the smart meter and shows it in the app and dashboard
- **NET2GRID app (Ynni):** the NET2GRID app can be downloaded for free, it gives real-time insight into your energy and gas usage in day, month & year charts
- **SmartBridge.local dashboard:** computer dashboard available to check data (http://smartbridge.local)

(Source: Net2Grid)

Highlights

- The online service Ynni provides detailed, real-time insight into energy consumption and costs. Ynni analyzes customer data and can measure how

much energy is consumed by individual appliances in the home. Thus, energy waste is reduced and customers are always in control of their energy consumption and bills.

- The efficiency of each appliance is calculated and monthly energy consumption is disaggregated into categories. Ynni gives insights in the consumption per appliance which can be compared with previous months, or against a benchmark of similar households.
- The results of any changes in energy usage are visible immediately. For example, Ynni can show the impact of turning down the heating, turning off electrical appliances which aren't in use, switching to led lights, replacing an old washing machine or insulating your home.

Product features	
Ynni App	SmartBridge
• Real-time insight in power usage • Historic energy and gas usage • Day, month & year charts • No account or subscription required • Data won't leave customer house • Only works when connected to home Wi-Fi • Only works together with SmartBridge Wi-Fi • Works with all energy suppliers	• Works with all smart meters without external power supply • Universal power socket for Legacy meters • Plug and play installation supporting WPS and AP mode • 5 years local storage • Open Source LAN API • 100% data quality 10 second data • 1 hour buffer compensating WiFi problems • WiFi friendly neighbor support • GDPR compliant • Encrypted data

Case Study 5

Where	***What***	***Who***
GERMANY	SaaS solution offering B2B residential customer engagement solutions	BEN Energy

BEN Energy offers an Energy Analytics Platform called *Smart-Meter-Toolbox*, which provides insight into customer behaviour and services from smart meter data. The *Smart Meter Toolbox* provides valuable customer knowledge to utilities, which is obtained directly from the smart meter data. The smart meter toolbox is rounded off by personalized services such as the dispatch of personal energy reports or individual consumption warnings. The Smart Meter Toolbox allows utilities to either use their own standalone dashboard or conveniently integrate customer knowledge into their internal systems, such as CRM.

Highlights

Smart Meter Toolbox main features

- Identification of household properties
- Determination of customer characteristics

- Load curve clustering (away from H0) and detection of the base load of individual households
- Recognition of unusual consumption - for both high and low consumption
- Identification of suitability for PV / storage of individual households (including battery configuration)
- Determination of energy efficiency potential of individual households and their origin
- Identification of relevant consumers in the household

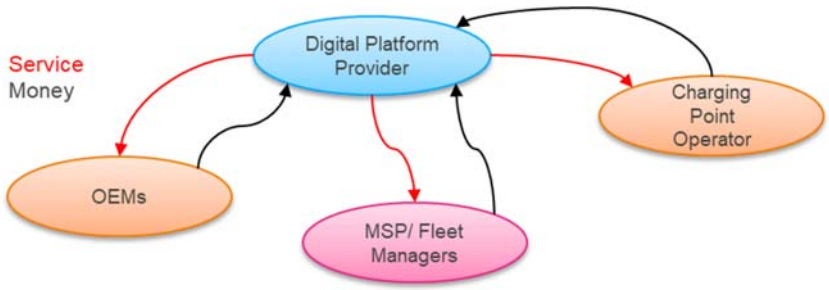
4.5 Smart EV charging and charging management

General description

Digital technologies, together with electrification, have a major impact on the transport sector and its increasing synergies with the power sector. The use case definition explores these synergies by focussing on EV charging and smart charging in particular. Availability of public and private charging is a precondition. This includes (ultra-)fast charging, even though slow and private charging will perhaps still prevail and remain most relevant for smart charging. Smart charging of electric vehicles (EVs) assumes some form of control of the EV charging process, allowing EVs to become a flexibility source for the power system ('batteries on wheels'). The use case covers both unidirectional 'V1G' smart charging and bidirectional 'V2G', i.e. vehicle-to-grid, business models.

Furthermore, smart charging potential will be affected not just by shifting from fossil fuels to electricity, but also by shifting in the mobility paradigm as a whole: from individual car ownership to car-sharing or other co-ownership models. Companies from different industries are racing to resolve the remaining technical and regulatory challenges for self-driving vehicles. Fully autonomous driving (so-called Level 5) is estimated to start implementation at scale in the 2030s (Litman, 2019). These evolutions imply that the smart charging business models will be increasingly connected with emerging mobility business models of B2B and B2C fleets. Platforms for EV fleet and charging management will also manage smart charging as one of the important functionalities already in the short term.

Until recently, EV charging business predominantly focused on hardware sales of mainly charging points and vehicles. Digitalisation marks further shift to data-driven and service-based business models. It increasingly facilitates the management of charging assets and services for both charging point operators (CPOs) and mobility service providers (MSPs) communicating through digital plaftorms. CPOs operate, and in some cases own a pool of charging points and make sure that the network works smoothly. They collect data for diagnostics, maintenance etc. MSPs help EV drivers find charging stations, activate charging, design pricing plans and arrange payment, billing and e-roaming. They could provide services to individual customers but also to fleets. In practice, some CPOs can also offer MSP services (e.g. Fortum). However, those CPOs might still be interested in providing access to their charging points also to other MSPs. The digital platform needed to enable communication between the different parties involvedis most likely to be operated either by CPO or MSP, as it can be already observed in the European (see Finnish case study below) and the U.S. markets. The digital platform can also provide useful data to Original Equipment Manufacturers (OEM) in the automotive industry on operations of their assets and improve the design loop. The graph below illustrates the case of an independent digital platform provider, to highlight that it can provide services to the three other parties (CPOs, MSPs and OEMs). As stated above, in practice, these parties may belong to a single entity.



CPO – Charging point Operator
MSP – Mobility service provider
OEM – Original Equipment Manufacturer

Opportunities

The main opportunities of smart charging include cost savings and/or additional revenue streams (V2G business model) for the consumer. Opportunities for the energy system are energy consumption optimization by evening the demand peaks and providing services to TSOs and DSOs. More detailed explanations on the specific opportunities of each business model are also provided in the UC on flexibility (**Error! Reference source not found.**) and in the policy scenarios (5.1).

Customers	Society / Energy system
• Energy cost savings (off-peak charging) • Additional revenue streams by providing ancillary services to TSOs and local services to DSOs • Backup power source & resilience • Access to electric mobility via sharing	• Energy cost savings • Avoidance of local grid issues • Higher RES shares through better integration • Provision of flexibility (closely related to UC3)

Business models

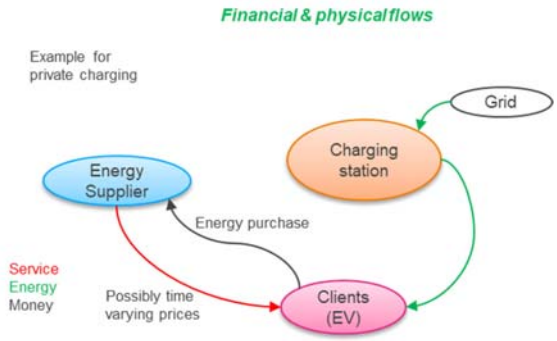
The two business models studied in this report are unidirectional 'V1G' smart charging and bidirectional 'V2G' (or 'V2X', including Vehicle-to-Home, V2H and Vehicle-to-Building, V2B) smart charging. Different actors could help customers to valorise the potential, either individually or within commercial (i.e. B2B) and retail (i.e. B2C) customers' fleets.

	1 'V1G' Smart Charging	2 'V2G or V2X' Smart Charging
Description	• Adjustment of the rate of charging (unidirectional) • Includes control of charging from distance and modifying it according to selected indicators (e.g. power prices, flexibility needs, etc.) • Can be part of a Home Energy Management System (HEMS), see UC1.	• Vehicle-to-Grid (V2G) includes services to the grid by charging/discharging the EV battery. It can be used to provide TSOs with ancillary services (balancing, frequency control) or to address local grid issues faced by DSOs. • V2X covers Vehicle-to-Home (V2H) and Vehicle-to-Building (V2B), where EV batteries are used as a flexible behind-the-meter asset for local energy optimization
Key actors	• EV manufacturers • TSO & DSO • Mobility service providers (MSP); charging point operators (CPOs), digital platform providers/operators • Energy suppliers • Aggregators	• EV manufacturers • TSO& DSO • Mobility service providers (MSP); charging point operators (CPOs), Platform providers, • Energy suppliers • Aggregator

BM1 – V1G Smart Charging

By adjustment of the time and rate of charging, V1G business models enable EV owners to charge their vehicle following variable (wholesale) electricity prices and, therefore, save on their electricity bill. In such a way, the overall system costs can decrease, as consumers are incentivised to charge their EV during off-peak times. In the future, smart charging is expected to comprise also services delivered for transmission and system operators, meaning that V1G and V2G business models will converge.

Another economic driver for V1G business models is the own consumption optimization by a prosumer: EVs are charged in times of excess local (PV) production. Naturally, V1G can be a feature of a Home Energy Management System (HEMS) as described in UC1.

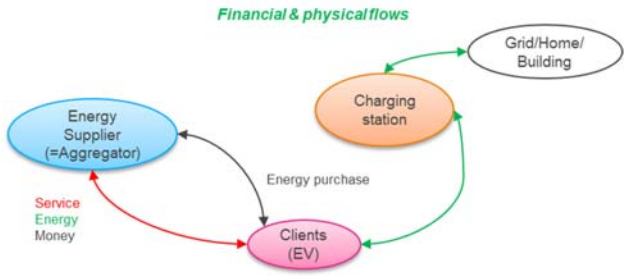


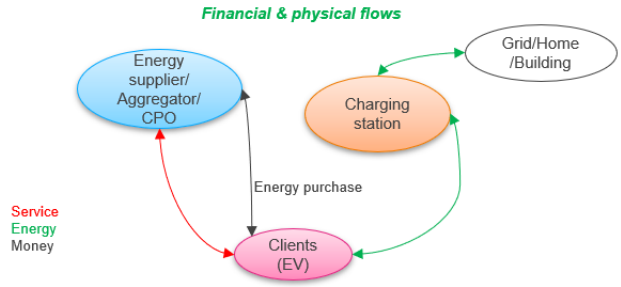
Revenue creation source

Wholesale markets	TSO Ancillary services	Services delivered to DSOs	Cost efficiencies	Subsidies	Behind the meter	Additional payment for green /local	Others

BM2 – 'V2G or V2X' Smart Charging

V2G business models use EV batteries to be active on energy markets and to provide services to DSOs and TSOs. Also, in addition to self-consumption services (BM1), V2H (Vehicle-to-Home) or V2B (Vehicle-to-Building) models can comprise personal power backup services delivered by the EVs. System operators use V2G as an ancillary services provider and as a flexibility source to address local grid issues. Balancing responsible parties can also rely on V2G services. Providing services to parties other than the EV owner (BM1) requires an aggregator to bundle the flexibility from a large number of households with a private charging point and/or from EVs connected to a public charging infrastructure. BM2 can thus be seen as an application of UC3. The graph below illustrates the case of private V2G charging, where the aggregator is the same entity as the energy supplier.





Revenue creation source

Wholesale markets	TSO Ancillary services	Services delivered to DSOs	Cost efficiencies	Subsidies	Behind the meter	Additional payment for green /local	Others

Technical maturity

On average, the TRL of the two business cases is assessed as medium to high. V1G and EV fleet & charging management already have clear market applications and well beyond the pilot phase, i.e. their TRL is high. V2G technology is still in pilot stage around the world, i.e. its TRL is medium. However, interoperability issues prevent the large scale adoption of the models.

In addition, power quality standardisation remains an issue. When EVs are charged, they may disturb the grid and cause a power outage. Power quality standard and charging safety certification exist at the national level in some cases (e.g. Netherlands) but not at the EU or global levels (**Key Issue #1**).

Another common technical issue is that buildings are not sufficiently equipped to ensure the installation of smart chargers. The Energy Performance in Buildings Directive requires that that 20% of spaces in commercial buildings have to be 'pre-wired' (see 1.5 Regulatory framework) but it does not mention installation of smart chargers.

V1G: While for instance, public charging stations already have V1G capability in the Netherlands (ElaadNL, sd), it is not yet standard in other countries. There are also standards like the OSCP 1.0 (Open Smart Charging Protocol), which communicates a 24-hour forecast of the available capacity of the electricity grid and the OCPP 2.0 (Open Charge Point Protocol) supporting a smarter management of the charging stations. In this way, service providers can fit the charging profiles of EVs within the boundaries of available capacity (Open Charge Alliance, 2019).

V2G**:** A first requirement for bi-directional EV charging is a battery that has the necessary characteristics in order to handle this activity. Not all batteries are suitable for V2G, e.g. LMP and Zebra cannot be used to provide ancillary services (Tractebel, 2018). Technological advancements in batteries will therefore define the success of bi-directional EV charging. Optimal charging behaviour may also be obliged in order to keep the state of charge of the battery at a certain optimal range, as increased battery degradation may occur due to frequent charging and discharging. Even though some research has already shown that this could be limited if the battery stays within a certain state of charge (Smartcitiesconnect, 2017), not all car manufacturers cover V2G in their battery guarantee of usually 5-8 years (BNEF , 2018). There are also no standards on the way to measure the SoC. Today, ad-hoc smart charging software connectors are required for this purpose (Tractebel, 2018).

Standardisation for V2G communication (both at the level of charging stations and cars) is still not fully implemented at both the EU and the global level (**Key Issue #1**). However, the development of IEC/ISO 15118 – Road vehicles, Vehicle to grid communication interface – focuses on the overall information exchanges between the parties when energy is exchanged (ISO, 2018). The standard also features plug & charge, a concept that guarantees the safety of data exchanges. Plug & charge also focuses on communication between the EV and the charging point and automatic identification (V2G clarity, 2019). While ISO 15118 focuses on the communication between the EV and the charging station, IEC 63110 focuses on the standardisation of the communication between the physical charging point (infrastructure) and the CPO which manages the charging point (V2G clarity, 2017).

Fleet and charging management: Open API integration is technically possible. It is important to develop complementary functionalities as the applications become relevant in the given market. This is already feasible/envisaged in the emerging solutions. The fleet and charging management business model also includes charging points operation and offering a wide charging network. Hence, interoperabiltiy regarding payment and charging between different charging points is key. A solution to this interoperability in charging and payments issue is e-roaming, which enables users to pay and charge across borders in the EU. Seamless and hassle-free experience is not yet fullly in place. Some innovative solutions based on blockchain that would allow for cross-border charging solutions with direct settlement have also been tested (see Share & Charge case study).

Technical feasibility High

TRL **7-8**

Key enabling digital technologies

Data Sources

Internet of things (IoT) | Smart meters/ AMI | Energy Management Systems | Mobile Services/ Apps | Communic. Technology/ 5G | Blockchain / DLT | Drones | Robotics/ advanced manufacturing | GIS | Social media

Data Visualisation, Analysis and Evaluation

Digital Twin | Artificial Intelligence (AI) | Big data | Cloud Computing | Edge Computing and processing | Predictive Analytics | Cybersecurity | Augmented Reality (AR) | Virtual Reality (VR) | Machine Learning

Data management

For implementing V1G business models, the smart meter needs to support advanced tariff systems. For V2G, real time data flows between the EVs and the grid operators and/or the aggregators are required. Data requirements are similar to the ones identified for aggregation business models in UC3. Fleet & charging management must ensure real time information on chargers and EVs' state. Not only consumption data but also a series of other type of data, such as charging station real time occupancy, tracking of position of cars, etc. Another issue concerning data is the interoperability of communication protocols between different charging points and EVs, as well as the different modes of payment. Global standards must be developed to ensure roaming of charging and payment systems across borders (see Regulatory feasibility).

V1G Smart Charging:

Stakeholder access to data	Validated (V) or non-validated (NV) data	Near-real time (RT) or historical (H) data	Granularity	Aggregated data (A) or by usage (U)	Communication requirements
☒ Customer ☒ Supplier or ESCO ☐ DSO ☐ Other	☒ V ☐ NV	☐ RT ☒ H	☐ minute or less ☐ 15min ☒ hourly ☐ more	☒ A ☐ U	☐ 2-way ☐ link with market data ☒ none

V2G Smart Charging:

Stakeholder access to data	Validated (V) or non-validated (NV) data	Near-real time (RT) or historical (H) data	Granularity	Aggregated data (A) or by usage (U)	Communication requirements

☐ Customer ☒ Supplier or ESCO ☐ DSO ☐ Other	☒ V ☒ NV	☒ RT ☐ H	☒ minute or less ☒ 15min ☐ hourly ☐ more	☒ A ☐ U	☒ 2-way ☐ link with market data ☐ none

Market maturity

The overall MRL of the two business cases is assessed as medium. V1G has a high MRL (8), due to the existing offerings in some markets (e.g. The Netherlands), however it is stilll not deployed universally as the lack of appropriate infrastructure and pricing schemes still act as barriers to the full market adoption of this business model. EV fleet & charging management also has a high MRL (8). There are many operational platforms in the analysed member state markets (see Finland case study) as well as in other EU countries (e.g. by companies like New Motion, Driivz, eMotowerks, EV Box). On the other hand, V2G has a low MRL (3). The business cases for this application can be drawn from the existing pilots. However, no project has reached commercial implementation.

Limited EV market and charging infrastructure deployment inhibits all the three use cases (**Key Issue #2**). It is often referred to as the 'chicken & egg dilemma'. On the one hand, the lack of charging infrastructure acts as a primary barrier to the ownership of EVs in a given location. On the other hand, due to the low number of EVs, public charging infrastructure is not profitable in areas with low EV uptake and businesses see investments in charging as too risky. However, as of September 2018, there are around 5 EVs per public charging point in western and northern Europe, well below the targeted ratio of 10:1. So it seems that the main issue is not the lack of charging infrastructure but more a lack of cars to plug-in (Transport & Environment, 2018).

***V1G*:** The need for smart charging infrastructure as well as incentives that can impact consumer behaviour are key issues for market adoption. Investment costs of new smart charging equipment have to be considered. Regarding energy prices, EV pricing offers with significant price differences between peak and off-peak or dynamic pricing are key to enable adoption of V1G, as stakeholders will view the fast payback of smart charging investment due to the high potential of savings (SEDC, 2017).

***V2G*:** In this case not only is V2G infrastructure needed but also V2G-ready EVs. This business case is still very much at pilot stage (25 pilots) across the EU (Everoze and EVConsult, 2018). A large enabler of the adoption of this model would be the perceived value of providing ancillary services. The prices in these ancillary services markets must be sufficiently high to justify the investments in the V2G infrastructure to stakeholders. Some early projects promise large incentives for EV owners to participate in V2G. In a pilot project undertaken by Nissan and Enel in Denmark, EV owners managed to gain up to 1,400 EUR per year/vehicle from participating in the frequency regulation market (Nissan Newsroom Europe, 2016). Another vector of perceived value is increased resilience brought by V2G, which contributes to the popularity of the concept e.g. in Japan, as the Fukushima disaster pushed to the development of such solutions (Everoze and EVConsult, 2018). In fact, the EV's battery can act as a backup power source and be used in V2X applications.

As the EV penetration in the transport fleet increases, driven mostly by falling battery prices and incentives, and the market for charging point operators in hardware sales and operation and maintenance matures, a transition to a digital platform for charging and fleet and charging management becomes an attractive solution, offered e.g. in as-a-service mode and/or as a whitelabelled solution. Parallel evolution of mobility business models such as car sharing (and in the future mobility as-a-service) further incite EV fleet creation.

BM	Presence on the market	Countries	Enablers / Barriers		Area
1	Service available on the market		Dynamic tariffs, infrastructure deployment	+	
	Service not available / low penetration level		No incentive & not enough EVs	−	
2	Service available on the market (only at pilot level)		Most pilot projects in the EU – favorable funding, developed balancing & ancillary services markets	+	
	Service not available / low penetration level		No incentives & no pilots	−	

V1G Smart Charging:

Market feasibility High

MRL **8**

V2G Smart Charging:

Market feasibility Low

MRL **3**

Regulatory feasibility

Regulatory feasibility is assessed as medium thanks to the Clean Energy package and its upcoming implementation in the Member States. Dynamic pricing and double taxation issues should be addressed in their implementation at the national level (**Key Issue #3**). However, national transposition of the new rules always represents a certain risk (of interpretation in detailed rules, delays etc.). Today, the issue exists even in relatively advanced e-mobility markets like the Netherlands or Finland (see case studies). The medium feasibility level score was also opted due to the many differences in regulations between member states on the matter. For example, while the Netherlands has some incentives for smart charging and an authority certifying safety to charge, the Czech Republic has no incentives for smart charging as well as long permitting procedures for public charging installations.

V1G: Dynamic electricity pricing or at least time-of-use (ToU) pricing (such as day & night/ peak and off-peak prices) are indispensable for the feasibility of smart charging. Barriers include flat energy prices and/or regulated prices. Also, even if the energy component of the bill is made dynamic as required by the Directive, end-consumer prices may still not incentivise smart charging. This is due to the fact that

the energy charge represents only one third of the average EU retail customer electricity bill, the rest are taxes, levies and network charges (European Commission, 2019). Taxes and levies make up to 40% of average EU electricity prices. More dynamic grid charges that would send long term incremental cost signals to consumers are discussed as one of the possible remedies (Refe, Mercados, Indra, 2015).

V2G: The points raised for V1G are also relevant for V2G. In addition, the double taxation problem, i.e. charging energy storage twice – once for withdrawal from the grid and then for injection to the grid - negatively impacts the V2G business case. National implementation of the New Electricity Directive should resolve this issue. With V2G, EVs will participate in flexibility provision to the system. Therefore, it is important to enable purchase of such services also at a local/DSO level, as also envisaged by the Directive.

More generally, incentives for further adoption of e-mobility and mobility as-a-service model in the transport sector are needed to further scale up this model. Issues regarding standards allowing cross-border EV charging should be handled. The Alternative Fuels Infrastructure directive set a base by effectively requiring establishment of bilateral roaming contracts, equipment of charging points with an internet connection and radio-frequency identification (RFID) card reader or a function for remote activation and interoperable communication protocols (Ferwerda, 2018). Nevertheless, different business models have emerged in European markets: bilateral roaming contracts as well as roaming hubs (such as e-Clearing.net, Hubject or Gireve), all developing their proprietary solutions. While there is no serious standardization effort for payment and billing systems in the context of e-roaming (**Key Issue #4**), the EU could potentially step in if interoperability of these systems is not achieved in the coming years. E.g. Open Charge Point Interface (OCPI) protocol is sometimes discussed as a possible suitable candidate for being widely adopted as the standard for e-roaming in the EU as it is compatible with all e-roaming business models (Ibid.).

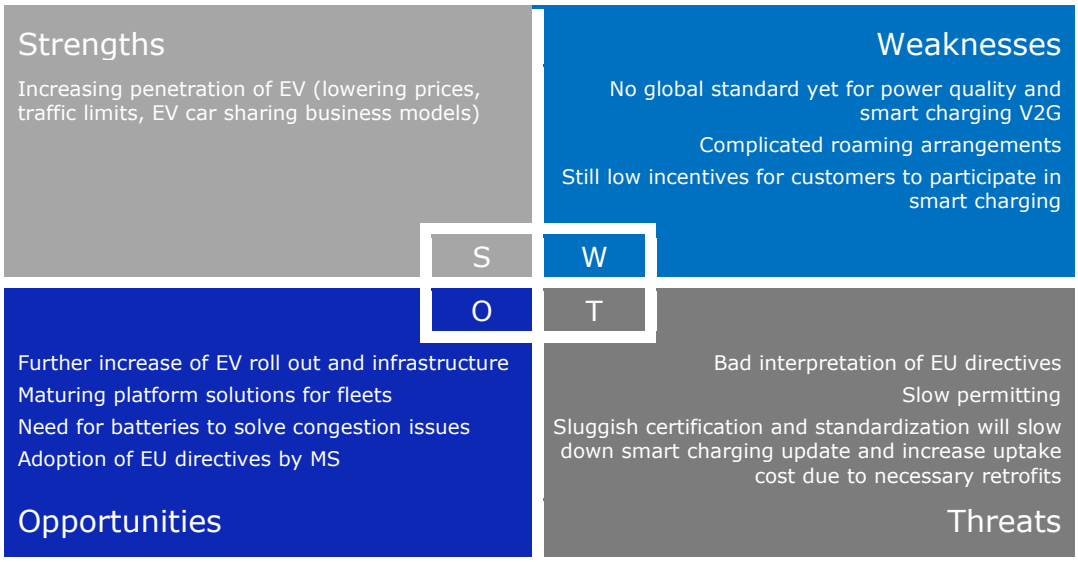
Regulatory feasibility Medium

Key EU legislation provisions by area	
Energy Union	• **The New Electricity Directive** requires Member states to: o Provide the necessary regulatory framework to facilitate the connection of publicly accessible and private recharging points to the distribution networks (art. 23). There are no specific provisions on smart charging /V2G equipment o Offer consumers dynamic electricity prices with at least one supplier and for every supplier with more than 200 000 customers. o Ensure that energy storage is not subject to double charges when providing flexibility back to the grid (art. 15.5) o Ensure that DSOs – in good coordination with TSOs - will be allowed to purchase flexibility from the distribution grid, this therefore includes smartly charged EVs (art. 32), while TSOs shall procure balancing services from all qualified sources, thus also from V2G operators (art. 40.4). o Clarification of rules for aggregation – see UC3 for details

	• **The Energy Performance in Buildings Directive:** New and renovated non-residential buildings must have a set number of recharging points and corresponding ducting, more MS flexibility for existing buildings. No requirements on smart charging capabilities of these chargers (art 2.5)
Digital Single Market	• Subject to general **GDPR** provisions and also upcoming **e-Privacy** provisions
Transport	• **Alternative fuels infrastructure Directive** (2014/94/EU16) sets the minimum standards for charging infrastructure for vehicles: o Charging operators should offer charging services on an ad hoc basis. o Customers under contract of one charge point operator should be allowed to charge at any other operator, i.e. requiring roaming between operators. • Clean mobility package, especially **Regulation setting CO2 standards for cars and vans** (political consensus reached in February 2019): o Average **CO2 emissions** of new cars registered in the EU will have to be 15% lower in 2025 and 37.5% lower in 2030, compared to the emission limits valid in 2021. The CO2 emissions of new vans will need to be 15% lower in 2025 and 31% lower in 2030. These are EU wide fleet targets. A review clause provides for a possible revision of the 2030 targets and for the introduction of binding reduction targets for 2035 and 2040 onwards.

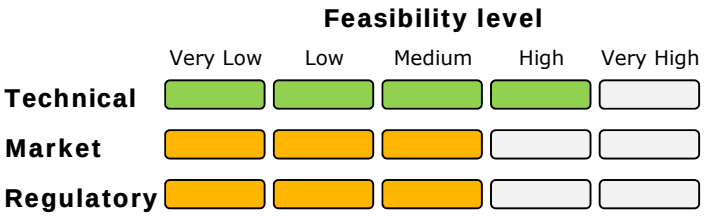
SWOT analysis

As the number of EVs keeps increasing in member states, standardisation and certification issues arise with the growing infrastructure and their operators. New directives by the EU may bring solutions but they must be correctly implemented by member states to obtain the desired effects.



Overall evaluation of UC feasibility level and key issues

Implementation status



Key issues

Key Issue	Description	Type of Issue
1. Lack of certification for power quality and standardisation for V2G	When an EV is charged, it can cause some disturbances to the grid. For cars, there are certifications and tests that determine whether the vehicle is safe to drive and charge. National certifications do exist, e.g. in the Netherlands. However, there are no EU or global standards for EV charging safety. In addition, the issue of standardisation for V2G communication, both at the level of charging stations and cars, is still unresolved, which further hampers the move from pilot projects to larger scale implementation.	
2. Customer acceptance of EVs, smart charging and car sharing	Different national evolutions. In some countries still low uptake of EVs due to range anxiety, underdeveloped network of charging infrastructure etc. On the other hand, platform as-a-service and charging as-a-service solutions grow with more EV penetration and EV fleets.	
3. Double taxes, levies and network charges for storage	In some member states (e.g. The Netherlands), storage is taxed twice and may pay also charges for the use of the network twice. First when it withdraws electricity from the grid, second when it injects it back to the grid. This acts as an important barrier to the V2G business case, as users who would inject their stored energy into the grid lose value. The New Electricity Directive solves this issue, however, it remains to be duly implemented into the national legislations.	
4. Absence of e-roaming & charging interoperability	EV roaming is the possibility of charging and paying between different charging spots, (i.e. of different charging point operators - CPOs), and in different countries. Interoperability regarding payment and charging between different charging points is key. Despite several initiatives, seamless and hassle-free experience is not yet fully in place.	

Preliminary identification of enabling policy / regulatory actions

In order to address the different identified challenge, some policy actions could be taken at EU level.

Key Issue #1: Lack of certification for power quality and standardisation for V2G

- BAU: Power quality standards and charging safety certification are adopted only at national level. The V2G standard ISO 15118 (communication between the EV and the charging station) and IEC 63110 (communication between the

physical charging point and the CPO which manages the charging point) are not adopted at EU level.

- In the Consistent Governance scenario by 2020, standards ISO 15118 and IEC 63110 are adopted at international level, simplifying various bidirectional business cases and allowing for interoperability of charging infrastructure management systems. Cross-border barriers for V1G and V2G business models are removed.

Key Issue #2: Customer acceptance of EVs, smart charging and car sharing

- BAU: Limited public charging infrastructure prevents customers to switch to EVs. Charging remains mainly private, i.e. potential customers living in cities (no garage) and/or tenants are not encouraged to buy EVs or participate in car sharing.
- In the Consistent Governance scenario:
  - In the framework of the Connecting Europe Facility (CEF), the EC will invest in charging infrastructure at targeted locations, to solve the chicken and egg dilemma (Transport & Environment, 2018)
  - Administrative barriers for tenants to ask for the installation of a charging point in their building are removed. In particular, the new Directive on the energy performance of buildings foresees that all new and thoroughly renovated residential buildings with more than 10 parking spaces must have the pre-wiring for a charging point. EC supports sharing of best practices regarding the allocation of the costs among tenants.
- In the Reinforced Legislation scenario by 2030, CO2 limits are very strict, such that customers are forced to switch to EV (and fuel cell vehicles) and car sharing. The Clean Vehicles Directive, which sets CO2/km targets for public authorities and companies for procuring cars and green buses will also foster investment in public charging infrastructure.

Key Issue #3: Double taxes, levies and network charges for storage

- BAU: The recast Electricity Directive clearly states that Member States shall ensure that "active customers that own an energy storage facility are not subject to any double charges, including network charges, for stored electricity remaining within their premises or when providing flexibility services to system operators" (Art. 15). However, this does not clearly include EVs and it remains a national decision on whether EV batteries are subject or not to double taxes, levies & charges.
- In the Consistent Governance scenario, more ambitious policy measures, secondary legislation stating that EV batteries are clearly not subject to double taxation.

Key Issue #4: Absence of e-roaming & charging interoperability

- BAU: A (current) lack of standardization of payment and billing systems prevent cross-border EV travelling (e-roaming). Issues are thus similar as for Key Issue #1.
- The Consistent Governance scenario considers that not only standards for communication (ISO 15118, IEC 63110) are adopted (Key Issue #1), but also

payment and billing systems among MSs are becoming interoperable by promoting open standards such as the Open Charge Point Interface (OCPI).

Case studies

BM 1 & 2 – E-mobility in the Czech Republic

Case Study 1

Where	***What***	***Who***
Czech Republic	V1G & V2G in the Czech Republic	CEZ

Cez is a Czech utility also acting as a CPO in the Czech Republic. The company has built a network of fast chargers within the Connecting Europe Facility (CEF) program.

Highlights

- V1G & V2G do not exist here yet as customers have low incentives to purchase smart charging equipment. Demand response is managed by ripple control system (so called 'HDO');
- A fleet and charging management & optimization platform is not in place yet. So far 2 000 EVs are on the roads. This figure is behind the target of the national action mobility plan;
- Regulation: EV owners are entitled to ToU (off & on-peak, day & night) pricing and there are considerations to change balance between fixed and variable element of grid connection tariffs for EV owners. On the other hand, there are no financial or any incentives for smart chargers and permitting procedures are long for public charging infrastructure.

BM 1 & 2 – Fortum & Virta

Case Study 2

Where	***What***	***Who***
Finland	Smart charging & Fleet and charging management in Finland	Fortum & Virta

Fortum is a Finnish utility also providing services as an MSP and claiming to be the leading CPO in the Nordics region. The company also provides services to other CPOs, OEMs, utilities and businesses.

Virta specialises in the EV mobility and charging field as an MSP and a CPO. The company also provides services to other CPOs.

Highlights

- Finland plans 5M EUR of investment only for public smart charging spots. Also, aggregation is mature (see UC3) but V2G is only present in two locations and not in proper use;

- Virta & Fortum provide V1G services installing devices at home and based on spot prices;
- For the fleet & charging management business model, both also offer a whitelabelled service for fleet operators. End users can then find a charging point, charge and pay. Both provide a CRM service and a roaming service. Virta acts as an MSP mediating transactions between EV drivers and charging points, but also enables charging point sharing including payment system. Its whitelabel solution to other MSPs and CPOs includes cloud connected charging devices, access management and automatic billing (Virta, 2019). Fortum Charge & Drive is similar and also offers leasing and fleet and charging management tools (remote monitoring and charging control). It also serves offering integrated charging solutions for end-users and OEMs (for car diagnostics) can be customers (Fortum, 2019);
- Fortum & Virta already have smart charging offers based on hourly spot prices. Their offers could be further improved if it was possible to react to real time data, which is already available from behind the meter devices;
- The double taxation problem was removed for big batteries however not for small battery owners (residential use).

BM 1 & 2 – ElaadNL, Dutch innovation centre on (smart) charging infrastructure

Case Study 2

Where	***What***	***Who***
The Netherlands	Smart charging in the Netherlands	Elaad NL New Motion Driivz

ElaadNL is a research centre in The Netherlands on smart charging. Research is made by several parties such as grid operators, governmental bodies, and private parties. New Motion and Driivz offer fleet and charging management solutions.

Highlights

- The development of standards is a big topic in The Netherlands. E-roaming, the solution to the interoperability issue, (proposed in NL & developed in NL,DE,DK & AT) is aimed to have a common data hub for drivers to be able to charge at any charging point. The solution uses the Open Charge Point Interface (OCPI) standard. There is also Standardisation work at global level is on the run in the context of the IEC/ISO 15118 Ed.2 for on-board discharging solutions (expected finalization by 2019). There is also a certification process of EVs for V1G as charging can cause problems to the grid;
- The V1G infrastructure is already spread but its use is limited. An example is Jedlix that temporarily postpones the charging of EVs and recharges them later on, when a lot of RE is generated;
- There are many V2G pilot projects, including an AC-V2G charging pilot in Utrecht, a pilot project in Amsterdam and a project involving PHEV Outlanders. (Everoze and EVConsult, 2018) ElaadNL also encourages the

deployment of V2G capable cars. The perceived value of smart charging in The Netherlands is still rather low. Potential financial opportunities are estimated to be between 40-65 EUR/year for EV owners and between 10-15/EV for grid operators. In a pilot project done by green energy supplier – Qurrent – savings are estimated to be up to 150 euros (Alfen, 2017).. However, no further publication of the project results is known to the authors since 2017;

- New Motion offers EV fleet & charging management solutions in The Netherlands. Based in Amsterdam, the company mainly provides services to CPOs but also to fleets such as leasing companies, car manufacturers, business locations as well as B2C services for EV owners. Driivz, an Israeli-based company providing similar solutions have announced a partnership with ElaadNL on the development of open global EV charging standards;
- While there are positive takeaways from the Dutch regulation such as the availability of dynamic pricing and the certifying authority of charging safety, there are also problems that still need to be addressed. The double taxation problem is not yet resolved as well as the incentives for smart charging that are deemed suboptimal.

BM 3 – Share & Charge foundation

Case Study 1

Where	***What***	***Who***
Germany	A solution to the interoperability issue	Share & Charge foundation

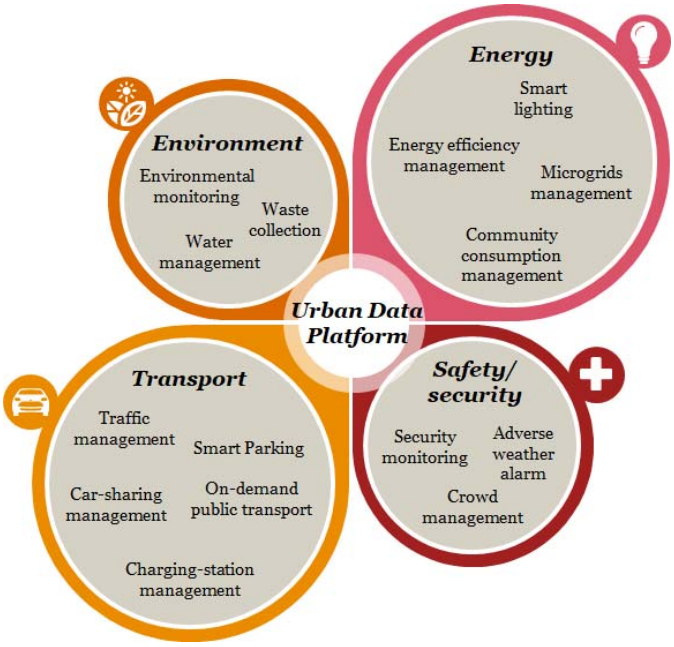
Highlights

- Share & Charge is an independent foundation conducting projects with several companies in the EV and energy sector. Their aim is to build a blockchain-based platform overcoming the interoperability issue. Projects include a peer-to-peer blockchain payment system for public and private charging spots, a cross-European roaming network also based on blockchain (Oslo2Rome). The foundation is based in Germany;

4.6 Urban data platforms

General description

Due to the ICT-led growth of cities across Europe, urban data platforms are gaining increasing importance in the governance of Smart Districts (see UC2) and Smart Cities. These platforms are able to combine data from a wide range of digital infrastructures in order to help municipalities deliver better services. They are instrumental to own/manage/elaborate data captured by IoT sensors and through the holistic view of the information they get, they aim at improving and creating innovative Integrated Services of different kinds. Urban data platforms help understanding the way infrastructures work and the interdependency between different domains (environment, energy, transport, safety).



Four types of data streams can be drawn from urban data:

- demand-side (understanding of specific urban processes)
- supply-side (monitoring of incidents)
- analytical stream (identification of data patterns and elaboration of impact assessments)
- standardization (alignment with international standards)

These platforms represent the meeting point between social needs and existing infrastructures. The correct elaboration of data allows municipalities and private parties to work together in order to eventually provide services and products to citizens. The capacity for cities to support and cultivate partnerships with public and private data owners,

final consumers and software developers is essential to this scope. Municipalities play a pivotal role, starting from the collection of data (from both service providers and citizens) up to the management of data-driven platforms.

In this context, concepts as data ownership and safety are very important for the development of UPDs based on a bottom-up approach. As it will be discussed in the following sections, data management represents a controversial issue because on the one hand, consumers are given the power to decide who can use their data and how; on the other hand, they often fear their data to be poorly safeguarded.

Opportunities

Data of our cities have an increasing value to governments and businesses as they seek to apply data-driven methodologies to improve the quality and efficiency of city services. Urban data platforms are capable of integrating a large amount of data from different urban infrastructures (energy/water grids, waste management facilities, traffic lights, intelligent lampposts, etc.) in order to enhance and improve the quality of services for final customers. Collected information allow both Municipalities and private operators to improve and efficiently combine services to citizen/customers.

Customers	Society / Energy system
• Access to Integrated Energy Services • Improved mobility services • Decreased taxes due to reduced bills for public energy consumption • Efficient public lighting, waste management, traffic monitoring, etc.	• Air quality monitoring and prevention/remedial actions • Advanced traffic planning and management (both public and private transport) • Predictive maintenance on city infrastructures • Security/safety planning and management

Business models

Two Business models have been identified. The first one is the Vertical Platform, which is characterized by the presence of only one focal point (e.g. urban mobility). For example, Waze/Tom Tom/etc. they have UDP on traffic data where citizens are engaged in gaming pursuing a common interest (having more info on jams) and the service provider monetise its job thanks to advertisement and other form of data monetisation. This BM option represents the basis for the full deployment of the second Business model: the Horizontal Platform, where different domains have real-time interconnection.

We should be aware of the fact that Vertical and Horizontal platforms have different level of market maturity, although they can leverage the same hardware and software solutions. Horizontal platforms may pursue social objectives and a clear business case shall be found. This type of platform is featured by multi operability (it will be able to integrate several data streams and offer advanced and coordinated services).

	1 Vertical platform	2 Horizontal Platform
Description	• Dedicated to one single aspect and carry out fragmented operations (on buildings/ lighting/mobility/smart water management/traffic management, etc.).	• Integrates data flows within and across city systems in a way that exploits modern technologies (sensors, cloud services, mobile devices, analytics, social media, etc.) and availability of sensors for multi-purpose measurements.
Key actors	• Citizens (car users/ buildings owners/ house owners) • Retailers/ESCOs/Utilities/Automotive companies/Utilities/Builders	• Citizens (car users, building owners, house owners) • Public authorities (cities, municipalities) • Service providers

BM1 – Vertical platform

This Business model is the easiest to develop. It does not entail high complexity level: data are gathered from a limited amount of sources and elaborated in accordance with one semantic code. Usually the data owner is the same entity running the platform, which reduces data ownership issues. This type of platform deals with only one domain of the city (e.g. waste management, security, energy, traffic, etc.) and lays down the basis for the development of platforms characterized by a higher interoperability level.

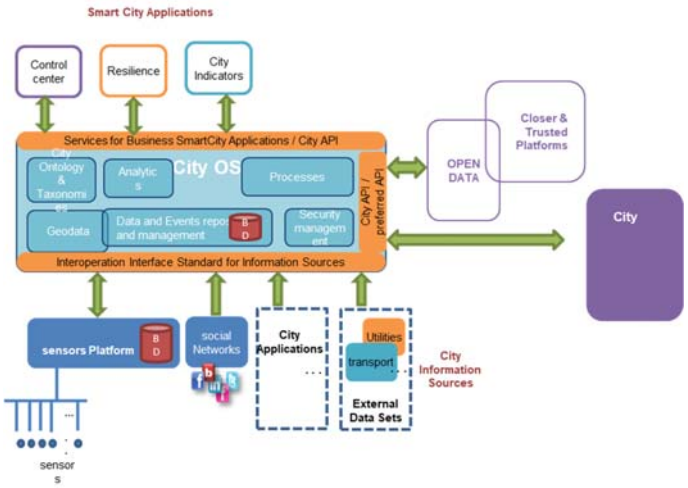
In the case of energy flows, interdependencies between several domains and related problems (energy production and consumption) might be figured out, as it is happening with the pilot project in France that is about to be implemented: the Lyon's pilot. The main categories of data that will be made available for the city urban data platforms are:

- Building energy monitoring data (refurbishment)
- Electric Car sharing (usage frequency, distances, battery capacity, etc.)
- Electrical and thermal heat grid data (electricity, heat flows, etc.)
- RES sites (PV/ST energy generated, energy transferred to grid, etc.)

BM2 – Horizontal platform

This business model is based on the combination of the increasing number of gathered data sets and possible new information, new services and applications, serving citizens and infrastructure needs. The complexity of this business model is given by the cross-domains interoperability and, consequently, by the larger amount of actors involved, which makes it hard to define economic flows.

Datasets are extremely heterogeneous as they are provided by diverse entities like government, citizens, sensor infrastructure or other information data sources. There are many platforms across Europe that include information on different domains, nevertheless these are at an initial stage of development because the integration of information from a wide range of domains still represents a challenge. The ultimate scope will be to design platforms featured by high interoperability and interactivity levels.



Technical maturity

Despite BM1 being featured by a medium maturity level, the technical advancement of BM2 is still very low. For this reason the overall evaluation ofthe technical maturity is low.

BM1 – Vertical platform

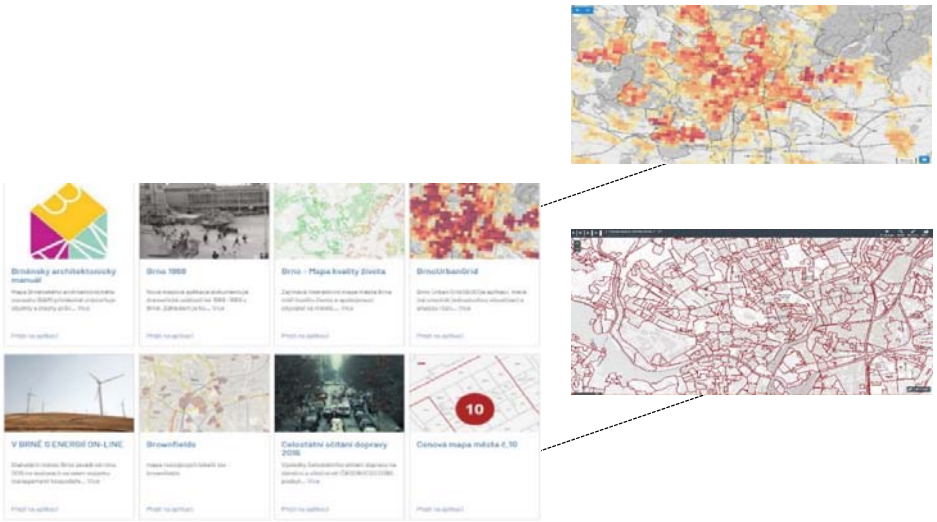
This business model has a medium technical maturity level. In many cases, the service is well functioning and able to deliver near-real time information also to citizens through smart apps. In some cases though, it has been reporter either a lack of expertise within the team running the platform either technical difficulties in making the IoT software interact with supporting devices due to the obsolete technologies that cannot be matched with new software.

BM2– Horizontal platform

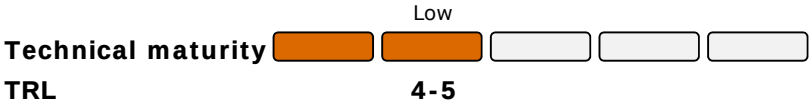
Some attempts of developing horizontal platforms have been reported, nevertheless, they still encounter relevant limitations in terms of interactivity. In Open Data Barcelona for example, data are mostly in XLS and CSV format (which requires downloads and cannot provide real time data). The same applies to Data Brno, where a wide range of data are in an obsolete 3D format, which is not user friendly.

As far as data are provided in such formats, interoperability is unfeasible. Technical difficulties are mainly due to the presence of multiple devices, IoT infrastructure, APIs and data formats that are creating substantial interoperability issues. It is therefore impossible to develop cross-domains platforms. There are many IoT platforms but their standards are not compatible with other IoT structures and this leads to insulated ecosystems (silos) belonging to BM1.

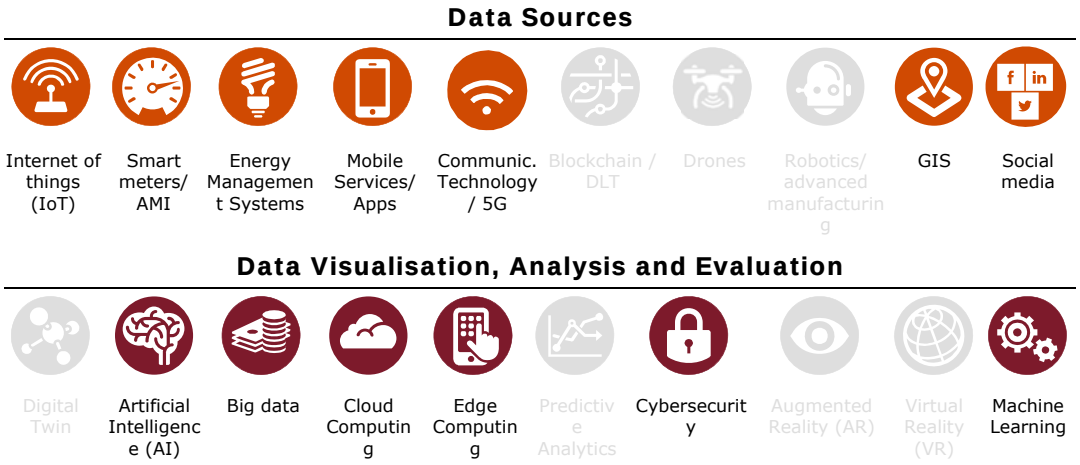
The industry is trying to address the interoperability problems through standardization (e.g. Amazon with AWS IoT and Microsoft with Azure IoT) and these different solutions should be able to eventually work together. Under Horizon 2020, the European Union has been funding several research projects focused on the federation of IoT platforms, however, since it may take time to get common standards, some action to accelerate the process may be necessary.



(Source: DATA BRNO)



Key enabling digital technologies



Data management

As already pointed out, there are increasingly abundant sources of data that can help governments in dominating the management of city services: these are created and contributed by either citizens or service providers. Governments can eventually allow public access to collected and elaborated data in open, machine-readable formats that can further encourage wider digital innovations.

For this UC, it is important to note that the way data are managed depends on the area/s where the UDP operates. For example, for demographic information, real-time data is not necessary, while for EV charging station that would be necessary. Similarly, the type of stakeholder accessing data changes depending on the type of data. A relevant example in this regard can be "Resource Efficiency": information on energy flows of public buildings can be requested by municipalities but not by private businesses.

In the context of energy related data, this include measurements from meters, thermostats, solar PV, batteries, and electric vehicles. Overall, there is great potential for municipalities in the management of data flows related to public services and either private or public buildings. Energy service companies provide these data. They use non-validated near real-time consumption data collected from connected home devices to provide the services described in this use case. Smart devices are connected together and linked to the smart metering signals via Home Area Networks (HAN).

The maximum time granularity of available smart meter readings determines what potential is at the disposal of consumers to optimise their consumption patterns. Usually, the granularity determines the type of time-of-use products that can be offered to consumers. The maximum time granularity for consumption data stored in the smart meter varies across MSs. The most commonly used granularity is 15 minutes, followed by 30 minutes and few MSs where it is 1 hour. The most technologically advanced home devices can provide a very high data granularity, down to the level of microsecond measurements of power consumption patterns and actions.

Managing not only public but also private data is critical to the creation of better services, but energy companies should be careful when sharing costumers' data with municipalities. In this respect, final costumers' trust and confidence are crucial, as without proper guarantees on data protection, consumers are likely to be reluctant to take risks. It is in fact essential that consumers are provided with clear and transparent information and have access to trusted mechanisms to manage their energy data and create value with it, while being in complete control of their private environment and behavioural habits. This will necessitate energy companies to adopt a robust data management strategy with a clear allocation of responsibilities, which ensures all relevant data sources are captured, stored and analysed in a secure way.

Consumption data requirements

Stakeholder access to data	Validated (V) or non-validated (NV) data	Near-real time (RT) or historical (H) data	Granularity	Aggregated data (A) or by usage (U)	Communication requirements
☒ Customer ☒ Supplier or ESCO ☐ DSO ☐ Other	☐ V ☒ NV	☒ RT ☐ H	☒ minute or less ☒ 15min ☐ hourly ☐ more	☒ A ☒ U	☒ 2-way ☐ link with market data ☐ none

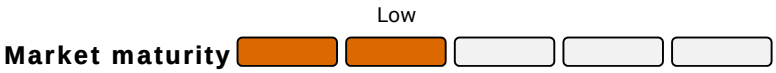
Market maturity

BM1 – Vertical platform

It can be observed that thanks to the growing openness, transparency and effectiveness of urban governance, the open data franchise has expanded and produced new tools such as Vertical platforms. Collaboration between private parties and municipalities is taking shape and data management is being defined case-by-case. However, the concept of real-time cities needs a further acceleration and standardised measures for data sharing could play a key role in this regard. Currently, the examples of vertical platforms are not many and they usually stick to the same domains (mainly transports). Many pilot projects on vertical platforms have been designed but they have not been implemented yet. With more clear guidelines, collaboration on a wider range of sectors could be finally achieved.

BM2– Horizontal platform

Since standardization and interoperability are still immature in the data market, the spread across Europe of BM2 is still slow. In this model, data come from a wide range of sources and are processed together in order to provide different urban services. Horizontal platforms should facilitate the reuse of resources by providing the appropriate information enabling processing efficiency through the latest and most advanced technologies, if possible, following the most popular standards and protocols in each sectors. In addition, as the EU regulation envisages, the information exposed should have permissive use rights and licenses and allow the responsibility of the publishing agent to be diminished, as well as to ensure that the traceability of the source data is maintained, once they have been reused. There are many examples of platforms aiming at achieving this type of service and that cover multiple areas, but for now, they rather have the outlook of databases. The use of common semantic standards will be vital to harmonise data and to provide services based on the combination of information coming from different areas. Summarily, interoperable and high interactive data platforms are not market ready and they are expected to grow slowly up to 2020 due to the difficulties in establishing either interoperability models and regulate interactions between involved actors.



MRL **4-5**

BM	Presence on the market	Countries	Enablers / Barriers		Area
1	Service available on the market		Successful PPP	+	
			Smart meters roll out	+	
			Limited sectors application	−	
2	Initial development stage		High automation level of the district	+	
	Not available on the market		Poor standardization	−	
			Unclear data access regulation at MS level	−	
			Low commitment and participation from citizens	−	
			Poor interoperability of IoT	−	

Regulatory feasibility

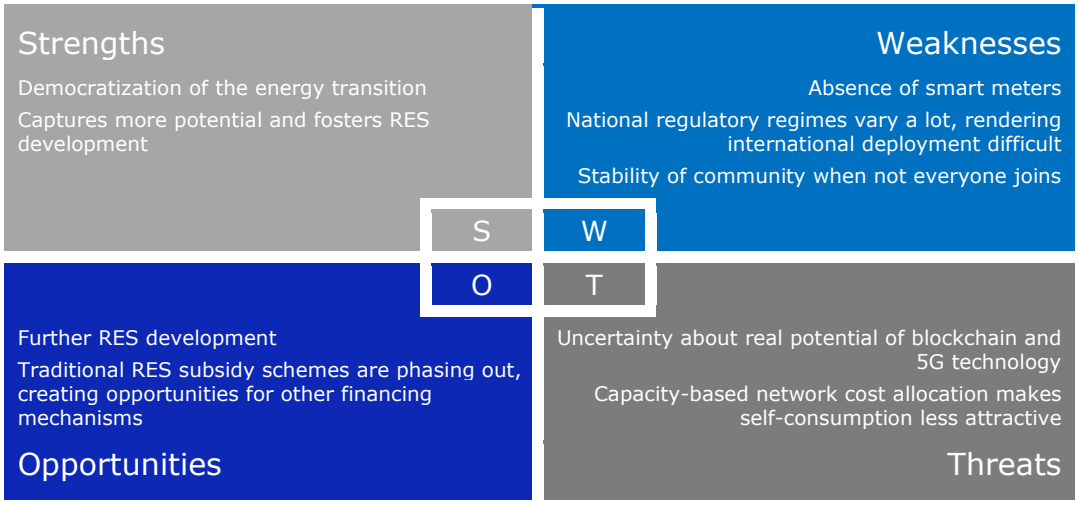
Regulation of UDPs mainly concerns three strictly related aspects: data privacy, data security and data sharing between third parties (data providers and municipalities). As the role of citizens is becoming central in the digitalisation process of many sectors, guaranteeing a safe data disclosure is a fundamental step for the development of new business models based on the use of data. Hence, the Digitising European Industry strategy brought the need to reinforce trust and security, which is happening through the adoption of new pieces of legislation as the General Data Protection Regulation (GDPR), which stipulates processing parameters for personal data and foresees the application of sanctions in case principles are not respected. The proposal for the e-Privacy Regulation complements GDPR in the electronic communications sector. While GDPR protects personal data, the e-Privacy Regulation protects the confidentiality of electronic communications and devices. In particular, when communications include personal data, the general rules of the GDPR apply, unless the e-Privacy Regulation lays down more specific rules. The e-Privacy Regulation will ensure the protection of fundamental rights and freedoms, in particular the respect for private life, confidentiality of communications and the protection of personal data in the electronic communications sector.

Thus, collection has to happen lawfully, fairly and in a transparent manner, and data should be processed in a secure manner, including protection against loss of the data. For what concerns non personal data, the Free-flow of non-personal data Regulation 2018/1807 will be entering in force in May 2019 and will ensure transparency principles are adopted, while data economy opportunities are unleashed.

Nevertheless, in order to encourage citizens' involvement it is necessary to grant security measures as well. According to Art. 21 of the Directive on Security of Network and Information Systems (NIS Directive) of 2016 Member States have to 'lay down the rules on penalties applicable to infringements' of the national security obligations, but sanctions on cybersecurity at the MS level is still under development. Currently, this part of legislation does not have the strength to guarantee data safety.

Another challenge concerns the articulation of appropriate policy frameworks needed by governments to facilitate investment in data-driven services in line with the priorities of a city. For an efficient management and planning of the energy flows within a city, Municipalities need to design ad hoc concession contracts with existing network operators to access necessary information, but so far, attempts to set standardised contractual terms resulted controversial. In France, for instance, some municipalities are trying to work closely with the Data protection agency and the CRE (Energy Regulation Agency) in order to find a suitable solution for regular data access. Summarily, regulation is underway to frame an enabling environment for UPDs to flourish; however, some adjustments may be necessary.

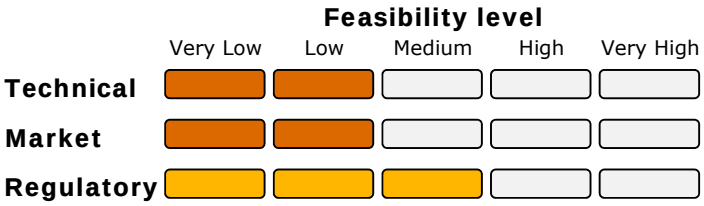
SWOT analysis



Overall evaluation of UC feasibility level and key issues

Summarising all the considerations made around this UC, the overall assessment, reported below, shows that UDPs are mainly suffering from market issues. This is due to either low technical and regulatory maturity.

Implementation status



Key issues

Following the order of appearance of the key issues identified in our analysis, the table below presents a summary, which helps linking such issues with the policy/regulatory actions needed to overcome them and allow a wider development of Urban Data Platforms.

Key Issue	Description	Type of Issue
1. IoT interoperability	• Needed of common standards to manage communication among different energy production and consumption points (e.g. CHP or PV local plants, EV chargers, smart lighting poles)	
2. Privacy and security	• Security concerns are preventing citizens from data sharing	
3. Lack of business models on data access	• It is difficult to set standardized and regulated terms to access data (e.g. DSO sharing data with the Municipality) • Data access issues when data are owned by different operators	

Preliminary evaluation of the need for policy/regulatory actions

Key issue #1: IoT interoperability

In order to address the challenge on IoT interoperability, it is required to keep standardisation as the prerequisite to specify technical methods, such as measurement and product safety, and maintain the New Legislative Framework principle by listing standards under the respective legislation.

Key issue #2: Privacy and security

Concerning privacy and security, the Commission should:

- Provide a clear definition of which energy related data has to be strictly regarded as a personal data and thus fall under the scope of GDPR to ensure a consistent interpretation across member States. Assess what are the implications on the energy market.
- Provide a common guidance for the allocation of GDPR roles and responsibilities to actors involved in smart metering systems personal data processing

According to the 'Cybersecurity Act', the use of such EU cybersecurity certification schemes is not mandatory, but will be indeed on a voluntary basis. In this regard, by 2030 the Commission could provide incentives to support the application of the schemes and sanctions in case of failure to adopt current legislation.

Key issue #3: Lack of business models on data access

Concerning Data access, EU guidelines on how to design accords on data sharing between service providers and municipalities should be published.

Case studies

BM1 – Vertical Platform

Case Study 1

Where	***What***	***Who***
Italy	Verona Smart App	AGSM Group

The Verona SmartApp was launched in October 2017. This application is the ultimate part of the Smart City Verona initiative. The city of Verona, in 2008, joined the Covenant of Mayors pact promoted by the European Commission and which encourages municipalities, as actors in a macro innovation process, to promote measures of environmental sustainability, energy efficiency and the use of renewables. The Verona Smart City projects aims at gradually integrating technology as a fundamental piece to make information travel, to bring the citizen closer to the Public Administration and to improve basic services related to energy, water, the environment and transport.

Services:

- Traffic and mobility: difficulty to provide real time data
- Monitoring of public transports (timetable and routes)
- Parking availability
- Recharge points for EV (possibility to reserve and unlock via device)

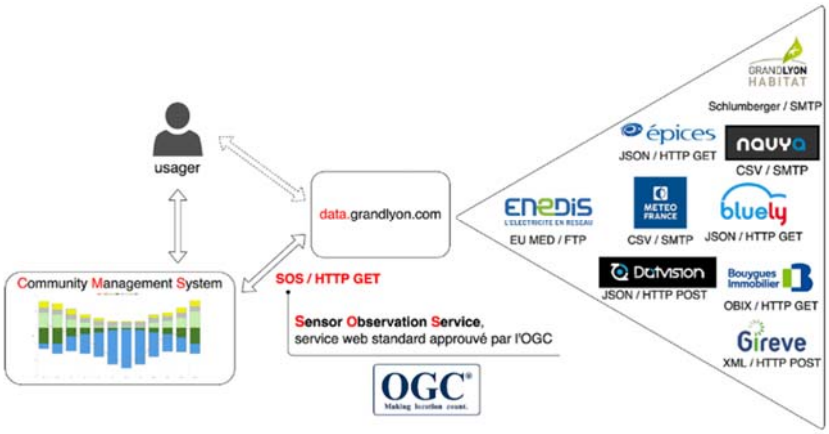
Highlights

- This platform provides only mobility-related information and on traffic it gathers information from Twitter;
- The Agsm Group is the unique collector and user of data. It deals with the production and distribution of electricity and heat, gas distribution and telecommunications services. The Group's activities are divided according to the functionality criteria and articulated among the various companies: AGSM lighting is responsible for data collection.

Case Study 2

Where	***What***	***Who***
France	Urbant Data Platform in Lyon	Smarter Togheter

Lyon is one of the six European cities that are part of SMARTER TOGETHER: a joint project that aims to improve citizen's quality of life in nowadays transforming cities. The project will focus on finding the right balance between ICT technologies, citizen engagement and institutional governance to deliver smart and inclusive solutions. The integrated and interactive data platform is applied to one pilot district of Lyon. The expected final output concerns the realization of an urban data platform for the whole city based on the integration of data from infrastructure components, e.g. building management systems, renewable sources (RES) production sites, traffic and mobility management systems (car/e-bike sharing) and creates a comprehensive collection of data for the various domains affected within the project.



Highlights

- Difficulties on the scalability of data gathering for the entire city
- Lack of expertise on the interaction between applications, sensors and actuators
- Building energy monitoring data (refurbishment)
- Electric Car sharing (usage frequency, distances, battery capacity, etc.)
- Electrical and thermal heat grid data (electricity, heat flows, etc.)
- RES sites (PV/ST energy generated, energy transferred to grid, etc.)
- Data platform is declared to the French data protection authority. Data with personal information can be stored with restricted use so that only the owner can have access to it. For the first time, the Lyon Metropolis is collecting energy data on its platform and developing a Community Management System to use these data. Involved actors and their role:
  - Grand-Lyon: Data platform operator
  - ENEDIS: Data provider (grid data)
  - SPL Lyon-Confluence: Data provider (district heating data)
  - Groups or owners of refurbished buildings: Data provider (energy consumption data)
  - Operators of e-mobility services: Data providers (e-mobility data)
  - Renewable energy producers: Data providers (production data)

BM2 – Horizontal Platform

Case Study 1

Where	***What***	***Who***
Spain	Open Data BCN	Ajuntament de Barcelona

Open Data BCN, is a project started in 2011 and it has evolved up to the point that now it is part of the Barcelona Ciutat Digital strategy. This strategy aims at fostering a pluralistic digital economy and developing a new model of urban innovation based on the transformation and digital innovation of the public sector and the implication among companies, administrations, the academic world, organizations, communities and people, with a clear public and citizen leadership.

Highlights

- Open Data BCN is transversal to several of the pillars of the city's strategy, is based on the main standards and international recommendations, adopting certain characteristics that summarize the principles of this movement;
- Open data by default. All public information managed by municipal public entities must be publicly exposed by default, allowing their reuse. Only information sensitive and affected by specific laws, such as personal information, documents subject to intellectual property, or data that violates public safety, will be considered as an exception;
- Quality and quantity of information. Any resource likely to be publicly exposed has a great potential value for its reuse. To the extent possible, these resources will be exposed in a timely manner. Likewise, the data published should be highly detailed and accurate, avoiding unnecessary manipulations such as aggregations or other operations that distort the primary and atomic data. Through the data catalog, metadata associated with the published resources are presented, which classify and describe such datasets with descriptive and technical information about publication dates or update periods, related topics, authors, licenses, etc;
- Data for the whole world. The published information will follow the principles of technological universality, allowing access to any group to which it may be of interest;
- Data to improve governance. Government teams that are making efforts to carry out their commitment to good governance will openly disclose clear information about the standards they use, the policies they are developing, their internal processes, and detailed data on the collections of resources exposed to their possible reuse.

4.7 Energy communities

General description

Energy community is an emerging concept for which there is no widely accepted definition yet. It can cover activities in various parts of the value chain, including generation, distribution, storage, supply, consumption etc. Traditionally, community energy activities focused on joint investments in local renewable projects. With digitalisation, additional business cases emerge at local level, with involvement of market developers including large corporates as well as citizen initiatives led by local authorities or natural persons. Covering both dimensions, the concept of energy communities in the context of this study is broader than the new definition of 'citizen energy community' and 'renewable energy community' by the updated Electricity Directive and RES Directive, respectively. Energy communities could also participate in aggregation, which is out of scope of this UC. Instead, it is addressed in UC1 and UC3.

Opportunities

From a systemic point of view, energy communities' business models enable a broader participation in renewable projects and, thus, foster the energy transition. But the actual transposition of models into facts depends on the allocation mechanism of non-energy related components of the retail electricity tariff (grid charges, RES support fees, taxes).

In fact, customers' convenience in shaping such solutions only partly depends on the balance between the cash-out needed to invest in distributed RES production plants and the savings coming from getting electricity at a lower cost. To this balance, the community shall add, for example, the CAPEX and the OPEX needed to build and operate the energy plants, OPEX to operate existing local grids (or even CAPEX, if absent), other grid cost components, and taxes. In this context, the opportunities to establish an energy community shall be carefully assessed before making decisions.

Customers	Society / Energy system
• More consumers can actively participate in the energy transition (e.g. tenants in a building, low-income or vulnerable household) • Reduction of the energy bill	• Supporting RES development through better access to financing and own consumption • Possibility to address local grid issues • Better allocation of RES support, towards the ones willing to pay for more local and green energy

Business models

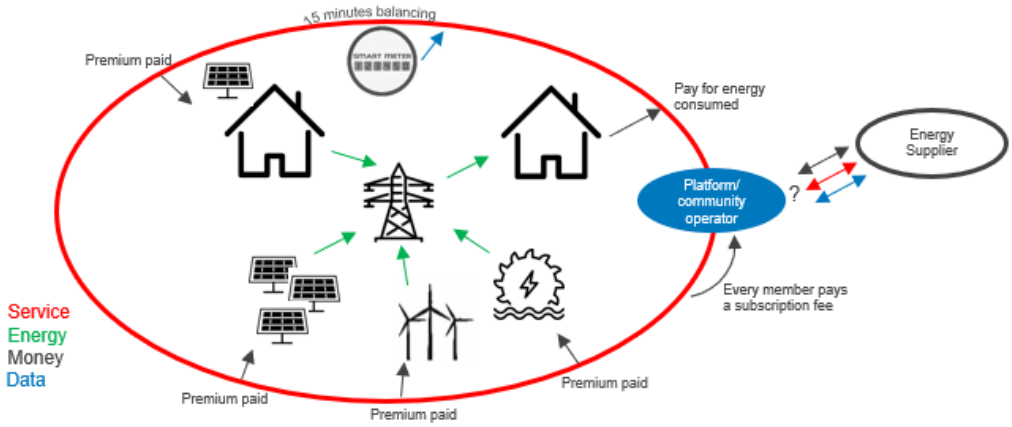
Energy communities cover a wide range of very different activities, as outlined in the ASSET report on Energy Communities (Tounquet, De Vos, Abada, Kielichowska, & Klessmann, 2019). This use case focuses on two types of business models enabled by digitalisation: Peer-to-Peer and collective self-consumption. These models can overlap, if P2P trading is confined to a limited geographical area. The business cases

presented below can also be combined with models described in UC8 (RES origin tracking).

	1 Peer-to-peer (P2P) trading	2 Collective self-consumption
Description	• Virtual energy sharing through peer-to-peer trading. • Often related to locally produced renewable energy	• A local community consuming their own electricity production • Citizens' or privately-owned energy community operator invests in RE, the excess energy unused by the community is sold to the public grid
Key actors	• Consumers • Renewable producers • Energy Suppliers • Community manager/ platform providers	• Consumers, prosumers • DSO • Community manager/ platform providers

BM1 – Peer-to-Peer (P2P) trading

Peer-to-peer trading platforms allow power exchange between small producers, prosumers and consumers. The platform operator manages the matching of production and consumption and possibly buys additional energy from renewable producers for balancing purposes. Producers and prosumers receive a contract- or bid-based price for energy injected into the grid, while consumers pay for their electricity consumed. Platform members usually pay a fee to the operator. Peer-to-peer trading may also reduce administrative costs and avoid supplier margins compared to a traditional supplier-based model. From an organizational point of view, there are several options regarding roles and responsibilities. They are currently evolving and vary between Member States, especially regarding the question whether the community operator is also the supplier and related questions around billing and balancing responsibilities.



Revenue creation source for the operator of the platform

Wholesale markets	TSO Ancillary services	Distribution network	Cost efficiencies	Subsidies	Behind the meter	Additional payment for green /local	Others

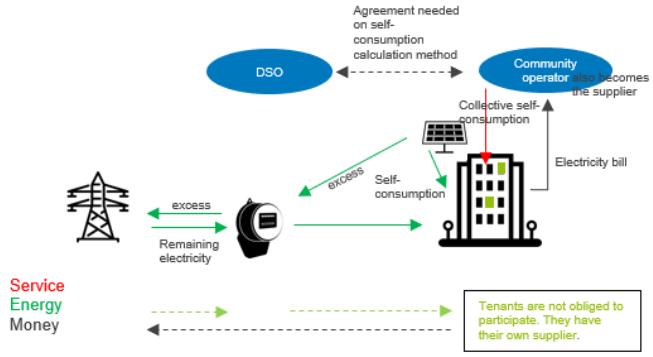
Others: platform subscription or transaction fees

BM2 – Collective self-consumption

Until recently, benefiting from own consumption has been limited to prosumers. This excludes consumers who either do not have the financial means or the space to invest in renewable energy. The collective self-consumption community can be seen as a particular variation of the P2P business model, where peers of the same location (typically a building) exchange energy. Renewable energy (PV, Wind) and CHP are produced locally and sold to the members of the community. Depending on the regulatory regime, the community operator may also become the electricity supplier of the members and needs therefore to contract the remaining electricity to be bought from the market.

Revenue creation source

Wholesale markets	TSO Ancillary services	Distribution network	Cost efficiencies	Subsidies	Behind the meter	Additional payment for green /local	Others



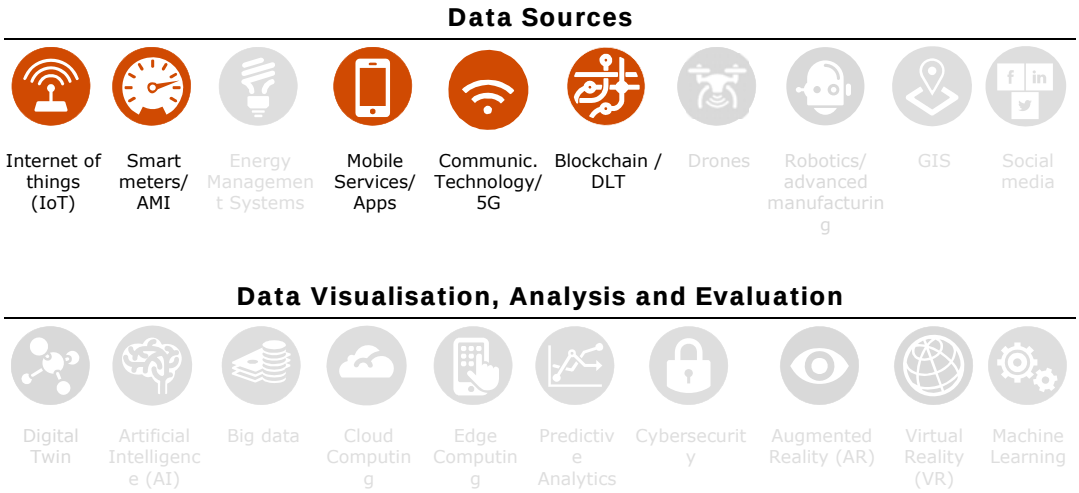
Technical maturity

The technology maturity reaches overall a medium to high level, as there are some implementations going beyond pilot projects, while there is not always a clear market application yet.

Although these business cases are also feasible without smart meters, smart metering substantially simplifies the operations including accounting and billing. The P2P applications could by further enhanced by smart contracts based on distributed ledger technologies (DLT), but as explained further in UC8, the DLT technology is not yet fully mature for this.

			High		
Technical feasibility					
TRL			**7-8**		

Key enabling digital technologies



Data management

P2P trading involves two components: the management of a data platform and possibly the activity of an energy supplier (performed by the platform operator or not), to ensure that the customer is supplied at every moment.

For virtual balancing demand and supply, data on production and consumption needs to be available in the appropriate time granularity (15 minutes). This is ensured by smart meters. Consumption and production data needs to be communicated to the platform in real time, to ensure matching at community level. From a billing and physical point of view, P2P business models work like any other supply contract and smart meters are therefore not a necessary condition for P2P business models.

Finally, legal uncertainty remains related to some conflicting articles of GDPR and upcoming e-Privacy Regulation (**Key Issue #1**, strongly linked to Key Issue #2 of UC3).

Collective self-consumption projects in principle do not require consumption and production data with a fine granularity. Collective self-consumption business models in Germany for instance can be implemented with traditonal meters and yearly readings. However, smart meters per tenant ease administration when not all tenants join the community

Consumption and production data requirements

Peer-to-peer trading:

Stakeholder access to data	Validated (V) or non-validated (NV) data	Near-real time (RT) or historical (H) data	Granularity	Aggregated data (A) or by usage (U)	Communication requirements
☒ Customer ☒ Supplier or ESCO ☒ DSO ☐ Other	☒ V ☐ NV	☐ RT ☒ H	☐ minute or less ☐ 15min ☐ hourly ☒ more	☒ A ☐ U	☐ 2-way ☐ link with market data ☒ none

Collective self-consumption:

Stakeholder access to data	Validated (V) or non-validated (NV) data	Near-real time (RT) or historical (H) data	Granularity	Aggregated data (A) or by usage (U)	Communication requirements
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Market maturity

The market's readiness level is defined as Low/Medium as all analysed projects have been implemented in an internal scope and as one-time pilots.

Energy communities can be seen among other as an alternative way of promoting the development of renewables, as opposed to classical FiT- or premium-based support. Since citizens can actively participate in the energy transition and acceptability of renewable projects may be higher by avoiding the NIMBY problem. From that perspective, energy communities may gain in importance. On the other hand, the margin to be gained is subject to some volatility when it depends on implicit behind-the-meter advantages (avoided or reduced network tariffs, taxes and charges for instance in case of net metering schemes or other exemptions) whose magnitude is not stable as it depends on the amount of network charges and policy costs and may be remodulated in case of regulatory changes (**Key Issue #2**). Therefore, in order to create good investment conditions, it is important that Member States put in place sustainable regulatory frameworks.

BM	Presence on the market	Countries	Enablers / Barriers		Area
1	Service available on the market		Experimental decree	+	
2	Service available on the market		Similar legal framework existed for CHP	+	
	Service available on the market		Dedicated tariff for energy communities	+	

Regulatory feasibility

In general, energy communities still lack clear definitions at national level. The Clean Energy Package has introduced a high-level definition and regulatory framework with minimum requirements that will have to be implemented in greater detail at National level over the next two years. While the CEP seems to exclude larger enterprises from the communities' governance, larger enterprises will be able to provide services and solutions to the communities.

Peer-to-peer trading: Roles and responsibilities of peer-to-peer platform operators are currently evolving and vary between Member States, especially regarding the question whether the community operator is also the supplier and related questions around billing and balancing responsibilities. In principle, however, the community operator is subject to the same obligations as any of energy supplier.

Collective self-consumption: while individual self-consumption is basically allowed in all Member States, collective self-consumption is a relatively new concept, therefore not all Member States, pending the transposition of the Clean Energy Package, have an enabling framework for it. When collective self-consumption is allowed, one of the main advantages from a regulatory point of view may be related to behind-the-meter advantages, i.e. the partial or total exemption to pay grid charges, taxes and levies that usually are to be paid in the final electricity tariff. As an example, in Italy it has been recently assessed by the Italian Regulator that the exemption to pay policy costs and levies by self-consumption in private network configurations causes a 1,4 billion € implicit cross-subsidization which is ultimately borne by the generality of consumers (ARERA, Memoria 94/2019/I/Com). In these cases the jointly acting self-consumers face the regulatory risk that a redesign of cost allocation methods for grid charges and RES support costs could make the business case more volatile. Implicit advantages such as exemptions to pay network tariffs or policy costs seem furthermore to be less stable in supporting investments in Energy Communities, as the amount of the support depends on the magnitude of system charges (that may decrease over time) rather than on more explicit values (for instance it could be linked to the higher costs that electricity generation in decentralized installations exhibit compared to centralized one). Therefore, it is of utmost importance that Member States ensure sustainable regulatory framework for collective self-consumption and design cost-reflective and non-discriminatory tariff schemes. For instance, in France the regulator CRE introduced a dedicated tariff for energy communities, which differentiates between a reduced rate, applied to local transit, and a higher rate, applied to non-local transit, thus to correctly reflect the costs of collective self-consumption for the system. Also, revenues from selling excess electricity to the market (at market values or subsidized) and possibly a higher willingness to pay for green and/or locally produced energy are part of the community's revenues. Note that tenants cannot be obliged to participate in the community, which complicates the business model, especially regarding the definition of the self-consumption ratio and if tenants do not have smart meters (**Key Issue #3**). In Germany, for instance, collective-self consumption business operators may face lengthy discussions with DSOs on methodologies to calculate own-consumption ratios when not everyone participates in the community.

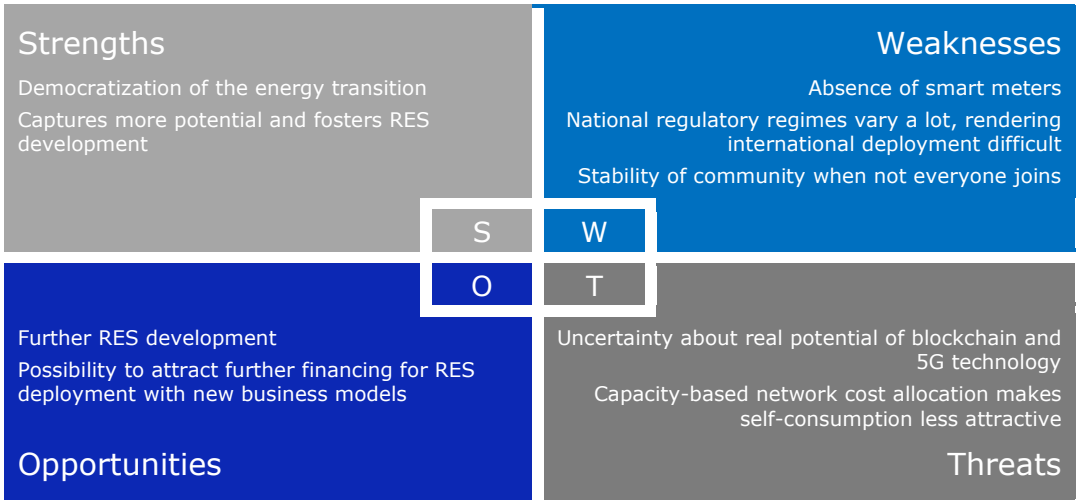
Low

Regulatory feasibility

Key EU legislation provision	
Energy Union	**The RES Directive (2018/2001)** requires MS to ensure that all customers, including low-income or vulnerable households and tenants, are entitled to (art. 21& 22): • Participate in P2P trading arrangements and engage jointly in becoming renewable self-consumers; • Sell & share their excess renewable energy; • Have a renewables self-consumer's installation owned by a third party; • Non-discriminatory access to support schemes & no unreasonable network charges and other charges, fees, • levies & taxes. • Participate in renewable energy communities. **The New Electricity directive** ensures a legal framework for *citizen energy communities* (art. 16). The directive defines citizen energy communities, their rights and responsibilities. • They are defined as legal entity based on voluntary and open participation. Their primary purpose is to provide • environmental, economic or social community opportunities to its members or to the local areas where it operates • rather than to generate financial profits. • DSOs are obliged to cooperate to facilitate energy transfers with citizen energy communities. while communities • are subject to non-discriminatory and cost-reflective network charges & connection charges. • Citizen energy communities can also own, establish, purchase or lease distribution networks and autonomously manage them; and can access all electricity market but are financially responsible for the imbalances

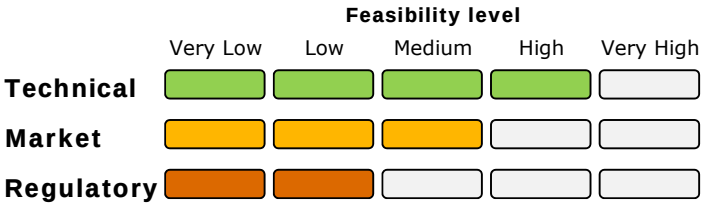
SWOT analysis

Overall, energy communities allow a democratization of the energy transition and represent an alternative to traditionally RES support. This is thus also the strongest opportunity for future development. On the other hand, the UC still faces regulatory uncertainty since definitions are not clear or inexistent at national level and models often rely on highly uncertain margins and on the further technological development (5G, blockchain, etc.).



Overall evaluation of UC feasibility level and key issues

Implementation status



Key issues

Key Issue	Description	Type of Issue
1. Sharing of consumption and production data jeopardizing the contractual relationship of P2P trading business models	Legal uncertainty remains related to some conflicting articles of GDPR and upcoming e-Privacy Regulation	
2. Dependence of collective self-consumption business models on behind the meter advantages	The margin of collective self-consumption business models depend i.a. on behind the meter advantages, i.e. by avoiding part of the retail tariff when self-consuming. This is especially the case for grid charges and policy costs. Current collective self-consumption initiatives still benefit from behind the meter advantages related to the avoidance of energy-based network tariffs. A redesign of grid cost allocation methods (especially from energy- to a capacity-based tariffs or the removal of exemptions) can quickly destroy the business case. For instance, in France a specific grid tariff structure has been introduced for collective self-consumption in order to correctly reflect the cost of self-consuming in grid charges	
3. Definition of community's self-consumption when not everyone joins the community	Rules are needed to calculate the own consumption of each member of the community in case there are no smart meters that register the consumption of each member with high frequency and granularity, in order to correctly regulate the energy settlement within a community. Such settlement rules are not necessary in the digitalisation scenario with smart meters. There is a balance to find between more accurate metering but also higher associated investment costs.	

Preliminary identification of enabling policy / regulatory actions

Key Issue #1: Sharing of consumption and production data jeopardizing the contractual relationship of P2P trading business models

- BAU: Legal uncertainty remains related to some conflicting articles of GDPR and upcoming e-Privacy Regulation (strongly linked to Key Issue #2 of UC3).
- More ambitious policy measures:

- ePrivacy clarified - anonymised data or data collection serving legitimate purpose and not impacting end user privacy can be shared

Key Issue #2: Dependence on behind the meter advantages

- BAU: as for individual self-consumption, the margin of collective self-consumption business models can be driven by behind the meter advantages, i.e. by avoiding part of the retail tariff when self-consuming. This is especially the case for grid charges. Current collective self-consumption initiatives still benefit from behind the meter advantages related to the avoidance of energy-based network tariffs. A redesign of grid cost allocation methods (especially from energy- to a capacity-based tariffs) can quickly destroy the business case.
- Future scenario:
  - A redesign of grid and policy cost allocation methods at national level, from energy- to capacity-based network tariffs, and the natural evolution of such costs, make the business case more volatile. Collective self-consumption initiatives lose their attractiveness and there is no significant development after 2020.

Key Issue #3: Difficulty to define own-consumption of communities if not everyone joins

- BAU: The main economic driver of collective self-consumption initiatives is, by definition, the avoidance of the full retail tariff of self-consumed energy. However, tenants of a building cannot be obliged to participate in an energy community. Rules are therefore needed to calculate the own consumption of the members of the community. There is a balance to find between more accurate metering but also higher associated investment costs. DSOs (aiming to recover their network costs through tariffs) and energy community operators may have conflicting objectives. In a BAU scenario, there is no further guidance on such rules, implying that development of self-consumption initiatives will be regionally disparate in countries with many DSOs (e.g. Germany).
- More ambitious policy measures:
  - The EC provides guidance on metering requirements and requires harmonised rules at national level, avoiding bilateral agreements with individual DSOs. However, the impact of clearly defined framework at national level is uncertain with respect to the further development of self-communities: rules can imply higher metering costs and possibly lower self-consumption ratios.

Case studies

BM 1 & 2 – P2P Trading & Collective self-consumption

Case Study 1

Where	***What***	***Who***
The Netherlands	P2P trading and collective self-consumption	Spectral, Powerpeers

Spectral focuses on renewable - based micro-grid solutions for communities, businesses and industrial facilities. Therefore operating within the peer-to-peer (incl. blockchain based pilot Jouliette with DSO Alliander) and self-consumption business models. Powerpeers offers a peer-to-peer business model where users can choose from whom they buy their energy. The model is not based on blockchain.

Highlights

- The cost of local grid connections are costly because smart meter rollout is not at 100% in NL.
- Self-consumption projects such as De Schoonschip (residential only micro-grid) and Republica Papaverweg (combination of residential, commercial, parking & hotel) give insights on functioning of micro-grids with different demand combinations.
- Peer-to-peer projects such as De Ceuvel test Peer-to-peer energy trading in a micro-grid through a blockchain network, tokens will also be used as a local economy.
- Experimental degree allows for establishment of regulatory sandboxes for local RE/CHP projects serving max. 10,000 customers of which. Min. 80% must be end consumers
- Spectral: Both De Schoonschip and Republica Papaverweg have benefitted from the experimental decree which is a regulatory exemption for a limited time.
- Energy sharing limited to limited postcoderoos level (neighbouring postal codes/ substation level) in the Netherlands.

Revenue creation source

Wholesale markets	TSO Ancillary services	Distribution network	Cost efficiencies	Subsidies	Behind the meter	Additional payment for green /local	Others

Others: Platform subscription fees

BM2 – Collective self-consumption

Case Study 1

Where	***What***	***Who***
Germany	Collective self-consumption	Solarimo, Naturstrom, Polarstern, Stadtwerke Mainova, etc.

Since 2017, collective self-consumption ("*Mieterstrom*") models can receive a support based on the renewable energy act EEG. Tenants can contract with the owner or the operator of a locally installed PV installation, who is becoming their supplier. Excess PV electricity is sold to the grid. On the other hand, the supplier is responsible for supplying the residual demand that is not met by local PV generation. Estimation of

about 5MW of RE capacity installed by collective self-consumption in Germany (expected to grow to 25MW until the end of the year).

Highlights

- No full smart meter rollout in Germany, only rollout pathway for customers with consumption above 10MWh. Therefore, self-consumption projects need a physical metering device at the level of the building. This device is very costly and affects viability of such business cases (especially for buildings with lower number of tenants) despite favourable regulation.
- Measuring own consumption in case not every tenant is participating is another complex issue. Different methodologies and technological solutions exist to adress this issue (**Key Issue #3).**
- There is a dedicated "Kundenanlage" framework (§3 EnWG) for entities between 1-100 customers operated by so-called energy community operator(s). Thanks to the framework that was historically implemented for CHP producing heat for large complexes with electricity sold locally it is easy to establish PV-based energy communities in Germany.
- Implicit subsidy for local self-consumption introduced in Germany, since part of the retail tariff can be avoided (**Key Issue #2).**
- Discussions and process to get approval of the project from local DSOs can be very slow (unlike connection procedures, DSOs have no obligation to respond within a certain time limit).
- Access to individual data is not necessary but still a need for yearly/monthly consumption level of customers.

Revenue creation source

Wholesale markets	TSO Ancillary services	Distribution network	Cost efficiencies	Subsidies	Behind the meter	Additional payment for green /local	Others

BM 2 – Collective Self-Consumption

Case Study 1

Where	***What***	***Who***
France	Allo Consumption	*I*

There are six existing collective self-consumption schemes in France.

Highlights

- The "ordonnance du 27 juillet 2016 relative à l'autoconsommation d'électricité" proposes a dedicated tariff scheme for energy community members (self-consumption & peer-to-peer business model).

- The part that is not self-produced is billed the standard way by the supplier, taxes included (Allo consumption). The part that is self-produced is paid for according to the contract that links the self-consumers together, taxes included. This allows consumers under the same LV/MV transformer to self-consume and exchange their generated energy.
- Regulator CRE introduced a **dedicated tariff for energy communities**, which differentiate between a reduced rate, applied to local transit, and a higher rate, applied to non-local transit. The DSO is in charge of metering the community consumption and implementing the net-metering between production and consumption. A dedicated tariff component was added to cover the costs associated to these activities.

Revenue creation source

Wholesale markets	TSO Ancillary services	Distribution network	Cost efficiencies	Subsidies	Behind the meter	Additional payment for green /local	Others

4.8 RES Origin Tracking

General description

This use case illustrates how digital solutions can help increasing investments in renewables by final customers of all segments (commercial, industrial, residential, public sector) by easing up the contracting of long-term renewable power purchase agreements (PPAs) schemes and other forms of direct RES financing. Due to the complexity and cost of the process, these to be a privilege to large customers only.

Furthermore, digital technologies can help reduce the cost of current policies that – either directly or indirectly – require the certification of the renewable feature of RES, that is a costly process requiring a central verification agency. For instance, art. 19 of the Renewable Energy Directive (2018/2001) stipulates that Guarantees of Origin shall be issued for all units of renewable energy generated, with a view to show to customers the commitment of generators to produce and suppliers to procure renewable energy.

While there is no specific regulatory framework on distributed ledger technologies (DLT), in particular blockchain they have a potential to enable a simplification of such processes as well as transparency. In essence, DLT are based on a decentralized verification process which records data on a transparent, accessible, time-proofed and immutable platform. Instead of trusting a third party to secure these data/transactions, it ensures accessibility and verification to all those allowed.

Opportunities

The main opportunity of the use case relates to lower transaction costs for direct support of renewable projects, therefore promoting acceptability and further support of RES. This may be achieved with block chains, allowing trusted and decentralized exchange between customers and RES producers without intermediaries.

Customers	Society / Energy system
• Choose the origin of the energy in an easier and more transparent way • Reduced complexity of contracts / • Lower transaction costs • Hedging of energy price risk	• Improved access to PPAs will support the acceptability and further development of RES • Cost saving because of administrative simplification

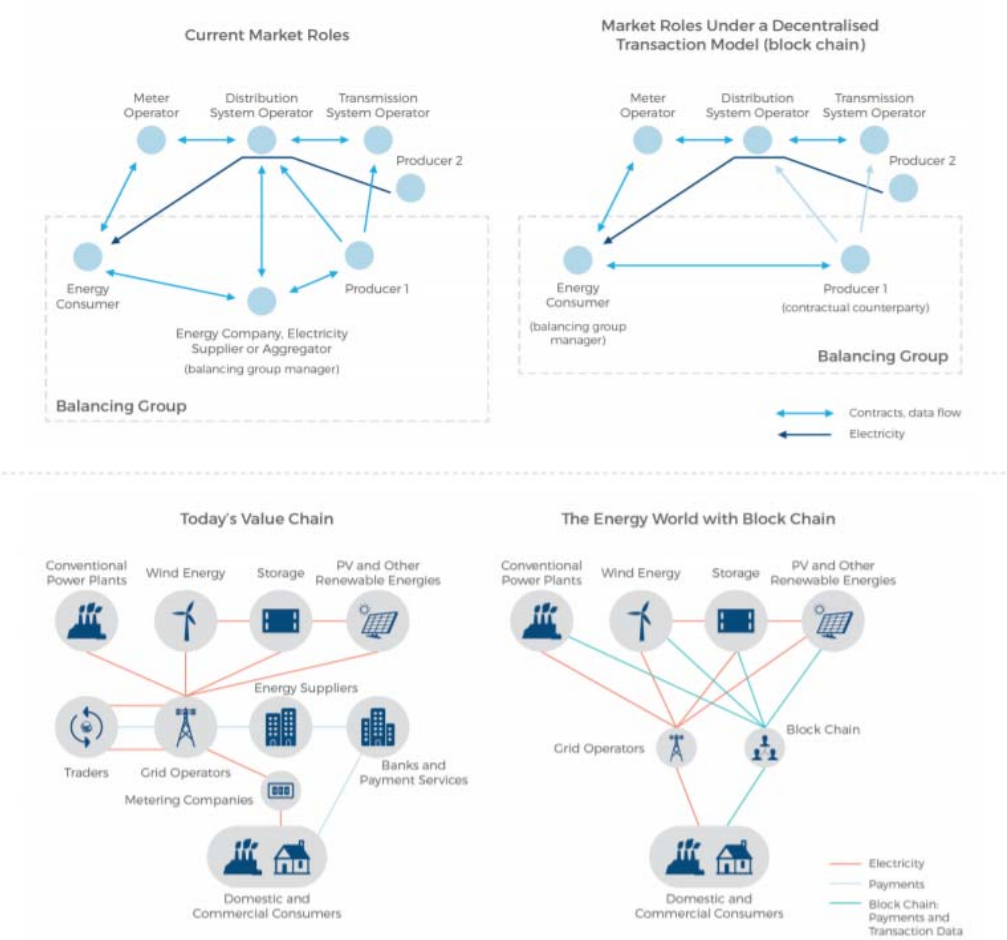
Business model

Smart PPAs are a form of funding that enables direct participation in RES financing and purchasing. Smart PPAs are based on digital platforms without which investors and project owners would not meet. The business model can be combined with the business models in UC7 at the community level (i.e. geographically limited area). Via platforms, money from a large number of usually small investors, in order to support projects of different kinds, often with a renewable energy, social and/or local dimension is collected. Different regulatory regimes exist as regards roles and responsibilities linked to the provision of the financial intermediary service. The

platform manager mainly gets a commission for successful funding as well as secondary revenue streams such as advertising fees or remuneration for providing project support.

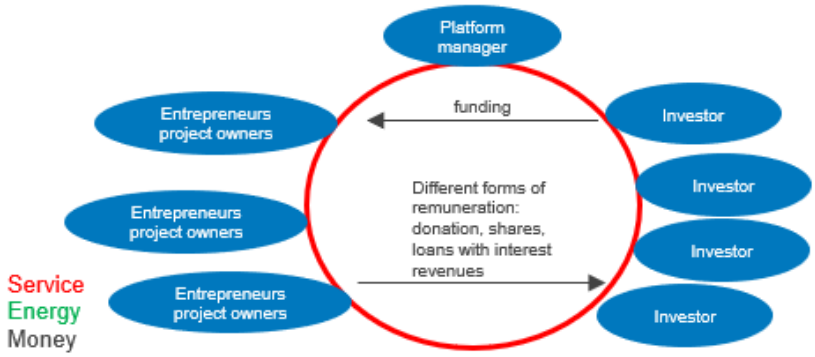
	PPAs
Description	• A platform links project owners looking for funding with investors, including individuals and small companies, willing to fund a certain energy project • Investors get a return in the form of shares, interest revenues, benefits in kind, etc.
Key actors	• Platform providers • Energy producers/project owners & suppliers • Investors/ buyers (i.e. industrial, commercial & residential consumers)

Figure 1 Market roles and value chains with block chain
Source: (Blockchain Commission for Sustainable Development, UN Development Programme, 2018)



Green PPAs are increasingly popular alternatives for corporate off-takers, offering supply of green energy while adding new renewable energy generation and providing price certainty for both parties. They can be purely financial or physical. However, regulatory complexity results in long lead times and high transaction costs, making this option inaccessible to smaller investors or individuals.

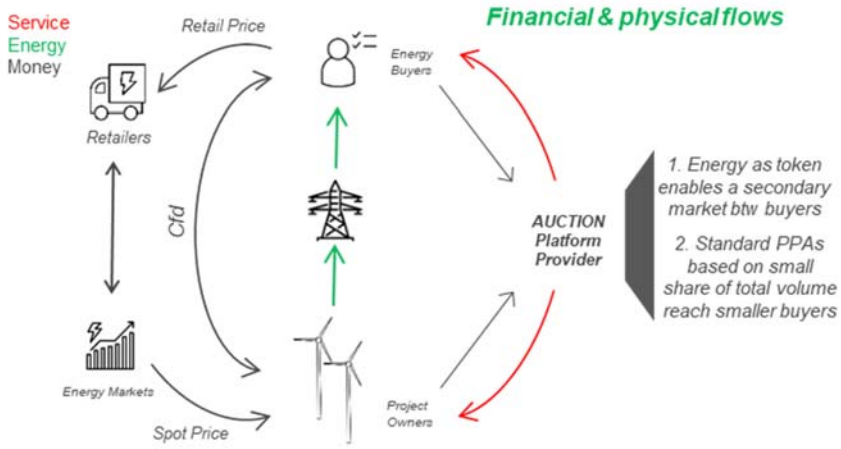
Under new business models using blockchain, smart PPAs might become accessible to more producers and consumers (beyond C&I customers), might be cheaper to put in place and take less time to validate, if blockchain registry is used. By simplifying the PPA process, more consumers will be willing to source their energy from renewable sources. PPA offers can therefore be added to a blockchain-based network, for off-takers to buy them directly without going through a long and onerous process.



Revenue creation source

Wholesale markets	TSO Ancillary services	Distribution network	Cost efficiencies	Subsidies	Behind the meter	Additional payment for green /local	User fee or transaction fee*

*commission for intermediation, advertising fee etc.



Technical maturity

A medium technology readiness level was assessed due to the fact that the use case is at the testing stage or at very limited implementation in the EU. While some pilots

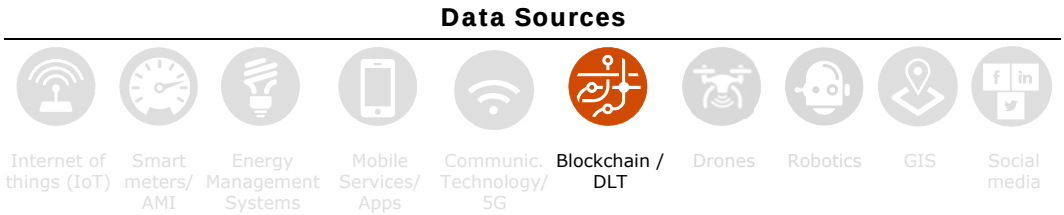
have been successful, these were conducted within a fixed environment, with large-scale pilots still not implemented. The main reason holding back such larger scale applications is the maturity of distributed ledger technologies, which will be further detailed in the following section (**Key Issue #1**).

DLTs have several opportunities. In theory, DLTs enable transparency and trust by providing access to the ledger to all (allowed) parties and therefore replacing a central authority. We focus here on blockchain, which falls under this set of technologies. Main issues regarding its advancement level will be explained.

At present, the technology is suitable for applications with a relatively lower number of transactions such as envisaged in this use case, whereas the scalability and speed are not adequate to the requirements of larger scale PPAs, or use cases such as peer-to-peer energy trading which call for real-time micropayments (see UC7). The choice of the right blockchain technology is key. Characteristics such as speed, security, scale and the accessibility (private, public or hybrid) of the platform should reflect the intended function of the technology. Currently, there are no mature public permission-less blockchains fully suitable for energy use cases. The major used solution is Ethereum but as a proof-of-work blockchain, it is highly energy intensive and slow for some use cases due to limited transaction throughput. It also has rather high transaction cost. Nevertheless, most cases in energy applications including WePower propose hybrid solutions (public and private combined blockchain structures) that overcome these issues. In addition, hardware blockchain wallets could be added to further enhance security and improve performance.

An additional issue is the technology's environmental footprint. As stated above, transaction verification protocols (consensus protocols) such as proof-of-work are energy demanding. As an example, Bitcoin's global electricity consumption was estimated to be greater than Austria's in 2015. While this is the case for Bitcoin, many other blockchain networks still rely on the proof-of-work consensus. A transition to proof-of-stake and sharing, which would solve some of the listed issues has been awaited but so far without full success.

Key enabling digital technologies



Data management

DLTs are based on a decentralized verification process which records data on a transparent, accessible, time-proofed and immutable platform. Instead of trusting a

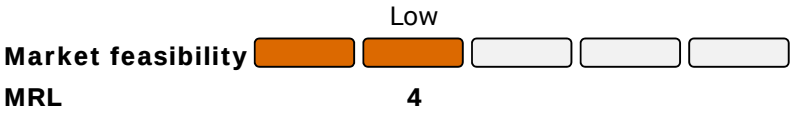
third party to secure these data/transactions, it ensures accessibility and verification to all those allowed. Since blockchain cannot be tampered with and they are accessible to involved party only, they are resistant to cyberattacks. However, these technologies are at an early testing scale. Their scalability and speed are not adequate yet (**Key Issue #1**). The ease of data management and security associated to these technologies might become a limit, once implemented on a broader scope.

Market maturity

Regarding the market's readiness level, it has been defined as Low/ Medium as all analysed projects have been implemented either by companies internally or as pilots. However, certain conditions are necessary for their implementation and real business model success.

Market-scale project is still needed. Access to data on transactions throughout a market in an interoperable standardised format is needed for scaling up (e.g. such as done in Estonia's Estfeed platform, see case study). But there are also competing alternatives to traceability. For example, Microsoft for example has a 24/7 PPA ensuring 100% green energy. They partner with an insurance company that takes some of the risks linked to forecasting of generation levels. This alternative model could spread to other (smaller) entities. (BNEF, 2018)

As the business model relies on blockchain technology, its wide adoption by customers will define its success. Issues include the use of energy tokens, which are another form of currency, as a way of payment and the volatility of such token prices. Blockchain and cryptocurrencies is in some cases linked to activities giving it a bad image such as the dark web, security flaws and the high energy consumption needed for the use of blockchain mining.



Regulatory feasibility

The regulatory feasibility of the use case depends on whether DLTs can be used as a tool to support existing schemes or to replace these schemes. Today, the use of DLTs for issuing PPAs is not explicitly recognised. Such technologies can act as opportunities to practically implement the provision in the RE Directive stating the facilitation of uptake of such agreements and remove unjustified barriers.

Compliance of blockchain-based use cases with GDPR can be an issue. "*It seems difficult to interpret some of the GDPR's rules in blockchains environment, which enables radical decentralisation of data storage and processing. In this case, information does not flow linearly from users to providers and back*" (EU Blockchain, 2018).

Renewable Energy Directive (2018/2001) requires that:

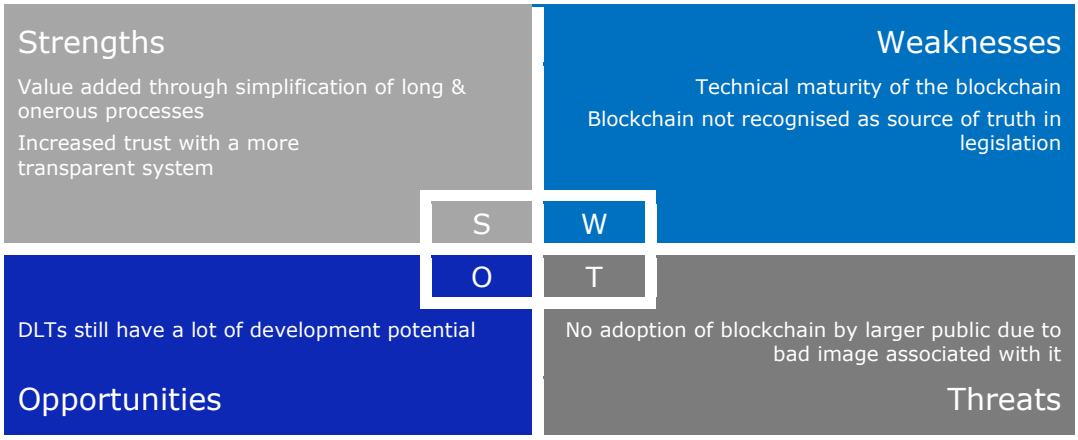
- Member States shall assess the regulatory and administrative barriers to long-term renewables power purchase agreements, and shall remove unjustified barriers to, and facilitate the uptake of, such agreements; and ensure that those

agreements are not subject to disproportionate or discriminatory procedures or charges (art. 15.8).

- Art. 19 describes the rules for GOs' issuance, disclosure, cancellation and accounting towards the Member States' RE energy targets. GOs can be issued for electricity and gas, including hydrogen, and heating and cooling. Member States may arrange for guarantees of origin to be issued for energy from non- renewable sources. A GO shall be of the standard size of 1 MWh. No more than one GO shall be issued in respect of each unit of energy produced. Member States and designated competent bodies shall ensure that the requirements they impose comply with the standard CEN - EN 16325. When a producer receives financial support from a support scheme for the production of energy from RE, the market value of the GO for the same production is appropriately taken into account in the relevant support scheme; and that such GOs are not issued directly to the producer but to a supplier or consumer who buys the renewable energy either in a competitive setting or in a long-term corporate renewables power purchase agreement. MS could also issue a guarantee of origin to the producer and cancel it immediately. The demonstration of a suppliers' share of RES in its energy mix must be done via GOs (art. 19.8)

Renewable energy communities are entitled to produce, consume, store and sell RE, including through RE PPAs (art. 22).

SWOT analysis



The use case simplifies existing certification or agreements processes through a faster and more transparent technology. Cases must therefore be perceived as valuable by external players for market applications, as only pilot tests have been achieved up to date. The maturity and advancement of the blockchain technology also plays a role in the adoption and the right use for the case. The need for easy access to data could also be prevented by political issues between market players.

Overall evaluation of UC feasibility level and key issues

Implementation status

Feasibility level

	Very Low	Low	Medium	High	Very High
Technical					
Market					
Regulatory					

Key issues

Key Issue	Description	Type of Issue
1. Acceptance & sustainability of blockchain technology	DLTs, including blockchain, are at testing stage, lacking larger scale applications. Scalability and speed are not adequate yet. Also, the technology's environmental footprint is currently an issue.	

Preliminary identification of enabling policy / regulatory actions

We identified one Key Issue, related to the current issue of **Acceptance & sustainability of blockchain technology**. Forward looking and as pointed out by (NERA, 2018), the European should put efforts on standardising and building consensus around blockchain technologies, by:

- the provision of funding for blockchain-based pilot projects. Through Horizon 2020, the European Commission has provided €83 million in funding for blockchain-related projects and could commit up to an additional €340 million from 2018 to 2020.
- considering the continued and increased use of "regulatory sandboxes".

Case studies

Case Study 1

Where	***What***	***Who***
Estonia	PPA procurement and trading platform	WePower

The WePower Platform is an online environment enabling Energy Buyers and Project Owners to find each other and enter Corporate PPAs. The Platform uses smart contracts and tokenized energy to execute and manage all transactions. They claim this enables an aggregation of multiple smaller contracts from smaller buyers to a large buying block. It also enables buyers to sell their agreement to third parties.

- WePower have successfully used blockchain (based on Ethereum) to tokenize energy and store transactions through the Elering (Estonian TSO) central data hub. This was a demonstration project and is now ready for a commercial test. The central data hub as well as the 100% smart meter roll out in Estonia have made the test possible. The central data hub is also GDPR compliant.
- The existence of the central data hub as the only source of data is crucial. Good coordination between DSOs and the TSO is also key for the creation of the central data platform.

4.9 Improved O&M

General description

Asset Performance management (APM) solutions enable to predict and prevent operational issues, reduce downtime and boost overall asset performance and life. Raw data is transformed into actionable intelligence, moving from reactive and preventative maintenance processes into predictive ones. In the O&M (Operations & Maintenance) sector, the advent of Digital Twin techniques allows to improve asset monitoring of both power grids (transmission and distribution grids) and of power generation (e.g. pumps, turbines, circuit breakers, etc.).

Digital Twin consists in creating a digital clone of the asset thanks to real-time data aggregation, which allows to constantly check its performance (expected vs actual measurements) with the opportunity to introduce AI algorithms to analyse feedback from sensors and network signals to automatically configure itself and optimize the overall energy network. In this way, asset owners can test scenarios, perform predictive maintenance, and optimize the asset to its full potential.

Opportunities

According to IEA, digital data and analytics can reduce power system costs in at least four ways: by reducing operations and maintenance costs; improving power plant and network efficiency; reducing unplanned outages and downtime; and extending the operational lifetime of assets (IEA, 2017).
In particular, digitalisation of power generation can offer a significant range of immediate operational and financial opportunities, namely:

- sensors, devices and software can enable operators to utilize a wide range of data in real time and improve decision-making;
- control systems enable improved performance and maintenance of vital infrastructure and equipment either on-site or remotely;
- advanced analytics enables predictive maintenance and simulation to optimize asset performance;
- remote monitoring and external support can address key human resource and knowledge retention issues.

Customers	Society / Energy system
• High efficiency (optimizing performance while minimizing operational costs) • Lower costs for start-ups • Increased revenue through fewer outages • Portfolio optimization	• Optimisation of transmission and distribution grid management in terms of availability, reliability and flexibility & reduced downtime • Lower carbon emissions from power plants thanks to improvement in their performance

Business models

Asset Performance Management (APM) solutions for improved O&M have been analysed in two different business models, respectively addressing networks and

power generation assets: Digital Power Grids (1) and Digital Power Plants (2). A third business model has been identified in new kind of services offered to power utilities as a solution to integrate all systems unlocking their IoT data potential: Platform-as-a-Service (PaaS) (3).

	1 APM – Digital Power Grid	2 APM - Digital Power Plant	3 Platform-as-a-Service (PaaS)
Description	• Predictive maintenance of transmission and distribution grids powered by digital twin and drone-based services. • Digital Twin as digital representation of the infrastructure which jointly stores, analyzes and displays data • UAVs (Unmanned Aerial Vehicles) used to assist in ordinary and predictive maintenance by capturing the current state and provide analysis of numerous factors	A Digital Power Plant (DPP) is a suite of digital applications that improve the performance of power plants and reduce asset downtime using cloud-based analytics on a digital platform. There is the synergy of hardware (machinery) and software, combining the diverse needs of power assets with high-speed,intelligent digital infrastructure.	Companies are using intelligent Business Process Management (iBPM) platforms as secure and scalable industrial end-to-end solution for connecting products, plants, systems and machines to unlock their IoT data potential. PaaS enables power utilities to transform data into productive business results.
Key actors	• Grid operators (TSOs and DSOs) • Technology providers	• Power utilities • Asset owners • Thermal power plants owners • Wind farm operators • Technology providers	• Power utilities • Asset owners • Thermal power plants owners • Wind farm operators • Grid operators (TSOs and DSOs)

BM1 – APM – Digital Power Grid

Transmission and distribution grid operators have a big opportunity to increase their revenue by improving operational efficiency in the area of asset management. There is a growing opportunity with digital transformation for energy transmission and distribution grid operators. They can pass from manual-based operations for asset management to a Digital Twin solution through the use of aerial data and advanced image data analytics obtained from Unmanned Aircraft Systems (UAS), commonly known as drones. The annual losses on energy sales caused by outages can be significantly influenced by improved asset management as well as by cutting down the recovery time after major blackouts (PwC, 2018).

The use of drones for O&M has indeed a great potential to improve workforce safety in remote areas, enabling a more automated maintenance, reducing costs and enhancing operating efficiencies.

BM2 – APM - Digital Power Plant

Digital technologies allow power generators to better manage process and automation knowhow; gain visibility and insights into the performance of equipment, plants and fleets to enhance decision-making; and ultimately, to find new ways to operate more competitively in the changing power market. From conventional power generation, including coal, gas, combined cycle, nuclear, hydro and waste-to-energy, to renewables like biomass, solar, tidal and wave, each sector and business has its own

priorities and challenges. These include heavy investment in improving the performance of legacy equipment, gaining greater access to expertise in remote geographies and automating compliance reporting. Power generators need digital solutions to solve specific business challenges in a scalable way to deliver real and measurable opportunities, sustainable over both the short and long term (ABB, 2017).

Conventional Power Generation (gas turbine)

The Renewable Energy Directive (2009/28/EC) required Member States to open their power grids to energy from renewable sources giving 'priority dispatch' for renewables and high-efficiency cogeneration, above other forms of energy generation (e.g. fossil fuels). This created a number of imbalances in the functioning of European electricity markets, mostly due to RES rising share and very low prices (nearly zero or even negative in some markets) of some RES-generated electricity.

In these market conditions, gas-fired generation role has mostly been limited to provide flexibility to support the integration of renewables, filling in the gaps where variable renewables (wind and solar) fall short. Therefore the need for a focus on gas turbine dynamic design and additional progress in efficiency and flexibility performance, both for new-build plants and for retrofits of existing plants. Improvements in ramping capabilities, start-up times, turndown ratios and part-load behavior are continuing in parallel with more moderate full-load efficiency improvements.

In this context, digitalisation is seen as the key driver for more dynamic and responsive power plants. The adoption of digital technologies and automation can significantly improve ramping capabilities, start-up times, turndown ratios and part-load behavior. However, improved and more consistent start-ups are just one potential opportunity of a more autonomous power plant.

Power generation can expect digital systems to modify most aspects of their operations. Increased data collection will require spending on analytics software and cybersecurity and will change their sources of revenue from simply providing energy to working in grid balancing markets. Digital solution for power generation can provide a number of services to meet the industry need, the most relevant being asset monitoring and performance optimization.

As for monitoring, process and system data are used through sensors, devices and software to know more about the plant or fleet in real time. Performance monitoring allows for comparison between actual and expected efficiency of equipment, plant and fleet more widely. Other forms of monitoring can allow for condition-based and predictive maintenance, such as cycling impact, boiler and turbine stress evaluator, vibration monitoring, sensor diagnostic/failure identification and continuous emissions monitoring.

Performance optimization solutions for power generation improve operational efficiency for both an individual plant (load response, fast start, efficiency, output control, emissions abatement) and across an entire fleet (load coordination). These solutions allow to lower variable costs, increase output, reduce emissions, lower operator variability and enable greater operational flexibility.

Renewables (wind turbine)

Digital technologies can help to optimize both the operations and forecasting of renewables, especially wind farms. By implementing digital systems and data analytics, renewable energy O&M costs can be reduced by 10%, production increased by 8%, and curtailment cut by 25% (BNEF, 2017). Machine learning algorithms applied to weather and power plant output data can dramatically increase the accuracy of forecasts. In addition to improving forecasting, retrofitting digital systems can improve renewables integration by allowing operational data to be provided directly to operators. Improved decision making based on data analytics will enhance daily O&M, substantially reducing O&M costs (OPEX) and the MWh production cost as a consequence.

Digital twins for prognosis of failures in key components help operators to decide how long they should operate it without maintenance interventions and decide at what point maintenance, overhaul and replacement of components will yield maximum opportunity. Using the new remote services, wind farm operators can switch from corrective and preventive maintenance programs to proactive O&M strategies. Reliability and availability of big wind turbines are essential – unscheduled downtime in a turbine will have a significant impact on power generation, revenue and profitability. Furthermore, the giant turbines will be installed far offshore, making O&M extremely challenging and expensive. By enabling condition based maintenance and greater predictability, digitalisation can help to increase energy yield and reduce costs.

For example, if the algorithms in the cloud platform detect that a turbine is developing a defect, the operator can take action to protect the turbine and the wind park's output. They can activate power prioritization mode and the defective turbine is operated in a reduced run mode. This helps to avoid excessive stress and accelerated component wear. At the same time, the wind park can balance active and reactive power to continue stable operation. It will continue to meet grid code requirements and generate revenue, while maintenance is planned to remedy the defective turbine with minimum downtime and maximum safety.

The European Technology & Innovation Platform on Wind energy (ETIPWind) has created a mindmap compiling the opportunities offered by digitalisation for wind energy (ETIP Wind, 2016). All these can be summarised in terms of facilitating system integration and continuing cost reduction.

BM3 – Platform-as-a-Service (PaaS)

Companies are using intelligent Business Process Management (iBPM) platforms as secure and scalable industrial end-to-end solution for connecting products, plants, systems and machines to unlock their IoT data potential. The Platform-as-a-Service (PaaS) business model has taken hold to enable power utilities to transform data into productive business results (PwC, 2018).

Such platforms are complete solution for industrial data monitoring and event management, combining asset connectivity, edge-to-cloud analytic processing, and a feature-rich user console. They usually consist in cloud based, open IoT operating system that let understand data by quickly and securely connecting products and plants to the digital world. They transform data into productive business results using advanced analytics. Interoperability and creation of API standards is hence the major issues for integrated digital platforms (**Key Issue #3**).

Digital industrial platforms are essential in connected smart factories, where the platform can take data from the machines, make it accessible to monitoring and control applications, allow third parties to develop applications based on that data, and connect different users and application developers. Equipped with appropriate business models, digital industrial platforms may ultimately be instrumental in the creation of ecosystems of market actors in a multi-sided marketplace. These ecosystems enable the creation of new innovative products and services and accelerate the development of standards.

Technical maturity

All BMs rely on mature and existing digital technologies, with many solutions available on the market. Market feasibility of this use case is therefore high (MRL=7-8), but with some market barriers mainly due to high cost of digital equipment for advanced O&M.

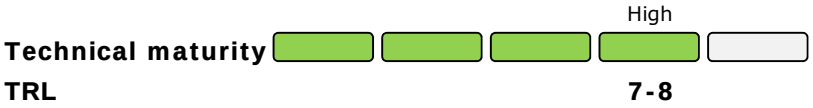
Asset Performance Management encompasses the technology solutions that enable real-time, remote control and automated maintenance for extending the life cycle or operating efficiency of assets. Predictive analytics, machine learning and robotics are used for smart asset planning and predictive maintenance.

However, the increased efficiency in supply services due to digitalisation comes with a price: increased exposure to cyber incidents and attacks (**Key Issue #2**). These threats apply to all generation, transmission, distribution and process technologies, and to energy market services. Ensuring resilience of the energy supply systems against cyber risks and threats is becoming increasingly important as widespread use of ICT and data communication is becoming the foundation for the functioning of infrastructures underlying the energy systems.

Therefore, it is essential to maintain equilibrium in critical infrastructure such as energy, which supports and sustains other critical infrastructures. A power outage often has serious consequences due to the cascade effect, inevitably affecting other sectors and their infrastructure. The Ukraine power grid attack in 2015 demonstrated the potential impact of cyberattacks on the electricity subsector. This well-planned hack on three power-distribution companies caused outages to 80.000 energy customers.

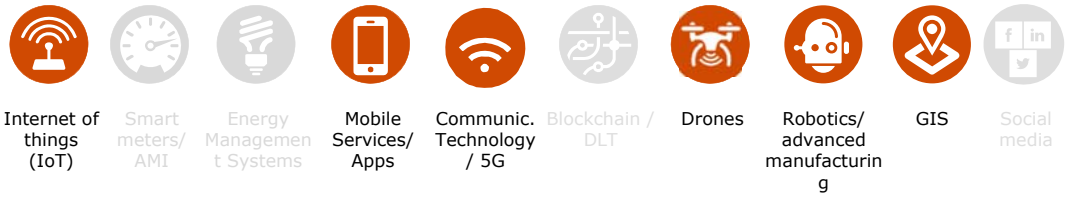
The focus of cybersecurity in the energy sector is to support the reliability and resilience even in the event of a cyberattack. Unlike IT systems, a control system in the energy sector that is under attack cannot be easily disconnected from the network as this could potentially result in safety issues, brownouts or even blackouts.

In BM1, the innovative use of remote sensing, data collection and management and artificial intelligence (AI) that can be applied to the inspection and maintenance of transmission and distribution assets. The pairing of drones with big data, storage and advanced image analytics can indeed help utilities achieve a wide range of their most pressing goals, including a reduction of operations and maintenance (O&M) costs, improved safety for line workers and, of course, reliability.



Key enabling digital technologies

Data Sources

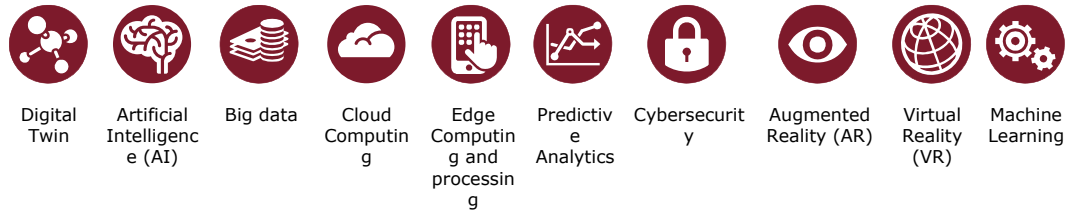


Drones: new platform with which to obtain aerial data at potentially lower costs of data acquisition, and to collect data in hard to reach areas

5G: enhancing data transfer allowing live data streaming and long-distance drone operations

IoT: sensor based real-time information about grid condition to immediately enabling immediate identification of malfunctions

Data Visualisation, Analysis and Evaluation



Advanced image data analytics: data processing and advanced analytics applied to aerial data allows organizations to assess the infrastructure and it's surrounding elements supporting maintenance decisions

AI: AI-powered analysis and interpretation of aerial data enabling preventive maintenance and process automation

Data management

BM1 – APM – Digital Power Grid

The quality and topicality of data regarding the location and technical condition of assets directly affects a company's ability to reduce facility downtime and overall maintenance costs

Drones guarantee high data accuracy and quality -Combination of imagery data, Machine Learning and AI is having a tremendous impact on the maintenance of critical infrastructure. Dedicated solutions for power and utility companies to acquire or manage data about physical infrastructure have to comply with industry security standards and national legal regulations for critical national infrastructure.

BM2 – APM – Digital Power Plant

Conventional Power Generation (Gas turbine)

Power plants owners want to be assured that their data is protected through contractual commitment with their digital solution provider, meaning their data is shared only with consent. Furthermore, customers' data is protected through restricted access for use only for specific services. Data ownership and data accessibility are key issues for them. In most solutions, the data is always owned by the customer - it is their intellectual property.

Renewables (Wind turbine)

A typical onshore wind farm generates 500 terabytes of data every 13 days. At a moderate 1,840 load operating hours and 20-year lifetime, this would translate into more than 61,000 terabytes for a single site. But most of the data generated by such a wind farm is never seen, let alone analysed or optimised (SETIS, 2018). In a digital wind turbine data management mainly relates to the following aspects:

- Data quality and standardisation (harmonisation of data format)
- Multi Access Data Pool: TSO data, weather forecasting data, local consumer demand
- Forecasting data: more digital sensors and more complex models will provide more accurate wind power forecasts from real-time to 2 weeks day ahead.
- Weather forecasts and local environmental data must be combined with operational specifications. Wind operators, in addition to supplying forecasts, also typically transmit data directly to system operators, so they can develop their own predictions.
- Digital systems can also supply data to operators that would otherwise be held by the turbine manufacturer. Access to this data can give deeper insights into operational strategies.

Market maturity

Moreover, in the context of increasing digitalisation of power assets, asset owners need to face the challenges related to the exponential rise of their assets vulnerability to cyberattacks. Cyber security risks are going to become more and more acute with implications for safety, efficiency, margins and ultimately operational viability. Finding solutions to these risks is not easy for asset owners, who are facing these major challenges:

- IT (information Technology) and OT (Operational Technology), both of which are critical in creating a secured environment for assets, have different priorities. IT may wish to introduce new measures to improve security, which OT sees as an imposition that could disrupt operations;
- successful and resilient cyber security programs require not only investment in technology, but also in acquiring skilled resources and evolving business processes to address new risks;
- finding the right security partners can also be challenging;
- it is hard to give a value to cybersecurity. Investment in cyber security should be seen as an insurance policy – a way to avoid potential costs and unacceptable risks that could be incurred through a disruption to operations brought on by a cyberattack.

BM1 – APM – Digital Power Grid

Grid operators are transforming manual-based asset management operations into Digital Twin powered solutions, enabling the integration of various data sources. At present, models with different maturity level of asset management ca be found in the energy distribution and transmission sector, from the most traditionalist to the most advanced (PwC, 2018).

The "best in class" category present on the market has the following features:

- Central asset management platform integrated with various data sources (including aerial inspections);
- Assets with key technical indicators monitored in real time, event management and connection with big data;
- Predictive maintenance based on real-time internal and external data;
- Use of AI-supported analytics for cost tracking, asset inventory, risk prioritization and emergency reporting.

Many TSOs and DSOs across Europe have started adopting drones for inspection of their power lines, such as Engie (France), Enel's e-distribuzione (Italy) and Endesa (Spain).

BM2 – APM - Digital Power Plant

Digitalisation holds great promise for the power generation industry. However, a range of internal and market challenges can constrain its effective uptake and implementation for those in the early stages of their digital journey.

Energy technology companies such as ABB, Siemens, GE, JCI and Schneider Electric are already offering many solutions, with sales of sensors for commercial infrastructure and software services.

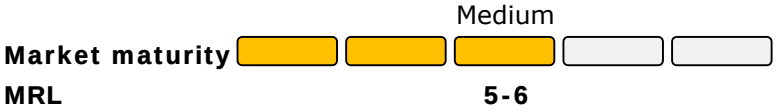
BM3 – Platform-as-a-Service (PaaS)

Many solutions are already available on the market, the major ones coming from some of the world's leading power companies, such as GE with PREDIX and Siemens with Mindsphere (see case studies), as well as from control systems companies, such as ABB.

To reinforce the European competitiveness in digital technologies, the European Commission is supporting the development of digital industrial platforms, which are essential for the integration of different key digital technologies into real-world applications, processes, products, and services. The EU, Member States, and regions need to cooperate and co-invest under common priorities in order to accomplish these actions. While digital industrial platforms are essential for the integration of key digital technologies, large sale piloting and experimentation is also needed to gradually develop and mature such platforms.

BM	Presence on the market	Countries	Enablers / Barriers		Area
1	Service available on the market		Use of drones for the inspection and maintenance of power transmission lines.	+	
2	Service available on the market		Power plants in Northern Italy competitive again in the ancillary service segment thanks to digital solutions	+	
	Service available on the market		Power plants that have been identified as critical infrastructures need to fulfil a different catalogue of IT-security measures drafted by the NRA	+	
3	Low penetration level		API standards and ICT interoperability	−	

In conclusion, digital solutions for asset management rely on mature technologies, with many solutions already available on the market. However, high costs of such digital solutions or sophisticated data analytics tools are currently hindering their deployment. As a result of our analysis, the market maturity of this use case can assessed as medium (MRL=5-6).



Regulatory feasibility

Power plants and transmission lines are considered critical national infrastructure, which often brings different requirements for performing flights over them as well as for storing and managing data. National legal regulations designed to ensure the safety of critical infrastructure require that power & utilities companies follow very strict rules on creating and updating documentation of assets' technical condition, as well as the timing of regular maintenance inspections (**Key Issue #1**).

Moreover, data on energy infrastructure have to be stored on secure servers in companies' headquarters, or with certified external companies guaranteeing the proper level of security, and managed by specially trained employees. Dedicated solutions designed for energy companies to acquire or manage data about physical infrastructure have to comply with industry security standards and national legal regulations (PwC, 2017).

The "Regulation (EU) 2018/1139 on common rules in the field of civil aviation" adopted in July 2018 sets the first ever EU-wide rules for civil drones, which will allow remotely piloted aircraft to fly safely in European airspace and bring legal certainty for this rapidly expanding industry. Until then, EU law gave competence to Member States for all drones lighter than 150 kg, so that there was very fragmented regulation across all Europe. Regulation (EU) 2018/1139 empowers the European Safety Agency (EASA) to propose to the European Commission the technical expertise to regulate drones of all sizes, including the small ones.

The scale of the threat to energy cybersecurity is massively increasing as energy systems develop ubiquitous intelligence and communication capabilities throughout their operations. In this context, the security of critical infrastructure is a core issue

in national, international, and corporate security dialogue and policies. Overall, the following cybersecurity issues needs to be primarily addressed:

- International agreements and standards on cybersecurity
- Well functioning, international incident handling/crisis management mechanism

Since 2013, when the first EU Cybersecurity Strategy was adopted and the Regulation (EU) No 526/2013 set out the current mandate and tasks for the European Union Agency for Network and Information Security (ENISA), the Commission started addressing such challenges in order to support the reinforcement of the EU's deterrence of, and resilience and response to, cyber-attacks.

With the Directive on security of network and information systems (the 'NIS Directive') adoption in 2016, the EU has introduced measures aimed at enhancing the protection of critical infrastructure. Such measures would be further reinforce and become more effective through cybersecurity certification as they also help increase the cyber resilience of critical infrastructures.

Across Europe, different initiatives have already been conducted by Member States in order to enhance the country's ability to face any cyber attack. For example:

- In France, the CSPN certification for black box testing of product security level is used for meters and data concentrator security certification. However, there is a lack of mutual recognition with other Member States: no market for suppliers, therefore no incentive for certification. That is why it has been mainly used only by SMEs so far;
- In Germany, the national IT-Security Act came into force in June 2015. Since May 2016, operators of critical infrastructures in the energy sector are obliged to report network and information security incidents that may have a disruptive effect on the provision of their service. In addition to that, all DSOs and TSOs need to fulfil a catalogue of IT-security measures and implement an Information Security Management System (ISMS) compliant with ISO/IEC 27001. Electricity generation plants that have been identified as critical infrastructures will need to fulfil a different catalogue of IT-security measures that is currently being drafted by the national regulatory authority.

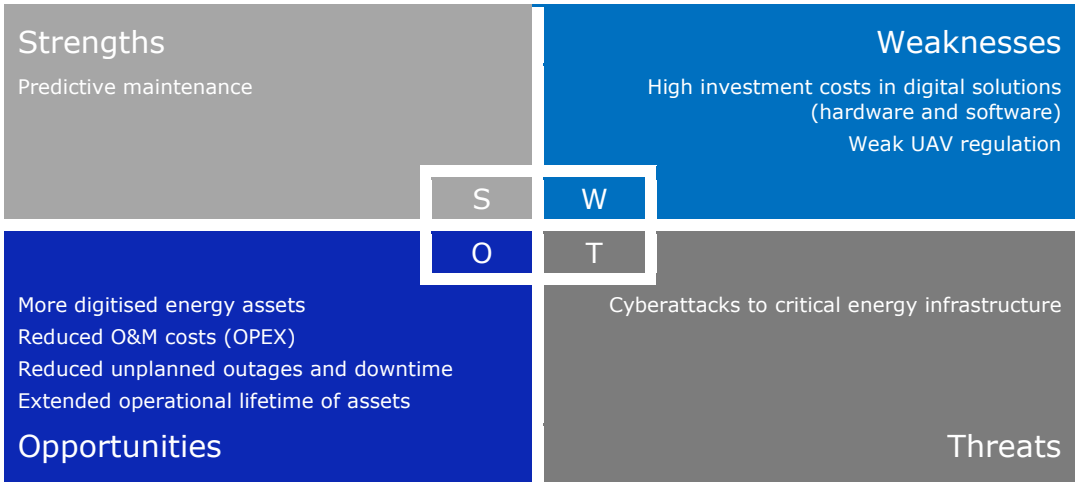
In September 2017, the Commission adopted the Cybersecurity Package. The package builds upon existing instruments and presents new initiatives to further improve EU cyber resilience and response. As part of the package, the Cybersecurity Act has been approved to better support Member States with tackling cybersecurity threats and attacks. It also establish a permanent mandate for ENISA to ensure that agency can provide support to Member States, EU institutions and businesses in key areas, including the implementation of the NIS Directive. ENISA will also contribute to stepping up both operational cooperation and crisis management across the EU.

For what concerns non personal data, the Free-flow of non personal data Regulation 2018/1807 will be entering in force in May 2019 and will ensure that transparency principles are adopted, while data economy opportunities are unleashed. Companies and public administrations around Europe will be allowed to store and process non-personal data everywhere in the EU and competent authorities will have access to

data with no geographical limitations and will be entitled to carry out regulatory control purposes.

Following the analysis of the current regulatory framework relevant for this use case, the overall regulatory feasibility can be evaluated as high.

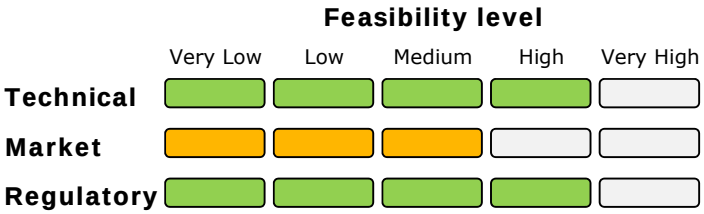
SWOT analysis



Overall evaluation of UC feasibility level and key issues

Summarising all the considerations made around this UC, the overall assessment, reported below, shows that asset performance management business models applied to energy critical infrastructure (both power grids and plants) could mainly suffer by cybersecurity and drones regulation issues. The current regulatory framework is already addressing these issues, with the limits shown in the analysis, which may advice additional actions to be taken.

Implementation status



Key issues

Following the order of appearance of the key issues identified in our analysis, the table below presents a summary which helps linking such issues with the policy/regulatory actions needed to overcome them and allow a wider development of this use case business models.

Key Issue	Description	Type of Issue
1. Drone use regulations and constraints created by their limitation	Drone-based solutions designed for power companies to acquire or manage data about physical infrastructure have to comply with industry security standards and national legal regulations. Power plants and transmission lines are critical national infrastructure, which implies to follow very strict rules for safety requirements in order to perform flights over them as well as for storing and managing data.	
2. Risk of cyberattacks and threats to a digitised energy critical infrastructure	As the power grid is increasingly dependent on the internet for operations, it becomes increasingly vulnerable to cyberattacks. Grid operators must operate their network and information utilities in compliance with defined minimum cybersecurity standards to be fixed within the national cybersecurity law.	
3. Need for APIs and interoperability standards for integrated platforms	Need to integrate and aggregate data collected from separate solutions from different product manufacturers in order to create meaningful data to create insights. After aggregating the necessary data, a system that can store the data, process it and analyse it, is needed.	

Preliminary identification of enabling policy / regulatory actions

From the use case analysis, it emerged that asset performance management business models applied to energy critical infrastructure (both power grids and plants) are mature and available on the market. However, there are still some key issues to be addressed in order to unlock the full potential of the analysed BMs.

Key Issue #1: Drone use regulations and constraints created by their limitation

Policy actions at EU level by 2030:

- *Reinforced Legislation scenario*: reinforce UAV legislation, especially focusing on remote drone flight.

Key Issue #2: Risk of cyberattacks and threats to a digitised energy critical infrastructure

Regulatory actions addressing this issue have been already taken with the NIS Directive, so that there is no need for further legislation, but for actions to support the implementation of current legislation. Cybersecurity measures are currently not mandatory for industries across MSs and require high investments to be compliant with them.

Policy actions at EU level by 2030:

- *Consistent Governance scenario* (see Section 5.3.2.2):
    - make cybersecurity measures and standards mandatory and introduce sanctionatory measures in case of failure to be compliant with current legislation (as done by GDPR and Telecom Package)
    - provide incentives to support their application

Key Issue #3: Need for APIs and interoperability standards for integrated platforms

Policy actions at Industry level by 2020 and 2030:

- *BAU scenario:* grant industry the necessary freedom to design innovative products, while keeping a good balance with progressive legislation (see Section 5.4.1.1).
- *Consistent Governance scenario*: Keep standardisation as the prerequisite to specify technical methods, such as measurement and product safety, and maintain the New Legislative Framework principle by listing standards under the respective legislation (see Section 5.4.1.2).
- *Reinforced Legislation scenario*: create legislation that is evidence-based, and regulating measurable, verifiable and relevant parameters, avoiding overlapping double regulation of products and parts (see Section 5.4.1.3).

Case studies

BM1 – APM – Digital Power Grid

Case Study 1

Where	***What***	***Who***
SPAIN	Use of drones for the inspection and maintenance of electricity lines	RED ELÉCTRICA DE ESPAÑA

Red Eléctrica de España developed two projects in 2017 for the use of drones - remotely piloted aircraft - for the inspection and maintenance of electricity transmission lines, as a commitment of the Company to innovation applied in order to increase the safety and efficiency of these operations. In 2018, the Company continued working with these devices and its own qualified personnel, completing the inspection of some 500 kilometres of line of the electricity transmission grid. In collaboration with the company AeroTools, Red Eléctrica has designed two drone aircraft prototypes with advanced functionalities designed to facilitate the undertaking of the specific inspection works on high-voltage overhead lines.

Highlights

- Telemetry system that provides audible information regarding the most relevant data, in addition to displaying it on the control panel, thus allowing the pilot to work without taking his eyes off the drone;
- Communication channel encryption system to guarantee higher quality and security of information;
- Autonomous flight system, by which the device recognises the environment and guides itself around the element being inspected without the intervention of the pilot, therefore reducing flight time and the possibility of error;
- Red Eléctrica has conducted a comparative evaluation with other official operators specialised in this type of work in order to analyse the effectiveness and efficiency of different sensors and inspection methodologies before the final implementation of this new operating procedure;
- Red Eléctrica has obtained the license as an official operator of remotely piloted aircraft, granted by the Spanish Aviation Safety and Security Agency (AESA).

BM2 – APM - Digital Power Plant

Case Study 1

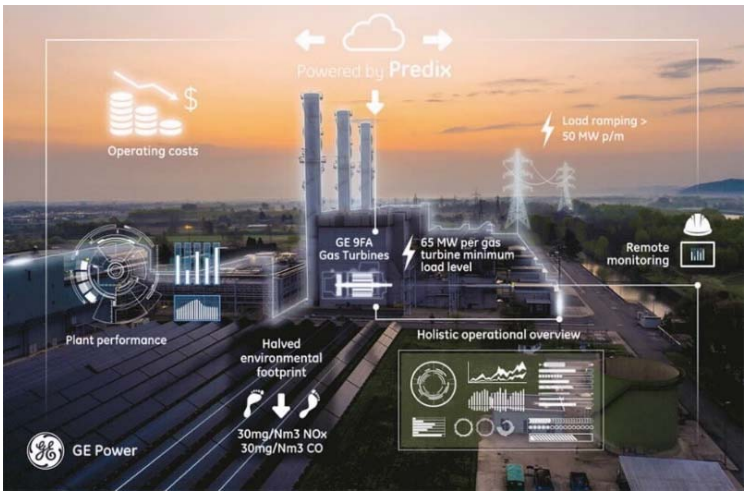
Where	***What***	***Who***
ITALY	Chivasso Power Plant	GE and A2A

New digital solutions have made the Chivasso power plant competitive again in the ancillary service market, and A2A is planning to install GE's software and hardware technologies in more power plants to utilize big data analytics to improve fleet performance and make smarter operational decisions.

GE's Operations Optimization software suite drives better plant and fleet performance across equipment manufacturers, site configurations and thermal cycles. This technology can deliver enterprise data visibility across A2A power plants, including non-GE equipment, providing a holistic understanding of the operational decisions that can expand capabilities, lower production costs and improve reliability.

Highlights

- 65 megawatt (MW) per gas turbine minimum load level and load ramping at up to 50 MW per minute or two-and-a-half times the normal rat;
- Start-up time of the entire plant in a range from 90 to 120 minutes in every condition.



Source: GE Power

Case Study 2

Where	***What***	***Who***
SPAIN	Control centre CORE	Iberdrola

Iberdrola deployed a technology to monitor and operate renewable generation facilities from a single dispatch center called CORE, located in Toledo (Spain). CORE centralizes the operation and control, in real time, of 7.000 megawatts (MW) of

installed power from 220 wind farms, 70 mini-hydropower plants and more than 6.000 wind turbines, spread across nine countries.

Highlights

- Information from sensors is fed to the central control center, which monitors in the region of 2 million operational signals;
- Both the quality of renewable energy and the management of the grid are improved thanks to advanced insights into fault detection, events and breakdown in turbines and control systems, reactive and active power regulation, and voltage in the connection point;
- By preventive measures remotely, both operational risk and maintenance expenses are significantly reduced.

BM3 – Platform-as-a-Service (PaaS)

Case Study 1

Where	***What***	***Who***
EU	PREDIX	

Asset monitoring and event management is the cornerstone of industrial digital transformation. Centralizing asset and Operational Technology (OT) data, applying analytics, then visualizing and acting on the results opens the door to the reduced downtime, lower maintenance cost. Predix Platform is a complete solution for industrial data monitoring and event management, combining asset connectivity, edge-to-cloud analytic processing, and a feature-rich user console.

Highlights

- GE developed Predix platform in order to turn real-time operational data into actionable insights. Platform offers a standardized way to enable an entire business to take advantage on operational innovations as: reduce sources of errors, develop and share best practice. In addition the Edge and Cloud deployment architectures complementary and enable mostly: lower costs based on the economics of a centrally based infrastructure in a pay-as-you-go model, improved system governance and reduce latency for mission control for safety critical features;
- There is no time like the present to decrease unplanned downtime, increase productivity, and minimized missed opportunities. By getting started with an industrial edge-to-cloud platform today, business addresses an immediate need, knowing that an extensible architecture is there to help them grow to meet future requirements.

Case Study 2

Where	***What***	***Who***
EU	Mindsphere	SIEMENS

Becoming a digital enterprise in the manufacturing industry means taking advantage of the internet of things (IoT) to collect all data across plants and systems. By combining data from physical assets and enterprise systems, companies have visibility and control over industrial assets. Siemens MindSphere is the cloud based, open IoT operating system that lets understand data by quickly and securely connecting your products, plants to the digital world. It transforms this data into productive business results using advanced analytics.

Highlights

- MindShere operating system developed by Siemens, enables company to connect physical, web - and enterprise – based systems in one central location. Siemens created a multi-tiered architecture that builds connectivity throughout MindConnect, It provides secured connectivity options to link devices, machines and plant to MindSphere in the cloud. In this way, customers is enabled to manage the applications without the cost of building an infrastructure and to access a global base of ready assets extracting data for analysis;
- Companies that have managed to incorporate IoT technologies have seen their profitability increase. IoT leads to transparent and optimized operations, gains in productivity, reduced risk and the development of new business models with the implementation of condition monitoring, predictive/prescriptive maintenance, asset performance management and complete digital twins – precise digital models of products and production operations.

4.10 Flexibility Market Platforms

General description

In an energy system with growing share of variable RES and distributed energy resources (DER), congestions start appearing, creating increased demand not just for 'horizontal' inter-TSO coordination but also for 'vertical' TSO-DSO coordination across voltage levels (Elies Lahmar, 2018). It is essential to make sure that DER can efficiently provide flexibility at both the local (i.e. at the distribution grid node) and system levels. A common assumption behind the flexibility platform use case is that services for TSOs & DSOs are procured in a market-based way and offered on a voluntary basis.

Flexibility market platforms are a mean to achieving this. Such platforms would comprise services like:

- Ancillary services for system balancing (delivered to TSOs);
- Services for congestion management (delivered to TSOs and DSOs);
- Commercial flexibility services (delivered to market parties like BRPs).

Opportunities

This use case can be considered as a complement to the use case on aggregation (UC3). While UC3 looks at how different models of aggregation can be set up to bring local flexibility to the market, the current use case is focused on the coordination between actors in need of flexibility (system operators and market parties). Aggregators are flexibility service providers (FSPs), next to others (producers, large consumers, etc.).

Customers	Society / Energy system
• Valorisation of customers' flexibility • Lower grid charges through better coordination between TSOs and DSOs and better resource planning for (local) congestion management	• Better resource planning through coordination and local congestion management, reducing overall system cost • More efficient RES integration, through local price signals

Business models

The core value proposition of this use case is to become an extended market place. In addition to wholesale and ancillary services marketplaces of today, such flexibility market platform would allow TSOs and DSOs to coordinate the tendering, activation and/or settlement of flexibility for each of their grids' purposes.

The aim is to build a liquid market, accessible to many actors. It is an emerging alternative to today's separate procurement of flexibility by TSOs and DSOs, that raises number of coordination issues as both network operators are potential users of the same distributed energy resources (DER). The current approach also requires that the flexibility service providers (FSP) have to connect to different platforms and choose between them.

The Flexibility Market Platform could be a new grid congestion and ancillary services platform interacting with the existing energy trading platform (BM1), or an extended market platform that would directly include a grid management and ancillary services mechanism from TSO level to DSO level (BM2). Even though they emerge as two distinct models, the differences may decrease as the design and operation procedures are detailed. They also face similar challenges as apparent from the following sections.

	1 Grid congestion management platform connected to energy trading platform	2 Single platform for energy trading and ancillary services
Description	• The market platform (flexibility for portfolio optimization) is separate from the TSO-DSO coordination platform (flexibility for ancillary services and congestion management) • TSO-DSO coordination platform for tendering, activation & settlement of flexibility • Different TSO-DSO coordination options are possible: new platform or extension of existing platform for system balancing	• Today, power exchanges provide platforms for energy & derivatives trading • This model implies development of flexibility products with TSO & DSO as a customer within these platforms; i.e. extension of possibilities from intraday flexibility to ancillary services • Flexibility Service Providers only access a single integrated platform to offer their flexibility
Key actors	• TSOs & DSOs • Market operators (power exchanges or other) • Flexibility service providers	• TSOs & DSOs • Market operators (power exchanges or other) • Flexibility service providers

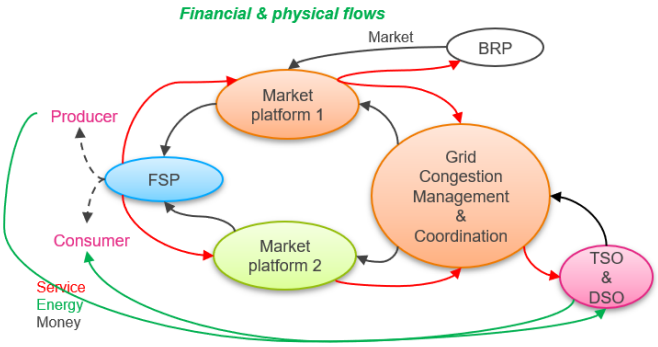
FSP = Flexibility Service Provider is a technology agnostic market role: it can include power generators, storage, flexible demand but also aggregators and virtual power plants that offer flexibility of the portfolio of assets they manage etc.

BRP = Balance Responsible Party

BM1 – Grid congestion management platform connected to energy trading platform

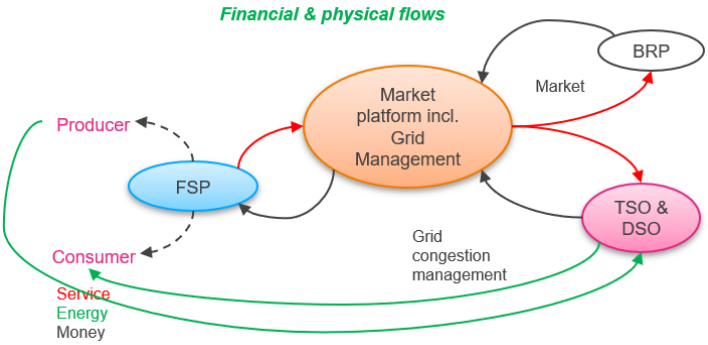
In this model, the requests from the TSOs and DSOs to the market occur through a coordinated mechanism which could include grid management products and, in the future, also ancillary services. This mechanism includes common determination of congestions by the grid operators. On the one hand, grid operators do load forecasts. On the other hand, the traders and BRP act on the intraday markets. The books for congestion management are separate from the market platform.

The FSPs access to the grid congestion management platform via the wholesale market in which they are active. They just need additional locational information to their bids if they want to bid for additional revenue from TSO-DSO services. The grid congestion management platform can potentially interact with more than one market place.



BM2 - Single platform for energy trading & ancillary services

This option goes further in terms of coordination. The FSP not only needs to access a single integrated platform to offer his flexibility, but there is also a full integration of the services at the platform level. This model is promoted by electricity market operators who realised the potential for providing a common market place for wholesale power exchange as well as all regulated products avoid market fragmentation. They would play a role of a central broker in this case, keeping also books for congestion management. This raises issues such as harmonisation of products and regulatory oversight over power exchanges (electricity market operators in many countries) if they are to run such marketplaces (de Heer, 2018).



Revenue creation source

Wholesale markets	TSO Ancillary services	Services provided to DSOs	Cost efficiencies	Subsidies	Behind the meter	Additional payment for green /local	Others

Other: Transaction fee on the solicited bids to the market platform operator

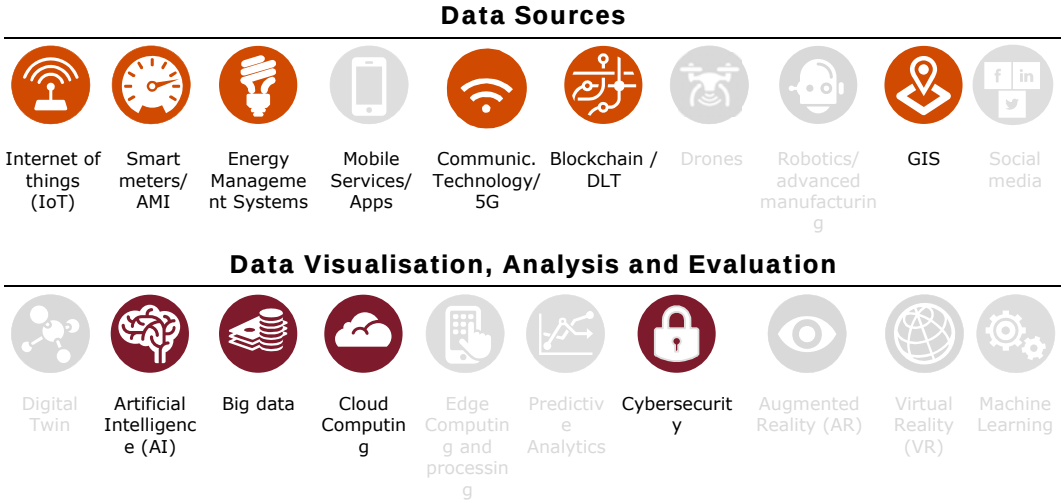
Technical feasibility

With multiple pilot projects, the solution is already beyond the prototype stage. Most of the main technical challenges identified were similar for both business models. They include:

- A corresponding digital infrastructure must still be created in most markets to enable the integration of flexibility from the potential downstream FSPs: via technical retrofitting of producers, consumers and storage facilities, new installations, and grid upgrading (link with UCs 1 and 3);
- Technological improvements implemented in the market will make the products more efficient;
- The goal is to identify the appropriate resources to be activated based on commercial and technical merit order list, considering the locational information as well as grid topology. Some products like congestion management are not easy to implement in the platform. Also participating market players will need to adjust their systems to make the implementation of local bids fully operational.

For BM2 / Single platform: If both vertical and horizontal integration, i.e. between TSO&DSO and for cross-border trading, are implemented in the platform, the challenge to develop algorithms that will ensure that the flexibility is used in a way that is most beneficial for the society (see the Finnish-Estonian case study).

Key enabling digital technologies



Data management

Flexibility platforms aim to coordinate energy and flexibility resources among system operators and market participants. This also includes the activation of resources from smaller customers at the distribution level. From that perspective, data management requirements are similar to UC3 on aggregation (smart meters, two-way communication, validation of data).

Since the coordination between the transmission and the distribution level is the core of flexibility platforms, data exchange requirements between DSOs and TSOs are substantial. Today, TSOs have to rely on a common representation of the

transmission grid (Common Grid Model, CGM) to calculate cross-zonal capacity (at wholesale level). The principles of the CGM are well established for the DAM and IDM, while they are still waiting for approval for the balancing market. Data exchanged on generation, load and especially the grid topology would be more considerable than today, but the information is there and in principle based on clearly defined technical characteristics about the networks, rather than on simplifications of the latter. It remains an open question how such initiatives should be coordinated with possible redefinition of price zones at wholesale level. The closer cooperation and coordination between TSOS and DSOs for data exchange could be organized at the level of the so-called Capacity Calculation Regions (CCR).

Similarly as for cross-zonal coordination, coordination of transmission and distribution operation would probably require to share all relevant information (e.g. structural, scheduling and real-time data about Significant Grid Users) in order to achieve an efficient and well-coordinated system operation. The Key Organizational Requirements, Roles and Responsibilities (KORRR) on data exchange developed by all European TSOs according to art. 40 of the SO GL and approved by all European NRAs define a high level framework to be implemented in all Member States in order to ensure the highest possible coordination and efficiency. The appropriate implementation of those data exchange principles is of utmost importance considering the increasing levels of distributed generation, of which TSOs by default don't have a clear observability, while DSOs – at least in some countries – already have thanks to digitalisation, and in particular thanks to smart metering systems and network automation.

Consumption data requirements

Stakeholder access to data	Validated (V) or non-validated (NV) data	Near-real time (RT) or historical (H) data	Granularity	Aggregated data (A) or by usage (U)	Communication requirements
☐ Customer ☒ Supplier or ESCO ☐ DSO ☐ Other	☒ V ☐ NV	☒ RT ☐ H	☒ minute or less ☒ 15min ☐ hourly ☐ more	☒ A ☐ U	☒ 2-way ☐ link with market data ☐ none

From the perspective of FSP, granularity depending on the product.

Market feasibility

Market feasibility is assessed as low as the service has been implemented only in one of the studied cases (and even then to a limited extent). Shift from demonstration in sandboxes to larger scale commercial pilots is clearly the next step for development. However, the liquidity may depend on the local DER capacities not just in each Country, but also region.

In some cases, the DSOs claim that they presently cannot assess both the depth of the local market and the capacity of market players to offer relevant products (i.e. not yet mature for standard products) and, meanwhile, each case will be different and market players will have to adapt their products to match the DSO needs.

BM1, to the authors' knowledge, is only operational in the Netherlands in the GOPACS scheme (see case study) to date and, thus, unique in Europe. BM2 has been implemented only in pilot projects for the moment.

However, as classical case since regulated actors are at the centre of the solution, regulatory feasibility (see 1.6) is crucial enabler for viability of the use case.

		Low			
Market feasibility					
MRL		**3**			

BM	Presence on the market	Countries	Enablers / Barriers		Area
1	Service available on the market		Congestions in transmission network driving the evolution, proactive operators	+	
	Service not available / low penetration level	Other countries	Lower urgency & missing regulatory framework (see 1.6)	−	
2	Service available on the market		Congestions and high DER share driving the evolution (for the former) or building on existing data platform (for the latter)	+	
	Service not available / low penetration level	Other countries	Lower urgency & missing regulatory framework (see 1.6)	−	

Regulatory feasibility

Regulatory feasibility is assessed as low as only one case has been implemented beyond pilots and there are number of critical regulatory challenges to be resolved, again common to both business models:

DSOs have rather low incentives to procure flexibility instead of line reinforcement. This is the traditional CAPEX vs. OPEX issue, where system operators, given the structure of the regulatory model, traditionally tend to have a bias towards capital-intensive infrastructure solutions (reinforcing or extending the grid by increasing the Regulatory Asset Base, "make" option), rather than to procure a service on a market (OPEX, "buy option").

As a result, DSOs may hesitate to advance on the flexibility platform design (**Key Issue #1**). Even in the Netherlands which implemented probably the most advanced GOPACS solution, involved parties perceive that better incentives to market-based solutions are needed (even though existing regulations are not completely blocking larger scale implementation).

Renewable energy sources, storage and demand side flexibility will be able to deliver services to DSOs, TSOs and market actors. If not coordinated, their activation by one actor may cause issues for another actor. There is thus a strong need to decide clear rules for coordination between TSO-DSO, and between market and system operators (TSO&DSOs). The use case has sketched two possible high level business models for such a coordination, but it is still an open debate how platforms could be designed in practice, with the risk that regionally fragmented markets arise (**Key Issue #2**).

The need to coordinate increases with the share of distributed energy resources and solutions for optimizing these resources varies from value-reflective tariffs to

distribution locational marginal prices – DLMP (Birk, Chaves-Ávila, Gómez, & Tabors, 2017). It is also not clear who is best placed for operating the platforms, e.g. the DSOs, TSOs or independent platform operators and how data needs to be exchanged to ensure efficient resource allocation close to real-time.

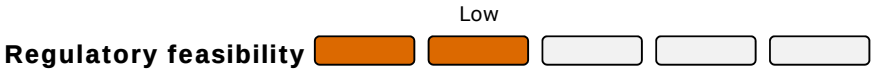
Note that the introduction of flexibility platforms, and in the extreme DLMP, are expected to create significant institutional changes to the current target model: regulation on the role of system operators and market operators will need to be revisited in order to enable them to make good use of the new available technologies and toolboxes to efficiently perform their existing or evolving roles. Also, the role of a BRP in a locally defined market would need to be revisited.

Markets require the definition of products that can be traded among market participants. Today, in Europe, such products exist only in wholesale markets based on zonal pricing (day ahead, intraday and balancing markets). Congestion within the zones is typically solved with non-market based redispatch. LProducts to address needs at distribution level are currently inexistent (**Key Issue #3**).

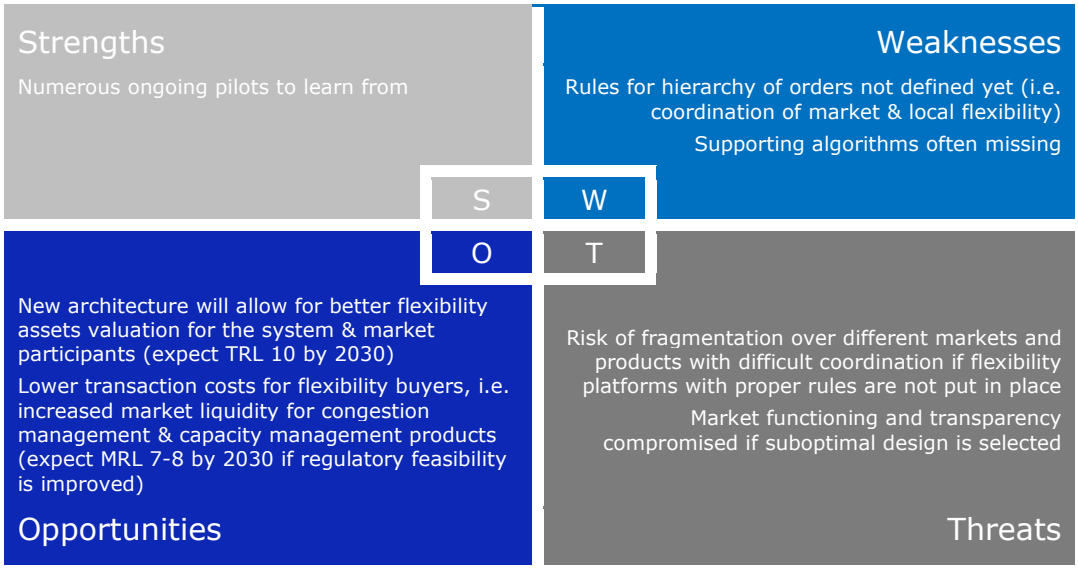
Such information is, however, a pre-condition for the design of flexibility market platforms. System operators should identify the new needs arising with more renewables at decentralized level, their geographical granularity and study the possibility to translate these needs into products to be traded in efficient local markets with rules that additionally avoid gaming by market participants like the "inc-dec" game.

Linked to Key Issue #2, these products, including their geographical dimension should be defined through a transparent and participatory process involving all interested stakeholders, under NRA's supervision, , in order to ensure system efficiency and avoid market fragmentation (Art. 32 Recast Electricity Directive).

Finally, linking the discussion with UC3 on aggregation, we stress that there might be a trade-off between the geographical granularity of a product and the value of aggregation. The finer the local definiton of a product, the smaller will be the role to play by aggregators and potentially the efficiency of the market where the product is traded. The right choice of the appropriate geographical granularity is open for debate.



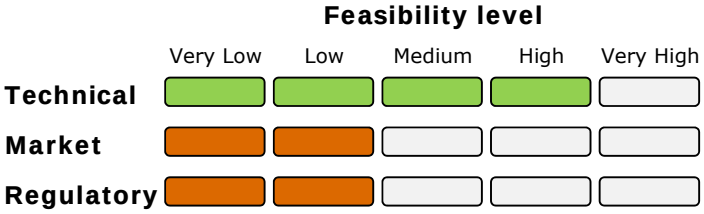
SWOT analysis



The rising number of pilot projects on this use case signal the high willingness to establish a common market place as a solution of the expected coordination issue. The flexibility platform is expected provide strong assistance in developing the market for congestion management and increasing market liquidity overall. Lessons learnt from the flagship projects could be replicated elsewhere.

Overall evaluation of UC feasibility level and key issues

Implementation status



Key issues

Key Issue	Description	Type of Issue
1. Low incentive for DSOs to procure market-based flexibility services	Given the structure of their regulatory asset base, DSOs may be biased towards capital-intensive solutions, rather than procuring a service on the market (most probably representing OPEX) to address local grid issues. This issue is addressed in the Recast Electricity Directive (art. 32 for instance). Under the current regulatory framework. Today there may still be little case for developing flexibility platforms.	
2. Insufficient TSO-DSO-Market coordination in the	There are many possible ways for coordination between system operators and market actors. National	

Key Issue	Description	Type of Issue
procurement of flexibility services	choices may be diverigng, leading to fragmented markets with barriers for cross-border trading.	
3. Absence of products reflecting "local" needs	Existing products generally do no't exhibit locational information, which is actually a pre-condition for the organization of local flexibility platforms. If not harmonised, local products may further fragment markets. At the same time, the optimal geographical dimension shall be defined accurately in order to maximise the overall efficiency (trade-off to find between geographical granularity and efficiency of markets/role of aggregation).	

Preliminary identification of enabling policy / regulatory actions

Key Issue #1: Low incentive for DSOs to procure market-based flexibility services

- Correct the bias OPEX/CAPEX in the remuneration scheme of system operators, i.e. by, for instance, setting ex ante the ratio between CAPEX and OPEX of recognized costs (as applied in the UK) and allowing and
- cllow and incentivise at the same time DSOs to procure services on the market where it is feasible and efficient, as foreseen by the Recast Electricity Directive (Art.32)

Key Issue #2: Insufficient TSO-DSO-Market coordination in the procurement of flexibility services

- Need to support regulatory sandboxes, with a gradual and forward-looking approach avoiding regulatory lock-in, as still open questions exist around who should manage the platform and how coordination should work in practice
- In any case, the EC should support harmonisation, to avoid heterogeneous solutions creating cross-border barriers

Key Issue #3: Absence of products reflecting "local" needs

- Require transparency on the needs
- Translate these needs into products, with an efficiently calibrated locational dimension (trade-off aggregation vs. geographical granularity) and with a minimum degree of harmonisation across Europe (to support cross-border activities), as foreseen by the new Electricity Directive (Art. 32 and 40, among others)

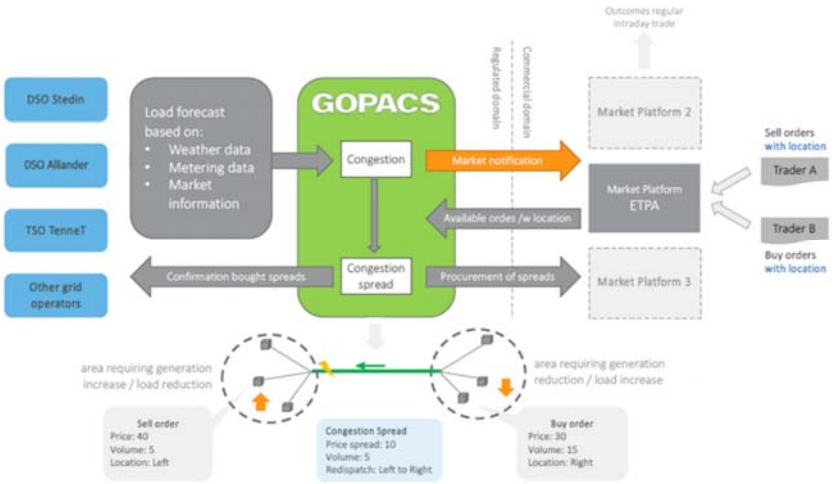
Case studies

BM1 – TSO-DSO Coordination platform GOPACS

Case Study 1

Where	***What***	***Who***
THE NETHERLANDS	TSO-DSO coordination platform GOPACS	TenneT (TSO), Stedin, Liander, Wesland Infra, Enexis (DSOs)

GOPACS is a TSO&DSO driven grid operators' platform. The network operators keep books for congestion management separately from the ETPA market platform to which GOPACS is connected. It builds on the IDCONS project and is driven by increasing congestion issues (so far mainly on TSO side). Connections to further market platforms are envisaged (discussions are ongoing with EpexSpot and Nord Pool power exchanges as well). All Dutch grid operators (TSO and DSOs) participate in the initiative.



(GOPACS, 2019)

Highlights

- Each year, the Dutch TSO TenneT spends around €50 million on preventing congestion mainly in the north-south direction, demonstrating that there is a lot of potential for orders that come with location data.
- GOPACS combines the buy and sell order with a location component if they are not already matched by the trading platform, i.e. leading to higher fulfilment of FSP offers. Grid operators pay the spread between the buy and the sell order.
- Hierarchy rules between the network operators are already defined: order can be used only if it does not cause congestion in another area and does not disturb the balance at the national level. In that way, counter actions in one area of the system do not create an issue somewhere else. If there is a need for an upward action at system level a DSO can communicate the unavailability to implement that action in an area of its grid. GOPACS algorithm will take this into account.

BM2 – Testing of the integrated platform concept

Case Study 1

Where	***What***	***Who***
GERMANY	Enera project/ Flexibility platforms in Germany	EpexSpot (power exchange), EWE AG (generator), EWE Netz, TenneT, Avacon Netz (network operators)

The Enera showcase in Lower Saxony focuses among other things on regional system services to stabilise the grid locally. The Power exchange EpexSpot manages both power market & congestion management. It expands its order books in the intraday market by adding information on the location of power generation plants.

Highlights

- The grid needs to substantially upgraded in order to make this solution work. It is to be equipped with more than 30,000 smart metering systems and sensors and connected to the communications network.
- Congestion between the north and the south is typical for the German market. According to the national Grid Expansion Acceleration Act (NABEG) for all the assets above 100kW, DSOs have to share flexibility from assets that are connected to their grids and above 100kW with the TSO.
- However, essentially nodal redispatching issues appear in the zonal market design. In this situation, one of the adoption challenges seen by the project participants is that local markets create incentives for gaming (such as increase congestion in order to get paid for decreasing it). Market design work is on-going for building in remedial actions such as bid caps and market caps that could be local, limited to a given area.

BM2 – The Finnish Baltic Single Flexibility Platform

Case Study 2

Where	***What***	***Who***
ESTONIA & FINLAND	Solution developed within the INTERRFACE project (H2020)	42 parties from 15 countries incl. Elering, Fingrid, Electrilevi, Elenia, Empower & ENTSO-E

The aim of the 3-year project starting in 2019 builds on Elering's (Estonian TSO) data platform and develops into a cross-border (i.e. horizontal integrated) flexibility market platform that could be used also for congestion management (i.e. also vertically integrated for both TSO and DSO needs.

Highlights

In the targeted solution, the Finnish-Baltic Single Flexibility Platform:

- Manages all flexibility resources together.
- Enables market-based coordination of the usage of same pool of flexibility resources by all interested parties (TSOs, DSOs, BRPs, etc.) on different market levels in a transparent and cost-effective way covering at least the following use cases: Congestion management, frequency/balance management, flexible grid connections, trading between market participants.
- Enables cross-border trades.
- Identifies the appropriate resources to be activated based on commercial and technical merit order list, taking into account the resource locational information as well as grid topology

5 Policy Scenarios

In this chapter, policy scenarios for digital transformation of the energy sector are presented, with a focus on power sector and synergies between power and other sectors.

Some digitalisation policies are being already implemented in the Clean Energy Package. The Directive (EU) 2019/944 – Internal Market for Electricity ('Electricity Directive') requires MSs to ensure the deployment of smart metering, which may be subject to an economic assessment of long-term costs and benefits, and updates dispositions to MSs in terms of Data management (Article 23) and Interoperability requirements and procedures for access to data (Article 24).

Apart from sector-specific provisions, the digitalisation of the energy sector is expected to be affected by horizontal EU-actions in the field of Privacy and Data Protection, Cybersecurity and ICT Interoperability / Standardisation.

These policy areas are currently being addressed by EU legislation by means of the General Data Protection Regulation (GDPR), the Free Flow of Non-personal Data, the Cybersecurity Package, the NIS Directive, and the New Deal for Consumers, representing a comprehensive and predictable framework to contribute to a more competitive and integrated EU market for data storage and data processing services.

Synergies breaking down regulatory siloes

Given the cross-sectoral nature of digitalisation, synergies between different sectors will be crucial to foster digitalisation. A cross-sectoral approach breaking down sectoral silos is hence needed in order to stimulate joint investments and coherence in regulatory frameworks, common standards and interoperability.

The interaction and cooperation between the energy and ICT sectors can increase the cost-efficiency of energy systems and create new opportunities for consumers and new opportunities for European companies. But this is not limited to the energy system. It will create interactions between various energy vectors such as electricity/gas and heating; and other sectors, such as transport system through EVs and smart home or 'sharing-economy' services offered to consumers. As the issue of digitalisation is transversal, cross- fertilisation solutions through interoperability, access to data, data processing and cybersecurity are needed.

In this context of blurring boundaries and evolving roles, it is important that regulatory siloes are addressed and overcome through integrated plans. Possible siloes can be identified at several levels:

- **Siloes along the value chain** (e.g. between TSOs and DSOs). As long as the distribution network is transformed by the increasing number of DERs and the role of network operators evolves, the need for coordination and data and information exchange between TSOs and DSOs increases. Breaking siloes is

fundamental to ensure secure and safe operation of the network, performing tasks such as congestion management, balancing, use of flexibility, real-time monitoring and control and network planning;

- **Siloes among technologies** (e.g. EVs and storage). Grid edge technologies act in a virtuous circle. Maximization of their value can be achieved if they can all contribute to achieve policy goals. Thus, rather than promoting specific technologies, regulation should set policy goals and reward for their achievement;
- **Siloes between industries** (e.g. IT/ telecommunications and energy or transport and energy). As the convergence of information and telecommunication technologies within electricity network operations continues, the technology roadmaps of various sectors should intersect, and regulatory entities should be at the forefront. This includes, for example, the convergence of the automotive and electricity sectors;
- **Siloes at geographical level**. City governance, fostered by a strong urbanization trend, will play an increasingly relevant role in the deployment of grid edge technologies. Coordination with national and regional policies will be critical to ensure efficient deployment. For example, the roll-out of EV charging stations will need the involvement of local stakeholders, urban planners, distribution operators and central regulators. From a broader perspective, improved regional integration (specifically, across states in the US or countries in the EU) could be a key factor in balancing intermittent and distributed resources. This would require a harmonisation of policies, especially with respect to power generation;

All this requires integrated plans that are most beneficial when combining technologies and data from diverse industries – for example between the automotive and electricity sectors, to support EVs. Synergies from these plans are leading to a faster expansion of technologies and more innovative business models than if they had been introduced individually.

Regulatory cooperation

In a world where digitalisation is leading to increased convergence of markets and bundled products, regulatory cooperation for consistent solutions for consumers and harmonisation for all sectors should become a primary objective of EU law making.

The Partnership for the Enforcement of European Rights (PEER) initiative is a good example of regulatory cooperation. PEER is a CEER-led initiative started on a pilot basis in 2017 in the context of market developments that break the traditional sectoral silos on which regulatory supervision should be taken.

PEER has been the first initiative to promote a consistent enforcement landscape within the EU. It started to strengthen much needed cooperation among sectoral regulators (telecoms, energy, financial, etc.), consumer protection authorities, data protection authorities, etc. to ensure European consumers are protected as traditional markets become more inter-twined in a digital world. Its ultimate objective is indeed to benefit consumers: to deepen understanding of cross-sectoral issues and contribute to facilitating consistent consumer rights enforcement generally (CEER, 2017).

The European Commission and several EU agencies (e.g. ACER and ENISA) as well as the European Consumer Organisation (BEUC) and the Network of Energy Ombudsmen and ADR bodies (NEON) support PEER's objective of cross-authority collaboration in the consumer interest.

Industry cooperation

Industrial cross-sector partnerships will also be critical to success as technologies converge and boundaries blur. For instance, in Europe, automakers and utilities are partnering to develop new business models, such as the development of energy storage facilities that rely on used EV battery modules, or ancillary services provided by vehicle-to-grid (V2G) technology. Partnerships could also be used to hasten the development of innovative business models that incentive the electrification of private sector fleets.

The EU strategies on Digitising European Industry and the Strategic Energy Technology Plan of the Energy Union aim to help European industry, and financial support to research and innovation has been given via Horizon 2020 programme.

Investments in the digitalisation policy of energy infrastructure

For digital innovation to happen, a reliable and intelligent energy and communication infrastructure covering the entire EU is needed. This means investing in the roll-out of future mobile networks like 5G and of smart meters but also in the installation of charging stations for electric cars.

The Commission has provided support to collaboration for a smart and sustainable infrastructure, buildings and cities, and the co-deployment of energy and telecommunication infrastructures via the Connecting Europe Facility (CEF), as well as the European Fund for Strategic Investments (EFSI) programmes.

Such support has been renewed and strengthened in the proposal for the new long-term European budget (MFF 2021-2027). Compared to the CEF 2014-2020, the reformed CEF has a more consistent total budget, with CEF Telecom replaced with CEF Digital witnessing the essential role digital connectivity infrastructure will play in the coming years for the success of the Digital Single Market. Moreover, the CEF supports projects with high added-value at European scale and helps leverage further investment from other sources, in synergy and complementarity with the new InvestEU and other Union programmes.

In addition to the above-mentioned EU initiatives, several actions can be taken to ensure that the necessary infrastructure is in place to enable new business models and the future energy system. These can include the definition of a model to deploy enabling infrastructure that is flexible, open and interoperable and ensuring customers and third parties can benefit from data generated by DERs and the digital grid.

New infrastructure is critical to accelerate the roll-out of DERs, increase customer convenience and capture the full value of grid edge technologies such as storage, demand response and EVs. Charging stations for EVs, smart meters, broadband communication infrastructure, and network remote control and automation systems (network digitization) are all fundamental enablers to services associated with DERs.

Defining clear ownership, the cost recovery and the model of deployment are critical to quicken infrastructure deployment. This might prove problematic as the benefits of the enabling infrastructure are spread to various stakeholders while the costs are typically borne by one party. For instance, countries have adopted different models for the roll-out of smart meters. Italy, Spain and others have chosen to allow the distribution company to own the installed smart meters and to pass its cost to customers through the rate, while in the UK the smart meter is owned by the customer that decides to purchase it from retailers. The grid-related approach has seen a faster roll-out and cost synergies from the mass deployment.

In some cases, there currently might not be any clear business case for the private sector to invest in physical infrastructure such as charging stations, where initial failures of private companies have led to limited interest by others to invest. In contrast, the regulated business model where a return could be earned based on these new rate base assets do provide a clear business case and interest by utilities. In such cases, to accelerate deployment the regulatory model would need to support regulated utilities to deploy the infrastructure where private companies will not. In addition, industry collaboration or public-private partnerships can offer viable alternatives.

Four Policy Scenarios by 2030

Following all these considerations, four different scenarios have been outlined regarding both EU and MSs regulatory policy:

- **Business As Usual (BAU)**: full implementation of the provisions of the Clean Energy Package, the General data Protection Regulation (GDPR), the Free Flow of Data and the New Deal for Consumers;
- **Consistent Governance (CG)**: adoption of legislative or non-legislative , sectorial or horizontal, measures, to be made, mostly MS level, that accelerates the digitalisation strategy designed by the Commission, safeguards consistency between different areas of sectorial regulation, in particular for energy, digital economy and transport, and ensures homogeneous application of the current Directives and Regulations, by best practices sharing among NRAs and the main market actors
- **Reinforced Legislation (RL)**: adoption of additional regulatory measures at the EU or the National level to address the obstacles to use cases identified under Task 3;
- **Active Digitalisation Policy (ADP)**: investments in the digitalisation policy of energy infrastructure throughout Europe and other digitalisation-enabling policies.

For the BAU scenario, full implementation of the already adopted provisions under the Energy Union and the Digital Single Market strategy has been foreseen by 2020.

Targeted policy actions have been proposed in order to tackle the key issues identified in the UCs analysis with the aim of removing the existing barriers hindering the full deployment of the UCs. The combination of the suggested policy actions, taking into account their level of intervention (legislative, non-legislative or regulatory measures), builds up the two policy scenarios by 2030 (CG and RL scenario).

In particular, the most relevant and recurring key issues have been addressed in the scenarios and grouped into the four policy areas of intervention with the greatest potential to unlock the digital transformation of the power sector (see Chapter 3):

1. **Flexibility services at the distribution level**
   - The cooperation between TSOs and DSOs (Key issue #2 of UC10)
   - A more active role of DSOs in the provision of flexibility services (Key issue #1 of UC10)
   - Specifications of the products for flexibility services (Key issue #3 and #4 of UC3 and Key issue #3 of UC10)
   - The role of independent aggregators in procuring flexibility services (Key issue #1 of UC3)
   - The access to consumption and production data (Key issue #2 of UC3)
2. **Privacy and Data Protection**
   - Customer privacy and data protection (Key issue #1 of UC1 and UC4)
3. **Cybersecurity**
   - Cybersecurity of ICT products (Key issue #2 of UC1 and UC4)
   - Cybersecurity of energy critical infrastructure (Key issue #2 of UC9)
4. **Interoperability and standardisation**
   - Interoperability between connected devices (IoT) (Key issue #3 of UC1)

Given the increasingly relevance digitalisation will have in the EU economy and society in the coming years, the next long-term EU budget for 2021-2027 – the Multiannual Financial Framework (MFF) – sets specific investment programmes dedicated to digital transformation.

The ADP scenario takes into account such foreseen investments, which will provide a vital support to current and future digitalisation-enabling policies and will thus significantly boost the digital transformation of the power sector. In particular, the actions included in the ADP scenario will have a direct impact only on those key issues strictly related to energy infrastructure and digital technologies.

5.1 Flexibility services at the distribution level

The increasing share of intermittent power generation, due to policies promoting electricity consumption from renewable sources, determines a growing need for flexibility services.

Traditionally, flexibility services have been a supply-side matter. In the near future, operators of storage, owners of electric vehicles and different groups of demand (households, SME, and industrial customers) will complement hydropower and gas-fired power plants in the provision of flexibility services.

Flexibility services involve a modification in consumption and generation patterns, in response to an external signal, to provide a service within the energy system.

The provision of flexibility services at the distribution level can deliver value to the electricity system through, e.g., congestion management, voltage control, and the mitigation of power quality problems. In addition, and other else being equal, the

increasing competition in the supply of flexibility services can lead to minor needs for network and capacity additions. In particular, flexibility will become crucial to adjust demand profiles to supply peaks in renewable generation, or to the available capacity in the distribution grids.

At the same time, resources connected at the distribution level can benefit from the provision of flexibility services by means of cost savings, the improved quality of distribution activities, and the remuneration of the services provided.

The analyses carried out on the UCs highlighted some key issues to be addressed to promote flexibility services at the distribution level in an effective way. Such issues are summarized as follows.

Main key issues

- **The cooperation between TSOs and DSOs:** the promotion of a greater cooperation between TSOs and DSOs to acknowledge the increasing relevance of resources connected at the distribution level for the provision of flexibility services. (Key issue #2 of UC10)
- **A more active role of DSOs in the provision of flexibility services**: the development of consistent investments and operations of distribution networks to promote the provision of flexibility services at the distribution level (Key issue #1 of UC10)
- **Specifications of the products for flexibility services**: the definition of the characteristics of the products for flexibility services to identify rights and obligations of different market participants in the provision of flexibility services (Key issue #3 and #4 of UC3 and key issue #3 of UC10)
- **The role of independent aggregators in procuring flexibility services**: the establishment of a consistent regulatory framework promoting clear roles and responsibilities of independent aggregators in the provision of flexibility services (Key issue #1 of UC3)
- **The access to consumption and production data**: the development of an efficient and valuable access to consumption and production data to allow a responsible engagement of demand in electricity markets (Key issue #2 of UC3)

The (EU) directives and regulations in force, as well as the Directive on common rules for the internal electricity market (and the Regulation on the internal market for electricity), establish measures with respect to the above-mentioned key issues. In the following paragraphs, the study identifies such measures in order provide a link between key issues and policy actions in the BAU scenario.

Further considerations are made to highlight additional actions to be carried out in the alternative policy scenarios (Consistent Governance, Reinforced Legislation, Active Digitalisation Policies) to complement measures discussed in the BAU scenario.

5.1.1 The cooperation between TSOs and DSOs

Key issue

The promotion of a greater cooperation between TSOs and DSOs to acknowledge the increasing relevance of resources connected at the distribution level for the provision of flexibility services (Key issue #2 of UC10).

Policy scenario design

BAU scenario	CG scenario	RL scenario	ADP scenario
Regulation (EU) 2017/2195 – Balancing Guideline Regulation (EU) 2019/943 – Internal Market for Electricity Regulation (EU) 2017/1485 – Electricity Transmission System Operation Guideline (SO GL) All TSOs' proposal for the Key Organisational Requirements, Roles and Responsibilities relating to Data Exchange in accordance with Article 40(6) of Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a Guideline on Electricity Transmission System Operation (KORRR)	National Regulatory Authorities' provisions concerning the obligation to consult on the implementation of the EU regulation on balancing services National Regulatory Authorities' provisions concerning the definition of a joint methodology between TSOs and DSOs for the allocation of costs resulting from the provision of active power reserves National Regulatory Authorities' provisions concerning the organisational requirements, role and responsibilities of TSOs and DSOs in relation to the cooperation and monitoring of network codes, network planning and operation National Regulatory Authorities' provisions on the processes TSOs and DSOs shall put in place for the operational implementation of the KORRR Consultation processes and design of pilot projects on the procurement of flexibility services at the distribution level and the development of flexibility platforms	Implementing act on flexibility services from distribution-connected demand and power generating facilities New Directive on the IEM	Horizon Europe CEF

5.1.1.1 BAU scenario

At present, provisions concerning the issue of the cooperation between DSOs and TSOs can be found in three different EU Regulations: Regulation (EU) 2017/2195 ('Balancing Guideline') establishing a guideline on electricity balancing, Regulation (EU) 2019/943 ('Electricity Regulation') on the internal market for electricity and

Regulation (EU) 2017/1485 ('SO GL') on Electricity Transmission System Operation Guideline. The latter has been implemented in its operational obligations with respect to the data exchange between TSOs and DSOs by means of the so-called KORR, i.e. "All TSOs' proposal for the Key Organisational Requirements, Roles and Responsibilities (KORRR) relating to Data Exchange" in accordance with Article 40(6) of SO GL.

In the following paragraphs, a description of these provisions is reported.

Regulation (EU) 2017/2195 (Balancing Guideline)

- **The obligation to consult in the implementation of the Balancing Guideline.** The Balancing Guideline affirms the obligation for Member States, National Regulatory Authorities and System Operators to "consult with relevant DSOs and take account of potential impacts on their system when applying the Regulation" (art. 3.2).
- **The cooperation in the provision of flexibility services.** The Regulation assigns a specific article (art. 15) to the issue of the "Cooperation [of TSOs] with DSOs" in order to ensure "efficient and effective balancing service" (art. 15.1).
- **A joint methodology for the allocation of costs resulting from the provision of active power reserves.** TSOs and DSOs shall elaborate a joint methodology for the allocation of costs resulting from the provision of active power reserves by reserve providing groups or units located in the distribution system (art. 15.3).

Regulation (EU) 2019/943 (Electricity Regulation)

- **The EU DSO Entity and the monitoring of implementation of the network codes and guidelines.** The Electricity Regulation institutes the so-called EU DSO entity (art. 55.2). The EU DSO entity shall cooperate with ENTSO-E with respect to several subjects such as, among others, "the monitoring of implementation of the network codes and guidelines adopted [pursuant to the Regulation] with respect to the operation and planning of distribution grids and the coordinated operation of the transmission and distribution networks" (art. 55.2).
- **The cooperation in the network planning and operation.** The Regulation obliges TSOs and DSOs to cooperate with respect to the planning and operation itself of networks (art. 57.1) through the exchange of all the necessary information and data concerning a wide range of activities, such as: the performance of generation assets and demand side response; the daily operation of the networks and the long-term planning of network investments, with the view to ensure the cost-efficient; the secure and reliable development and operation of their networks.
- **The coordinated access to resources connected at the distribution level.** The Regulation also highlights, for the first time, the issue of a coordinated "access to resources such as distributed generation, energy storage or demand response that may support particular needs of both DSOs and TSOs" (art. 57.2).

Regulation (EU) 2017/1485 (SO GL)

- **The coordination between DSOs, TSOs (and Significant Grid Users) in the definition of the applicability and scope of data exchange concerning distribution-connected power generating facilities.** The Regulation affirms the obligation for DSOs and TSOs to "determine the applicability and scope of […]: (a) structural data […]; (b) scheduling and forecast data […]; (c) real-time data […]" with respect to distribution-connected power generating facilities" (art. 40):

  - structural data include information as: general data of the power generating module, including installed capacity and primary energy source or fuel type; FCR (Frequency Containment Reserve) data; FRR (Frequency Restoration Reserve) data; RR (Replacement Reserve) data; protection data; reactive power control capability; capability of remote access to the circuit breaker; data necessary for performing dynamic simulation according to the provisions in Regulation (EU) 2016/631; and voltage level and location of each power generating module (art. 48);
  - scheduling and forecast data concern data relative to scheduled unavailability, scheduled active power restriction and its forecasted scheduled active power output at the connection point; any forecasted restriction in the reactive power control capability (art. 49);real-time data include evidence on: the status of the switching devices and circuit breakers at the connection point; and the active and reactive power flows, current, and voltage at the connection point (art. 50).

- **The coordination between DSOs, TSOs (and Significant Grid Users) in the definition of the applicability and scope of data exchange concerning distribution-connected demand facilities.** The Regulation affirms the obligation for DSOs and TSOs to "determine the applicability and scope" (art. 50) of the following data related to distribution-connected demand facilities (art. 53):

  - structural minimum and maximum active power available for demand response and the maximum and minimum duration of any potential usage of this power for demand response;
  - a forecast of unrestricted active power available for demand response and any planned demand response;
  - real-time active and reactive power at the connection point;
  - a confirmation that the estimations of the actual values of demand response are applied; and at the day-ahead and close to real-time the following data:
  - structural minimum and maximum active power available for demand response and the maximum and minimum duration of any potential activation of demand response in a specific geographical area defined by the TSO and DSO;
  - a forecast of unrestricted active power available for the demand response and any planned level of demand response in a specific geographical area defined by the TSO and DSO;
  - real-time active and reactive power;
  - a confirmation that the estimations of the actual values of demand response are applied.

- **The coordination between DSOs and TSOs with respect to the delivery of active power reserves.** The Regulation affirms the obligation for DSOs and TSOs to "cooperate in order to facilitate and enable the delivery of active power reserves by reserve providing groups or reserve providing units located in the distribution systems" (art. 182). In particular, the prequalification process for the FCR, FRR and RR services shall specify the following information: voltage levels and connection points of the reserve providing units or groups; the type of active power reserves; the maximum reserve capacity provided by the reserve providing units or groups at each connection point; and the maximum rate of change of active power for the reserve providing units or groups.

KORRR

- **Key Organisational Requirements, Roles and Responsibilities (KORRR) relating to Data Exchange.** "By 6 months after entry into force of the SO GL, all TSOs shall jointly agree on key organisational requirements, roles and responsibilities in relation to data exchange" (art. 40.6 of the SO GL). TSOs shall apply the KORRR "by 18 months after entry into force of the SO GL" (art. 18), i.e. by February 2019. Such data exchange involves the structural, scheduled and real time data concerning distribution-connected power-generating and demand facilities.

  The KORRR defines in particular the key roles, requirements and responsibilities of the TSOs, the DSOs, the closed distribution system operators and the Significant Grid Users involved in the data exchange. In particular, the KORRR aims at achieving a certain level of harmonisation across Member States with respect to data exchange without prejudice to national or regional specificities. To this aim, the KORRR does not define the detailed information to be exchange between TSOs, DSOs, and other significant stakeholders. Rather, it establishes the responsibilities at a national level of who shall define and approve the detailed information to be exchanged.

5.1.1.2 Consistent Governance scenario

The BAU scenario highlights several areas of actions with respect to the cooperation between TSO and DSOs.

Areas of action

- *The obligation to consult on the implementation of the Balancing Guideline*
- *The cooperation in the provision of flexibility services*
- *A joint methodology for the allocation of costs resulting from the provision of active power reserves*
- *The monitoring of implementation of the network codes and guidelines*
- *The cooperation in the network planning and operation*
- *The coordinated access to resources connected at the distribution level*

- *The coordination between DSOs, TSOs (and Significant Grid Users) in the definition of the applicability and scope of data exchange concerning distribution-connected power generating facilities*
- *The coordination between DSOs, TSOs (and Significant Grid Users) in the definition of the applicability and scope of data exchange concerning distribution-connected demand facilities*
- *The coordination between DSOs and TSOs with respect to the delivery of active power reserves*
- *Key Organisational Requirements, Roles and Responsibilities (KORRR) relating to Data Exchange.*

The Consistent Governance scenario mostly foresees the adoption of sectorial regulatory measures at the national level aimed at ensuring the consistent and effective enforcement of the Electricity Regulation, SO GL, Balancing Guideline, and the KORRR with respect to the cooperation between TSOs and DSOs in the above-mentioned areas of actions.

The Electricity Regulation on the internal market for electricity affirms the necessity of a coordinated approach between TSOs and DSOs in the access to distribution-connected resources. Similarly, the Balancing Guideline affirms the need of coordination between DSOs and TSOs in the procurement of flexibility services. Therefore, the CG scenario expects the launch at the EU level of expert groups and consultation processes with relevant stakeholders to develop common knowledge and guidelines for the development of possible models of procurement of flexibility services at the distribution level and the consequent definition, for each possible model, of coordinated roles and responsibilities of TSOs and DSOs.

Among such models a focus shall be given to the development of platforms for trading and procuring flexibility. Platforms might represent an option for a coordinated and effective procurement of flexibility services. Since platforms are gaining increasing consideration across different Member States, the elaboration of common guidelines for the development of flexibility platforms at the EU level can ensure system security and stability and level playing field for the market.

Policy Actions

A1. *NRAs' decisions for the enforcement of the obligation to consult on the implementation of the Regulation (EU) 2017/2195 (Balancing Guideline)*

- *The obligation to consult on the implementation of the Balancing Guideline*

NRAs shall adopt decisions establishing the areas for which the cooperation between DSOs and TSOs is required with respect to the implementation of the Balancing Guideline, the role and responsibilities of both DSOs and TSOs in the implementation of the Regulation and the processes to be implemented to ensure a consistent and effective cooperation in the implementation of the Regulation itself.

A2. *NRAs' decisions for the enforcement of Regulation 2017/2195 (Balancing Guideline) with respect to the development of a joint*

methodology for the allocation of costs related to the provision of active power reserves

- *Methodology for the allocation of costs related to the provision of active power reserves*

Member States' NRAs shall also ensure an effective implementation of the Guideline on balancing services by defining, with respect to the allocation of the costs for the provision of active power reserves:

- the type of costs to be considered in the allocation process;
- the guidelines for the definition of the methodology to be applied for the allocation and the settlement procedure;
- the indication of other balancing services for which a joint methodology for the allocation of costs related to the procurement of such services shall be elaborated by DSOs and TSOs as well as related aspects as the guidelines/goals to be respected in the definition of the methodology, and the settlement procedure.

A3. *NRAs' decisions for the enforcement of Regulation 2019/943 on the internal market for electricity (Electricity Regulation) with respect to the coordinated monitoring of implementation of network codes and guidelines and planning and operation of networks*

- *The monitoring of implementation of the network codes and guidelines*

The recent Regulation (EU) on the internal market for electricity establishes the obligation for DSOs and TSOs to cooperate in the monitoring of implementation of network codes and guidelines. Thus, in order to ensure a consistent application of this provision is essential that NRAs establish:

- role and responsibilities of TSOs and DSOs in the monitoring activities;
- governance of the monitoring activities;
- timing and frequency of the monitoring process;
- specific issues to be monitored;
- development of key performance indicators and possible remedial actions in the case the monitoring activity would reveal delays in the implementation of guidelines and network codes;
- role and responsibilities of ACER and National Regulatory Authorities (NRA) in ensuring the timely implementation of network codes and guidelines.

- *Cooperation in the network planning and operation*

The Electricity Regulation affirms the obligation for DSOs and TSOs to cooperate in the planning and operation of their respective networks. Thus, in order to ensure a consistent application of this provision is essential that NRAs provide for a definition of:

- roles and responsibilities of TSOs and DSOs in the process;
- a classification of the activities for which the exchange of data is required: e.g. the performance of generation assets and demand side response, the daily operation of the networks and the long-term planning of network investments,

with the view to ensure the cost-efficient, secure and reliable development and operation of their networks;
- types of information and data to be exchanged for each activity;
- timing and frequency of the exchange of information;
- interoperability requirements for data exchange
- roles and responsibilities of ACER and NRA in ensuring the timely and effective exchange of information with respect to the development and operation of networks.

A4. *NRAs' decisions for the enforcement of Regulation 2017/1485 (SO GL) with respect to the effective implementation of the KORRR*

The SO GL establishes the obligation for TSO, DSOs and Significant Grid Users to exchange data with respect to distribution-connected power generating and demand facilities to ensure system security and stability. Such obligation requires TSOs and DSOs to cooperate with respect to both the applicability and the definition of the scope of the information exchange. To make information exchange effective, the SO GL establishes the obligation for TSOs and DSOs to agree with respect to the so-called key organisational requirements, roles and responsibilities (KORRR). In the BAU scenario, Member States' TSOs have already acknowledged "All TSOs' proposals on KORRR" which, according to the SO GL, should have been developed by 6 months from the entry into force of the SO GL.

The CG scenario expects that NRAs approve decisions aimed at making operational the provisions of the KORRR according to national and regional specificities of the markets involved by the information exchange. In particular, NRAs' decisions shall regulate operational aspects not included in the KORRR such as, e.g.:

- frequency and granularity of the data exchange;
- formats and templates to be used for the data exchange;
- possible differentiations in the frequency and granularity of data exchange according to the dimension of the concerned demand and power generating facilities;
- role and responsibilities of DSOs and TSOs in the collection of data from distribution-connected facilities and consequent role and responsibilities in the exchange between the two system operators.

A5. *Consultation processes and design of pilot projects for the development of flexibility platforms aimed at promoting a coordinated provision of flexibility services and access to distribution connected resources*

The Electricity Regulation on the internal market for electricity establishes the necessity of a coordinated access of TSOs and DSOs to distribution-connected resources. More explicitly, the Balancing Guideline affirms the obligation for DSOs and TSOs to coordinate in the provision of flexibility services. The data exchange between TSOs, DSOs and Significant Grid Users regulated by the SO GL (A.4) is just one of the several dimensions involved by a coordinated procurement of flexibility services between TSOs and DSOs at the distribution level.

The provision of flexibility services from distribution-connected demand and power generating facilities may occur according to different models which differentiate

between them, mainly, with respect to the role and responsibilities of TSOs and DSOs in the procurement of such services.

To ensure an effective coordination between TSOs and DSOs and the development of a harmonised approach across Member States - in respect of the Regulation on the internal market of electricity and the Guideline on balancing services, as well as of national and regional specificities - is desirable an action at the EU level aimed at:

- collecting knowledge on the state of the art of the regulation, the market design and possible pilot projects ongoing in Member States with respect to the procurement of flexibility services at the distribution level;
- defining guidelines for the development of pilot projects at the Member State level;
- developing common knowledge and guidelines for the development of a coordinated approach between TSOs and DSOs in the procurement of flexibility services at the distribution level, according to different possible models.

To this aim, the CG scenario foresees the implementation at the EU level of:

- consultation processes involving relevant stakeholders from Member States as e.g TSOs, DSOs, NRAs, Significant Grid Users, RES associations, ICT providers, Aggregators, Suppliers, Consumer associations, etc;
- the appointment of stakeholders' expert groups and experts, also from Member States.

The areas of action to be addressed shall involve the different dimensions of the coordination between TSOs and DSOs in the procurement of flexibility services such as, e.g.;

- the pre-qualification criteria according to which resources connected at the distribution level can offer flexibility services;
- characteristics of the services to be provided, i.e. rights and obligation of distribution-connected resources in the provision of flexibility;
- responsibilities and role of TSOs and DSOs in the procurement of flexibility services at the distribution level and the respective scope of activities to this aim;
- digital platform models for the trading and procurement of flexibility services;
- interoperability requirements for digital platforms.

5.1.1.3 Reinforced legislation

The Reinforced Legislation scenario foresees the adoption of a New Directive on common rules for the internal market for electricity and of an Implementing act on flexibility services from distribution-connected demand and power generating facilities.

Ten years after the adoption of the Electricity Directive, digitalisation could have shaped even more drastically the organisation of the electricity system by encouraging, e.g., the emergence of peer-to-peer energy trading (P2P) and Virtual Power Plants (including demand aggregators).

Virtual Power Plants (VPPs) can provide grid services, which include transactions in wholesale markets for energy, transmission rights and ancillary services organised by

the TSO. At the same time, VPPs with awareness of the location of their distributed energy sources in a distribution network can provide grid services to DSOs for active distribution network management as e.g. reducing losses, improve voltage regulation and prevent thermal limits from being violated.

Therefore, a new Directive would be needed to establish new common rules aimed at acknowledging and promote adequately the emergence of P2P and VPPs and of an increasing share of distribution-connected generating and demand facilities and their impact on the cooperation between TSOs and DSOs.

As discussed in the following sections, the new Directive would also encompass provisions on a more active role of DSOs, the characteristics of flexibility services in the light of the provision of the services at the distribution level, and the role of independent aggregators.

The RL scenario also expects the adoption of an Implementing act aimed at ensuring a uniform application of the Electricity Directive with respect to the coordinated access of DSOs and TSOs to resources connected at the distribution level and, thus, to the provision of flexibility services.

To this aim, evidence and knowledge achieved by means of the consultations and expert groups on the procurement of flexibility services at the distribution level, the development of flexibility platforms (CG scenario) and the design of pilot projects are essential. The Implementing act shall provide guiding principles for the design and operation of possible models of interaction between DSOs and TSOs with respect to the different aspects involved by the procurement of flexibility services at the distribution level included the possible developments of flexibility platforms. Guiding principles on the design and operation by MSs of pilot projects on the procurement of flexibility services at the distribution level shall be included as well in the Implementing act.

In the following a list of the areas which need further actions with respect to those expected to be implemented in the CG scenario.

Areas of action

- *The cooperation in the provision of flexibility services*
- *The coordinated access to resources connected at the distribution level*
- *The impact of the emergence of P2P and VPP on the areas and activities for which the coordination between TSOs and DSOs is needed*

Policy Actions

A1. *Implementing act on flexibility services from distribution-connected demand and power generating facilities*

The Implementing act shall contain guiding principles for the design and operations of possible models of coordination between TSOs and DSOs for the procurement of flexibility services from distribution-connected demand and power generating facilities. The act shall thus address the different aspects involved by the market design supporting the procurement of flexibility services at the distribution level:

- the pre-qualification criteria according to which resources connected at the distribution level can offer flexibility services;
- characteristics of the services to be provided, i.e. rights and obligation of distribution-connected resources in the provision of flexibility;
- responsibilities and role of TSOs and DSOs in the procurement of flexibility services at the distribution level and the respective scope of activities to this aim;
- digital platform models for the trading and procurement of flexibility services;
- interoperability requirements for digital platforms;
- the roles of ENTSO-E and of the EU DSO entity in promoting the cooperation between TSOs and DSOs;
- the rights and obligations of aggregators in the interactions with TSOs and DSOs for the trading of flexibility services.

A2. *The new Directive on the internal market for electricity (and related Regulations)*

A new Directive on the internal market for electricity appears desirable to address possibly emerging issues in the market design of the electricity sector due to the increasing penetration of digitalisation and share of distribution-connected demand and power generating facilities.

In particular, the new Directive shall address emerging issues concerning the emergence of VPPs and P2P trading which are expected to become more diffused as generation becomes more decentralised and digitalisation more effective.

In addition, the new Directive shall address more in-depth the issue of cooperation between DSOs and TSOs with respect to the last Electricity Directive. As in the RL scenario it is expected that the procurement of flexibility services at the distribution level would become an effective dimension of system security and market design, the new Directive shall ensure the development of a competitive and harmonised procurement across MSs.

Therefore, the new Directive shall address aspects as e.g.:

- the characterisation of the level playing field principle in the development of P2P trading platforms and VPPs;
- role and responsibilities of the relevant stakeholders concerned by P2P trading platforms and development and operation of VPPs;
- the characterisation of the principle of non-discrimination with respect to the role and responsibilities of TSOs and DSOs in the procurement of flexibility services at the distribution level according to different models of procurements;
- the characterisation of the principle of the level playing field in the development and operation of flexibility platforms;
- the roles of ENTSO-E and of the EU DSO entity in promoting the cooperation between TSOs and DSOs;
- the role, functions and responsibilities of ACER and NRAs in enforcing the Directive;
- the possible Regulation (EU) that shall be adopted to fully implement the Directive.

5.1.1.4 Active Digitalisation Policy Scenario

The Horizon Europe programme for R&I activities in the field of energy system and grids may represent an enabling factor in promoting a greater cooperation between TSOs and DSOs. For example, R&I with respect to the employment of Artificial Intelligence and Data Analytics for asset management might lead to greater efficiency and accuracy in the coordinated management of network planning and operation by DSOs and TSOs.

In addition, the Horizon Europe can be employed to fund innovative pilot projects for the procurement and provision of flexibility services at the distribution level including the development of flexibility platforms.

Similarly, the new CEF programme intends at exploiting the synergies between digital and energy infrastructures that might support the development of digital platforms. The aim is to facilitate the interactions between the different actors of the energy system and to allow for a greater coordination of TSOs and DSOs for the procurement of flexibility services.

5.1.2 A more active role of DSOs in the provision of flexibility services

Key issue

Development of consistent investments and operations of distribution networks to promote the provision of flexibility services at the distribution level (Key issue #1 of UC10).

Policy scenario design

BAU scenario	CG scenario	RL scenario	ADP scenario
Directive (EU) 2019/944 – Internal Market for Electricity Regulation (EU) 2019/943 – Internal Market for Electricity	Adoption of decisions by MSs' NRAs implementing the Directive (EU) 2019/944 – Internal Market for Electricity and the Regulation (EU) 2019/943 – Internal Market for Electricity	Regulation (EU) establishing guidelines on the regulatory methodology for distribution (and transmission) networks License modification	Horizon Europe CEF

5.1.2.1 BAU Scenario

The procurement of flexibility services at the distribution level requires a radical transformation of the DSOs' business model. Such transformation does not come without costs since it requires a significant change in the development and operation of distribution networks. Thus, a consistent regulatory framework encouraging a more active a sophisticated role of DSOs is essential.

The Directive of the European Parliament and of the Council on common rules for the internal market in electricity introduces, for the first time, specific provisions with respect to the institutional and regulatory framework accompanying the evolution of

the DSOs' role. Coherently, the Electricity Regulation encompasses provisions about the regulatory methodology to be adopted with respect to distribution networks. Both the acts highlight the importance of an incentive-based regulatory framework with respect to both efficiency and DSOs' performances related to the operation of their networks.

In the following, a description of the measures entailed by the Directive and Regulation is provided.

Directive (EU) 2019/944 – Internal Market for Electricity (Electricity Directive)

- **An incentive-based regulatory framework.** According to the Directive, "Member States shall provide the necessary regulatory framework to allow and provide incentives to distribution system operators to procure flexibility services, including congestion management in their areas, in order to improve efficiencies in the operation and development of the distribution system" (art. 32.1).
- **The remuneration of reasonable costs.** The regulatory framework shall be designed to ensure the procurement of flexibility services from "all the existing resources" – "distributed generation, demand response or energy storage" – in a "cost-effective" way and to "adequately" remunerate DSOs for the procurement of such services. In particular, DSOs shall be able to recover their "reasonable corresponding costs, including the necessary information and communication technology expenses and infrastructure costs" (art. 32.2).
- **Adoption of a long-term network development plan**. The establishment of the obligation to define a network development plan illustrating the needed investments "for the next five- to- ten years" (art. 32.3) also requires, likely, to set a length of the regulatory period consistent with the required time-horizon established for the planning network investments. The plan shall provide particular emphasis on "the main distribution infrastructure which is required in order to connect new generation capacity and new loads, including recharging points for electric vehicles" and the "the use of demand response, energy efficiency, energy storage facilities or other resources that the distribution system operator is to use as an alternative to system expansion".
- **The coordination in the procurement of products and services.** The Directive affirms the obligation of coordination between DSOs and TSOs and other relevant market participants for "the procurement of products and services necessary for the efficient, reliable and secure operation of the distribution system" (art. 31.6 and 32.2).

Regulation (EU) 2019/943 – Internal Market for Electricity (Electricity Regulation)

- **An incentive-based regulatory framework.** Consistently with the Directive, the Electricity Regulation establishes that "tariff methodologies shall reflect the fixed costs […] and shall provide appropriate incentives to transmission system operators and distribution system operators, over both the short and long run, in order to […] facilitate innovation […] in areas such as digitalisation, flexibility services and interconnection" (art. 18.2).

To this aim, regulatory methodologies may "introduce performance targets in order to provide incentives to distribution system operators to increase efficiencies in their networks, including through energy efficiency, flexibility and the development of smart grids and intelligent metering systems" (art. 18.8).

5.1.2.2 Consistent Governance Scenario

The BAU scenario highlights several areas of actions with respect to the provision of flexibility services at the distribution level, which are summarized below.

Areas of action

- *The adoption of a regulatory framework covering all the reasonable costs of DSOs for the procurement of flexibility services from all the existing resources*
- *The adoption of an incentive-based regulatory framework for DSOs to procure flexibility services*
- *The adoption of a long-term network development plan*
- *The coordination between DSOs and TSOs in the procurement of flexibility services*

Both the Electricity Directive and the Electricity Regulation affirm important principles with respect to Member States' regulatory methodology for distribution networks. Output-based approaches encompassing standards of performances, penalties and incentives have demonstrated to be effective in encouraging the needed investments and efficiency in the operation of natural monopolies.

In the CG scenario NRAs are thus expected to adopt decisions shaping the regulatory methodology for the remuneration of DSOs, according to the binding Electricity Regulation. In addition, NRAs' decisions shall also implement the obligation for the development by DSOs of network plans encompassing a five to ten year time-horizon. Network plans shall be developed and subject to the NRAs' assessment before the starting of each regulatory period to allow for a forward-looking approach to the operation and development of the network. Such approach would ensure a timely and consistent development of distribution networks with respect to a fast-changing environment where disruptive phenomenon as digitalisation affect to a large extent the energy transition.

Policy Actions

A1. *NRAs' decisions on the regulatory framework for DSOs*

- *A regulatory framework covering all reasonable costs of DSOs*

The NRAs' decisions on the regulatory framework for DSOs. NRAs shall undertake binding decisions with respect to the following areas of action concerning the regulatory methodology for the remuneration of DSOs:

  - the types of fixed costs which could be encompassed in the Regulatory Asset Base of each DSO (e.g. infrastructure costs, ICT investments, deployment of smart meters if DSOs, instead of suppliers, are responsible);

- the regulatory treatment of amortization and depreciation of Capex;
- the methodology for the computation of the Weighted Average Cost of Capital for the remuneration of the RAB;
- the necessity to take into account regional specificities in the definition of those parameters of the regulatory methodology which depend, e.g., from the macro-economic conditions of each country. For example: inflation rate, country risk premium, etc.
- the length of the regulatory period;
- the role of the EU DSO entity (art. 30.1 of the Regulation of the European Parliament and of the Council on the internal market for electricity) in addressing the evolution of the regulatory framework at Member States' level to promote a more active role of DSOs;
- role and responsibilities of ACER and NRAs in promoting the evolution of Member States' regulatory framework.

- *An incentive-based regulation to promote flexibility*

The NRAs' decisions on the regulatory framework for DSOs. NRAs shall also establish measures aimed at promoting efficiency and flexibility services by DSOs:

- the adoption of a regulatory framework aimed at promoting efficiency in the operating costs of DSOs as, e.g. the RPI-X approach employed in most Member States. Such approach should develop an adequate balance between efficiency and investments needed to ensure flexibility, network development, service quality, etc.;
- a definition of the classes of Opex which can be subject to remuneration;
- the adoption of a menu of regulation to reduce information asymmetries with respect to efficiency;
- the adoption of an output-based regulation in all Member States setting the standards of performance that DSOs shall respect or out-perform with respect to several dimensions such as reliability of the system, number of connection, timing for the delivering of connections etc. and including objectives related to the implementation of operations in the area of digitalisation and procurement of flexibility services (e.g. minimum number of charging infrastructure for EVs, deployment of smart meters etc.);
- the adoption for each standard of an incentive mechanism based on premiums - in the case standards are achieved or outperformed - and penalties in the case of DSOs' underperformance with respect to the target set by the regulatory framework.

- *A long-term developing plan for electricity distribution*

The NRAs' decisions on the regulatory framework for DSOs. MSs' regulatory provisions shall also provide indications with respect to the development of network plan by DSOs as:

- the obligation for DSOs to adopt network plans with a time-horizon of duration from five to ten years;
- the obligation to adopt a Cost-Benefit-Analysis to justify the choice of the investment actions included in the plan;

- the link between investments planned and outputs set within the output-based regulatory framework;
- the estimated value of the investment;
- the timing for the completion of the planned investments;
- the extension of the regulatory period consistently with the time-horizon adopted for the network development plan.

A2. *The license modification*

- *Promoting the procurement of flexibility services from all the existing resources*

The obligation to procure flexibility services from all the existing resources can be enforced by introducing a modification to the license conditions of DSOs.

5.1.2.3 Reinforced Legislation Scenario

The CG scenario expects the adoption of an EU Regulation to promote a new regulatory framework aimed at encouraging a new role of DSOs and a smarter operation of distribution networks.

Areas of action

- *The adoption of a regulatory framework covering all the reasonable costs of DSOs for the procurement of flexibility services from all the existing resources.*
- *The adoption of an incentive-based regulatory framework for DSOs to procure flexibility services.*
- *The adoption of a long-term network development plan.*
- *The coordination between DSOs and TSOs in the procurement of flexibility services*

The Electricity Regulation sets general principles, despite binding, with respect to the regulatory framework that DSOs shall put in place for DSOs. Therefore, a large degree of heterogeneity across member States might occur in the implementation of the Electricity Regulation.

In order to make sure that DSOs across MSs are engaged to the same extent and at the same peace in the promotion of flexibility, and smarter grids more in general, the GC foresees the adoption in 2030 of a Regulation on guidelines for the regulation of distribution networks

Such guidelines may provide detailed technical and operational rules to adopt consistent and effective regulatory approach for the development of a forward looking and output-based regulation for distribution network across Member States. In addition, the new Regulation would allow to consider possible evolution of the regulatory approach to acknowledge more effectively the increasing role of P2P and VPPs.

The Regulation will acknowledge the issues discussed in the CG scenario and additional domains.

Policy Actions

A1. *The new Regulation on guidelines for the regulation of distribution networks*

The areas of action of the CG scenario

- The building blocks of the harmonised regulatory framework concerning electricity distribution. An output-based regulation linked to the achievement of minimum standards of performance with respect to digitalisation, flexibility, reliability, quality of the services. Member States can adopt additional goals and standards with respect to the minimum set of standards set in the Directive. With respect to the efficient operation of distribution network, the Directive might establish an RPI-X approach to stimulate the efficiency of network operations;
- The class of Opex and Capex subject to the EU regulatory framework;
- A harmonised methodology for the computation of the WACC;
- The length of the regulatory period.

Additional areas of action

- The objectives of the evolution of the regulatory framework concerning electricity distribution;
- The principles that should lead changes in MSs' regulatory frameworks addressed by the Regulation;
- The role, responsibilities and functions of DSOs to acknowledge a more sustainable and digitalised energy sector;
- The roles of the EU DSO in promoting the adoption of the new regulatory framework in each MS;
- The roles of National Regulatory Authorities in promoting the adoption of the new regulatory framework in each MS;
- Further changes in the regulatory methodology to acknowledge the role of P2P and VPPs;
- The milestones for the enforcement of a full harmonisation of the regulatory frameworks across Member States and the governance of the transition period occurring form the approval of the Regulation and alignment of the regulatory framework across Member States.

5.1.2.4 Active Digitalisation Policy Scenario

The combination of the Horizon Europe and CEF programmes might represent an important boost in promoting a more active role of DSOs in the procurement of flexibility services. Actually, these programs might complement regulatory incentives in encouraging network investments aimed at promoting a smarter role of DSOs and customers.

To this purpose, Horizon Europe might also represent the appropriate framework for R&I activities concerning the deployment of large-scale storage as well as P2P energy trading and VPP. As seen in the RL scenario both P2P trading and VPP might become a game changer which might significantly reshape the design of the energy system and by requiring an even more active and smarter role of DSOs.

5.1.3 Specifications of the products for flexibility services

Key issue

The specifications of the products for flexibility services allow identifying rights and obligations of resources connected at the distribution level with respect to their participation in electricity markets (Key issue #3 and #4 of UC3 and key issue #3 of UC10).

Policy scenario design

BAU scenario	CG scenario	RL scenario	ADP scenario
Regulation (EU) 2017/2195 (Balancing Guideline) Regulation (EU) 2019/943 – Internal Market for Electricity Directive (EU) 2019/944 – Internal Market for Electricity	Further secondary legislation establishing guidelines on electricity balancing service (amending Regulation (EU) 2017/2195)	New Directive on the IEM	No actions

The procurement of flexibility services at the distribution level requires, in addition to a greater coordination between TSOs and DSOs and more active role of DSOs, a clear definition of the subjects entitled to provide such services as well as of their rights and obligation.

To this purpose, the Balancing Guideline establishes important principles with respect to the settlement of imbalances, congestion management and the transparent and non-discriminatory procurement of flexibility services. Similar remarks are included in the Electricity Regulation and the Electricity Directive on the internal market for electricity.

In the following, a description of the measures entailed by the Balancing Guideline and the Electricity Regulation and Electricity Directive is provided.

5.1.3.1 BAU Scenario

Regulation (EU) 2017/2195 (Balancing Guideline)

- **The settlement of imbalances.** The Balancing Guideline affirms the general principle that "all market participants should be financially responsible for the imbalances they cause in the system" (art. 17).

  To this aim, an efficient pricing methodology for the imbalance settlement "should create positive incentives for market participants in keeping their own balance or helping to restore the system balance in their imbalance price area, thereby reducing system imbalances and costs to society. Such pricing approaches should strive for the economically efficient use of demand response and other flexibility resources, subject to operational security limits" (art.18, 30 and 32 of Balancing

Guideline). In particular, the Balancing Guideline establishes that "imbalance prices should reflect the real-time value of energy" to make balancing markets and the overall energy system fit for the integration of the increasing share of variable renewable energy (§17).

In particular, the Balancing Guideline suggests the "single price" methodology as the pricing methodology for imbalance settlement (art. 55).

- **Characteristics of flexibility service products**. With respect to balancing markets, standard products for balancing energy and balancing capacity shall, in particular, […] "facilitate the participation of demand facility owners, third parties and owners of power generating facilities from renewable energy sources as well as owners of energy storage units as balancing service providers" (Balancing Guideline, art. 25). More in general, with respect to balancing services markets, TSOs and DSOs shall set terms and conditions relative to balancing services shall allow "the aggregation of demand facilities, energy storage facilities and power generating facilities" (art. 18.4).

Regulation (EU) 2019/943 – Internal Market for Electricity (Electricity Regulation)

- **The settlement of imbalances.** The Electricity Regulation establishes the principle that "all market participants shall be responsible for the imbalances they cause in the system and that each balance responsible party shall be financially responsible for its imbalances and shall strive to be balanced or shall help the electricity system to be balanced" (art. 5). The imbalances shall be settled at a price that reflects the real-time value of energy (Electricity Regulation, art. 6).

- **Efficient congestion management.** The Electricity Regulation provides indirect incentives to DSOs and TSOs in mitigating congestion management activity. In particular, both DSOs and TSOs are subject to a reporting activity towards the competent regulatory authority with respect to the level of development and effectiveness of market-based re-dispatching mechanisms for power generating, energy storage and demand response facilities; the reasons, volumes in MWh and type of generation source subject to re-dispatching (art. 13.2).

  In addition, to mitigate the activation of re-dispatching activities, the Regulation imposes to TSOs and DSO to take appropriate grid-related and market-related operational measures "in order to minimise the downward re-dispatching of electricity produced from renewable energy sources or from high-efficiency cogeneration".

  Moreover, "Network development shall also take into account the constraints set for re-dispatching […] which shall not prevent network planning from taking into account limited re-dispatching where the transmission system operator or distribution system operator is able to demonstrate in a transparent way that doing so is more economically efficient and does not exceed 5 % of the annual generated electricity in installations which use renewable energy sources and which are directly connected to their respective grid […]" (art. 13.2).

Directive (EU) 2019/944 – Internal Market for Electricity (Electricity Directive)

- **Characteristics of flexibility service products.** The Electricity Directive establishes that DSOs shall procure, in particular, "non-frequency balancing services needed for its system in accordance with transparent, non-discriminatory and market-based procedures" (art. 31.7). To this aim, DSOs shall establish the "specifications for the flexibility services procured" and "standardised market products for such services" (art. 32.2) and procedures ensuring the participation of all market participants including "producers from renewable sources, demand response, operators of energy storage facilities and aggregators" (art. 32.2). These specifications shall ensure the effective and non-discriminatory participation of all market participants (Electricity Directive art. 32.2). The provision of flexibility services shall be allowed, indeed, in each electricity market and according to a non-discriminatory treatment with respect to the access to such markets, the stipulation of contracts with aggregators, tariffs and network charges.
- **Prequalification criteria for the provision of flexibility services.** With respect to the entitlement of providing balancing services, neither the Electricity Directive nor the Electricity Regulation provides indications with respect to particular pre-qualification measures with reference to single resources or aggregators. The participation of market operators selling energy from renewable sources, engaged in demand response, operating energy storage facilities or engaged in aggregation is subject, indeed, to the definition of technical requirements for the participation established by the DSOs or the TSOs (for balancing services markets) in close cooperation with other market participants (art. 31 and art. 40 of the Directive).

5.1.3.2 Consistent Governance Scenario

The BAU scenario highlights the following areas of actions with respect to the provision of flexibility services.

Areas of action

- *The settlement of imbalances*
- *Characteristics of products for flexibility services*
- *Efficient congestion management*
- *Prequalification criteria for the provision of flexibility services*

The Balancing Guideline, the Electricity Regulation and Electricity Directive establish important guidelines with respect to the characteristics of flexibility services and, specifically, those provided at the distribution level.

However, a detailed and exhaustive framework is necessary to provide a clear definition of the rights and responsibilities of resources providing flexibility services. Such clarification is necessary in order to achieve an effective and valuable competition between subjects providing flexibility services as well as a mitigation of costs for the procurement of flexibility services and related, e.g., to congestions and imbalances.

To this aim, the CG scenario expects the adoption of a further secondary legislation amending the current Balancing Guideline and establishing a new Regulation (EU) on guidelines on electricity balancing. Such further secondary legislation shall provide more detailed technical and operational rules with respect to the characteristics of balancing services, the rules to be followed with respect to imbalances and congestion management and possible prequalification criteria for resources willing to provide balancing services.

Policy Actions

A1. *Further secondary legislation amending Regulation (EU) 2017/2195 (Balancing Guideline)*

- *The settlement of imbalances*

With respect to the settlement of imbalances prices no amendments are needed since the Balancing Guideline already establishes the single price approach as the suggested pricing methodology for imbalances.

- *Characteristics of products for flexibility services*

The new guideline on balancing services shall also introduce the following provisions:

  - the principle of non-discriminatory participation of all market participants connected at the distribution level in each electricity markets including aggregators, renewable generation, demand, operators of storage;
  - the right for all market participants to provide flexibility services according to a non-discriminatory treatment with respect to the access to such markets, the stipulation of contracts with aggregators, tariffs and network charges;
  - the provision of flexibility services by resources connected at the distribution level according to a level playing field with traditional market operators providing such services;
  - the characteristics of the flexibility services that can be provided by market participants connected at the distribution level;
  - the design of market-based mechanisms to procure flexibility resources at the distribution level in coordination with TSOs;
  - possible changes to the market design, if needed, to effectively acknowledge the provision of flexibility services at the distribution level;
  - the establishment of a transitory period during which pilot projects can be implemented by DSOs and TSOs to test and collect information about the provision of flexibility services connected at the distribution level;
  - the roles and responsibilities of DSOs, TSOs and National Regulatory Authorities in promoting the provision of flexibility services by demand, storage and distributed generation.

- *Efficient congestion management*

The new guideline on balancing services shall address the following issues:

  - guideline and standards with respect to actions and regulatory provisions needed to mitigate the impact of congestions and redispatching measures;

  - the roles and responsibilities of DSOs, TSOs and National Regulatory Authorities in managing congestions.

- *Prequalification criteria for the provision of flexibility services*

The new guideline on balancing services shall address the following issues:

  - the technical requirements that all market participants connected at the distribution level shall respect to provide flexibility services;
  - other requirements than technical characteristics and performances which are considered to be essential, without prejudice for the principle of non-discrimination, to provide flexibility services;
  - the roles and responsibilities of DSOs, TSOs and National Regulatory Authorities in defining and enforcing prequalification criteria.

5.1.3.3 Reinforced Legislation

The new Regulation (EU) establishing guidelines on electricity balancing, expected in the CG scenario, elaborates a comprehensive framework with respect to the following issues.

Areas of action

- *The settlement of imbalances*
- *Characteristics of flexibility products*
- *Congestion management*
- *Prequalification criteria for the provision of flexibility services*
  - *Impact of P2P and VPPs on the design of balancing markets*
  - *Impact of P2P and VPPs on imbalance settlement*
  - *Impact of P2P and VPPs on the characteristics of the products to be offered in balancing markets*
  - *Impact of P2P and VPPs with respect to the coordination between VPPs, TSOs and DSOs*

The New Directive on the internal electricity market addressing new roles of TSOs and DSOs in the light of emerging flexibility services at the distribution level cannot neglect a more incisive action on the characteristic of flexibility services.

The emergence of P2P and VPPs could significantly shape the modalities through which flexibility services at the distribution level and transmission level could be provided. Therefore, it is essential that following 10 years from the fourth Directive on the IEM (the actual Electricity Directive), a new Directive could take into account the possible impact on the provisions of flexibility services in the light of the emergence of P2P and VPPs.

Policy Actions

A1. *The new Directive on the internal electricity market (and related Regulations)*

The areas of action of the CG scenario

The new Electricity Directive could address the following issues related to the areas of action emerged in the CG scenario:

- the principle of non-discriminatory participation of all market participants connected at the distribution level in each electricity markets including aggregators, renewable generation, demand, operators of storage;
- the right for all market participants to provide flexibility services according to a non-discriminatory treatment with respect to the access to such markets, the stipulation of contracts with aggregators, tariffs and network charges;
- the obligation for TSOs and DSOs to procure flexibility services to all market participants able to provide such services;
- the provision of flexibility services according to a level playing field between different types of resources;
- the roles and responsibilities of DSOs, TSOs and National Regulatory Authorities in promoting the provision of flexibility services based on efficient, transparent and non-discriminatory conditions;
- the obligation for NRAs or TSOs to define the technical requirements that all market participants shall respect to provide flexibility services;
- the adoption of imbalance prices promoting efficient signals to market participants aimed at promoting a more responsible participation in electricity markets;
- the roles of TSOs and DSOs in managing congestions.

Additional areas of action

Further areas to be addressed by a new Electricity Directive with respect to flexibility services can be:

- the definition in each Member State of an implementation model concerning the coordination of TSOs and DSOs in the procurement of flexibility services;
- the activities concerning the procurement of flexibility services for which a coordination between TSOs and DSOs is needed;
- the roles and responsibility of ACER and NRAs in enforcing provisions of the Directive with respect to flexibility services;
- impact of P2P and VPPs on the design of balancing markets;
- impact of P2P and VPPs on imbalance settlement;
- impact of P2P and VPPs on the characteristics of the products to be offered in balancing markets;
- impact of P2P and VPPs with respect to the coordination between VPPs, TSOs and DSOs.

5.1.3.4 Active Digitalisation Policy

With respect to the specifications of the products for flexibility services, the ADP scenario does not provide for actions that can be deemed to produce a direct effect on such key issue.

5.1.4 The role of independent aggregators in providing flexibility services

Key issue

The establishment of a consistent regulatory framework promoting clear roles and responsibilities of independent aggregators and their non-discriminatory participation in each electricity market (Key issue #1 of UC3).

Policy scenario design

BAU scenario	CG scenario	RL scenario	ADP scenario
Directive (EU) 2019/944 – Internal Market for Electricity Regulation (EU) 2017/2195 (Balancing Guideline)	Regulation (EU) establishing guidelines on independent aggregators Regulatory provisions at the Member States level	New Directive on the IEM	CEF

The distributed nature of resources providing flexibility services encourages the development of independent aggregators, which will likely have an important role in promoting the provision of balancing services at the distribution level. The Directive on the internal market for electricity defines "independent aggregators" as "market participants engaged in aggregation of customers and not affiliated to customer's supplier".

At present, the Electricity Directive is the only legislative provision setting a minimum framework for independent aggregators. Namely, the Directive is concerned about the development of transparent and non-discriminatory rules with respect to the participation of independent aggregators in electricity markets, the provision of flexibility services by them and a clear definition of roles and responsibilities of such market operators. The Directive also establishes obligations for electricity suppliers to refrain from behaviours aimed at preventing customers' possibility to enter into a contract with an aggregator.

The Balancing Guideline further stresses the rights of customers to enter into a contract with a independent aggregators without facing discriminatory actions by their suppliers.

In the following, a description of the provisions encompassed by the Electricity Directive and by the Balancing Guideline is provided.

5.1.4.1 BAU Scenario

Directive (EU) 2019/944 – Internal Market for Electricity (Electricity Directive)

- **The role of independent aggregators.** The Directive of the European Parliament and of the Council on common rules for the internal market in electricity establishes that "all customer groups (industrial, commercial and households) should have access to the electricity markets to trade their flexibility and self-generated electricity. […] and that "market participants engaged in aggregation are likely to play an important role as intermediaries between customer groups and the market (§39)"

  The Directive considers aggregation an advantage for promoting demand response services and Member States shall "foster participation of demand response through aggregation" (art. 17.1).

  To this purpose, TSOs and DSOs shall treat market participants engaged in the aggregation of demand response in a "non-discriminatory manner, in the procurement of balancing services, alongside producers based on their technical capabilities" (art. 17.2).

- **A consistent regulatory framework for aggregators.** The Directive establishes that Member States shall adopt regulatory framework ensuring: "the right for each market participant engaged in aggregation, including aggregators, to enter electricity markets without the consent of other market participants; non-discriminatory and transparent rules that clearly assign roles and responsibilities to all electricity undertakings and customers; and non-discriminatory and transparent rules and procedures for the exchange of data between market participants engaged in aggregation and other electricity undertakings that ensure easy access to data on equal and non-discriminatory terms while fully protecting commercially sensitive information and customers' personal data" (art. 17.3).

- **The role of suppliers in promoting aggregators.** Electricity suppliers also play a role in promoting the development of aggregators. Actually, the Directive states that customers shall be free to purchase and sell electricity services including aggregation independently from their electricity supply contract and the consent of electricity undertakings (art. 13.1 and art. 13.2). In addition, suppliers shall not impose "discriminatory technical and administrative requirements, procedures or charges [to consumers] on the basis of whether they have a contract with a market participant engaged in aggregation" (art. 13.4). Moreover, final customers who have a contract with independent aggregators not to be subject to undue payments, penalties or other undue contractual restrictions by their suppliers (art. 17.3).

  Aggregation of is permitted on all electricity markets – "including balancing services and capacity markets, so as to encourage the participation of demand response" (§39) – and Member States shall develop an appropriate implementation model and approach to governance for independent aggregation. The regulatory framework shall respect the principles of non-discrimination and of fair and transparent rules and products defined with respect to all electricity market (§39).

- **The rights of customers.** With respect to customers, the Directive establishes the principle of non-discriminatory treatment – in the form of "disproportionate or discriminatory technical requirements, administrative requirements, procedures

and charges, and not cost-reflective network charges" – for active customers selling self-generated electricity, participating in flexibility schemes and energy efficiency schemes (art. 12.1 and art. 12.2). In particular, network charges, subject to cost-reflectivity, shall account separately for the electricity fed into and consumed from the grid (art. 12.2) and shall not "discriminate either positively or negatively against energy storage or aggregation and shall not create disincentives for self-generation, self-consumption or for participation in demand response" (art. 18, Electricity Regulation).

For customers with storage facilities, the Directive defines the principle of non-discriminatory treatment as: "the right to a grid connection within a reasonable time, after the request; avoid any double charges, including network charges, for stored electricity remaining within their premises or when providing flexibility services to system operators; avoid disproportionate licensing requirements or fees" (art. 12.5).

Regulation (EU) 2017/2195 (Balancing Guideline)

- **The role of aggregators.** Consistently, the Balancing Guideline aims, among other goals, to facilitate "the participation of demand response including aggregation facilities and energy storage", in the balancing markets, "while ensuring they compete with other balancing services at a level playing field".

5.1.4.2 Consistent Governance scenario

The BAU Scenario highlight the following open issues with respect to the role of aggregators.

Areas of action

- *The role of independent aggregators*
- *A consistent regulatory framework for aggregators*
- *The role of suppliers in promoting aggregators*
- *The rights of customers in the engagement with aggregators*

The CG Scenario suggests the adoption of a more detailed policy framework to address the increasing importance of independent aggregators in promoting flexibility services at the distribution level. In order to allow independent aggregators to participate in electricity markets at a level playing field and responsibly, thus bringing value to customers and the whole electricity system, the development of a timely and exhaustive legislative framework is essential. For this purpose, the CG scenario expects the adoption of a binding Regulation (EU) establishing guidelines on independent aggregators to address issues as:

- technical prerequisites for the access of independent aggregators to electricity markets and the provisions of flexibility services;
- their coordination with TSOs and DSOs;
- the principles of transparent and non-discriminatory access and participation of independent aggregators in electricity markets;

- obligations with respect to TSOs and DSOs with respect, e.g., to the exchange of information.

In addition, Member States shall adopt regulatory provisions, through their NRAs, to ensure customers' rights to stipulate a contract with independent aggregators and suppliers' obligations in refraining from behaviours aimed at preventing customers and aggregators to enter into a commercial relationship with aggregators.

Policy Actions

A1. *The new Regulation (EU) establishing guidelines on independent aggregators*

- *The role of independent aggregators*

The adoption of a Regulation (EU) on independent aggregators shall address, first, the role of independent aggregators:

- the definition and characteristics of "independence" for aggregators.
- *A consistent regulatory framework for independent aggregators*

The adoption of a Regulation (EU) on independent aggregators appears desirable to develop a consistent and exhaustive framework across Member States for a responsible and valuable development of these new market operators. The guideline shall provide indications on issues as:

- the principles to be adopted in the development of a regulatory framework, in each Member State, for independent aggregators;
- the right for each market participant engaged in aggregation, including aggregators, to enter electricity markets without the consent of other market participants;
- the technical and financial requisites of aggregators to be eligible as market participants;
- the criteria that independent aggregators shall follow in the aggregation of resources connected at the distribution level;
- the rights and responsibilities of independent aggregators in the provision of flexibility services;
- the obligation of communication and coordination between suppliers, TSOs, DSOs and customers;
- the eventual supervisory role of NRAs with respect to the fairness and accountability of independent aggregators, in the interest of consumers;
- the rules addressing a secure, reliable and correct exchange of data between independent aggregators and other market participants according to transparent and non-discriminatory procedures;
- the definition of minimum standards with respect to data format and interoperability with respect to the exchange of data between aggregators and other electricity undertakings;
- the obligation for TSOs and DSOs to treat market participants engaged in the aggregation of demand response in a non-discriminatory manner, in the procurement of balancing services;

- the establishment of a competition in the provision of flexibility services at a level playing field between different resources;
- the definition of minimum standards to comply with to fully protect commercially sensitive information and customers' personal data.

A2. *Regulatory provisions at the Member States' level*

- *The role of suppliers in promoting aggregators*

Member States' NRAs or Antitrust Authorities shall adopt regulatory provisions, in the form e.g. of industry codes, aimed at ensuring customers' rights to enter into a contract with an independent aggregator. Industry or codes of conduct shall address issues as:

- the obligation for suppliers to not impose discriminatory technical and administrative requirements, procedures or charges [to consumers] on the basis of whether they have a contract with a market participant engaged in aggregation.

- *The rights of customers in the engagement with independent aggregators*

Member States' NRAs or Antitrust Authorities shall adopt regulatory provisions, in the form e.g. of industry codes, aimed at ensuring customers' rights to enter into a contract with an independent aggregator. Industry or codes of conduct shall address issues as:

- the right for customers to enter into a contract with an independent aggregator independently from their electricity supply contract and the consent of electricity undertakings;
- the right for customers who have a contract with independent aggregators not to be subject to undue payments, penalties or other undue contractual restrictions by their suppliers;
- the right for customers to not receive a discriminatory treatment in the form of disproportionate or discriminatory technical requirements, administrative requirements, procedures and charges, and not cost-reflective network charges;
- the application of network charges, subject to cost-reflectivity, shall account separately for the electricity fed into and consumed from the grid.

5.1.4.3 Reinforced Legislation

The CG Scenario addresses mostly by means of a Regulation (EU) and Member States' regulatory provisions the following issues.

Areas of action

- *The role of independent aggregators.*
- *A consistent regulatory framework for aggregators.*
- *The role of suppliers in promoting aggregators.*
- *The rights of customers in the engagement with aggregators*

- *Establishment of the obligation to cooperate between VPPs and aggregators*
- *Exchange of information between VPPs and aggregators*
- *Rules governing the coordination between VPPs and of both with DSOs and TSOs*

The RL scenario suggests that the new Directive on the internal electricity market introduced with respect to previous key issues may also be an effective legislative action in deterring Member States from delays in the adoption of a comprehensive regulatory framework aimed at promoting the role of independent aggregators.

In order to promote flexibility services at the distribution level, and the consequent benefits for the whole energy system is important that the role, the responsibilities and prerequisites of independent aggregator are established timely and clearly.

As power markets become more integrated and innovation shapes them at a fast peace across European Countries, the new Directive might be an effective measure to regulate issues as, among others: the for independent aggregators to enter electricity markets without the consent of other market participants; the requisites of aggregators to be eligible as market participants; the types of flexibility services that aggregators can provide, the rights and responsibilities of independent aggregators in the provision of flexibility services, the relationship between aggregators TSOs and DSOs.

The RL also considers a more incisive action with respect to the rights of customers' to enter into contracts with independent aggregators. To this aim, the legislative package "New Deal for Consumers" is expected to consider issues as: the obligation for suppliers to not impose discriminatory technical and administrative requirements, procedures or charges [to consumers] on the basis of whether they have a contract with a market participant engaged in aggregation; the right for customers to enter into a contract with an independent aggregator independently from their electricity supply contract and the consent of electricity undertakings.

Policy Actions

A1. *The new Directive on the internal electricity market (and related Regulations)*

The areas of action of the CG scenario (a consistent regulatory framework for aggregators)

- The principles to be adopted in the development of a regulatory framework, in each Member State, for independent aggregators.
- The definition of "independence" for aggregators.
- The right for each market participant engaged in aggregation, including aggregators, to enter electricity markets without the consent of other market participants.
- The technical and financial requisites of aggregators to be eligible as market participants.
- The characteristics and the technical features of the flexibility services that aggregators can provide.

- The criteria that independent aggregators shall follow in the aggregation of resources connected at the distribution level.
- The rights and responsibilities of independent aggregators in the provision of balancing services.
- The obligation of communication and coordination between suppliers, TSOs, DSOs and customers-
- The eventual supervisory role of NRAs with respect to the fairness and accountability of independent aggregators, in the interest of consumers.
- The rules addressing a secure, reliable and correct exchange of data between independent aggregators and other market participants according to transparent and non-discriminatory procedures.
- The definition of minimum standards with respect to interoperability with respect to the exchange of data between aggregators and other electricity undertakings.
- The obligation for TSOs and DSOs to treat market participants engaged in the aggregation of demand response in a non-discriminatory manner, in the procurement of flexibility services.
- The establishment of a competition in the provision of flexibility services at a level playing field between different resources.
- The necessary Regulation (EU) to be adopted to enforce the Directive.

Additional areas of action

- The objectives of the Directive with respect to independent aggregators.
- The obligation for TSOs, DSOs and suppliers to share relevant data with aggregators to allow for the provision of more efficient ancillary.
- The roles of National Regulatory Authorities in promoting the integration of independent aggregators in the electricity market.
- Establishment of the obligation to cooperate between VPPs and aggregators
- Exchange of information between VPPs and aggregators
- Rules governing the coordination between VPPs and of both with DSOs and TSOs.

5.1.4.4 Active Digitalisation Policy

As for the cooperation between TSOs and DSOs, the CEF programme intended at exploiting the synergies between digital and energy infrastructures might support the development of digital platforms aimed at facilitating the interactions between the different actors of the energy system including aggregators.

5.1.5 The access to consumption and production data

Key issues

The development of an efficient and valuable access to consumption and production data to allow a more active and responsible participation of distributed generation and consumption units in electricity markets (Key issue #2 of UC3).

Policy scenario design

BAU scenario	CG scenario	RL scenario	ADP scenario
Directive (EU) 2019/944 – Internal Market for Electricity	Regulatory provisions at the Member States level	Binding (EU) standards on common EU interoperability standards	No actions

5.1.5.1 BAU Scenario

Access to consumption and production data is fundamental to allow an active, aware and responsible participation in electricity markets of demand, distributed generation and operators of storage facilities.

The Electricity Directive develops a comprehensive framework with respect to data access, stemming from billing information to contracts with aggregators. In the following an overview of these provisions is presented.

Directive (EU) 2019/944 – Internal Market for Electricity (Electricity Directive)

- **Access of customers to data.** Member States shall ensure that "final customers are entitled to receive all relevant demand response data or data on supplied and sold electricity at least once per year" and "free of charge" (art. 13).

  To the aim of promoting an effective access to data, the technical features of smart metering systems are important. The Electricity Directive acknowledge the right of customers to obtain metering data on their electricity input and off-take via a "standardised communication interface or through remote access, or to a third party acting on their behalf, in an easily understandable format allowing them to compare offers on a like-for-like basis" (art. 20).

- **Access to data by eligible parties.** Access to the data is entitled, in addition to consumers, to eligible parties with the explicit consent of final customers (art. 23).

- **Interoperability requirements.** In order to promote competition in the retail market the Electricity Directive establishes that Member States shall facilitate the full interoperability of energy services within the Union. To this aim, the Commission shall adopt, by means of implementing acts, interoperability requirements and non-discriminatory and transparent procedures for access to data concerning metering and consumption as well as data required for customer switching, demand response and other services. In addition, Member States shall ensure that electricity undertakings apply the interoperability requirements and procedures for access to these data. Those requirements and procedures shall be based on existing national practices (art. 24).

5.1.5.2 Consistent Governance Scenario

The BAU scenario emphasizes the need of adopting interoperability requirements for the access and exchange of data related to energy services and the access by customers and third parties to relevant consumption and production data:

Areas of action

- *The entitlement of final customers to access all relevant consumption and production data*
- *The access to consumption and production data by eligible third parties*
- *Adoption and implementation of interoperability requirements by Member States to promote data access and exchange*

The CG scenario considers the adoption of regulatory provisions by Member States' NRAs, in compliance with the Directive on the internal electricity market, aimed at addressing issues as: the rights of customers to receive relevant data on demand response and production, the rules for a secure and fair access to data by eligible third parties, the adoption and implementation of interoperability requirements to promote exchange and access to data related to energy services

Policy Actions

A1. *Regulatory provisions at the Member States' level*

- *The entitlement of customers to access consumption and production data*

Member States shall adopt regulatory provision such as industry codes or measures introducing mandatory provisions in the supply and distribution contracts aimed at establishing:

  - the entitlement of final customers to receive all relevant demand response data or data on supplied and sold electricity at least once per year and free of charge.
- *The access to consumption and production data by eligible parties*

Member States' regulatory provisions shall address issues concerning the access by eligible parties to consumption and production data:

  - the definition of parties entitled to access consumption and production data;
  - the definition of prerequisites and conditions to access data;
  - the principle of non-discriminatory and transparent access to data;
- *The adoption of interoperability standards*

Member States' regulatory provisions shall ensure:

  - the implementation of the interoperability requirements defined by the European Commission (art. 24, Electricity Directive) to promote the access to data;
  - the right for customers to obtain metering data on their electricity input and off-take via a standardised communication interface or remote access, or to a

third party acting on their behalf, in an easily understandable format and able to allow the comparison of deals on a like-for-like basis.

5.1.5.3 Reinforced Legislation Scenario

The CG Scenario mostly establishes regulatory provisions at the level of Member States and network codes to address the open issues concerning the access to production and consumption data.

Areas of action

- *The entitlement of final customers to access all relevant consumption and production data*
- *Access to consumption and production data by eligible parties.*
- *The adoption of interoperability requirements for metering and consumption data*

In the case the provisions concerning the relevant areas of action of interventions would be not acknowledged in a timely and effective manner, further actions would be required. In particular, the RL scenario considers the legislative measures encompassed by the "New Deal for Consumers" a valuable tool to promote an effective commitment of Member States in addressing the issues of the CG scenario with respect to the access of customers to both consumption and production data.

In order to make customers the protagonists of the energy transition, the development of an active and responsible participation of consumers to electricity market is essential and can be no more postponed.

Policy Actions

A1. *EU interoperability requirements*

The areas of action of the CG scenario

- The adoption and implementation by Member States of the interoperability requirements set by the European Commission compliant to the art. 24 of the Electricity Directive.
- Definition of EU common standard communication interface/or remote access protocols/standards across Member States in to promote the entitlement to data access for eligible parties other than customers, such as suppliers, transmission and distribution system operators, aggregators, energy service companies, and other parties which provide energy or other services to customers.
- The adoption of transparent procedure for eligible parties to have access, in a transparent and non-discriminatory way, to the data on metering and consumption data as well as data required for customer switching, demand response and other services

- The right for customers to obtain metering data on their electricity input and off-take via a local standardised communication interface and/or remote access, or to a third party acting on their behalf, in an easily understandable format and able to allow the comparison of deals on a like-for-like basis

5.1.5.4 Active Digitalisation Policy

With respect to this key issue, the ADP scenario does not provide for actions that can be deemed to produce a direct effect on such key issue.

5.2 Privacy and Data Protection

As the deployment of smart meters and Home Energy Management Systems (HEMS) spreads across Europe, an increasingly significant amount of final customer data will be collected, processed by eligible parties and made available to entitled stakeholders. That generates final customer privacy and data protection issues, creating new risks for the data subjects by exposing them to possible price discriminations, unauthorised consumer profiling and household security threats, previously absent in the energy sector.

In this respect, UC1 and UC4 analysis highlights that final costumers' trust and confidence are crucial, as without proper guarantees on data protection, consumers are likely to be reluctant to take risks and might possibly dismiss innovation in favour of conventional meters and analogic devices.

Key issue

- **Customer privacy and data protection:** need for detailed provisions to ensure that data protection issues posed by smart metering systems are properly tackled (Key Issue #1 of UC1 and UC4).

5.2.1 Customer privacy and data protection

Policy scenario design

In order to tackle the issues arising from the UCs analysis, three main scenarios have been depicted, encompassing specific measures which are described in the following paragraphs.

BAU scenario	CG scenario	RL scenario	ADP scenario
Electricity Directive e-Privacy GDPR	Guidelines for consistency between GDPR and e-Privacy rules Guidelines for consistency between GDPR and the recast Electricity Directive	No actions	No actions

5.2.1.1 BAU Scenario

Since the mid-1990's, data protection legislation in the European Union (EU) has been primarily based on EU Directive 95/46/E (Data Protection Directive).

In a more and more digitalised world, where digital services, social networking and Internet of Things (IoT) generate huge amounts of data, the European Commission deemed to develop new regulations for data privacy and protection to keep pace with digitalisation trends, i.e. General Data Protection Regulation (GDPR) and e-Privacy regulation.

In the energy sector, the deployment of smart metering systems in particular exposes final customers to privacy and data protection risks, as the smart meters could indeed represent the entrance gate to get a privileged access to the household's private life and sensitive data. In this regard, some specific provision on smart meters data protection have been already provided in the Electricity Directive, in line with the relevant Union data protection and privacy rules. When it comes to implementation, translating these into practical measures to ensure that data protection issues posed by smart metering systems are properly tackled, is of highest priority and key to realising the full potential of smart metering in Europe.

The GDPR and the proposal for an e-Privacy regulation

The General Data Protection Regulation (GDPR) entered in force in May 2018 setting up rules concerning the protection of natural persons with regard to the processing of personal data the free movement of personal data.

Concerning customer privacy, the Commission's proposal (COM (2017) 10) for an e-Privacy Regulation (Regulation on Privacy and Electronic Communications) is currently under legislative process in the European Parliament and the Council.

- **GDPR and e-Privacy rules.**

The proposal for the e-Privacy Regulation complements GDPR in the electronic communications sector. While GDPR protects personal data, the e-Privacy Regulation protects the confidentiality of electronic communications and devices. In particular, when communications include personal data, the general rules of the GDPR apply, unless the e-Privacy Regulation lays down more specific rules. The e-Privacy Regulation will ensure the protection of fundamental rights and freedoms, in particular the respect for private life, confidentiality of communications and the protection of personal data in the electronic communications sector. It also guarantees the free movement of electronic communications data, equipment and services in the Union.

On the 13th March 2019, the European Data Protection Authorities (DPAs) adopted an opinion on the interplay between the e-Privacy Directive and GDPR on e-communication data.

The GDPR and the Electricity Directive

The Electricity Directive 2019/944, when regulating smart metering systems deployment (Art. 19), addresses specific issues related to final customer privacy and protection of their data through the smart metering systems requirements (Art. 20), tackles data management issues (Art. 23) and mandates the development and set up

of interoperability requirements and procedures for access to data (Art. 24). Moreover, the Directive provides explicit references to the recently (May 2018) adopted Regulation (EU) 2016/679, the General Data Protection Regulation (GDPR) where in Art. 20 (1)point (c) states that "*the privacy of final customers and the protection of their data shall comply with relevant Union data protection and privacy rules*".

- **Qualification of final customer energy related data**

From our analysis, one of the first issues that arose when dealing with final customer data processed by smart metering systems is whether all these data shall be regarded as personal data.

While registration data provided by the customer when signing the contract for the smart meter installations are unquestionably personal data, the conclusion is less obvious when considering all the customer energy related data, which are identified by the Electricity Directive, Art. 23 (1) as "*metering and consumption data as well as data required for customer switching, demand response and other services*".

They can be reasonably regarded as personal data because they can be linked with the natural person who is responsible for the metering contract via a unique identifier (i.e. meter identification number) and disclose information on his/her energy usage, thus providing insights on his/her daily life.

Although the above reading of final customer energy related data would be in line with GDPR definition of personal data that includes "*information revealing the economic situation of the data subject*", an explicit correlation of the two definitions is still missing.

Due to lack of clarity, there are different interpretations emerging in different Member States, where stakeholders are questioning about which smart meter data, for which purposes and under which restrictions should be used in compliance with GDPR.

- **Smart meters data management and allocation of responsibilities**

Art. 23 of the Electricity Directive clearly establishes that issues on data management shall be tackled at national level, with Member States required to "*organise the management of data in order to ensure efficient and secure data access and exchange, as well as data protection and data security*".

Therefore, no common specific data management model is recommended at EU level, and each MS, independently of the adopted data management model, have to authorise, certify or, where applicable, supervise the parties responsible for data management (Art. 23 (4)).

Art. 23 (3) explicitly states that "*The processing of personal data within the framework of this Directive shall be carried out in accordance with Regulation (EU) 2016/679*".

The GDPR identifies characteristics and responsibilities of data controllers, processors and third parties authorised by controllers and processors to collect and process personal data (Art. 24-31).

However, the allocation of these roles and responsibilities might not be straightforward and it is likely that there will be difficulties in applying the relevant

definitions at MS level without a clear guidance at EU level. This could be mainly due to the number of actors smart metering systems involve, the complexity of their relationships, the number of different smart metering deployment arrangements and data management models developed at MS level.

- **Rights of the data subject**

The Electricity Directive recalls and reflects some of the rights of the data subject listed in the GDPR.

Art. 20 f) reflects Art. 14 of the GDPR on the ***right to be informed***, requiring Member States to ensure that, prior or at the time of installation of smart meters, final customers are duly informed about their energy consumption and "*the collection and processing of personal data in accordance with the applicable Union data protection rules*".

Art. 20 e) reflects Art. 15 of the GDPR on the ***right of access***, stipulating that, under their explicit request, final customers are entitled to access their metering and consumption data in an easily understandable format.

Art. 23 (2) guarantees the right to access to the final customer data also to any eligible party in a non-discriminatory manner and simultaneously. The parties responsible for data management, in accordance with the applicable Union legal framework, should provide the access to eligible parties.

Art. 23 (5) specifies that access should be free of charge for final customers, while paid for eligible parties, with Member States required to set the relevant charges while ensuring them to be reasonable and duly justified.

Finally, Art. 20 expressly refers to the ***right to data portability*** introduced for the first time by Art. 20 (1) of the GDPR. It states that for the purposes of Art 20 point (e) "*it shall be possible for final customers to retrieve their metering data or transmit them to another party at no additional cost and in accordance with their right to data portability under Union data protection rules*".

All these data protection measures enabling provisions about information and access to metering data constitute therefore a set of minimum functionalities to be integrated in all smart metering systems, which can be a clear reference to the "***data protection by design***" principle under the GDPR.

5.2.1.2 Consistent Governance Scenario

Moving from the BAU scenario, some issues still need to be addressed in order to ensure consistency between currently adopted or foreseen regulations on data protection. Moreover, further actions are required to adapt the provisions of GDPR to those of the energy sector directives and regulations, such as the deployment of smart metering systems.

Therefore, the Consistent Governance scenario would expect guidelines at EU level ensuring such consistencies. For example, the allocation of GDPR roles and responsibilities to all actors involved in smart metering systems personal data processing.

Policy Actions

The following guidelines aimed at ensuring consistency between cross-sector regulations should be adopted in each of the encompassed areas of action.

A1. *Guidelines for consistency between GDPR and e-Privacy rules*

- *GDPR and e-Privacy rules*

  The Commission should guarantee consistency between e-Privacy and the GDPR rules to secure a high level of privacy protection for customers and legal clarity for businesses.

A2. Guidelines for consistency between GDPR and the Electricity Directive

- *Qualification of final customer energy related data*

  The Commission should provide a clear definition of energy related data, specifying which of them fall under the scope of GDPR in order to ensure a consistent interpretation across Member States. Then, the Commission should assess the implications on national energy markets.

- *Smart meters data management and allocation of responsibilities*

  The Commission should define a clear guidance at EU level for the allocation of GDPR roles and responsibilities to all actors involved in smart metering systems personal data processing.

- *Rights of the data subject*

  The Commission should define guidelines for MSs in order to guarantee that the "***data protection by design***" principle under the GDPR is respected in the smart metering systems deployment. The guidelines should envision how to integrate the provisions about information and access to metering data in all smart metering systems.

5.2.1.3 Reinforced Legislation Scenario

This key issue does not foreseen policy actions in a RL scenario, as the main policy actions needed are aimed at ensuring a consistency between the currently foreseen and approved regulations in the data privacy and energy sector. Such policy actions have been already envisioned in the CG scenario.

5.2.1.4 Active Digitalisation Policy

With respect to this key issue, the ADP scenario does not provide for actions that can be deemed to produce a direct effect on customer privacy and data protection.

5.3 Cybersecurity

Ensuring resilience of the energy supply systems against cyber risks and threats is becoming increasingly important as widespread use of ICT and data communication is becoming the foundation for the functioning of infrastructures underlying the energy systems.

UCs have shown that several key issues related to cybersecurity need to be dealt with in order to guarantee a safe digitalisation process of the energy sector. Cyber security risks are going to become more and more acute with implications for safety, efficiency, margins and ultimately operational viability. The more devices are getting digital, the more critical infrastructures are subject to cyberattacks. The increased exposure to cyber incidents and attacks represents an important concern for customers that are not welcoming the growing availability of digital services.

As energy systems develop ubiquitous intelligence and communication capabilities throughout their operations, the security of critical infrastructure is now a core issue in national, international, and corporate security dialogue and policies.

For example, as the energy grid infrastructures across Member States are not harmonised, smart meters connected to the grid need have different characteristics and different security properties. Currently, a number of national certification schemes exist, as for many years each Member State has been developing and improving its own certification scheme, but a standardised EU cybersecurity system would be necessary.

The following key issues have been identified while analysing several use cases.

Main Key issues

- **Cybersecurity of ICT products:** customer concerns on their security in terms of risk of cyberattacks through ICT devices (Key issue #2 of UC1 and UC4)
- **Cybersecurity of energy critical infrastructures:** vulnerability of power assets to cyberattacks (Key issue #2 of UC9).

5.3.1 Cybersecurity of ICT products

Policy scenario design

BAU scenario	CG scenario	RL scenario	ADP scenario
Directive (EU) 2016/1148 on security of network and information systems Cybersecurity Act 2019	Implementing Act on cybersecurity measures	New Regulation on Cybersecurity	Digital Europe Programme

5.3.1.1 BAU Scenario

In the Business-As-Usual scenario, rules are there to tackle the identified issues. In fact, in recent years, the Commission has been providing measures to design both policies and implementing bodies to deal with cybersecurity, as listed below. The BAU scenario which includes policies tackling the issue under evaluation is composed by the following actions, ranging from strategic addresses to technical regulations.

The BAU Scenario highlights that cybersecurity certification schemes are scattered across the Union and there is a need for homogeneous ones. While national certification initiatives are already in place or are emerging, they shall also be mutually recognised since not all EU Member States are part of the main European mechanism based on mutual recognition. The Cybersecurity Act introduced a common

certification framework, but this should be seen as the basis to design a common standards in the future. In order to efficiently tackle common challenges and bring forward best practices of Member States, a series of provisions should be envisaged in an Implementing Act. Such act would better define areas of intervention of ENISA and its coordination with national authorities. By doing so, it would be possible to align efforts towards the identification of a common certifications for the main European Industries.

The Directive on security of network and information system

- **Supervisory role of National competent authorities**. (Art. 8) Each Member State shall designate one or more national competent authorities on the security of network and information systems. The competent authorities shall monitor the application of this Directive at national level.
- **Incidents management.** (Art. 9) Member States should be adequately equipped, in terms of both technical and organisational capabilities, to prevent, detect, respond to and mitigate network and information system incidents and risks. They should therefore ensure that they have well-functioning Computer security incident response teams (CSIRTs) complying with essential requirements to guarantee effective and compatible capabilities to deal with incidents and risks and ensure efficient cooperation at Union level.

Cybersecurity act

- **The reinforcement ENISA's role.** With the Regulation (EU) No 526/2013 it was set the European Union Agency for Network and Information Security (ENISA) which has to assist the Union and the Member States in enhancing and strengthening their capability and preparedness to prevent, detect and respond to network and information security problems and incidents. The new (EU) Regulation (The Cybersecurity Act) approved in March 2019 repeals the Regulation (EU) 526/2013 on ENISA and aims to reinforce its role as the EU's centre of advice and expertise with regard to cybersecurity matters.
- **EU cybersecurity certification.** (Art. 46) The lack of Union-wide mechanisms of certification is one of the main issues affecting the single market in the field of cybersecurity that reduces the choice of viable and usable cybersecurity technologies. For this reason, the Cybersecurity Act has proposed the creation of an EU certification with a view to creating a digital single market for ICT products, ICT services and ICT processes.

The BAU Scenario highlights that cybersecurity certification schemes are scattered across the Union and there is a need for homogeneous ones. While national certification initiatives are already in place or are emerging, they shall also be mutually recognised since not all EU Member States are part of the main European mechanism based on mutual recognition. The Cybersecurity Act introduced a common certification framework, but this should be seen as the basis to design a common standards in the future. In order to efficiently tackle common challenges and bring forward best practices of Member States, a series of provisions should be envisaged in an Implementing Act. Such act would better define areas of intervention of ENISA and its coordination with national authorities. By doing so, it would be possible to

align efforts towards the identification of a common certifications for the main European Industries.

5.3.1.2 Consistent Governance Scenario

The Consistent Governance scenario envisages the introduction of an Implementing Act to provide clarification and specific guidelines on ICT cybersecurity. Coordination of national efforts will be essential to deliver stronger legislative action as foreseen in the Reinforced Legislation, which suggests new regulation setting binding standards for common cybersecurity certifications and indicates the application of sanctions whenever security standards are breached.

Policy Actions

A1. *The new Implementing Act on cybersecurity measures*

- *Supervisory role of National competent authorities*

The new (EU) Implementing Act shall establish a good level of coordination with ENISA through:

  - Periodical workshops to facilitate the exchange of best practices
  - Allocation of responsibilities according to the matter (e.g. cross-border issues addressed by ENISA)

- *Management of incidents*

The new Implementing Act on cybersecurity measures should foresee ENISA to intervene when Member States have not developed national CSIRTs. To regulate the intervention:

  - Deadline of compliance with the Directive before having ENISA intervening
  - Ad hoc working group of ENISA and the National Competent Authority

- *The reinforcement of ENISA's role*

The new Implementing Act on cybersecurity measures should set guidelines to establish:

  - Competence areas of ENISA
  - frequency of monitoring of Member State's actions
  - Periodical workshops to facilitate capacity building on cybersecurity

- *EU Cybersecurity certification*

The new Implementing Act on cybersecurity measures should provide indications for the harmonisation with existing standards at the national level through workshops and consultations with national competent authorities and establish of a roadmap to deliver a common certification for each relevant area.

5.3.1.3 Reinforced Legislation Scenario

The use of certification schemes will be voluntary unless future EU legislation prescribes an EU certificate as a mandatory requirement to satisfy a specific cybersecurity need. The Reinforced Legislation Scenario envisages a stronger position in this regard through the adoption of a New Regulation on Cybersecurity. Once features of a common standard are identified, which should be point of arrival of the CG scenario, it would be possible to design an energy certification and to introduce sanctions in the case of incompliance with set requirements. This will be an incentive to certify the quality and verify the security of the products and services in question.

Policy Actions

The action reported below intervenes on all the issues highlighted in the Consistent Governance scenario (National competent authorities, CSIRTs, reinforced role of ENISA, Cybersecurity certification framework) but for clarity purposes, they all fall under the umbrella labelled as Cybersecurity certification framework at Union level. That is because all the issues of the GC fall under the scope of the creation of common certifications.

A1. *The cybersecurity certification at Union level*

The new EU Regulation on Cybersecurity shall define the creation of EU cybersecurity certifications for different areas with **mandatory standards** and **sanctions**:

- Ad hoc minim requirement for relevant operators
- Role of the National competent authorities and CSIRT
- ENISA makes random checks of compliance and can request National authorities to provide information at any time

5.3.1.4 Active Digitalisation Policy

The Commission recognises that cybersecurity is of key importance to ensure trust in digital products and services and thus needs to be addressed at European level, given the speed and wide propagation of cyber-attacks. Investment at EU level will provide the public and private sectors with more secure infrastructure and with the tools and expertise to address the origins and propagation of attacks, and the means to track and prevent them.

Besides continuing investment in research and development with Horizon Europe, the Commission proposed with the Digital Europe Programme investments to reinforce capabilities and ensure that the Union has technological and industrial capacities to secure its economy, society and democracy.

Moreover, support is provided through the Connecting Europe Facility (CEF) Programme for further development of cybersecurity capabilities. Indeed CEF is facilitating the upscaling of the operational capabilities of Member States and assisting operational co-operation through the Cybersecurity DSI. In particular this work programme aims to reinforce investments among key stakeholders.

5.3.2 Cybersecurity of energy critical infrastructures

Policy scenario design

BAU scenario	CG scenario	RL scenario	ADP scenario
Directive (EU) 2016/1148 on security of network and information systems Cybersecurity act 2019 Recast Electricity Directive Recast Electricity Regulation	Cybersecurity network code for critical infrastructures Guidelines	New Regulation on Cybersecurity	Digital Europe Programme

On the issue related to the protection of critical infrastructures, the same regulation as for ICT products applies. However, some specific mentioning to critical infrastructures are reported below. Additionally, both the Directive and Regulation on the internal market for electricity foresee cybersecurity measures.

5.3.2.1 BAU Scenario

The Directive on security of network and information systems

- **Common definition of operators of essential services.** The operator of essential services means a public or private entity of a type referred to in Annex II, which meets the criteria laid down in Article and this includes energy critical infrastructures (electricity suppliers, TSOs and DSOs).
- **The security and notification requirements**. Security and notification requirements should apply to operators of essential services to promote a culture of risk management and ensure that the most serious incidents are reported. Since a shared culture of security is vital for sectors that rely heavily on ICTs, such as energy, transport, water, banking, according to the Directive, Member States' businesses in these sectors will have to comply with network and information system security under existing and future legal acts of the Union. Operators of essential services shall take appropriate and proportionate technical and organisational measures to manage the risks posed to the security of network and information systems, which they use in their operations.

Cybersecurity act

- **Common Cybersecurity schemes.** The efficiency of the European cybersecurity certification schemes, and whether specific schemes should be made mandatory, should be assessed in light of the cybersecurity-related legislation of the Union, in particular Directive (EU) 2016/1148, taking into consideration the security of the network and information systems used by operators of essential services.

Directive on the Internal Market for Electricity (recast Electricity Directive)

- **Data security and smart meters.** The Electricity Directive (EU) 2019/944, addresses specific issues related to smart meters and cybersecurity. According to Art. 20, where smart metering is positively assessed, Member States shall implement smart metering systems in accordance with European standards and the security of the smart metering systems and data communication is ensured in compliance with relevant Union security legislation having due regard of the

best available techniques for ensuring the highest level of cybersecurity protection while bearing in mind the costs and the principle of proportionality.

Regulation on the Internal Market for Electricity (recast Electricity Regulation)

- **The Cybersecurity code.** In Chapter VII of the proposed Regulation sets out pre-existing powers and rules for the Commission to adopt delegated acts in the form of network codes or guidelines. It provides for clarifications as to the legal nature and the adoption of network codes and guidelines and enlarges their possible content to areas such as cyber security rules. According to Art. 55, the Commission is empowered to adopt delegated acts concerning the establishment of network codes in various areas including cybersecurity.
- **The role of an EU DSO entity on cybersecurity (Art 50).** In order to raise efficiencies in the electricity distribution networks in the Union and ensure close cooperation with transmission system operators and ENTSO for electricity, a European entity of distribution system operators in the Union ("EU DSO entity") should be established. Amongst its tasks there are data management, cyber security and data protection (Art.51)

5.3.2.2 Consistent Governance Scenario

Cybersecurity threats exploit the increased complexity and connectivity of critical infrastructure systems common security standards are necessary. The BAU Scenario is featured by the presence of multiple certification initiatives across Europe and a lack of coordination between them results in increased fragmentation in the domain of ICT certification – and in the smart-metering industry, resulting in duplication of efforts. Measures to protect critical infrastructures should be further reinforced and become more effective through cybersecurity certification that could help increase the cyber resilience of critical infrastructures.

The following areas of action covered by this key issue are addressed in the CG scenario:

Policy Actions

A1. *New cybersecurity guidelines*

- *The security and notification requirements*

New guidelines shall set common procedures for essential operators notification requirements:

  - Deadlines
  - Responsible bodies (stronger role of ENISA)
  - Format
  - Definition of a common standard at the European level with respect to the information to be exchanged

- *The EU DSO entity for electricity*

New guidelines shall define the modalities of collaboration between the EU DSO with:

- National Competent authorities
- CSIRTs
- ENISA

A2. *The Cybersecurity network code for critical infrastructures*

- *Information systems used by operators of essential services*

The Cybersecurity network code for critical infrastructures shall be based on information systems used by operators of essential services.

- *Data security and smart meters*

The Cybersecurity network code for critical infrastructures shall provide indications on minimum requirements to guarantee data security of smart meters.

- *The Cybersecurity code*

The Cybersecurity network code for critical infrastructures shall be based on information systems used by operators of essential services.

5.3.2.3 Reinforced Legislation Scenario

In the Reinforced Legislation Scenario, the Cybersecurity network code for critical infrastructures should fall under a new Regulation, which foresees the establishment of a set of common certification standards divided per area. Furthermore, the new Regulation shall better address the role of the EU DSO, an entity whose establishment is foreseen in the Electricity Regulation without specific references on how it should act in the context of cybersecurity.

Policy Actions

A1. *New Cybersecurity regulation*

- *The EU DSO entity for electricity*

A new Cybersecurity Regulation shall clearly address roles and responsibilities of the European DSO in guaranteeing cybersecurity of critical infrastructures.

- *The Cybersecurity code*

A Cybersecurity network code for critical infrastructures shall be included in a new Regulation on Cyber Security.

5.3.2.4 Active Digitalisation Policy

It is crucial to invest in cybersecurity, as trust and awareness are the foundation for a functioning Digital Single Market. The EU has responded to these challenges by adopting a wide range of cybersecurity measures, including the first EU-wide cybersecurity legislation (NIS). Besides continuing investment in research and development with Horizon Europe, the Commission proposed with the Digital Europe Programme investments to reinforce capabilities and ensure that the Union has technological and industrial capacities to secure its economy, society and democracy.

Such an investment programme will be instrumental to be able to protect citizens, governments and businesses across the EU. For instance, cybersecurity capacities for both public administration and businesses will be enhanced via increasing access to testing and certification facilities.

In addition, the CEF Telecom Work Programme 2019 includes actions contributing to projects of common interest in the field of digital service infrastructures (DSIs). Among them, the Cybersecurity DSI provides the enabling infrastructure and support arrangements so that capabilities for operational co-operation exist in the Member States and that secure information exchange can take place. The actions will continue to support the enhancement of cybersecurity capabilities of the EU and will address key players such as national competent authorities, single points of contact, operators of essential services, digital service providers.

5.4 Interoperability and standardisation

The digitisation of the global economy and society affects all sectors and is necessary in order to maintain competitiveness. Having common ICT standards will become increasingly important, as in the future, many more devices will be connected to each other - ranging from smart EV charging and battery storage, to appliances and electric heating and cooling with smart thermostats that can be integrated with rooftop PV panels.

UC1, in particular, shows the need to establish open and universal standards for connectivity that enable devices and software technologies to communicate with one another easily. Moreover, in other UCs analysis the same challenge on interoperability of connected devices has been mentioned, therefore a set of measures is proposed to tackle it in the different scenarios.

Key issue

- **Interoperability between connected devices:** need to ensure interoperability between different connected devices (Key issue #3 of UC1).

5.4.1 Interoperability between connected devices

Policy scenario design

In order to tackle the issues arising from the UCs analysis, three main scenarios have been depicted encompassing specific measures, described in the following paragraphs.

BAU scenario	CG scenario	RL scenario	ADP scenario
Recast Electricity Directive European standard for smart appliances (SAREF)	Common Guidelines for MSs Dissemination Actions	New evidence-based legislation Implementing Acts	Digital Europe Programme

5.4.1.1 BAU Scenario

Large-scale deployment of grid-edge technologies will require interoperability and compatibility between technologies to ensure the combination of multiple services

and "plug and play" is possible, which can be ensured through open technology standards and interoperability.

Currently, issues related to interoperability requirements in the context of smart metering systems are addressed in the new Directive on the Internal Market for Electricity (recast Electricity Directive 2019/944). Therefore, the BAU scenario includes all policy actions deriving from its adoption and implementation at MS level.

The public sector should convene private sector participants to define these open standards, which will ensure standardization but still allow for flexibility and innovation in this space. A well-cited example is the open standards set in the telecom industry, resulting in devices that are easily and automatically able to operate between various networks globally. In addition, the discussion by some companies regarding creating closed loop or open system charging infrastructure also falls under this area.

The utility and technology industries have taken steps in this direction, with initiatives such as those addressing smart metering communication protocols (for example, Meters and More and PRIME).

Moreover, to stimulate the rollout of connected devices across Europe, the European Smart Metering Industry Group (ESMIG) has adopted a set of open standards (originating in the European Commission) to which members' products should comply. These standards will allow the competitive development of applications from various sources, creating business models for industry stakeholders, including consumers.

Complying with open standards is a basic condition, but it is not sufficient to achieve the interoperability level required. Interpretation Communication standards are often complex and textual description may lead to multiple interpretations of the same conditions by different manufactures and system integrators. This leads to a varied set of approaches to devices' development and implementation and, eventually, some companies (e.g. Google and Amazon) developed their own communication protocols. European manufacturers prefer to adapt to these market standards, which are becoming standards de facto.

Since a family of standards for energy-related data has been already created for smart appliances, called SAREF (Smart Appliances REFerence ontology), further policy actions will be proposed in CG and RL scenarios.

Directive on the Internal Market for Electricity (recast Electricity Directive)

- **Interoperability between energy management and smart metering systems**

The Directive (EU) 2019/944, provides the following definition of interoperability for smart metering systems: *'interoperability' means, in the context of smart metering, the ability of two or more energy or communication networks, systems, devices, applications or components to interwork to exchange and use information in order to perform required functions.*

The Electricity Directive indeed envisages smart metering systems interoperability as a fundamental requirement to promote the active participation of consumers in the

electricity markets. Smart meters deployed by MSs should indeed be interoperable, in particular with consumer energy management systems and with smart grids, in accordance with the applicable Union data protection rules (Art. 19 (1)).

To this extent, in Art. 19 (3), the proposed Directive encourages Member States to promote and adopt relevant available standards, including standards that enable smart meters interoperability, on the level of the data model and the application layer (recital (55)), and best practices. In this regard, MSs are also required to consider future and innovative energy services and the importance of the development of data exchange, smart grids and the internal market for electricity.

- **Interoperability requirements and procedures for access to data**

In order to ensure uniform conditions for its implementation, the Electricity Directive envisages that implementing powers should be conferred on the Commission to determine interoperability requirements and non-discriminatory and transparent procedures for access to metering data, consumption data, as well as data required for customer switching, demand response and other services. Those powers should be exercised in accordance with Regulation (EU) No 182/2011 of the European Parliament and of the Council.

Art. 24 of the Electricity Directive addresses this topic. In particular:

- Art. 24 (1) requires MSs to facilitate the full interoperability of energy services within the Union in order to promote competition in the retail market and to avoid excessive administrative costs for the eligible parties.
- Art. 24 (2) requests the European Commission *to adopt, by means of implementing acts, interoperability requirements and non-discriminatory and transparent procedures for access to data referred to in Art. 23(1)*, i.e. metering and consumption data as well as data required for customer switching, demand response and other services.
- Art. 24 (3), with reference to Art. 24 (2), requests Member States to ensure that electricity companies comply with such requirements that will be developed by the Commission taking into account existing national practices.

European standards for smart appliances (SAREF)

- **Common language for smart appliances**

The Internet of Things (IoT) enables a seamless integration of home appliances with related home comfort and building automation services, matching user needs with the management of distributed energy across the grid, exploiting the benefits of demand response. Therefore, for consumers to monetise their flexibility, and for businesses to turn this into novel consumer services that lead to a more comfortable and healthy living environment, connected devices must be able to communicate in a simple way.

On the regulation side, the European Commission, in close collaboration with industry and ETSI (European Telecommunications Standards Institute) financially supported a study to create a language (so-called 'reference ontology') for smart appliances, which became an EU standard in 2015. The standard, called SAREF (Smart Appliances REFerence ontology), creates a reference language for energy-related data, to be

used by home devices (from lamps and consumer electronics to white goods like dishwashers) allowing them to exchange information with any energy management system (which could physically be in the home or in the cloud). In 2017, a new version modular and domain independent, allowing the incorporation of different modules (extensions) for the different domains. The first three extensions that have been standardised are: SAREF for Energy (SAREF4ENER), SAREF for Environment (SAREF4ENVI), SAREF for Buildings (SAREF4BLDG).

The SAREF family of standards enable interoperability between solutions from different providers and among various activity sectors in the Internet of Things (IoT) and therefore contribute to the development of the digital single market. These standards are designed to run on top of the oneM2M system, the global IoT partnership project of which ETSI is a founding partner. OneM2M provides the communication and interworking framework to share the data among applications; SAREF provides the semantic interoperability necessary to share the information carried by the data.

In July 2019, ETSI SmartM2M Technical Committee released three new specifications for smart cities (SAREF4CITY), industry and manufacturing (SAREF4INMA), and smart agriculture and food chain (SAREF4AGRI) domains. Finally, ETSI TC SmartM2M is working on new extensions for automotive, water, health and wearables, and on the development of an open portal to gather direct contributions to SAREF to be completed by 2020.

5.4.1.2 Consistent Governance Scenario

Given the growing importance of synergies between ICT and Energy sector, the Horizon 2020 framework programme (H2020) already provides a match between the two sectors concerning interoperability. In the H2020 ICT Work Programme 2018-2020, the contribution of the Energy Challenge is set within the topic "*Interoperable and smart homes and grids*" (DT-ICT-10-2018-19), for which 30 M€ of budget is planned.

Standardisation should be kept as the prerequisite to specify technical methods, such as measurement and product safety, and maintain the adopted legislative framework principle by listing standards under the respective legislation.

For this reason, a Consistent Governance scenario would expect common guidelines for MSs when promoting and adopting standards to ensure smart meters and connected systems interoperability, and on how to facilitate the full interoperability of energy services within the EU. Moreover, the CG scenario would consider the promotion of the Smart Appliances REFerence ontology (SAREF) by massive dissemination actions.

All areas of action covered by this key issue are addressed in the CG scenario:

Policy Actions

A1. *Common guidelines for MSs*

- *Interoperability between energy management and smart metering systems*

The EC should provide common guidelines to MSs for the adoption of standards and best practices for smart metering systems interoperability. Particular attention should be posed in ensuring compliance with applicable EU data protection rules when dealing with smart metering systems interoperability with consumer energy management systems and with smart grids.

- *Interoperability requirements and procedures for access to data*

In order to have a common EU-wide strategy for ICT interoperability and access to data, the EC should provide common guidelines to MSs on how to facilitate the full interoperability of energy services in the EU.

In this regard, as a first step, a common EU data format for market players, including suppliers, could facilitate interoperability in the European energy market while reducing costs for investments and operations. Indeed, a standardisation of the data format could help stakeholders to reap the benefits of digitalised data access and exchange. However, further research is necessary in order to gain full understanding of the total cost and benefits and the effects, both positive and negative, that standardisation could have on innovation. Although a common EU data format might generate high costs in the transition period from national standards to an EU standard, it might entail long-term benefits.

A2. *Dissemination actions*

- *Common language for smart appliances*

In order to ensure a wider adoption of the existent standard reference language SAREF, its use should be promoted by massive dissemination actions at EU level.

5.4.1.3 Reinforced Legislation Scenario

The RL scenario, additionally to the CG scenario, would foresee more incisive and ambitious legislative actions in order to create a more comprehensive legislative framework that is more evidence-based and verifiable.

The following two out of the three areas of action covered by this key issue are addressed in the RL scenario:

Policy Actions

A1. *New evidence-based legislation*

- *Interoperability between energy management and smart metering systems*

The EC should propose new legislation that is evidence-based, verifiable and regulating measurable, supported by the introduction of relevant parameters, in order to avoid overlapping double regulation of products and parts. This will help developing interoperability and compatibility between technologies to ensure the combination of multiple services.

A2. *Implementing acts*

- *Interoperability requirements and procedures for access to data*

According to the Directive on the Internal Market for Electricity, the EC should adopt interoperability requirements and transparent procedures for access to data by means of implementing acts. In this regard, MSs should consequently ensure that energy companies comply with such requirements and take into account national practices. In this process, industry should be granted the necessary freedom to design innovative products, while keeping a good balance with progressive legislation.

5.4.1.4 Active Digitalisation Policy

Ensuring the wide use of digital technologies across the economy and society is one of the five key priorities of the Digital Europe Programme for 2021-2027. The new European investment programme foresees to promote large-scale deployment projects that will assist the transition of areas of broad public interest to the digital age. They will align investments of Member States and the EU to ensure wide availability and interoperability of the resulting solutions. Deployment, best use of digital capabilities and interoperability will be mainly implemented through direct management by the European Commission.

6 Roadmap

6.1 Choosing the preferred scenario

For each key issue, only few policy actions were selected among those proposed in the policy scenarios in order to indicate a preferential path for the digitalisation of the power sector by 2030. Such policy actions are expected to overcome in the fastest and most effective way the key issues identified in each policy area, while best exploiting the new opportunities offered by digitalisation.

Synergies between different sectors will be crucial in order to stimulate joint investments and coherence in regulatory frameworks, so that cross-fertilisation solutions are needed through interoperability, common standards, access to data, data processing and cybersecurity. In this context a cross-sectoral approach breaking down sectoral silos is suggested. Policy actions that most effectively capture the cross-cutting nature of digitalisation were thus selected as preferred actions.

Such type of actions are those represented in the CG scenario, which is composed of sectoral or horizontal measures aiming at safeguarding consistency between areas of sectorial regulation, in particular for energy and digital economy. Moreover, the CG scenario foresees the application of common horizontal measures. The value added of the policies concerned by the CG scenario also relies on the technical and punctual measures it entails. Actually, guidelines and implementing acts involved by the CG scenario may promote an effective and more straightforward and harmonised implementation of actions to encourage digitalisation by Member States.

In addition to these actions, the foreseen investments for the next EU long-term budget 2021-2027 that are included in the ADP scenario have been considered in the roadmap, because of the vital support such investments will provide to current and future digitalisation-enabling policies, contributing to significantly boost the digital transformation of the power sector.

The selected policy actions configure an ADP scenario (CG+Investments) which have been hence assigned to different time horizons in order to outline the roadmap to 2030 for the digital transformation of the power sector.

Compared to the picture sketched in the inception phase of the study, the need for including a 2025 deadline arose from the analysis, as reported in the Roadmap. In such a scenario, the Commission will create suitable conditions for the digitalisation of the power sector exploiting the most from the strategy-setting and market design effort made so far, complying with the need of empowering customers, enhancing competition and create new opportunities for the EU industry.

The roadmap starts with the full implementation of the policies currently in force or that will be adopted in 2020 at the latest. The roadmap consequently considers an

intermediate milestone, 2025, by which the most urgent policy actions shall be implemented and by which it is expected that MSs will be compliant with the current legislative framework. Finally, in the time horizon 2025-2030 the roadmap identifies the measures that are considered to be more effective to fully address the key issues emerged in UCs by 2030.

To deliver the digitalisation opportunities to the energy market, it is essential to address, in a timely manner, the emerging issues with respect to market design and operations that may affect the provision of flexibility services at the distribution level.

To this purpose, it appears desirable that Member States adopt all the necessary actions to comply with the current legislation: the Regulation (EU) 2017/2195, the Electricity Directive (EU) 2019/944 and the Electricity Regulation (EU) 2019/943. In addition, to enhance and support compliance by MSs, it is recommended that the latter implement the actions presented in the CG scenario, which mostly refer to the adoption of binding EU guidelines.

The choice of the CG scenario as the preferred one, is justified by the opportunity this scenario offers to address the harmonisation of MSs' regulatory framework by means of timely and binding rules.

Regulations introducing network codes represent indeed an effective tool since they provide detailed technical and operational rules addressing in-depth the design of electricity markets, the role of responsibilities of the actors involved in these markets and the rules to implement to ensure compliance with the principles established by Directives or other Regulations.

Concerning digital-related policy areas, one of the key priorities is to build trust and acceptance of digital technologies among energy consumers. To this extent, the issues related to consumer concerns about their data protection, privacy and security need to be addressed in a timely manner.

A robust regulatory framework is already in place both in the field of data protection and cybersecurity. The former sees the General Data Protection Regulation (GDPR) and the Free Flow of non-personal Data Regulation in force and the e-Privacy Regulation expected to be adopted in the next months, while the latter can rely on the NIS Directive and the Cybersecurity Package implementation.

Therefore, actions mostly referring to the adoption of binding EU guidelines are needed, which are presented in the CG scenario.

6.2 Preferred scenario implementation timeline

Key	2020	2020 - 2025	2025 - 2030
Cooperation between TSOs and DSOs	Full implementation of the Regulation on the IEM to enhance the cooperation between TSOs and DSOs in the implementation of network codes and guidelines, network planning and operation and the procurement of flexibility services at the distribution level. Compliance by Member States with the Regulation (EU) 2017/2195 with respect to the obligation of TSOs and DSOs in the implementation of the guideline on electricity balancing.	Full implementation of the Balancing Guideline with respect, in particular, to the obligation to consults on the implementation of the Guideline itself; the definition of a joint methodology for the allocation of costs related to the provision of active power reserves. Full implementation of the Regulation on the internal market for electricity with respect to: the monitoring of implementation of the network codes and guidelines; the network planning and operation. Adoption of NRAs' decisions for the enforcement and operational implementation of the KORRR. Consultation processes and creation of expert panels at the EU level to develop guidelines for the promotion of the provision of flexibility services at the distribution level by means of coordination between TSOs and DSOs and flexibility platforms. Exploitation of the Horizon Europe framework to promote R&I in the field of AI and Data Analytics to achieve greater coordination and synergies between TSOs and DSOs in the planning and operation of networks and develop pilot projects for the provision of flexibility services at the distribution level. Implementation of the CEF programme to promote synergies between digital and energy infrastructure to support e.g. the development of digital platforms aimed at facilitating the interactions between the different actors of the energy system including TSOs and DSOs.	Adoption of an Implementing act on flexibility services from distribution-connected demand and power generating facilities Adoption of a new Directive on the internal market for electricity to address emerging issues in market design arising from the development of P2P trading and VPP and the procurement of flexibility services at the distribution level
Specifications of the products for flexibility services	Full implementation of the Regulation on IEM to promote the obligation for TSOs and DSOs to adopt market-based mechanisms for re-dispatching.	Adoption of a further secondary legislation amending the Balancing Guideline and aimed at regulating issues as: characteristics of products for flexibility services; guideline concerning actions for the mitigation of the	

	Full implementation of the Directive on the IEM to establish the obligation for TSOs and DSOs to define the technical requirements for the provision of flexibility services by resources connected at the distribution level (also through aggregators).	impact of congestions and redispatching measures; prequalification technical and non-technical criteria for the provision of flexibility services.	
More active role of DSOs in the provision of flexibility services	Full implementation of the Regulation on the IEM to promote the implementation of incentive- and output-based regulatory frameworks for electricity distribution networks.	Full implementation of the new Regulation on the IEM with respect, in particular, the adoption of incentive-based and consistent regulatory frameworks acknowledging the new role of distribution networks. Exploitation of both the Horizon Europe and CEF programmes to complement national regulatory approaches in promoting network investments and encouraging a smarter and more active role of DSOs.	Adoption of Regulation (EU) establishing guidelines on the remuneration of distribution networks
The role of aggregators in procuring flexibility services	Full implementation of the Directive on the IEM to promote the adoption of a regulatory framework at the Member States' level aimed at encouraging the development of independent aggregators, and their non-discriminatory participation to electricity markets. Full implementation of the Regulation on the IEM to establish obligations aimed at deterring electricity suppliers from hampering the right of customers to stipulate contracts with independent aggregators.	Full implementation of the new Regulation on the IEM with respect, in particular, the promotion of independent aggregators' participation to electricity markets. Utilization of the CEF programme to promote e.g. the development of market platforms aimed at fostering an active role of aggregators and their interactions with other stakeholders of the energy system.	Adoption of Regulation (EU) establishing guidelines on independent aggregators
The access to consumption and production data	Full implementation of the Directive on the IEM to establish the right of customers and third eligible parties to receive all relevant consumption and production data, in an understandable format able; the development of interoperability requirements at the EU level.	Full implementation of the new Directive on the IEM with respect, in particular, the access and exchange of customers' consumption and production data. Development of EU recommendations/guidelines on interoperability standards at the EU level.	Adoption of binding (EU) interoperability requirements
Customer privacy and data protection	Full implementation of the Directive on the IEM including the provisions related to data protection of smart meters' data in the smart metering system deployment.	Full implementation of the new Directive on the IEM with respect to smart meters data management model.	Development of EU recommendations/guidelines for setting principles that need to be complied by all data management models for smart meters in place or currently under design.

Cybersecurity of ICT products	Designation one or more national competent authorities on the security of network and information systems.	Definition of a roadmap to deliver common certifications for each relevant EU sector. Adoption by the Commission of a series of provisions in order to efficiently tackle common challenges and bring forward best practices of MSs.	Adoption by the Commission of a New EU Regulation on Cybersecurity: ▪ defining the creation of EU cybersecurity certifications for different areas with mandatory standards and sanctions in the case of incompliance with set requirements ▪ including a cybersecurity network code for critical infrastructures, in order to address roles and responsibilities of the European DSO in guaranteeing cybersecurity of critical infrastructure.
Cybersecurity of energy critical infrastructures	Full implementation of the Regulation on the IEM to establish a European entity of distribution system operators in the Union ("EU DSO entity") in order to raise efficiencies in the electricity distribution networks in the Union and ensure close cooperation with transmission system operators and ENTSO for electricity.	Adoption by the Commission of new cybersecurity guidelines to define the modalities of collaboration between the EU DSO and National Competent authorities, CSIRTs, and ENISA. Adoption by the Commission of a cybersecurity network code for critical infrastructures. Implementation of the CEF programme to improve MSs compliance with the NIS Directive and higher levels of crisis response.	
Interoperability between connected devices	Full implementation of the Directive on the IEM to define smart metering systems interoperability as a fundamental requirement to promote the active participation of consumers in the electricity markets.	Adoption by the Commission of common guidelines to MSs for the adoption of standards and best practices for smart metering systems interoperability. Adoption by the Commission of Implementing Acts to determine interoperability requirements and non-discriminatory and transparent procedures for access to data.	Adoption of binding (EU) interoperability requirements supported by the introduction of relevant parameters (KPIs) for products and parts.

7 Recommendations

7.1 Flexibility services at the distribution level

The climate and energy goals to 2030 set by the European Commission represent an exemplary viewpoint with respect to the role that digitalisation can play in the achievement of a decarbonised energy sector.

The growing share of distributed generation together with the increasing engagement of customers may unlock unprecedented opportunities for the energy system. One of the most significant source of opportunities may arise from the provision of flexibility services by resources connected the distribution level. The possibility to modify consumption and generation patterns at the distribution level, in response to a market signal, may facilitate the integration of renewable generation sources while mitigating the costs for congestion management, grid and capacity development.

In order to make such opportunities reality, it is essential to address in a timely manner emerging issues with respect to market design and operations which may affect the provision of flexibility and emerging services at the distribution level.

In the following, punctual recommendations for each of the key issues concerning the provision of such services at the distribution level will be provided.

7.1.1 Cooperation between TSOs and DSOs

To promote the efficient provision of flexibility services from distribution-connected demand and power generating facilities the cooperation between DSOs and TSOs is essential with respect to a wide range of aspects, as emerged from UCs and the review of the legislative framework in place.

To this purpose, the following actions are recommended:

- ***Member States' NRAs shall adopt the decisions discussed in the CG scenario to enforce in a timely manner the Electricity Regulation with respect to the monitoring of implementation of the network codes and guidelines and the planning and operation of networks.*** The definition of common rules in the development, operation and functioning of networks is a prerequisite for the development of an effective model for the procurement of flexibility services at the distribution level. The provision of flexibility services from distribution-connected resources cannot disregard, indeed, a coordinated access of TSOs and DSOs to demand and distributed power generating facilities.

Such actions shall be undertaken in 2020.

- ***Member States' NRAs shall adopt the decisions discussed in the CG scenario to enforce the operational requirements of KORRR and make the data exchange effective in a timely manner.*** Making data exchange effective and clarifying the role and responsibilities of TSOs and DSOs to this aim can

promote flexibility services at the distribution level without prejudice to system security and stability.

Such actions shall be undertaken in 2020.

- ***The EC shall consult with relevant stakeholders and to organise expert panels to acquire knowledge on possible models of coordination between TSOs and DSOs implemented or under scrutiny across Member States.*** Such actions shall develop guidelines for:

  - the development of a coordinated approach between TSOs and DSOs in the procurement of flexibility services at the distribution level, according to different possible models by ensuring harmonisation across Member States without prejudice to national specificities;
  - the definition of guidelines for the development of pilot projects at the Member State level concerning the procurement and provision of flexibility services at the distribution level;
  - the acquisition of knowledge and the development of guidelines with respect to the development of flexibility platforms.

Such actions shall be completed by the end of 2021.

- ***The EC shall use the results of the consultation process and of the expert groups to adopt an implementing act concerning the design and operation of possible models of interaction between DSOs and TSOs with respect to the procurement of flexibility services at the distribution level.*** The implementing act will ensure a timely and harmonised enforcement by Member States of the provision of the Electricity Regulation and Directive concerning the role of TSOs and DSOs in the provision of flexibility services at the distribution level.

Such action shall be completed by the end of 2022.

- ***Implementation of the Horizon Europe framework and CEF programmes.*** The implementation of the Horizon Europe framework to promote R&I in the field of AI and Data Analytics to foster the coordination and synergies between TSOs and DSOs may provide, in addition to regulatory measures, also an important contribution to the development of flexibility services at the DSOs level. Such funds may help the development of projects aimed at increasing network observability and security as well as the development of platforms for the trading of flexibility services at the distribution level. In addition, the utilization of CEF funds to develop e.g. digital platforms aimed at facilitating interactions between DSOs and TSOs can represent an effective add-on to this aim.

7.1.2 Characteristics of the products for flexibility services

The characterization of the products for flexibility services at the distribution level is an essential aspect for the provision of flexibility services. Such products, indeed, defines the characteristics of the services to be provided, rights and obligation of the providers of such services, the needed technical requirements and the roles and responsibilities of the TSOs and DSOs involved in the procurement of the services.

To ensure a proper characterisation of the products for flexibility services the following actions are recommended.

- ***Member States enforce by means of NRAs the provisions of the Electricity Directive with respect to aspects emerged in the BAU scenario.*** NRAs shall define the prequalification criteria necessary to provide flexibility services and develop a market design for the provision of flexibility at the distribution level which fulfils the non-discriminatory treatment of all market participants as suggested by the Electricity Directive.

Such actions shall follow consultations with DSOs and TSOs and shall be implemented before 2025.

- ***Further secondary legislation amending Regulation (EU) 2017/2195 (Balancing Guideline).*** To ensure a harmonised and timely development of the products for flexibility services, amendments at the current Balancing Guideline appear desirable. The Guideline should encompass the definition of the principles set in the CG scenario with respect to the characterisation of the products for flexibility services.

Such intervention shall be adopted no later than 2023.

7.1.3 More active role of DSOs in the provision of flexibility services

Network investments at the distribution level are an essential condition for a smarter role of distributors and customers and, consequently, for unlocking the opportunities of digitalisation.

To ensure that the most valuable investments and operations are undertaken to promote flexibility at the distribution level the following actions are recommended.

- ***Adoption of NRAs' decisions shaping the regulatory methodology for the remuneration of DSOs in the operation and development of their network according to the provisions of the Electricity Regulation.*** Such decisions shall encompass the adoption of an output-based regulation based on incentives and penalties to promote the development and management of smart grid able to promote the provision of flexibility services at the distribution level.

  In addition, NRAs' decisions should also adopt a long-term approach by imposing, in compliance with the Regulation, the development by DSOs of network plans encompassing a five to ten year time-horizon.

  Such plans shall become the base according to which NRAs assess the compatibility of network investments and operations with respect to the outputs set by national Regulators, over a given regulatory period, also with reference to the promotion of flexibility. It is thus recommended that network plans are developed and subject to the NRAs' assessment before the starting of each regulatory period to allow for a forward-looking approach to the operation and development of the network.

NRAs' decisions shall be adopted before 2025.

- ***Implementation of the CEF and Horizon Europe programme.*** The exploitation of the CEF and Horizon Europe programme can represent an additional lever to support investments in smarter and digitalised distribution networks to allow for the provision of flexibility services at the distribution level. It is thus recommended to consider a proper funding of such programmes in order

to allow an adequate support to innovative projects in the digitalisation of the distribution network.

All these actions shall be implemented in a timely manner and before 2025.

- ***Adoption of Guidelines on the regulatory approach for distribution (and transmission network).*** Despite being binding, the Electricity Regulation only sets general principles with respect to the regulatory framework that DSOs shall put in place for DSOs. Therefore, heterogeneity across Member States can be expected with respect to the timely and uniform implementation of the recommendations set in the Regulation. In order to make sure that DSOs across MSs are engaged to the same extent and at the same pace in the promotion of flexibility, and smarter grids more in general, the Commission could adopt a Regulation establishing guidelines for detailed technical and operational rules to promote a forward looking and output-based regulation for distribution networks across Member States. A greater harmonisation of the regulatory approach for distribution networks will ensure that any Member State lagging behind in the development of smart grids is able to promote a more active role of demand with opportunities for demand itself and the energy system as a whole.

This action shall be undertaken before 2030.

7.1.4 The role of aggregators in providing flexibility services

Given the distributed nature of demand and the increasing role of digitalisation to empower customers, independent aggregators may play an important role to unlock the great potential of demand in contributing to the delivery of the energy transition. Aggregation of demand may, indeed, overcome several market failures which are currently preventing demand to deliver greater value to the energy system. Transaction costs, information asymmetry and lack of appropriate knowledge may deter demand from entering PPAs or providing flexibility services.

- ***Adoption of NRAs' decision to encourage the participation of independent aggregators to electricity markets according to a level playing field.*** The Regulation and the Directive on the IEM establish the adoption by MSs of a regulatory framework aimed at encouraging a non-discriminatory participation of aggregators in electricity markets. It is thus recommended that Member States comply with the provisions set in the Regulation and the Directive on the IEM by adopting NRAs' decisions promoting a non-discriminatory participation of independent aggregators in electricity markets at the level playing field with other market operators.

  In addition, it appears desirable that NRAs encompass the obligations of TSOs and DSOs in promoting the participation of independent aggregators in electricity markets as well as of electricity suppliers. The latter, in particular, shall avoid practices preventing customers to stipulate contracts with independent aggregators.

All these actions shall be implemented before 2025.

- ***Implementation of the CEF programme.*** The CEF programme can provide an important contribution to the role of aggregators by promoting e.g. the development of platforms connecting the different stakeholders of the energy

system involved by the provision of flexibility services and encouraging synergies between digital and energy infrastructures.

The employment of the CEF programme shall be performed in 2021.

- ***Adoption of Guidelines on independent aggregators.*** To ensure the integration and harmonisation of electricity markets, Member States shall establish consistent and harmonised regulatory frameworks to allow the participation of independent aggregators in progressively more integrated regional electricity markets. For this reason, and given the emergent nature of independent aggregators, the adoption of binding EU guidelines on independent aggregators (as suggested in the CG scenario) is recommended. Guidelines may support Member States in the implementation of consistent and exhaustive technical and operational rules for the participation of independent aggregators in electricity markets and in particular in the provision of flexibility services.

Guidelines should be implemented before 2025.

7.1.5 The access to consumption and production data

The Directive on the IEM establishes the right for customers and third eligible parties to access consumption and production data in order to promote an active role of demand in fostering the transition through renewable generation and the provision of flexibility services. In addition, the Directive affirms the necessity to promote interoperability for data access. In particular, the EU encourages interoperability to foster the realization of an integrated internal market increasingly based on digitalisation.

- ***Adoption of NRAs' decision to promote customers' right to access data.*** NRAs shall adopt decisions aimed at promoting customers' empowerment by ensuring their right to access their consumption and production data upon request and in an understandable format. Such regulatory provisions shall be adopted as soon as feasible to allow for a responsible participation of customers in electricity markets according to the principles established in the Electricity Directive. The possibility for customers to access to their metering data is, indeed, an essential condition to allow them to benefit from competition in the retail electricity markets as well as to engage them in more sophisticated activities such as the provision of flexibility services with opportunities for customers themselves and the energy system as a whole.

NRAs' decision shall be adopted by the end of 2021.

- ***Adoption of binding interoperability standards.*** The Commission shall consult with ACER, ENTSO-E, NRAs and the EU DSO-entity in order to establish binding guidelines for the adoption of interoperability requirements. As data will increasingly shape the development of electricity markets - in terms of both customer empowerment and the development of new tariffs, new figures such as aggregators will also impact, consequently, the integration of electricity markets. Therefore, it is important that binding and harmonised interoperability requirements are developed across Member States.

These actions shall be implemented by the end of 2023.

7.2 Privacy and Data Protection

7.2.1 Customer privacy and data protection

The Electricity Directive promotes the adoption of a regulatory framework for data protection of smart meters, embedding relevant GDPR provisions and tailoring those to the needs and specificities of smart meters' implementation and functioning.

To this purpose, the following actions are recommended:

- ***MSs shall comply with the provisions set in the Electricity Directive by adopting a data management model for smart meters in order to ensure efficient and secure data access and exchange.*** Independently of the adopted data management model, each MS shall authorise, certify or, where applicable, supervise the parties responsible for data management.

- ***MSs shall carry out the collection and processing of personal data coming from smart meters in accordance with the GDPR.*** In line with customer-centric policies aiming at increasing energy consumer engagement and empowerment, MSs shall ensure that, prior to or at the time of installation of smart meters, final customers are duly informed about their energy consumption.

Given the high priority of addressing privacy concerns expressed by consumers over their personal energy-related data treatment, all these actions shall be adopted in a timely manner - and no later than 2022 - in order to build trust in more digitally engaged consumers.

Finally, to facilitate the large-scale deployment of smart metering systems across all MSs, the Commission shall develop EU guidelines on principles that need to be complied with by all data management models for smart meters in place or currently under design.

7.3 Cybersecurity

7.3.1 Cybersecurity of ICT products

The NIS Directive proposes a set of measures to boost the level of cybersecurity of network and information systems in Europe in order to increase resilience and enhance cybersecurity preparedness in Europe.

To this purpose, the following actions are recommended:

- ***MSs shall improve their national cybersecurity capabilities*** by designating one or more national competent authorities on the security of network and information systems, who shall monitor the application of the Directive at national level and shall coordinate with ENISA.

- ***MSs shall establish Computer Security Incident Response Teams (CSIRTs) to deal with incidents and risks and ensure efficient cooperation at EU level between the MSs.*** ENISA shall intervene when MSs have not developed national CSIRTs.

MSs should have complied with such provisions by May 2019.

Over the recent years, the Commission carried out consistent work on cybersecurity certification schemes in order to tackle security concerns expressed by consumers about the cybersecurity risks associated with the ICT products and servers storing their personal data.

The Cybersecurity Act is the greatest expression of this work, as it sets up an EU cybersecurity certification framework for ICT products, services and processes. The proposed framework creates a comprehensive set of rules, technical requirements, standards and procedures to agree each scheme.

To this respect:

- ***The EC shall define a roadmap to deliver in a timely manner a common certification scheme for each relevant EU area and proceed with consultations with national competent authorities to harmonise with existing standards at the national level.*** By doing so, it would be possible to align efforts towards the identification of common certifications for the main European Industries. In tandem with developments on the proposed Cybersecurity Act, there will be supports for repositories, tools for awareness raising and assistance for security certification of digital products and services.

As the proposed EU cybersecurity certification schemes are not mandatory, but will be on a voluntary basis:

- ***The EC shall adopt a new EU Regulation on Cybersecurity defining the creation of EU cybersecurity certifications for different areas with mandatory standards and sanctions in the case of incompliance with set requirements.*** For example, the creation of ad hoc minim requirements for relevant operators and a clear definition of the role of the National competent authorities and CSIRTs. ENISA shall be enabled to make random checks of compliance and to request National authorities to provide information at any time.

The Cybersecurity Act also reinforces the role and responsibilities of ENISA. In order to better define areas of intervention of ENISA and its coordination with national authorities, the Commission shall envisage a series of provisions in an Implementing Act to efficiently tackle common challenges and bring forward best practices of MSs.

The combined effect of these actions will result in increased cyber-resilience and consumer trust in digital products and services. The investments proposed in the framework of the Digital Europe Programme for 2021-2017 will reinforce capabilities and ensure that the Union has technological and industrial capacities to secure its economy, society and democracy.

7.3.2 Cybersecurity of energy critical infrastructures

The NIS Directive aims to build and spread a culture of security across sectors that are vital for EU economy and society, where a cyberattack could disrupt an essential service, and rely heavily on ICTs, such as energy and digital infrastructure.

To this purpose, the following actions are recommended:

- ***Each MS shall identify Operators of Essential Services (OES) among key economic actors and businesses in these sectors, which will have to take appropriate security measures and to notify serious incidents to the***

relevant national authority. Under the Directive, also key Digital Service Providers (DSP), such as search engines, cloud computing services and online marketplaces, will have to comply with the security and notification requirements.

- ***The EC shall adopt new cybersecurity guidelines to set procedures for essential operators notification requirements, including deadlines, responsible bodies (stronger role of ENISA), format, definition of a common standard at the European level with respect to the information to be exchanged.*** Moreover, the new cybersecurity guidelines should define the modalities of collaboration between the EU DSO with National Competent authorities, CSIRTs and ENISA.

The Commission shall adopt these guidelines no later than 2022.

The Electricity Directive establishes that MSs shall implement smart metering systems in accordance with European standards on security in order to ensure the highest level of cybersecurity protection while bearing in mind the costs and the principle of proportionality. To this regard:

- ***MSs shall follow the "security by design" principle when proceeding with the deployment of smart meters.***

Following the Electricity Regulation:

- ***The EC shall adopt delegated acts in the form of network codes on cybersecurity to provide indications on minimum requirements to guarantee data security of smart meters.***

The Commission shall adopt these network codes no later than 2023.

7.4 Interoperability and standardisation

7.4.1 Interoperability between connected devices

The Electricity Directive envisages smart metering systems interoperability as a fundamental requirement to promote the active participation of consumers in the electricity markets.

In the deployment of smart metering systems:

- ***MSs shall promote and adopt relevant available standards, including standards that enable smart meters interoperability on the level of the data model and the application layer and best practices.*** To this extent, MSs shall consider future and innovative energy services and the importance of the development of data exchange, smart grids and the internal market for electricity.

- ***MSs shall facilitate the full interoperability of energy services within the Union in order to promote competition in the retail market and to avoid excessive administrative costs for the eligible parties.***

In line with the provisions of the Electricity Directive:

- ***the EC shall adopt Implementing Acts to determine interoperability requirements and non-discriminatory and transparent procedures for***

access to metering data, consumption data, as well as data required for customer switching, DR and other services.

- ***MSs shall ensure that electricity companies comply with requirements which are yet to be developed by the Commission taking into account existing national practices.***

Such actions shall be taken no later than 2023.

In order to enable interoperability in the smart appliances' domain relevant for energy:

- ***the EC shall promote the adoption of the SAREF family of standards (reference ontology) by widespread dissemination actions to support their wider diffusion across all Europe.***

This action shall be taken as soon as possible.

Annex I – Detailed analysis of the policy context

This Annex describes in detail the current EU policy context relevant for this study, with a particular focus to those policy measures and investments creating a bridge between energy and digital.

The following paragraphs summarize in a comprehensive way all the relevant legislative and non-legislative initiatives presented by the European Commission under the Energy Union and the Digital Single Market strategies, starting from 2015. Among them, the most notable are the Clean Energy Package, the Free Flow of non-personal Data Regulation, the Network and Information Systems Directive (NISD) and the Cybersecurity Package. In addition, the General Data Protection Regulation (GDPR) and the New Deal for Consumers have been analysed for their high impact on the digitalisation of the power sector.

Energy Union

The Energy Union strategy aims to give EU consumers secure, sustainable, competitive and affordable energy by enhancing Europe's energy and climate policies. It also commits the EU to be the world leader on renewable energy, energy efficiency and on fighting climate change. The Energy Union's measures, by helping to deliver the Paris Agreement goals, can boost the European economy and industry by attracting investments and creating new job opportunities.

The Energy Union strategy relies on five mutually-reinforcing and interrelated pillars:

- *Security, solidarity and trust*: diversifying Europe's sources of energy and ensuring energy security through solidarity and cooperation between EU countries
- *A fully integrated internal energy market*: enabling the free flow of energy through the EU through adequate infrastructure and without technical or regulatory barriers
- *Energy efficiency*: improved energy efficiency will reduce dependence on energy imports, lower emissions, and drive jobs and growth
- *Climate action, decarbonising the economy*: the EU is committed to a quick ratification of the Paris Agreement and to retaining its leadership in the area of renewable energy
- *Research, innovation and competitiveness*: supporting breakthroughs in low-carbon and clean energy technologies by prioritising research and innovation to drive the energy transition and improve competitiveness.

The fourth State of the Energy Union report was published in April 2019 and shows that Europe's energy supply is now safer, more viable and more accessible to everyone than it was only a few years ago.

2030 climate and energy framework

In 2014, the European Commission defined a set of EU-wide targets for the period 2021-2030 in accordance with Paris Agreement commitments (COM 2014/15). The main targets focus on gas emissions levels, renewable energy share and energy efficiency improvement.

A joined-up approach for the period up to 2030 helps ensure regulatory certainty for investors and coordinate EU countries' efforts. The framework helps drive progress towards a low-carbon economy and build an energy system that ensures affordable energy for all consumers creating new opportunities for growth and jobs, providing greater security of energy supplies and reducing import dependence for the European Union. The Commission proposal brings environmental and health benefits reducing air pollution and improve energy efficiency.

	Greenhouse gas emissions	Renewable energy	Energy efficiency	Inter-connection	Climate in EU-funded programmes
2020	-20%	20%	20%	10%	2014-2020 20%
2030	≤ -40%	≤ 32%	≤ 32,5%	15%	2021-2027 25%

Clean Energy Package

In order to promote an effective and valuable combination of the five dimensions of the Energy Union, legislative and regulatory frameworks at the EU and MSs' level shall provide adequate incentives to promote an efficient Governance of the energy sector and efficient behaviours by market and network operators, and customers.

To this purpose, the EU has recently developed a new energy policy framework – the Clean Energy for All Europeans package - promoting the goals of the Energy Union strategy by revising the current regulatory and legislative framework in the light of game changers as digitalisation and decentralization in shaping energy transition. The package includes eight different legislative acts, and emphasises three key objectives:

- puting energy efficiency first
- achieving global leadership in renewable energies
- providing a fair deal for consumers

The package was first presented by the Commission in November 2016 and it has been progressively adopted until 22 May 2019. The new EU laws related to clean energy constitute a significant step towards the realisation of the Energy Union and will also help deliver on the EU's Paris Agreement commitments.

Consistently, the new package of measures:

- empowers European consumers to become fully active players in the energy transition by "providing them with information, choice and through creating flexibility to manage demand as well as supply";

- establishes "a modern design for the EU electricity market, adapted to the new realities of the market: more flexible, more market-oriented, better placed to integrate a greater share of RES";
- fixes two new targets for the EU for 2030: a binding renewable energy target of at least 32% and an energy efficiency target of at least 32.5%, with a possible upward revision in 2023.

The adoption process for each of the eight measures is shown in the table below:

	European Commission Proposal	**EU Inter-institutional** Negotiations	**European parliament** Adoption	**Council** Adoption	**Official Journal** Publication
Energy Performance in Buildings	30/11/2016	Political Agreement	17/04/2018	14/05/2018	19/06/2018 – Directive (EU) 2018/844
Renewable Energy	30/11/2016	Political Agreement	13/11/2018	04/12/2018	21/12/2018 – Directive (EU) 2018/2001
Energy Efficiency	30/11/2016	Political Agreement	13/11/2018	04/12/2018	21/12/2018 – Directive (EU) 2018/2002
Governance of the Energy Union	30/11/2016	Political Agreement	13/11/2018	04/12/2018	21/12/2018 – Regulation (EU) 2018/1999
Electricity Regulation	30/11/2016	Political Agreement	26/03/2019	22/05/2019	14/06/2019 – Regulation (EU) 2019/943
Electricity Directive	30/11/2016	Political Agreement	26/03/2019	22/05/2019	14/06/2019 – Directive (EU) 2019/944
Risk Preparedness	30/11/2016	Political Agreement	26/03/2019	22/05/2019	14/06/2019 – Regulation (EU) 2019/941
ACER	30/11/2016	Political Agreement	26/03/2019	22/05/2019	14/06/2019 - Regulation (EU) 2019/942

In order to deliver energy transition, the Energy Union strategy, and the promoting legislative framework "Clean Energy for All Europeans", is closely linked to policies for the Capitals Market Union, the Digital Single Market, the New Skills Agenda for Europe, the Investment Plan for Europe, and the Security Union.

In the following, a brief description of the policies of the Clean Energy for All Package is reported with a focus limited to those acts that affects the bridge between digitalisation and the power sector.

Energy performance in buildings

Building sector plays a fundamental role in energy consumption reduction, since it is responsible for approximately 40% of energy consumption and 36% of CO2 emissions in the EU, making them the single largest energy consumer in Europe. The energy performance in buildings directive (Directive 2018/844), amending 2010 Directive (Directive 2010/31), outlines specific measures for the building sector.

The **Energy performance of buildings directive (EPBD)** is, together with the Energy efficiency directive, the main legislative instrument to promote the energy performance of buildings and to boost renovation within the EU.

The EPBD (2010/31/EU) has been in force since 2010 and helps consumers to make informed choices allowing them to save both energy and money. It has also resulted in a positive change of trends in the energy performance of buildings; following the EPBD introduction of energy efficiency requirements in national building codes, buildings of today consume only half as much as typical buildings from the 1980s.

The revised EPBD (2018/844/EU), which amends parts of the 2010 EPBD and introduces new elements, is an important part of the implementation of the Juncker Commission priorities to build "a resilient Energy Union and a forward-looking climate change policy". The Commission launched a public consultation in June 2015 to help underpin the revised directive, including for example targets to accelerate cost-effective renovation of existing buildings, with the vision of a decarbonised building stock by 2050, and the mobilisation of investments. It was adopted on 9 July 2018 and constituted an important and concrete first delivery of the 'Clean energy for all Europeans' package and sent a strong political signal on the EU's commitment to the clean energy transition, as the building sector has a vast potential to contribute to a carbon-neutral and competitive economy.

The revised EPBD covers a broad range of policies and supportive measures that will help national governments in the EU boost energy performance of buildings and improve the existing building stock in both a short and long-term perspective. For example, taking both Directives together:

EU countries will have to establish stronger long-term renovation strategies, aiming at decarbonising the national building stocks by 2050, with indicative milestones for 2030, 2040 and 2050, measurable progress indicators and with a solid financial component. The strategy should clearly contribute to achieving the energy efficiency targets, as outlined in the National Energy & Climate Plan (NECP);

a common European scheme for rating the smart readiness of buildings, optional for EU countries, will be introduced; smart technologies will be further promoted, for instance through requirements on the installation of building automation and control systems and on devices that regulate temperature at room level; e-mobility will be supported by introducing minimum requirements for car parks over a certain size and other minimum infrastructure for smaller buildings; EU countries will have to express their national energy performance requirements in ways that allow cross-national comparisons.

These will have to be reviewed every five years and, if necessary, updated; health and well-being of building users will be promoted, for instance through an increased consideration of air quality and ventilation; all new buildings must be nearly zero-energy buildings (NZEB) from 31 December 2020. (Since 31 December 2018, all new public buildings already need to be NZEB); energy performance certificates must be issued when a building is sold or rented, and inspection schemes for heating and air conditioning systems must be established; EU countries must set cost-optimal minimum energy performance requirements for new buildings, for the major renovation of existing buildings, and for the replacement or retrofit of building elements (heating and cooling systems, roofs, walls and so on); EU countries must

draw up lists of national financial measures to improve the energy efficiency of buildings.

EU countries have until 10 March 2020 to write the new and revised provisions into national law.

Renewable Energy

With a view to showing global leadership on renewables, the EU has set an ambitious, binding target of 32% for renewable energy sources in the EU's energy mix by 2030. A fixed EU-wide target would leave to greater flexibility for member States to meet emissions reduction levels in the most cost-effective manner.

The **Renewable Energy Directive (Directive 2018/2001)** establishes a regulatory framework for the promotion of the use of energy from renewable sources by setting binding EU-wide targets on the share of renewable energy. Member States shall collectively ensure that the share of energy from renewables in 2030 is at least 32 %. To reach this goal, the Commission lays down rules on financial support schemes and compels member States to include 2030 targets in 10-year National Energy & Climate Plans (NECPs) for 2021-2030. The Directive also highlights cooperation mechanisms and simplified administrative procedures to comply with EU targets.

Member States shall also ensure an improved guarantee of origin system of energy from renewable sources, specifying detailed information, such as the energy source, whether it relates to electricity, gas or heating and cooling and the location. Among the Commission's instructions, there are also procedures about self-consumption, for both individual renewables self-consumers and jointly acting renewables self-consumers. As regards the energy communities, final customers are provided with guarantees about their rights and obligations.

Member States are demanded to increase the share of renewable energy in heating and cooling sector by an indicative 1.3 percentage points as an annual average, including the right for consumers to disconnect from inefficient energy systems and the possibility for third party access for suppliers of renewables. In the transport sector, the binding target is 14% of renewables (3.5% for biofuels).

The renewable energy directive entered into force in December 2018 and Member States shall bring into force the laws by 30 June 2021.

Energy Efficiency

Putting energy efficiency first is a key objective in the package, as energy savings are the easiest way of saving money for consumers and for reducing greenhouse gas emissions.

Energy efficiency targets and energy labels encourage industry to innovate and invest. More energy efficient buildings can save energy, reduce bills, address health issues, lower air pollution, and improve people's quality of life.

The **Energy Efficiency Directive (Directive 2018/2002)** contributes toward the Energy Union strategy in terms of reduction of EU's dependency from energy import from other countries (security dimension of energy supply), GHG emissions reduction, jobs and growth, consumer rights and energy poverty.

It promotes energy efficiency across the EU through a common framework of measures covering every stage of the energy chain, from generation to distribution and final consumption. Its aim is to achieve energy consumption and energy imports reduction, supporting producers with incentives and investment schemes and granting more transparency in households energy bills.

It sets the discipline for building renovation in particular for the Public Administration and it compels each Member State to adopt a range of instruments and policies to promote behavioural changes to engage consumers and consumer organisations. The Commission's aim is to encourage efficiency in heating and cooling sector and demand Member States to evaluate other measures to promote energy efficiency, such as incentives, additional regulatory provisions, guidelines adoption or simplification of administrative procedures.

The 32.5% energy efficiency target by 2030 is at core of the Commission's provisions. The instructions aim to remove barriers in the energy market and involve EU countries in the process by asking them to set their own national contributions in national energy and climate plans.

The Commission's prescriptions set clearer rules on energy metering and billing, and it demands EU countries to have transparent, publicly available national rules on the allocation of the cost of heating, cooling and hot water services. Member States shall also strengthen social aspects of energy efficiency by taking energy poverty into account in designing energy efficiency schemes and alternative measures

The transposition in all the EU countries is expected by 25 June 2020. This is the case except for certain amended rules, such as rules for metering gas ,electricity, heating, cooling and domestic hot water or billing information for gas and electricity, for which the deadline is 25 October 2020.

Governance regulation

The package includes a robust governance system for the Energy Union, through which each Member State is required to draft integrated 10-year National Energy and Climate Plans (NECPs) for 2021 to 2030 outlining how they will achieve their respective targets on all dimensions of the Energy Union, including a longer-term view towards 2050. Since the adoption of the Regulation, Member States have submitted their drafts. The Commission is currently analysing each national plan draft in order to deliver specific recommendations to Member States by 30 June 2019.

On 24 December 2018, the Regulation on the **Governance of the Energy Union and Climate Action** entered into force (Regulation 2018/1999). Agreed as part of the CEP, the Regulation aims to implement strategies and measures which ensure the objectives of the energy union, to stimulate cooperation between Member States, to promote long-term certainty and predictability for investors across the EU and foster jobs, growth and social cohesion. The Commission aims to reduce administrative burdens, by integrating and streamlining most of the current energy and climate planning, and ensuring consistent reporting by the EU and its MS under the UN Framework Convention on Climate Change and the Paris Agreement.

Under the Regulation, each Member States is required to submit a draft **National Energy and Climate Plan (NECPs)** by the end of 2018, which is then assessed by the Commission. The national plans shall include the necessary measures to reach

2030 targets in terms of decarbonisation, renewable energy share, energy market changes, energy efficiency and research and development activities.

If the draft NECPs do not sufficiently contribute to reaching the Energy Union's objectives – individually and/or collectively – then the Commission may make recommendations for countries to amend their draft programmes by the end of June 2019. The final version of NECPs must be submitted by the end of 2019.

Electricity Market Design

A further part of the package seeks to establish a modern design for the EU electricity market, adapted to the new realities of the market – more flexible, more market-oriented and better placed to integrate a greater share of renewables.

On 11 November 2016, the Commission presented a proposal for a of the Electricity Directive (COM 2016/864) on common rules for the internal market in electricity, as part of the measures of the Clean Energy Package.

The **Electricity Directive (EU) 2019/944** establishes common rules for the generation, transmission, distribution and supply of electricity, together with consumer protection provisions, with a view to improving and integrating competitive electricity markets in the Community. The provisions focus on consumers pre-existing and new rights and lay down general principles that Member States have to ensure that the EU electricity market is competitive, consumer-centred, flexible and non-discriminatory, such as the right to choose a supplier. The tasks assigned to a DSOs are clarified, such as those concerning the procurement of network services to ensure flexibility and the integration of electrical vehicles and data management. The role of DSOs is specified with respect to storage and recharging points for electric vehicles. Among the Commission's instructions there is also a general rules summary to apply to TSO's. The Electricity Directive focuses in particular on ancillary services, and the rules concerning the Independent National Energy Regulators.

The provisions address specific issues related to smart meters and cybersecurity. According to Art. 20, where smart metering is positively assessed, Member States shall implement smart metering systems in accordance with European standards and the security of the smart metering systems and data communication is ensured in compliance with relevant Union security legislation having due regard of the best available techniques for ensuring the highest level of cybersecurity protection while bearing in mind the costs and the principle of proportionality.

The Directive has been adopted by the Council on 22 May 2019 and the Directive will entry into force on the twentieth day after its publication in the Official Journal of the European Union. Member States shall comply to point 4 and 5 (a) of Article 70 of the Directive, respectively by 25 October 2020 and by 31 December 2020. Directive 2009/72/EC will be repealed from 1 January 2021.

Smart meters deployment in the Electricity Directive

The Electricity Directive sets new guidelines for future smart metering deployment (Art. 19) at national level in order to assist the active participation of customers in the electricity market.

Art. 19 (6) specifies that the Directive provisions concerning smart metering systems apply only to future installations and to installations that replace older smart meters.

Smart metering systems that have already been installed, or for which the 'start of works' began, before 4 July 2019, may remain in operation over their lifetime. However, smart metering systems that do not meet the requirements of Art. 20 and Annex II cannot remain in operation after 5 July 2031, which is 12 years from the entry into force of this Directive.

As envisaged by the Electricity Directive 2009/72/EC, the recast Electricity Directive confirms that the smart metering systems deployment may be subject to a cost-benefit assessment to be undertaken in accordance with the principles laid down in Annex II. Annex II disposes that the economic assessment should take into account the long-term costs and benefits not only to consumers, but also to the whole value chain, following the methodology for the cost-benefit analysis and considering a timetable with a target of up to ten years for the deployment of smart metering systems.

The minimum functional and technical requirements for the smart metering systems recommended to be considered in a cost-benefit analysis remain those provided in Commission Recommendation 2012/148/EU, along with the best available techniques for ensuring smart meters the highest level of cybersecurity and data protection. Nevertheless, the obligatory functionalities when it comes to the actual deployment are those explicitly stated in Article 20.

According to Annex II (3), where the deployment of smart metering systems is assessed positively, at least 80% of final customers shall be equipped with smart meters with the following timeframes:

- within seven years of the date of the positive assessment or
- by 2024 for those Member States that have initiated the systematic deployment of smart metering systems before the 4th of July 2019 which is the date of entry into force of the Directive

On the other hand, when the deployment of smart metering systems has been negatively assessed, Art. 19 (5) requires MSs to ensure that this assessment is revised at least every four years, or more frequently, in response to significant changes in the underlying assumptions and in response to technological and market developments. Moreover, MSs shall notify to the Commission the outcome of their updated cost-benefit assessment as it becomes available. In cases of negative CBAs, Art. 21 disposes that MSs should allow consumers to benefit from the installation of a smart meter, upon request and under fair and reasonable conditions, and should provide them with all the relevant information. Finally, where consumers do not have smart meters, they should be entitled to meters that fulfil the minimum requirements necessary to provide them with the billing information specified in the Directive.

State of play of smart meters deployment in Europe (as of 1/1/2019)

According to the Electricity Directive 2009/72/EC, MSs should roll-out electricity smart meters to 80% of consumers by 2020 if the result of a cost-benefit analysis is positive.

As of 1/1/2019, only seven MSs have already completed the rollout of electricity smart meters or reached at least the 80% target (Denmark). Among them, three MSs completed it before 2017 (Finland, Italy and Sweden), while the other three (Malta, Estonia and Spain) completed their roll-out in 2017. Moreover, DK has already reached 80% of their metering points. Other MSs have made good progress during

2017 and they plan to complete the roll-out by 2020. In particular, Luxembourg and Netherlands shall complete it by 2019, while France by 2020 and Latvia later than 2020.

In some MSs, like Croatia, Romania, Slovakia and Portugal, the roll-out has started but has still not reached such a significant level yet (<50%). Finally, in many countries, deployment has yet to begin and no clear vision is in place for the near term future. Among them are: Germany, Bulgaria, Cyprus and Hungary. (Tractebel, PwC, Navigant, Sweco, 2019)

Furthermore, in MSs where consumers have not had smart meters installed yet, a number of suppliers are introducing their own metering system in order to allow them to benefit from dynamic price contracts (e.g. Germany). However, it is crucial that these additional meters are fit for purpose to avoid problems due to inconsistency in metering data and to ensure that the implementation of such meters does not impact on the customer's experience (e.g. the ability to switch supplier).

The Commission aims to set the basis to achieve the Energy Union's objectives by enabling market signals to be delivered for increased efficiency, higher share of renewable energy sources, security of supply, flexibility, sustainability, decarbonisation and innovation.

Therefore, the European Commission presented detailed rules for the internal market of electricity in the proposal for a recast of the **Electricity Regulation** (COM 2016/861), which emphasizes the importance of undistorted market signals to provide for increased flexibility, decarbonisation and innovation and updates and complements the main definitions used in the Regulation.

The Regulation includes general rules for the electricity market, such as balance responsibility and balancing market, day-ahead and intraday markets and forward markets. It sets technical bidding limits and dispatching of generation and demand response. The Regulation provides network access and congestion management rules, as a bidding zone review, general principles of capacity allocation and congestion management, allocation of cross-zonal capacity across timeframes and network charges and congestion income. The provisions concern also resource adequacy and transmission system operation**.** In particular, the European network of transmission system operators for electricity and its tasks.

The Commission also establishes regional coordination centres specifying its mission, tasks and cooperation procedures. With regard to distribution system operation**,** the Commission establishes the EU DSO entity highlighting principal rules and procedures, main tasks and cooperation between distribution system operators and transmission system operators. The adoption and establishment of network codes, applicable in all Member States, is necessary to address cross-border network and market integration issues. Eight network codes/guidelines for electricity have been developed so far: connection codes NC RfG (Requirements for Generators), NC DCC (Demand Connection). Those two codes, published in 2016, have a direct impact on DSO's. NC DCC not only imposes the DSOs to check compliance of grid users offering demand response, as it is the case for NC RfG for the generating units. It also requires specific technical capabilities in new or substantially modernised interconnection points between DSO and TSO, e.g. on reactive power. NC HVDC (High Voltage Direct Current Connection)**.**

In 2017, the Commission has not proposed any new developments of gas and electricity codes for the coming years. Rather, it encourages a timely and robust implementation of the current codes and guidelines.

The **Regulation (EU) 2019/943** has been adopted by the Council on 22 May 2019, published on the Official Journal of the European Union on 14 June 2019 and shall apply from 1 Jan 2020.

Electricity network codes and guidelines

Each year, the European Commission draws up an 'annual priority list' of areas to be included in the development of network codes for electricity, with input from a public consultation. The Commission, with further input from the Agency for the Cooperation of Energy Regulators (ACER) and the European Network of Transmission System Operators for Electricity (ENTSO-E), adopts proposals for network codes development. The proposals for network codes are checked by the Electricity Cross-Border Committee of specialists, board of national energy ministries, and then adopted by the Council of the European Union and the European Parliament approvals.

The active role of consumers in electricity markets, encouraged by the digital transformation, will show itself in the provision of flexibility services through demand response, distributed generation, operation of storage and vehicle to grid services. The design of the balancing market shall thus be able to promote the integration of resources connected at the distribution level in the provision of flexibility services.

The Electricity Balancing Guideline is also about allowing new players such as demand response and renewables to take part in this market. The Balancing Guideline aims to increase security of supply, limit emissions and diminish costs to customers.

The Regulation on guidelines for electricity balancing (Regulation 2017/2195) establishes common principles for the procurement, settlement and activation of frequency containment reserves, frequency restoration reserves and replacement reserves. In doing so, the Regulation acknowledge, though to an early stage, the increasing importance of distributed capacity resources in the provision of balancing services. Actually, the guideline on electricity balancing clearly states, among its goals, that of facilitating the participation, to the balancing market, of renewable energy sources, demand response including aggregation facilities and energy storage while ensuring they compete with other balancing services at a level playing field. The Regulation entails provisions on the role and responsibilities of TSOs (and their obligation to cooperate with the DSOs), balancing service providers and balancing service parties. In addition, the guideline on balancing services institutes the creation of an European platform for the exchange of balancing services and establishes the harmonisation of MSs' balancing markets' gate closure together with the introduction of provisions with respect to the requirements for products for balancing energy and the allocation of cross-zonal capacity for the exchange of balancing services. Principles to be applied in the formation of balancing services' prices and settlement of imbalances are also addressed by the (EU) Regulation.

Strategic Energy Technology Plan (SET Plan)

The European Strategic Energy Technology Plan (SET Plan) builds on one of the five dimensions of the Energy Union strategy 'Research, innovation and competitiveness',

aiming to accelerate the development and deployment of low-carbon technologies. It is part of a new European energy Research & Innovation (R&I) approach designed to accelerate the transformation of the EU's energy system and to bring promising new zero-emissions energy technologies to market.

The SET Plan promotes R&I efforts across Europe by supporting the most impactful technologies in the EU's transformation to a low-carbon energy system. It promotes cooperation amongst EU countries, companies, research institutions, and the EU itself. The SET Plan comprises the SET Plan Steering Group, the European Technology and Innovation Platforms (ETIP), the European Energy Research Alliance, and the SET Plan Information System (SETIS).

In particular, the Integrated SET Plan:

- Identifies 10 R&I actions aligned to the Energy Union objectives
- Addresses the whole innovation chain, from research to market uptake, and tackles both financing and the regulatory framework
- Adapts the governance structures under the umbrella of the SET Plan to ensure a more effective interaction with EU countries and stakeholders
- Proposes to measure progress via overall Key Performance Indicators (KPIs), such as the level of investment in research and innovation, or cost reductions.

2050 long-term strategy

On 28 November 2018, the European Commission adopted a strategic long-term vision for a prosperous, modern, competitive and climate neutral economy by 2050 – "A Clean Planet for all" (COM 2018/773).

The strategy shows how Europe can lead the way to climate neutrality by investing into realistic technological solutions, empowering citizens, and aligning action in key areas such as industrial policy, finance, or research – while ensuring social fairness for a just transition. It will build on the new energy policy framework established under the Clean Energy for All Europeans package.

Following the invitations by the European Parliament and the European Council, the Commission's vision for a climate-neutral future covers nearly all EU policies and is in line with the Paris Agreement objective to keep the global temperature increase to well below 2°C and pursue efforts to keep it to 1.5°C.

The purpose of this long-term strategy is not to set targets, but to create a vision and sense of direction, plan for it, and inspire as well as enable stakeholders, researchers, entrepreneurs and citizens alike to develop new and innovative industries, businesses and associated jobs. It looks into the portfolio of options available for Member States, business and citizens, and how these can contribute to the modernisation of our economy and improve the quality of life of Europeans. The long-term strategy also seeks to ensure that this transition is socially fair and enhances the competitiveness of EU economy and industry on global markets, securing high quality jobs and sustainable growth in Europe, while also helping address other environmental challenges, such as air quality or biodiversity loss.

The strategy foresees that the road to a climate neutral economy would require joint action mainly in 7 strategic areas: energy efficiency; deployment of renewables; clean, safe and connected mobility; competitive industry and circular economy;

infrastructure and interconnections; bio-economy and natural carbon sinks; carbon capture and storage to address remaining emissions.

Digital Single Market

The Digital Single Market (DSM) strategy is one of the 10 European Commission priorities for 2015-2019 (Priority n°2). The Strategy was adopted on 6 May 2015 (COM 2015/192) and it includes 16 specific initiatives which have been delivered by the Commission by January 2017. They focus on areas where the EU can bring specific added value, concentrating on European digital projects whose scope and scale cannot be realised by individual countries alone. Legislative proposals are currently being discussed by the co-legislator, the European Parliament and the Council.

The DSM Strategy is built on three pillars:

- *Access:* better access for consumers to digital goods and services across Europe, which includes measures that can assure better access to consumers and businesses to digital tools and services across European countries;
- *Environment*: creating the right conditions and a level playing field for digital networks and innovative services to flourish with the aim of creating the proper conditions and a level paying field for the development of digital networks and innovative services;
- *Economy and society:* maximizing the growth potential of the digital economy in order to benefit from the digital economy improvement

The DSM strategy aims to reach an open market where it is easy for businesses and people to operate effectively. Pursuing this objective, the Commission has given the impulse to the development of a set of policy instruments and funding opportunities to support Member States in the digital transformation process.

The completion of the EU Single Digital Market also needs a clear and stable legal environment to stimulate innovation, tackle market fragmentation and allow all players to tap into the new market dynamics under fair and balanced conditions. This will provide the bedrock of trust that is essential for business and consumer confidence.

It is therefore essential that EU businesses grasp the opportunities of digital technology to remain competitive at global level, that EU start-ups are able to scale up quickly, with full use of cloud computing, big data solutions, robotics and high speed broadband, thereby creating new jobs, increased productivity, resource efficiency and sustainability.

At the same time, the digital infrastructures on which the digital economy depends need to be robust, resilient and able to adapt to evolving threats. Otherwise the trust of people and businesses will be eroded and digital uptake held back.

On 10 May 2017, the Commission published a mid-term review of the DSM Strategy (COM 2017/228). It presents and evaluates the progress in implementing the Strategy since 2015 and highlights where further actions are needed. It takes stock of the progress made, calls on co-legislators to swiftly act on all proposals already presented, and outlines further actions on online platforms, data economy and cybersecurity.

The European Commission presented 30 legislative initiatives under the Digital Single Market strategy. Of these legislative initiatives, as of 1 May 2019, 29 have been politically agreed or finalised by the European Parliament and the Council of the European Union, with only one legislative initiative (e-Privacy) still on the table for the European Parliament and the Council of the European Union to adopt (European Commission, 2019).

The 30 legislative proposals fall under five main areas:

- *Connectivity:* meeting Europe's growing connectivity needs, including in rural and remote areas and boosting competitiveness by 2020
- *e-Commerce*: making it easier to buy and sell online across borders
- *Data*: creating a competitive data economy within the Digital Single Market.
- *Media/copyright*: promoting European content and providing citizens with more choice and access
- *Trust*: strengthening trust and EU's capacity to respond to cyberattacks
- *e-Gov*: making it easier for citizens to deal with public administrations online

In particular, the legislative initiatives relevant for this study fall in three areas, that is Connectivity, Data and Trust (Cybersecurity), and are presented in detail in the following sections.

Connectivity

Modern connectivity in Europe requires a better coordination of radio spectrum waves as it is a key resource for mobile communications to support the internal market for wireless.

The EU Radio Spectrum Policy concerns the identification of needs for spectrum coordination at EU level, the harmonisation of spectrum usage, the establishment of policy priorities and the regulatory environment setting for access to radio spectrum. The Radio Spectrum Policy Programme (RSPP) aims to address a variety of important issues, including the development of innovative technologies and services to drive growth in the EU economy as well as overcoming the digital divide.

The Commission can adopt implementing decision to harmonise technical conditions with regard to the availability and efficient use of spectrum. It addresses a number of specific goals that can only be achieved at EU level, while the allocation and management of radio spectrum is administered by national administrations.

Legislative Initiatives

European Electronic Communications Code

The new European Electronic Communications Code, proposed by the Commission in September 2016 and agreed on by the European Parliament and the Council in December 2018 (Directive 2018/1972), modernises the EU telecoms rules, which were last updated in 2009, and stimulates competition to drive investments and strengthen the internal market and consumer rights.

It sets EU-wide common rules and objectives on how the telecom industry should be regulated. It applies to providers of networks and/or services and defines how they can be regulated by national Regulators. It brings the rules up to date, to take account of technological developments (more internet use, less traditional telephony) and to safeguard consumer choice.

The Code entered into force on 20 December 2018 and Member States have until 21 December 2020 to transpose the Directive into national law.

The agreed rules are crucial for achieving Europe's connectivity targets and providing everyone in the EU the best possible internet connection, so they can participate fully in the digital economy.

In particular, the new Electronic Communications Code allows to:

- Enhance the deployment of 5G networks by ensuring the availability of 5G radio spectrum by end of 2020 in the EU and providing operators with predictability for at least 20 years in terms of spectrum licensing; including on the basis of better coordination of planned radio spectrum assignments.
- Facilitate the roll-out of new, very high capacity fixed networks by making rules for co-investment more predictable and promoting risk sharing in the deployment of very high capacity networks; promoting sustainable competition for the benefit of consumers, with a regulatory emphasis on the real bottlenecks, such as wiring, ducts and cables inside buildings; and a specific regulatory regime for wholesale only operators. Moreover, the new rules will also ensure closer cooperation between the Commission and the Body of European Regulators for Electronic Communications (BEREC) in supervising measures related to the new key access provisions of co-investment and symmetric regulation.
- Benefit and protect consumers by:
  - ensuring that all citizens have access to affordable communications services, including universally available internet access, for services such as e-government, online banking or video calls;
  - ensuring that international calls within the EU will not cost more than 19 cents per minute, while making sure that the new rules would not distort competition, innovation and investment;
  - giving equivalent access to communications for end-users with disabilities;
  - promoting better tariff transparency and comparison of contractual offers;
  - guaranteeing better security against hacking, malware, etc.;
  - better protecting consumers subscribing to bundled service packages;
  - making it easier to change service provider and keep the same phone number, including rules for compensations if the process goes wrong or takes too long;
  - increasing protection of citizens in emergency situations, including retrieving more accurate caller location in emergency situations, broadening emergency communications to text messaging and video calls, and establishing a system to transmit public warnings on mobile phones.

Non-legislative Initiatives

On 14 September 2016, the Commission proposed the so-called "Connectivity Package", a set of measures to prepare Europe's digital future and to ensure that everyone in the EU will have the best possible internet connection to participate in the digital society and economy. The Commission proposed a strategy for "Connectivity for a Competitive Digital Single Market - Towards a European Gigabit Society" (COM 2016/ 587), which includes common EU connectivity targets for 2025 and a series of complementary initiatives to help reach these objectives encouraging

investment in very high capacity networks across the EU, including in remote and rural areas. Such initiatives include a 5G Action Plan (COM 2016/588) to foster a coordinated approach for the deployment of 5G infrastructures and the establishment of a new European Electronic Communications Code (COM 2016/590), which come into force in December 2018 (Directive 2018/1972).

EU connectivity targets for 2025

They will serve as a measurable and achievable benchmark for decision makers in the private and the public sector, building on and boosting existing network investments up to and beyond 2025. In order to address future broadband needs, the Commission proposes three main strategic objectives for 2025:

- Gigabit connectivity: download/upload speeds of 1 Gbps for all of the main socio-economic drivers, such as schools, transport hubs and main providers of public services as well as digitally intensive enterprises
- High performance 5G connectivity: uninterrupted 5G wireless broadband coverage for all urban areas and major roads and railways, starting with fully-fledged commercial service in at least one major city in each EU member state already by 2020
- Improved connectivity in rural areas: access to networks offering a download speed of at least 100 Mbps, which can be upgraded to 1 Gbps, for all European households (rural or urban)

The Commission estimates that reaching these EU connectivity objectives requires € 500 billion investment by 2025 in very large networks. This money will largely have to come from private sources, while public support will be needed in less profitable areas. In order to deliver a High-Performance Internet Connectivity for the Digital Single Market, the Commission launched the Connecting Europe Broadband Fund supporting the financing of broadband network infrastructure, as a financial instruments of the Connecting Europe Facility (CEF) stimulating the deployment and modernisation of broadband networks.

5G Action Plan

On 14 September 2016, the Commission launched the 5G Action Plan (COM 2016/588) to boost EU efforts for the deployment of 5G infrastructures and services across the Digital Single Market by 2020. The action plan set out a clear roadmap for public and private investment on 5G infrastructure in the EU.

It proposes an EU framework for Member States and industrial sectors to cooperate in the development and introduction of 5G wireless technologies in the European Union with the goal to stimulate the necessary investments.

The plan foresees a common EU calendar for a coordinated 5G commercial launch in 2020, as well as joint work with Member States and industry stakeholders to identify and allocate spectrum bands for 5G, organise pan-European 5G trials as of 2018, promote common global 5G standards and encourage the adoption of national 5G deployment roadmaps across all EU Member States. The agreement on spectrum for 5G was adopted as part of the Electronic Communications Code of 4 December 2018.

The 5G Action Plan is closely related to the new European Electronic Communications Code: they are both aimed at fostering the competitiveness of our industry in the Digital Single Market. They both support the deployment and take-up of 5G networks,

notably as regards the timely assignment and availability of radio spectrum, more favourable conditions for small cell deployment or sectorial issues preventing the deployment of particular services, investment incentives and favourable framework conditions.

Data economy

Data has become an essential resource for economic growth, job creation and societal progress. Data analysis facilitates the optimisation of processes and decisions, innovation and the prediction of future events. This global trend holds enormous potential in almost all fields, climate, energy and smart cities included.

The "data economy" concept is characterised by an ecosystem of different types of market players collaborating to ensure that data is accessible and usable. This enables the market players to extract value from this data, by creating a variety of applications with a great potential to improve daily life (e.g. home comfort and security, traffic management, etc.). The "data economy" measures the overall impacts of the data market – i.e. the marketplace where digital data is exchanged as products or services derived from raw data – on the economy as a whole. It involves the generation, collection, storage, processing, distribution, analysis, elaboration, delivery, and exploitation of data enabled by digital technologies (IDC, 2017).

As announced in the DSM strategy (COM 2015/192), the Commission's objective is to create a clear and adapted policy and legal framework for the data economy, by removing remaining barriers to the movement of data and addressing legal uncertainties created by new data technologies.

To this end, the Commission adopted on 10 January 2017 a Communication launching the "Building a European Data Economy" initiative as part of the DSM strategy (COM 2017/9).The initiative aims at enabling the best possible use of the potential of digital data to benefit the economy and society. To do so, the Commission intends to unlock the re-use potential of different types of data and facilitate its free flow across borders to achieve a European digital single market.

In addition, as foreseen in the mid-term review of the DSM strategy (COM 2017/228), the Commission intends to support the creation of a common European data space (COM 2018/232) — a seamless digital area with the scale to enable the development of new products and services based on data. Data should be available for re-use as much as possible, as a key source of innovation and growth. The measures announced in the Communication cover different types of data and include a proposal for a review of the Directive on the re-use of public sector information (PSI Directive).

Legislative Initiatives

Free flow of non-personal data Regulation

Free flow of non-personal data is a pre-requisite for a competitive data economy within the Digital Single Market. To fully unleash the data economy benefits a free flow of data must be ensured, allowing companies and public administrations to store and process non-personal data wherever they choose in the EU.

The Commission's work on free flow of data was announced in the context of actions to enhance the data economy in the Communication "Building a European Data

Economy" (COM 2017/9), and, in a more targeted context, in the Communication "DSM mid-term review" (COM 2017/228).

In September 2017, the Commission proposed a new Regulation aiming at removing the four main obstacles to the free flow of data within the EU:

- Unjustified data localisation restrictions by Member States' public authorities,
- Legal uncertainty about legislation applicable to cross-border data storage and processing,
- Lack of trust in cross-border data storage and processing linked to concerns amongst Member States' authorities about the availability of data for regulatory scrutiny purposes
- Obstacles to movement of data across IT systems due to vendor lock-in practices.

The free flow of non-personal data Regulation (Regulation 2018/1807) was formally signed by the European Parliament and the Council on 14 November 2018 and entered into force on 28 May 2019. This Regulation introduces the principle of the free flow of non-personal data across borders into EU law, thereby establishing the free movement of non-personal data as the General Data Protection Regulation (GDPR) does for personal data. Together with the GDPR, the new Regulation on the free flow of non-personal data provides for a stable legal and business environment on data processing. As part of the new rules, the Commission was required to publish guidance on the interaction between this Regulation and the GDPR. The Commission published the guidance on 29 May 2019, which gives practical examples on how the rules should be applied when a business is processing datasets composed of both personal and non-personal data. It also explains the concepts of personal and non-personal data, including mixed datasets; lists the principles of free movement of data and the prevention of data localisation requirements under both, the GDPR and the free flow of non-personal data Regulation; and covers the notion of data portability under the Regulation on the free flow of non-personal data. The guidance also includes the self-regulatory requirements set out in the two Regulations.

The new Regulation prevents EU countries from putting laws in place that unjustifiably force data to be held solely inside national territory. Companies and public administrations around Europe will be allowed to store and process non-personal data everywhere in the EU and public competent authorities will have access to data with no geographical limitations and will be entitled to carry out regulatory control purposes.

Furthermore, the new Regulation ensures an easier switching of cloud service providers for professional users by encouraging and facilitating the development of self-regulatory 'codes of conduct' at Union level, in order to contribute to a competitive data economy, based on the principles of transparency and interoperability and taking in due account open standards.

Finally, full consistency and synergies with the cybersecurity act is ensured, with the Regulation clarifying that businesses, when storing and processing data across borders in the EU or in the cloud, will continue to apply the same security requirements they already apply.

Public Sector Information (PSI) Directive

In the EU, the public sector is one of the most data-intensive sectors. The vast amounts of data it holds, known as Public Sector Information (PSI), range from anonymised personal data on household energy use to general information about national education and may be open depending on national access regimes. The re-use of these data can contribute to the growth of the European economy, with a great impact on the energy sector.

On 25 April 2018, the Commission adopted the 2018 Data Package, addressing for the first time different types of data (public, private, scientific) within a coherent policy framework, making use of different policy instruments. As part of this package, the Commission proposed a review (COM 2018/234) of the Directive 2013/37/EU on the re-use of public sector information (PSI Directive) (Directive 2013/37), which was the object of an extensive public consultation process.

On 22 January 2019, the European Parliament, the Council of the EU and the Commission reached an agreement on the proposal and, once adopted, the Directive would be renamed as the "Open Data and Public Sector Information Directive" and will make public sector and publicly funded data re-usable.

The PSI Directive is built around two key pillars of the internal market, that is transparency and fair competition, and focuses on the economic aspects of the re-use of information rather than on access to information by citizens. It encourages the Member States to make as much information available for re-use as possible. It addresses material held by public sector bodies in the Member States, at national, regional and local levels, such as ministries, state agencies and municipalities, as well as organisations funded mostly by or under the control of public authorities (e.g. meteorological institutes). Any re-use of personal data under the PSI Directive must be in full respect of the rights and obligations contained in the GDPR.

In particular, the new Directive will:

- Identify, by way of adoption of an implementing act, a list of high-value datasets such as geospatial or statistics data to be provided free of charge. These datasets have a high commercial potential, and can speed up the emergence of value-added EU information products and services and the development of AI.
- Stimulate the publishing of dynamic data and the uptake of Application Programme Interfaces (APIs).
- Limit the exceptions which currently allow public bodies to charge more than the marginal costs of dissemination for the re-use of their data.
- Strengthen the transparency requirements for public–private agreements involving public sector information, avoiding exclusive arrangements.

e-Privacy

One of the objectives of the DSM Strategy is to increase trust and security of digital services. The reform of the data protection framework, and in particular the adoption of Regulation (EU) 2016/679, the General Data Protection Regulation (GDPR), was a key action to this end. The DSM Strategy also announced the review of Directive 2002/58/EC (e-Privacy Directive) in order to provide a high level of privacy protection for users of electronic communications services and a level playing field for all market players.

On 10 January 2017, the Commission published a proposal (COM 2017/10) for a regulation on the respect for private life and the protection of personal data with a focus on electronic communications (e-Privacy). The proposal reviews the e-Privacy Directive, foreseeing in the DSM Strategy objectives and ensuring consistency with the GDPR. It also guarantees the free movement of electronic communications data, equipment and services in the Union. The proposal's aim is to enhance security and confidentiality of communications (including content and metadata, e.g. sender, time, location of a communication) and define clearer rules on tracking technologies such as cookies and on spam.

Since September 2017, the EU Council published several redrafts of the proposal, which is still on the table for the European Parliament and the Council of the European Union to adopt. A common Council position may be adopted likely after the European Parliament elections (May 2019).

Among the issues discussed: the need to clarify the relationship between e-Privacy and the GDPR, privacy settings, the legal grounds for data processing other than consent, as well as the applicability of the new rules to service providers assisting competent authorities for national security purposes, and the concept of public interests as a basis justifying restrictive measures.

The European Data Protection Authorities (DPAs), assembled in the European Data Protection Board, adopted an opinion on the interplay between the e-Privacy Directive and GDPR (in particular on the competences of DPAs). They also called upon EU legislators to intensify efforts towards the adoption of the e-Privacy Regulation.

Non-legislative Initiatives

European Cloud Initiative

As part of the measures of the Digitising European Industry initiative, the Commission published a communication on the European Cloud Initiative (COM 2016/178). According to the Commission, legal, technical and funding barriers impede the free flow and exploitation of EU research data across EU countries, even though Europe is the largest producer of scientific data in the world. The Communication supports the development of a European Open Science Cloud, by creating a trusted, open environment for sharing scientific data, connecting scientists and scientific disciplines globally, offering open services to analyse and reuse research data. The European Cloud initiative also propose the implementation of a European Data Infrastructure to allow fully unlocking the value of Big Data and digital by default.

The European Cloud initiative will facilitate clear and credible certification of services, to allow users to benefit from secure, reliable and high-quality cloud services. It foresees a series of actions, including: to develop a European open science cloud for European researchers and their global scientific, federating existing scientific clouds and research infrastructures and supporting the development of cloud-based services by 2016.

Cybersecurity

Legislative Initiatives

The European Union has taken a number of actions to increase resilience and enhance its cybersecurity preparedness. The first EU Cybersecurity Strategy (JOIN 2013/1) adopted in 2013 set out strategic objectives and concrete actions to achieve resilience, reduce cybercrime, develop cyberdefence policy and capabilities and establish a coherent international cyberspace policy for the EU. In that context, important developments have taken place since then, including firstly the second mandate for the European Union Agency for Network and Information Security (ENISA) (Regulation 526/2013) and the adoption of the Directive on security of Network and Information Systems (the 'NIS Directive') (Directive 2016/1148).

Furthermore, in 2016, the European Commission adopted a Communication on "Strengthening Europe's Cyber Resilience System and Fostering a Competitive and Innovative Cybersecurity Industry" (COM 2016/410). In this communication, further measures were announced to step-up cooperation, information and knowledge sharing and to increase the EU's resilience and preparedness, also taking into account the prospect of large-scale incidents and a possible pan-European cybersecurity crisis.

In the mid-term review of the Digital Single Market published in May 2017 (COM 2017/228), the Commission identified cybersecurity issues as one of the three key challenges to tackle in the future years and announced a number of actions, including a review of the 2013 EU Cybersecurity Strategy and of the mandate of ENISA (Regulation 526/2013).

Network and Information Systems Directive (NISD)

As part of the first EU Cybersecurity strategy "An Open, Safe and Secure Cyberspace" (JOIN 2013/1) launched in 2013, the Network and Information Systems Directive (NISD) (Directive 2016/1148) was adopted by the European Parliament on 6 July 2016 and entered into force in August 2016.

The NIS Directive is the first EU-wide horizontal cybersecurity law and proposes a set of measures to boost the level of cybersecurity of network and information systems in Europe. It is designed to build resilience by:

- Improving national cybersecurity capabilities;
- Fostering better cooperation at EU level between the Member States;
- Promoting a culture of risk management and incident reporting among key economic actors, notably operators providing essential services (OES) for the maintenance of economic and societal activities and Digital Service Providers (DSPs).

In order to improve national cybersecurity capabilities, MSs must designate one or more national competent authorities and Computer-Security Incident Response Teams (CSIRTs) and establish national strategies.

In order to ensure EU-level cooperation among all the Member States, the Directive sets up a cooperation group to support and facilitate strategic cooperation and the exchange of information among Member States. Moreover, MSs are required to set a CSIRT Network in order to promote swift and effective operational cooperation on specific cybersecurity incidents and sharing information about risks.

Moreover, the NISD aims to build and spread a culture of security across sectors that are vital for EU economy and society, where a cyberattack could disrupt an essential service, and rely heavily on ICTs, such as energy, transport, water, banking, financial market infrastructures, healthcare and digital infrastructure.

Each MS shall identify Operators of Essential Services (OES) among key economic actors and businesses in these sectors, which will have to take appropriate security measures and to notify serious incidents to the relevant national authority. Also key digital service providers (search engines, cloud computing services and online marketplaces) will have to comply with the security and notification requirements under the new Directive.

Designated competent authorities shall monitor the application of the Directive, supervise digital service providers and participate in the work of the cooperation group of competent authorities from each MS. Member States had to transpose the Directive into their national laws by 9 May 2018 and identify operators of essential services by 9 November 2018.

Cybersecurity Act

On 13 September 2017, the Commission presented the so-called "Cybersecurity Package" with the Joint Communication "Resilience, Deterrence and Defence: Building strong cybersecurity for the EU" (JOIN 2017/450). The package builds upon existing instruments and presents new initiatives to further improve EU cyber resilience and response in three key areas:

1. Building EU resilience to cyber-attacks
2. Creating an effective criminal law response
3. Strengthening global stability through international cooperation

As part of the package, in order to improve cyber resilience and increase trust in the Digital Single Market, the European Commission presented a legislative proposal (COM 2017/477), the so-called "Cybersecurity Act", including:

- Reform proposal for strengthening ENISA's role, giving the **EU Cybersecurity Agency** a permanent mandate, more tasks and adequate resources to assist MSs in dealing with cyber-attacks.
- Set up of an **EU cybersecurity certification framework** for ICT products, services and processes.

The reformed ENISA will provide support to Member States, EU institutions and businesses in key areas, including the implementation of the NISD and the proposed cybersecurity certification framework. It will also improve the EU's preparedness to react by organising annual pan-European cybersecurity exercises and by contributing to better information sharing between MSs through the network of CSIRTs.

The EU-wide ICT certification framework proposed in the "Cybersecurity Act" creates a comprehensive set of rules, technical requirements, standards and procedures to agree each scheme. Each scheme will be based on agreement at EU level for the evaluation of the security properties of a specific ICT-based product or service e.g. smart cards. This certificate will attest that ICT products and services that have been certified in accordance with such a scheme comply with specified cybersecurity requirements. The resulting certificate will be recognised in all Member States, making it easier for businesses to trade across borders and for purchasers to understand the security features of the product or service. The Cybersecurity Agency, ENISA, will put in place and implement this certification process towards a single cybersecurity market.

The Framework's schemes would be voluntary and would not create any immediate regulatory obligations on vendors or service providers. The schemes would not contradict any applicable legal requirements, such as the EU legislation on data protection.

Once the Framework is established, the Commission will invite the relevant stakeholders to focus on three priority areas:

- Security in critical or high-risk applications
- Cybersecurity in widely-deployed digital products, networks, systems and services used by private and public sector alike to defend against attacks and apply regulatory obligations
- The use of "security by design" methods in low-cost, digital, interconnected mass consumer devices which make up the Internet of Things

These priorities should take particular account of the evolving cybersecurity threat landscape, as well as the importance of essential services in the crucial sectors within the NISD scope, including energy. At the same time, specific sectors face specific issues and should be encouraged to develop their own approach. In this way, general cybersecurity strategies would be complemented by sector-specific cybersecurity strategies in areas like financial services, energy, transport and health. In the energy sector for instance, combining very old and cutting edge information technologies, particularly with the real-time requirements of the power grid.

On 12 March 2019, the European Parliament’s Plenary confirmed the political agreement reached by the co-legislators on the Cybersecurity Act, which is expected to entry into force in May 2019. The text has been signed by the European Parliament and the Council on 17 April 2019.

European Cybersecurity Competence Network

In the 2017 Joint Communication (JOIN 2017/450), it was recognised that it is also in the Union's strategic interest to ensure that essential cybersecurity technological capacities are retained and developed to secure the Digital Single Market, and in particular to protect critical networks and information systems. The Union must be in a position to autonomously secure its digital assets and to compete on global cybersecurity market.

For this reason, the Joint Communication considered the possibility of reinforcing Union cybersecurity capability through a network of cybersecurity competence centres with a European Cybersecurity Competence Centre at its heart. This would seek to complement the existing capacity building efforts in this area at Union and national level.

In this context, in September 2018, the Commission proposed the set-up of a European Cybersecurity Industrial, Technology and Research Competence with a network of National Coordination Centres (COM 2018/630). The proposal aims to support cybersecurity technological and industrial capacities and to increase the competitiveness of the Union's cybersecurity industry. The European Parliament and the Council adopted their negotiating mandates on 13 March 2019.

Non-legislative Initiatives

“NIS Toolkit” for the NIS Directive Implementation

In 2018, the Commission proposed as part of the "Cybersecurity package" an implementation toolkit ("NIS Toolkit") to support MSs in their efforts to implement the NIS Directive swiftly and coherently across the EU (COM 2017/476).

The "NIS Toolkit" provides practical information to Member States, e.g. by presenting best practices from the Member States relevant to the implementation of the Directive and guidance on how the Directive should be operating in practice.

Blueprint for rapid emergency response

The 2017 Joint Communication, building also on previous initiatives, outlined a set of proposed actions including, among others, creating a blueprint for effective and coordinated response to large scale cybersecurity incidents and crises. A fast and effective response also relies on a swift information exchange mechanism between all key players at national and EU level, which in turn requires clarity on their respective roles and responsibilities.

On this regard, the Commission consulted institutions and Member States on a "Blueprint" which was presented in a Recommendation (Commission Recommendation 2017/1584) included in the "Cybersecurity Package". The Blueprint explains how cybersecurity is mainstreamed to existing Crisis Management mechanisms at EU level and sets out the objectives and modes of cooperation between the Member States as well as between Member States and relevant EU Institutions, services, agencies and bodies when responding to large scale cybersecurity incidents and crises. The Recommendation also requests Member States and EU institutions to establish an EU Cybersecurity Crisis Response Framework to operationalise the Blueprint. The Blueprint will be regularly tested in cyber and other crisis management exercises and updated as necessary.

Cybersecurity in the energy sector

On 3 April 2019, the European Commission adopted a Recommendation on cybersecurity in the energy sector (Commission Recommendation 2019/553) setting out the main related issues and asking Member States to encourage stakeholders to develop necessary knowledge and skills cybersecurity-related. National security framework should include the Commission's considerations to implement the relevant cybersecurity measures. The Recommendation provides guidance on specific real-time requirements of energy infrastructure components to enable the application of cybersecurity measures to real time working sectors. The Commission considers also cascading effects preparedness measures to adopt due to the grids interconnections. The definition of the state-of-the-art technologies can help MS to manage the co-existence of two different types of technologies, an older technology, designed before cybersecurity threats and new technology reflecting digitalisation progress.

Digitising European Industry (DEI)

On 19 April 2016, the European Commission launched the first industry-related initiative of the Digital Single Market strategy, in its communication "Digitising European Industry" (COM 2016/180). The Communication introduce a set of measures to support and complement the various national initiatives for digitising industry, such as 'Industry 4.0'. Different policy instruments, financial support schemes, coordination and legislative powers will trigger further public and private investments in all industrial sectors and create the framework conditions for the

digital industrial revolution. The initiative aims to reinforce the industrial and innovation pillar of the Digital Single Market strategy, enhancing EU competitiveness in digital technologies.

The DEI initiative constitutes a European platform complementing Member States' initiatives for the digitalisation of industry and supports the creation of Digital Innovation Hubs Network. The European Commission launched the European catalogue of Digital Innovation Hubs that counts more than 200 already existing operational hubs and that will keep growing with new additions in the future. Its aim is to ensure collaboration between different hubs. The initiative strengthens leadership through partnerships and industrial platforms, defines a regulatory framework to update regulation in key fields, as cybersecurity and free flow of data, and define specific initiatives to develop digital skills and opportunities for Europeans.

On 1 June 2017, the European Parliament adopted the resolution on developing an integrated industrial digitalisation strategy (IDS) that strengthens cohesion, job creation and innovation. IDS must be based on a competitive business environment that promotes private investment, an appropriate regulatory framework that prevents administrative burdens, a cutting-edge digital infrastructure and an EU coordination structure to ensure a common strategic approach to platforms and initiatives on industrial digitisation.

The Communication is accompanied by two communication concerning the development of a European Cloud for the scientific data sharing and the definition of Commission's ICT standardisation Priorities for the Digital Single Market.

Interoperability and standardisation

ICT Standardisation Priorities for the Digital Single Market

For the next wave of technology standardisation, the European Commission identifies a list of priorities highlighting the political and strategic importance of ICT standardisation as a crucial element of the Digital Single Market.

In particular, in its Communication of 19 April 2016 (COM 2016/176), the Commission identifies five priority areas: *5G communications*, *Cloud computing*, *Internet of Things (IoT)*, *Big data technologies and Cybersecurity.* These are the essential technology building blocks of the Digital Single Market.

In the area of smart energy, more than 70% of standards are ICT standards. Their implementation would empower consumers and ensure more transparent and competitive retail markets.

5G standards will realise the wider ambitions of the Digital Single Market. The next convergence wave is expected to target industrial and professional businesses supporting the digital transformation. The standardisation process should be inclusive of vertical industries though each vertical industry typically has its own standard body and association. This is needed to ensure a globally applicable and consistent set of 5G mobile communication standards which can benefit all industrial sectors at large.

Standardisation is the critical element to deliver a single market for IoT. It can facilitate the interoperability, compatibility, reliability, security and effective operations. IoT standards may support the emergence of business models unleashing the commercial capabilities of systems and device integration.

A large number of proprietary or semi-closed solutions to address specific needs have emerged, leading to high fragmentation and to the creation of non-interoperable applications, based on different architectures and protocols. As opposed to proprietary solutions, open standards are considered a solution in the IoT landscape, because of their net positive effects as regards large scale deployment, widespread adoption and preventing lock-in situations.

The European Union needs open standards that support the entire value chain, integrating multiple technologies, based on streamlined international cooperation that build on an IPR framework enabling easy and fair access to standard essential patents. Large-scale implementation and validation of cross-cutting solutions and standards is now the key to interoperability, reliability and security in the EU and globally.

The Commission will foster an interoperable environment for the Internet of Things, working with ESOs and international SDOs. This will develop consensus targeting reference architectures, protocols and interfaces. The Commission will assess if further steps are needed to tackle identified interoperability failures, and if necessary, consider using legal measures to recommend appropriate standards.

Several standardisation initiatives currently co-exist, in individual Standard Development Organisations (SDOs) or partnerships (e.g. ETSI SmartM2M, ITU-T, ISO, IEC, ISO/IEC JTC 1, oneM2M, W3C, IEEE, OASIS, IETF, etc.) and also in conjunction with a number of industrial initiatives (e.g. All Seen Alliance, Industrial Internet Consortium (IIC), Open Interconnect Consortium (OIC), Platform Industrie 4.0 etc.).

The Commission has used its Horizon 2020 and Connecting Europe Facility funds to strengthen existing and deploy forward-looking standardisation activities, with H2020 putting a particular focus on promoting open standards. The Commission will continue to support effective knowledge transfer between R&D&I projects and the standardisation organisations. Moreover, through its Joint Research Centre, the Commission will provide pro-active scientific and technical support in the priority standardisation areas. In addition, the Commission will fund large-scale pilot projects in the priority areas identified, in order to validate and improve the take-up of standards.

Interoperability of smart appliances

The implementation of demand side flexibility requires technical infrastructures that manage demand to be coupled. Interoperability is key especially where the DSO infrastructure provides information (e.g., smart meter data) that is needed by demand side flexibility applications. On the side of the consumer premises, an important step in addressing the interoperability issue in the smart appliances industry was made by the EC in 2013, by launching a standardisation initiative (SMART 2013/0077) in collaboration with the European Telecommunications Standards Institute (ETSI). The aim was to create a shared semantic model of consensus to enable interoperability in the smart appliances domain relevant for energy, where the development of a reference ontology was targeted as the main interoperability enabler. This resulted in the definition of the Smart Appliances REFerence ontology (SAREF), which was published in 2015 by ETSI as a Technical Specification (TS 103 264 V1.1.1).

SAREF was created with the intention to interconnect data from different protocols and platforms, for instance ZigBee, UPnP (now OCF) and ZWave, enabling the communication between in-home devices that use different protocols and standards. SAREF is not about the actual communication with devices and has not been set up to replace existing communication protocols and standards, but it lays the base for enabling the translation of information coming from existing (and future) protocols and standards to and from all other protocols and standards that are referenced to SAREF.

The SAREF initiative has been welcomed by the Smart Appliances and IoT industry that clearly indicated the intention to adopt the SAREF ontology and its related communication framework (i.e., oneM2M). In 2016, ETSI requested a Specialists Task Force (STF) to provide input on the management of SAREF and create dedicated extensions for specific domains. To that end, the STF 513 was established and, in March 2017, the latest version of SAREF has been published (SAREF 2.0), including an extension for the energy domain, called SAREF4ENER, with the goal to interconnect smart appliances from different manufacturers in demand response use cases by means of a Customer Energy Manager (CEM) that communicates using SAREF. Other two extensions have been already standardised for Environment (SAREF4ENVI) and for Buildings (SAREF4BLDG), while new extensions of SAREF to the Smart Cities, Smart Industry & Manufacturing, and Smart AgriFood domains are currently under development, turning SAREF into the umbrella that enables better integration of semantic data from and across various vertical domains in the IoT.

Digital technologies in the energy sector

Digital technologies already play an important role in the energy sector. This holds particularly true for smart grids and smart metering systems, smart home appliances, smart charging solutions for electric vehicles and smart cities. In all these areas, digital technologies create various opportunities. They can help the consumer to participate actively in the energy market and use energy more efficiently. They can also foster a better use of energy from renewable sources.

Digital technologies are an essential ingredient of the energy transition and can support the new panorama of the service-oriented energy system responding to new expectations of the customers for high quality and personalised services. The roll-out of smart meters and smart metering infrastructure in Europe will open up wide opportunities for connecting the smart homes, smart buildings and industry 4.0 with the energy grids. Recent studies estimate that digitisation of products and services can add more than €110 billion of annual revenue in Europe in the next five years.

Big data and data analytics, AI, IoT, and smart grids have great potential to improve productivity, efficiency, competition and sustainability of energy systems delivering value to each segment of the power sector as wholesale and retail markets, transmission and distribution networks.

5G

In the near future, our digital economy and society in the next decade will be based on 5G, the "fifth generation" of telecommunication systems. 5G will provide connectivity not only to individual users but also to connected objects and will serve

a wide range of applications and sectors including professional uses, such as energy management.

5G will foster digital development with the support of Artificial Intelligence and Cloud Computing systems by enabling the distribution of computing and storage throughout the infrastructure.

The deployment of 5G is expected to generate €213 billion in revenues worldwide in 2025 and could lead to €113 billion in benefits per year across these sectors: automotive, health, transport and energy. EU investment in 5G research and standards is necessary to support the traffic and to boost networks and Internet architectures in emerging areas such as Machine-to-Machine (M2M) communication and the IoT.

In 2013, the European Commission established a Public Private Partnership on 5G (5G PPP) to accelerate research and innovation in 5G technology. The Horizon 2020 Programme has been supporting this activity with a public funding of EUR 700 million, with a great impact on EU industry.

The Commission adopted in 2016 a 5G Action Plan for Europe, to launch 5G services in all EU Member States by end 2020, and launched the monitoring tool "European 5G Observatory" to report on the spectrum auctions and national 5G strategies elaborated by MSs.

In the energy sector, 5G technologies facilitate energy efficiency solutions as well as renewable energy and distributed generation integration, playing a fundamental role for balancing activities. Moreover, they enable the connection between smart home devices and smart grids, and offer advanced connectivity infrastructure for smart city initiatives (5G PPP).

The physical infrastructure will need to support a two-way energy flow originating from the distributed energy resources, which in turn implies new needs for communication technologies, intelligence, business models and market structure.

The deployment of 5G networks requires the timely availability of a sufficient amount of harmonised spectrum. The EU has powers to define technical aspects of spectrum use, but MSs decide when it is made available to mobile operators in their territory and under what conditions.

Member States and the Commission, working together in the Radio Spectrum Policy Group (RSPG), have recognised the importance of the early identification of common EU-wide pioneer spectrum bands to enable 5G take-up as early as in 2018. This is indispensable to give proper guidance to industry and keep the EU on a par with spectrum availability in other regions of the world.

This first set of such pioneer bands should include a mix of spectrum with different characteristics to address the versatile 5G requirements. The spectrum mix should include:

- Spectrum below 1 GHz (*700 MHz band*): its availability by 2020, as proposed by the Commission (Decision 2017/899), is critical for 5G success and will form the foundation of the wide-area coverage for 5G for rural areas and building penetration
- Spectrum between 1 GHz and 6 GHz (*3.5 GHz band*) offers a high potential to become a strategic band for 5G launch in Europe. On 24 January 2019, the European Commission adopted an Implementing Decision (Decision

2019/235) to harmonise the radio spectrum in the 3.4-3.8 GHz band. The 3.5 GHz band can carry a significant amount of traffic and is more suited to the small antennas that are necessary in devices carried about the person, such as smart phones and watches

- Spectrum above 6 GHz, i.e. super high frequency 24-28 GHz (*26 GHz band*) can carry the vast amounts of data forecast to be necessary for the densities supported by 5G, but they are easily blocked by obstructions and do not travel very far within the earth's atmosphere. The major limit of high-band is that it has low coverage area and building penetration is poor. On 14 May 2019, the Commission adopted an Implementing Decision (Decision 2019/784) to harmonise the radio spectrum in the 24.25-27.5 GHz (or 26 GHz) band, which is a big leap towards the deployment of 5G across Europe

The Implementing Decision of May 2019 finalizes the EU-wide coordination of all three pioneer bands (700 MHz, 3.6 GHz and 26 GHz) needed for 5G rollout in the Member States. Following this decision, MSs can set common technical conditions and allow the use of the 26 GHz band by 31 December 2020.

Internet of Things (IoT)

The IoT technology represents the next step towards the digitisation of our society and economy. The connection between objects and the internet through communication networks will have a great impact on industry, organisations and academic institutions, and it will address many societal challenges including climate change and energy efficiency.

According to European Commission, the market value of the IoT in the EU is expected to exceed one trillion euros in 2020 and the number of connected devices, such as household equipment, wearable electronics, vehicles and sensors is expected to exceed 20 billion by 2020.

The Internet of Things (IoT) has already started to make a clear impact in the energy sector by cutting O&M costs through system modernisation and predictive maintenance models and by creating more connected homes and buildings leading to energy savings and increased safety levels.

Tangible business opportunities for the IoT, cloud and data analytics technologies can be found across all the "smart environments" identified in the energy sector.

Smart homes constitute a clear business opportunity thanks to the widespread use and affordability of smart devices. The IoT is already enabling a wide range of home automation solutions making homes a "mini IoT environment". Home automation solutions, including centralized control of lighting, heating, ventilation and air-conditioning and remote control of appliances, are already a reality and, to some extent, an established market. Smart homes may also adapt energy consumption based on dynamic tariffs and optimise the management of self-consumption, storage and feed-in to the grids.

The availability of cheap connected IoT sensors is the basis for more refined and decentralised real-time monitoring. It enables accurate measurements and forecasting and contributes to the adoption of renewable energy, which requires controls with faster reaction times and needs to be balanced with flexibility of generation, active demand and storage.

In this context, the smart city is becoming one of the biggest fields of application for IoT technologies. Cities are increasingly filled with devices equipped with sensors, actuators and other appliances providing information about various parameters of importance to management, such as information about public transport, traffic intensity, environmental data, occupancy of parking spaces and energy consumption in public buildings.

IoT technology merges the distinct pillars of the modern city (energy, mobility, buildings, water management, lighting, waste management, environment) into a structured, interconnected ecosystem. These technologies should integrate robust respect security features as well as privacy by design and by default, reduce cost, emissions and energy consumption while being reliable, long lived, future proof and scalable. The aim is to create a city centric ecosystem to increase the efficiency of the city.

In March 2015, the European Commission launched the Alliance for Internet of Things Innovation (AIOTI), the largest European IoT Association, to work closely with all IoT stakeholders and actors involved in the establishment of a competitive European IoT market. Since 2015, the Commission adopted a set of supporting measures to accelerate the integration of IoT for the benefit of European citizens and businesses.

As part of the "Digitising European Industry" initiative, the Commission published in April 2016 the staff working document "Advancing the Internet of Things in Europe" (SWD 2016/110) to avoid fragmentation and to foster interoperability for IoT. The EU's IoT vision is based on three main pillars: a single market for IoT, a prosperous IoT ecosystem and a human-centred IoT approach.

The "European Data Economy" initiative contributes to the creation of a European single market for IoT by handling a large diversity and large volumes of connected devices. In 2018, the Commission published a document (SWD 2018/137) to provide a first map of liabilities to fully benefit from IoT products and services. The aim is to provide answers to the questions brought by the creation of a big connected environment, mainly related to technical and semantic interoperability, and to the complexity of programming systems to integrate device and service providers to deliver IoT solutions.

Security, liability, privacy and data protection are critical challenges for IoT deployment, with users' trust for private, business or governmental use the biggest challenge for IoT acceptance. In response to such emerging challenges, operators using the IoT should adopt trusted IoT label as a demonstration of compliance to the NIS Directive's requirements for consumer products, providing transparency about different levels of privacy and security.

An important issue related to security and data protection is secure authentication. Networked devices that exchange data with other IoT devices need to be properly authenticated to avoid security problems.

In the smart home ecosystem, poor security measures in the design of connected devices may expose them to cyber-attacks. In absence of a contractual relationship to cater for cyber-attack damages, courts could impose tort liabilities on businesses for the harm that a cyber-attack causes to third parties.

Artificial Intelligence (AI)

The potential of Artificial Intelligence (AI) powered systems is immense and not yet fully known or predictable at this stage. AI applications and systems can generate autonomous decision-making and behaviour in the physical environment in which they operate including physical contact with humans and their property. This inevitably carries an inherent risk of causing damage to a third party's physical integrity or property.

In the energy sector, AI can have several interesting applications in both retail and trading areas, all linked to AI-enabled predictability. AI solutions can optimise investment and permit fault prediction by predictive maintenance of devices. In terms of energy efficiency, AI can forecast energy demand of the system while enabling customers to interact with devices, leading to a more personalised usage profile. In the trading area, machine learning solutions predict asset availability and market prices in near real time.

To build robust models at the core of AI-based systems, high quality data is a key factor to improve performances. The Commission adopted a legislation to improve data sharing and open up more data for re-use. It includes public sector data as well as research and health data (see section 'Data Economy').

AI could boost EU's research and industrial capacity by dealing with technological, ethical, legal and socio-economic aspects. In this context, the Commission adopted a common European approach to ensure competitiveness and technological progress with the aim to put AI at the service of European citizens and economy.

On 25 April 2018, in its Communication "Artificial Intelligence for Europe" (COM 2018/237), the European Commission decided to increase annual investments in AI by 70% under the research and innovation programme Horizon 2020. It will connect and strengthen AI research centres across Europe, support the development of an "AI-on-demand platform" that will provide access to relevant AI resources in the EU for all users, and promote the development of AI applications in key sectors, such as energy, financial services and construction.

The Commission aspires to prepare MSs to socio-economic changes brought about by AI, by supporting business-education partnerships to develop digital skills and competences, in accordance with the labour market changes. The Commission aims to develop an appropriate ethical and legal framework ensuring GDPR compliance and legal clarity in AI-based applications. The final Ethics Guidelines for Trustworthy Artificial Intelligence prepared by the High-Level Group on Artificial Intelligence published on 8 April 2019 will constitute the legal bases for the AI systems development.

On 10 April 2018, 25 European countries signed a Declaration of cooperation on Artificial Intelligence. It builds further on the achievements and investments of the European research and business community in AI.

On 7 December 2018, the European Commission and the Member States published a "Coordinated Plan on Artificial Intelligence" (COM 2018/795) in order to promote the development of AI in Europe. The Coordinated Plan aims to make the most of the opportunities offered by AI, ensure the respect of European values and address new challenges brought by AI through cooperation between MSs.

On 8 April 2019, the Commission launched the Communication on "Building Trust in Human-Centric Artificial Intelligence" (COM 2019/168) putting European values are at the heart of creating the right environment of trust for the successful development and use of AI. Such development shall be compliant with laws and regulations, respectful of European ethical principles and values, and technically and socially robust.

Blockchain

Blockchain technology is the best-known Distributed Ledger Technology (DLT), developed for financial applications such as electronic currency and decentralised data storage systems. It avoids one centralised location and the need for intermediaries to perform transactions. Information stored on a blockchain is at the same time shared, verifiable, public and accessible. Blockchain technologies have evolved in many directions: there are both public, permissionless blockchain networks, in which anyone can read the data and become part of the network or act as a validator, and private, permissioned blockchains, which limit the access to a set of registered participants or validators (EU Blockchain Observatory, 2018).

Blockchain technology may bring great improvements for the European industry, administrations and citizens. It can enable the provision of more efficient services and the emergence of new ones by improving business processes in governments, companies and organisations. Blockchain is primarily known for cryptocurrency applications, but the development of such technology has the potential to provide solutions to some of the challenges faced by the energy industry (M. Andoni, V. Robu, D. Flynn, S. Abram, D. Geach, D. Jenkins, P. McCallum, A. Peacock, 2018).

In the energy sector, blockchain technologies can reduce costs by optimising energy processes, improve energy security, especially concerning security of supply, and promote renewable generation and low-carbon solutions. Peer-to-Peer (P2P) networks and smart contracts execution are application domains of blockchain-enabled systems, which encourage end-consumers and prosumers participation in local energy markets (E. Mengelkamp, J. Gärttner, K. Rock, S. Kessler, L. Orsini, C.Weinhardt, 2018) by providing innovative trading platforms. Blockchain open and transparency solutions promote competition and facilitate consumer mobility and switching by supporting smart grid interoperability and IoT development (Mattila J., 2016).

For TSOs and DSOs, the use of blockchain can enhance their capacity to record more precisely the use of their network, allowing the exact collecting of network fees, and provide peer-peer transactions data to better manage the capacity and power flows on their network.

In May 2017, in the Digital Single Market mid-term review, the Commission recognised the potential of blockchain-inspired technologies for EU administrations, businesses and the society in general (COM 2017/ 228). For this reason, the European Commission has engaged in a continuous dialogue with blockchain constituencies, including organisations that envisage the use of such technologies and are running proof of concepts or pilots.

In February 2018, the European Commission launched the EU Blockchain Observatory and Forum and has already invested in projects supporting the use of blockchain in technical and societal areas. The EU Observatory monitors technology developments

and inspire common actions by making recommendations on the role the European Union could play in blockchain. Its aims is to produce a comprehensive source of blockchain knowledge by sharing information and opinions.

Since April 2018, 26 Member States plus Norway and Liechtenstein agreed to sign a Declaration creating the European Blockchain Partnership (EBP) and established a European Blockchain Services Infrastructure (EBSI) to support the delivery of cross-border digital public services, with the highest standards of security and privacy. As per the mandate of the Joint Declaration signed on 10 April 2018, the Partnership will complete the identification of use-cases where blockchain technology can be an added-value and will set Guiding Principles and Specifications to describe the overall policy and technical governance of the EBSI.

On 6 March 2019, the EU Commission facilitated the foundation of the International Association for Trusted Blockchain Applications (INATBA). The 105 founding members are organisations in Europe, North America and Asia. They together will work through INATBA on establishing a dialogue with public authorities and regulators to foster a convergence of the legal frameworks applying to the distributed network economy.

Some of the key security challenges associated with the cloud can be addressed by using the decentralized, autonomous, and trustless capabilities of DLT. Blockchain ensures that each party is held accountable for its individual roles in the overall transaction and thus prevents disputes. In particular, blockchain's decentralized and consensus-driven structures are likely to provide a more secure approach when the network size increases (Kshetri, 2017).

Blockchain technologies have an immediate applicability in terms of security across different industry sectors. It can be used to secure and fight cyber-attacks to critical infrastructure, including companies that support energy distribution, telecommunications, and financial services (S. Shakelford, S. Myers, 2017). With reference to the implication for the energy sector, blockchain technologies can also be applied to IoT, by eliminating the usage of centralised devises. As a consequence, it can enhance the security of smart appliances and supply chain sensors (D.Puthal, N. Malik, S.P. Mohanty, E. Kougianos, C. Yang,).

The EU allocated EUR 141 million to blockchain related projects, and potentially up to EUR 340 million could be committed before the end of 2020. Under the Leadership in Enabling and Industrial Technologies (LEIT) research programme, a Collective Awareness Programs for Sustainability and Social Awareness (CAPS) project has pioneered research on blockchain technologies.

Data Protection

General Data Protection Regulation (GDPR)

The Commission adopted the General Data Protection Regulation (GDPR) (Regulation 2016/679), recasting the previous rules provided by the directive 95/46/EC, to ensure trust and security in data management activities in the European Union. The provisions protect fundamental rights and freedoms of natural persons and in particular their right to the protection of personal data. The Regulation plays a fundamental role in dealing with activities such as collection and usage of consumption data. GDPR has important implications for the energy sector, in terms

of energy data management, due to smart meters deployment and energy data monitoring.

The instructions apply to the processing of personal data regardless of whether the processing takes place in the Union or not. Citizens are given more control over their personal data and data related right are granted. Consumers are entitled to an easier access to their data, a new right to data portability, a clearer right to erasure personal data, the 'right to be forgotten' and the right to know when their personal data has been hacked. In particular, companies and organisations have the obligation to inform individuals promptly of serious data breaches and notify the relevant data protection supervisory authority. The same rules applies when non-EU companies offer services or goods, or monitoring behaviour of individuals within the EU. The Commission also lays down privacy-friendly techniques such as pseudonymisation, when identifying fields are replaced by artificial identifiers, and encryption, when data is coded that only authorised parties can read it. Lastly, the new data protection rules will cut most notification obligations and the costs associated.

The GDPR entered into force since the 25th of May 2018. The Commission is expected to report on the evaluation and review of the regulation by 25 May 2020.

GDPR and smart meters

Data Protection Impact Assessment (DPIA) Template

Related to smart grids, the European Commission collaborated with the EC Smart Grid Task Force to develop a Data Protection Impact Assessment (DPIA) Template for smart grid and smart metering systems (Recommendation 2014/724). The objective is to guarantee protection of personal data throughout the EU, while the requirement to perform data protection impact assessments is included in the GDPR. The Template is an evaluation and decision-making tool that helps entities planning or executing investments in smart grids to identify and anticipate risks to data protection, privacy, and security and will help industry identify data protection risks in smart grid developments from the start.

The DPIA test phase was initiated in 2014 and continued for two years. The GDPR focuses on the protection and processing of personal data, so that the document focuses on the protection of personal data, including processing, usage, storage, and accuracy.

The DPIA Template is addressed to Smart Grid operators (Distribution System Operators, Generators, Suppliers, Metering Operators, Energy Service Companies). Since the collection and usage of Personal Data (e.g. household consumption, usage data) is one of the key business enablers for Smart Grid operators, they are very likely to be subject to GDPR obligations as Data Controllers.

The Template, albeit itself non-compulsory, will serve as an evaluation and decision-making tool of supporting Smart Grids operators in complying with the GDPR, implementing privacy by design principle, carrying out risk management processes or other voluntary commitments. The Template is also expected to contribute to coherent application of the GDPR across Member States and to promote a common methodology for adequate Personal Data processing for Smart Grids operators.

The Template defines the necessary process steps to find appropriate controls attributed by examples of controls measures and helps monitoring Smart Grid

application from the start. Data Controllers in the Smart Grid environment that apply the Template may take competitive advantage by providing trust and gaining reputation for their commitment to Personal Data Protection.

GDPR and IoT

IoT systems generate, handle, collect and combine data from different sectors and sources. The Commission services consider that it is essential to facilitate the flow and transfer of data across every processing step. To allow for flexible and interoperable systems, data should be made available, accessible and easily aggregated, processed, as well as trusted, thus combining quality, reliability and security.

One possible obstacle to data flow and access can be the concept of data ownership, because data generated by an IoT device is not always the property of the owner of the device or of the owner of the sensors. The Commission services are analysing existing business models to better understand 'ownership' models and the contractual conditions under which access is given to data and data are transferred. Data ownership may also lead to obstacles in accessing data. Some public services may in the future increasingly rely on access to data that is privately-owned.

Current contractual arrangements may lead to restrictions in relation to data sharing with third parties, or to lock-in situations, dynamics that are very relevant during the stages of data processing when IoT data are transformed into valuable data.

There is a need to further explore whether access and re-usability of privately-owned data used for public policy objectives should be guaranteed by law and under which conditions of remuneration, like it has been decided for the public sector information through the PSI directive.

In order to advance the IoT in Europe, IoT design must comply with the GDPR, which aims to increase trust in digital services and IoT, by defining the principle of 'data protection by design and by default'. It is expected to incentivise businesses innovation, methods, and technologies for security and protection of personal data.

The GDPR promotes techniques such as anonymization, pseudonymisation and encryption to protect personal data to encourage the use of IoT. Moreover, the new regulation highlights the adoption by the IoT industry of specific data protection codes of conducts and certification schemes, and the development and elaboration of new Data Protection Impact Assessment frameworks and guidance. In addition, the Commission and Member States will support industry involvement in research and development activities for privacy by design and by default technologies and solutions.

Special data protection rules apply to electronic communications services directive (e-Privacy Directive) which is in the process of being reviewed, in particular to adapt it to the new general data protection framework and to ensure consistency with the GDPR.

GDPR and AI

The GDPR introduces a number of guarantees, protecting individuals and strengthening the role of consent for the processing of personal data. It endorses a principle of data minimisation, limiting the use of data to the purpose for which they

have been collected. It promotes transparency of data processing and establishes a right of explanation for the subjects of a decision based on automated process.

These principles may, at first, seem to limit the scope of AI development in Europe. Yet, the GDPR gives businesses incentives to find innovative solutions to process data while respecting GDPR provisions.

GDPR compliance have been provided by different types of solutions, such as local data processing on data subjects' devices, as envisaged in the '*GoFair*' project, and secure data sharing through a workflow tool that automatically anonymises and adapts changing datasets, used by a UK start-up called *Anon*.

More generally, the principle of accountability enshrined in the GDPR is set to foster the accuracy of data, and increase trust and reliability of results. Studies show that mature information governance is a determinant of business success and data protection can been seen as an enabler, not a barrier, to innovation.

The respect for the privacy of users, promoted by the European Commission, would increase the acceptance of AI technologies by society and emerge as global standard. Big multinational companies are likely to adopt GDPR-compliant business models worldwide, rather than operating different models in different regions. People around the world are becoming more concerned about the potential misuse of their data.

GDPR and Blockchain

As the set of provisions on personal data protection laid down in the GDPR was conceived and written before blockchain technology was widely known, many of them seem to be in contrast with blockchain's decentralised approach to data storage. Public, permissionless blockchain represent the greatest challenges in terms of GDPR compliance, because of their distributed nature.

The first point of tension between GDPR and blockchain comes from the fact that information can only be added and not erased, while GDPR ensures to data subjects the right of data erasure and rectification.

The identification of the 'data controller' can constitute another source of tension: GDPR aims to ensure the possibility to identify the person or entity with ultimate responsibility for data usage. While in private, permissioned blockchain networks, the identification of the data controller is possible, in the case of public, permissionless blockchain networks, it becomes more difficult. Private blockchain networks are generally operated by consortiums of companies or government agencies, which can impose strict data processing rules by making all participants commit to a set of terms and conditions. However, contractual terms and conditions do not constitute a legitimate reason to see the data of each subject.

Moreover, GDPR requires that data can only be transferred to third parties outside the EU if the location in question offers equivalent levels of protection as those found in Europe, but in many permissionless blockchains, it is not possible to selectively limit where the data goes.

The blockchain technology, by design, automatically processes information and replicates the full data set throughout the network, which clashes with the GDPR's right to avoid the automatic processing of personal data. The GDPR stipulates that data subjects have the right to be informed about such processing and that they have the right to request human intervention or challenge a decision made by a machine.

For these reasons, the way lawmakers will reconcile GDPR provisions and blockchain technologies will have huge impacts on entrepreneurs and blockchain-based platforms and application designers. The blockchain technology is at a stage where the foundations are still being built, so that some of these foundations will be able to incorporate GDPR provisions over time. Therefore, as blockchain evolves, it may be possible to find ways to make the technology GDPR compliant.

Consumer rights and protection

Although the EU already has some of the strongest rules on consumer protection in the world, the review of EU consumer rules and recent EU-wide breaches of these rules showed that it is difficult to enforce them fully in practice and that there was still room for improvement to better protect consumers.

The rights the EU has put in place for consumers delivered real benefits both to citizens and businesses through major pieces of legislation governing consumer rights, unfair commercial practices and unfair contract terms. This has given both European citizens and businesses a high level of protection and certainty, but the marketplace is changing fast.

The need to modernise some consumer protection rules and strengthen the level of compliance has been confirmed by a large-scale evaluation of rules on consumer protection finalised by the Commission in 2017, i.e. REFIT 'Fitness Check' (SWD 2017/209) and Consumer Rights Directive evaluation. The evaluation concluded that EU consumer protection rules have helped the operation of the Single market and provided a high level of consumer protection. They are fit for purpose overall but must be better applied and enforced. The evaluation also identified areas where EU consumer law could be updated and improved.

Consumer rights and protection have been a central theme in several initiatives under the 10 Commission priorities for 2015 -2019, such as the Energy Union and the Digital Single Market strategy.

Energy consumer empowerment is a core principle of the Energy Union strategy, under which, on 15 July 2015, the Commission presented a proposal for delivering a "New Deal for Energy Consumers" (COM 2015/339) to reinforce consumer rights in the energy market.

The proposal is based on a three-pillar strategy:

1. helping consumers save money and energy through better information;
2. giving consumers a wider choice of action when choosing their participation in energy markets;
3. maintaining the highest level of consumer protection.

Consumers need to become just as well-informed and empowered as buyers and sellers on wholesale markets through clearer billing and advertising rules, trustworthy price comparison tools and by leveraging their great bargaining power through collective schemes (such as collective switching and energy cooperatives). Finally, consumers need to be free to generate and consume their own energy under fair conditions in order to save money, help the environment, and ensure security of supply.

Consumer interests have been a central theme in the Digital Single Market strategy, which brought about several legislative initiatives to end mobile phone and data roaming charges and ban unjustified geoblocking, so that consumers can access or purchase products or services from a website based in another Member State, and ensure cross-border portability of online content services.

Under the Digital Single Market Strategy, the Commission has delivered on many initiatives that adapt consumer rules to the online world, for instance by putting an end to roaming charges or unjustified geoblocking. In addition, the new Consumer Protection Cooperation Regulation (Regulation 2017/2394), adopted in 2017 and applicable as on 17 January 2020, will improve the public enforcement and cross-border cooperation of consumer authorities.

Finally, an agreement has been reached on the digital contracts proposals, a central element of the Digital Single Market strategy aiming to modernise consumer contract rules for the supply of digital content (COM 2015/634) and for the sale of goods (COM 2015/635).

New Deal for Consumers

In order to ensure a fair Single Market for both consumers and businesses for the future years and address the related challenges, the Commission committed to deliver a 'New Deal for Consumers'. It is recognized that better enforcement of the rules, effective tools for redress and better consumer knowledge of their rights will enhance consumer trust and confidence.

The 'New Deal for Consumers' builds on the existing consumer policy framework and takes it a step further by proposing modern rules fit for today's changing markets and business practices, stronger public and private enforcement tools and better redress opportunities.

In practice, the 'New Deal for Consumers' aims to:

- modernise existing rules and fill the gaps in the current consumer *acquis*;
- provide better redress opportunities for consumers, support effective enforcement and greater cooperation of public authorities in a fair and safe Single market;
- ensure equal treatment of consumers in the Single market and guarantee that national competent authorities are empowered to tackle any problems with 'dual quality' of consumer products;
- improve communication and capacity-building to make consumers better aware of their rights and help traders to comply more easily with their obligations;
- look at future challenges for consumer policy in a fast evolving economic and technological environment.

To achieve the above goals, on 11 April 2018, the Commission adopted the "New Deal for Consumers package", which proposes changes to the legislative framework (two proposals for Directives) complemented by a set of non-legislative actions, as set out in its Communication (COM 2018/183).

The legislative package is composed of the following two instruments:

- A proposal on representative actions for the protection of the collective interests of consumers and repealing the Injunctions Directive 2009/22/EC

(COM 2018/184). This proposal aims to improve tools for stopping illegal practices and facilitating redress for consumers where many of them are victims of the same infringement of their rights, in a mass harm situation;

- A proposal to amend Council Directive on unfair terms in consumer contracts, Directive on consumer protection in the indication of the prices of products offered to consumers, Directive concerning unfair business-to-consumer commercial practices and Directive on consumer rights (COM 2018/185). This proposal's aim is to ensure better enforcement and to modernise EU consumer protection rules, in particular in light of digital developments.

A clear and trusted service can support the development of price comparison tools and empower energy consumers (ACER/CEER, 2018). The proposed online marketplace requirements represent a great opportunity for consumers allowing them to contract a new supplier online, reinforcing the importance of online protections, which work alongside the requirements for price comparison tool identified in the Directive on common rules for the internal market of electricity (CEER, 2018).

On 2 April 2019, the European Parliament and the Council have reached a provisional agreement on stronger and better enforced consumer protection rules.

Annex II – Summary of Policy Scenarios

BAU Scenario

Policy actions by 2020

UC	KI #	Key issue	Topic	Policy action
10	2	**The cooperation between TSOs and DSOs**	The obligation to consult on the implementation of the Regulation (EU) 2017/2195	Obligation to consult with relevant DSOs and take account of potential impacts on their system when applying the Regulation (EU) 2017/2195 – *Balancing Guideline (art. 3)*
			The cooperation in the provision of flexibility services	Obligation to cooperate for TSOs and DSOs to ensure the efficient and effective provision of balancing services - *Regulation (EU) 2017/2195 (art. 15)*
			The elaboration of a joint methodology for the allocation of costs resulting from the provision of active power reserves	Obligation to elaborate a joint methodology for the allocation of costs resulting from the provision of active power reserves - *Regulation (EU) 2017/2195 (art. 15)*
			The monitoring of implementation of the network codes and guidelines	Institution of the so-called EU DSO entity with the obligation to cooperate with the ENTSO-E with respect to several subjects such as, among others, the monitoring of implementation of the network codes and guidelines adopted [pursuant to the Regulation] with respect to the operation and planning of distribution grids and the coordinated operation of the transmission and distribution networks – *Electricity Regulation (art. 55).*
			The cooperation in the network planning and operation	Obligation for the DSOs to exchange of all the necessary information and data the performance of generation assets and demand side response, the daily operation of the networks and the long-term planning of network investments, with the view to ensure the cost-efficient, secure and reliable development and operation of their networks - *Electricity Regulation (art. 55)*

UC	KI #	Key issue	Topic	Policy action
			The coordinated access to resources connected at the distribution level	Obligation to establish a coordinated access to resources such as distributed generation, energy storage or demand response that may support particular needs of both DSOs and TSOs - *Electricity Regulation (art. 57)*
			The coordination between DSOs, TSOs (and Significant Grid Users) in the definition of the applicability and scope of data exchange concerning distribution-connected power generating facilities	Obligation for DSOs and TSOs to determine the applicability and scope of structural data, scheduling and forecast data with respect to distribution-connected power generating facilities" (art. 40) – *SO GL (art. 40; 48; 49; 50)*
			The coordination between DSOs, TSOs (and Significant Grid Users) in the definition of the applicability and scope of data exchange concerning distribution-connected demand facilities.	Obligation for DSOs and TSOs to TSOs to determine the applicability and scope of data concerning forecasted, available and real-time active power for the demand-response with respect to distribution-connected demand facilities" (art. 40) - *SO GL (art. 50; 53)*
			The coordination between DSOs and TSOs with respect to the delivery of active power reserves	Obligation for TSOs and DSOs to cooperate in order to facilitate and enable the delivery of active power reserves by reserve providing groups or reserve providing units located in the distribution systems - *SO GL (art. 182)*
			Key Organisational Requirements, Roles and Responsibilities (KORRR) relating to Data Exchange	Approved proposal of all TSOs about the key organisational requirements, roles and responsibilities in relation to data exchange regulated by the SO GL (art. 40; 48-53) - *KORRR*
10	1	**A more active role of DSOs in the provision of flexibility services**	The adoption of a regulatory framework covering all the reasonable costs of DSOs for the procurement of flexibility services from all the existing resources	Adoption of a regulatory framework providing incentives to distribution system operators to procure flexibility services, including congestion management in their areas, from all the existing resources in a cost-effective way and the adequate remuneration of DSOs for the procurement of such services: reasonable corresponding costs, including the necessary information and communication technology expenses and infrastructure costs – *Electricity Directive*

UC	KI #	Key issue	Topic	Policy action
			The adoption of an incentive-based regulatory framework for DSOs to procure flexibility services	Adoption of a regulatory framework providing incentives to transmission system operators and distribution system operators, over both the short and long run, in order to facilitate innovation in areas such as digitalisation, flexibility services and interconnection - *Electricity Regulation* (art. 18)
			The adoption of a long-term network development plan	The establishment of the obligation to define a network development plan illustrating the needed investments encompassing a time-horizon from five to ten years - *Electricity Directive* (art. 32)
			The coordination between DSOs and TSOs in the procurement of flexibility services	The obligation of coordination between DSOs and TSOs and other relevant market participants for the procurement of products and services necessary for the efficient, reliable and secure operation of the distribution system - *Electricity Directive (art. 31 and 32)*
10 3 3	2 3 4	**Specifications of the products for balancing services**	The settlement of imbalances	Adoption of a methodology for the pricing of imbalances able to reflect the real-time value of energy and create positive positive incentives for market participants in keeping their own balance or helping to restore the system balance in their imbalance price area, thereby reducing system imbalances and costs to society – *Regulation (EU) 2017/2195 (art. 17, art. 55).*
			Characteristics of products for flexibility services	Flexibility services shall facilitate the participation of demand facility owners, third parties and owners of power generating facilities from renewable energy sources as well as owners of energy storage units as flexibility service providers. TSOs and DSOs shall define terms and conditions to allow the aggregation of demand facilities, storage and power generation facilities – *Regulation (EU) 2017/1195 (art. 25, 18, 32)*
			Efficiency in congestion management	Obligation for DSOs and TSOs of a reporting activity towards the competent regulatory authority with respect to the characteristics, level of development and effectiveness of market-based redispatching mechanisms and to take appropriate grid-related and market-related operational measures to minimize downward redispatching - *Electricity Regulation (art. 13).*
			Prequalification criteria for the provision of flexibility services	The obligation for TSOs and DSOs to define technical requirements for the participation, for the provision of flexibility services, of market operators selling energy from renewable sources, engaged in demand

UC	KI #	Key issue	Topic	Policy action
				response, operating energy storage facilities or engaged in aggregation - *Electricity Directive (art. 31, art. 40)*
10	3	**The role of aggregators in procuring flexibility services**	The role of independent aggregators	Market participants engaged in aggregation of customers and not affiliated to customers' suppliers represent an advantage for promoting demand response services - *Electricity Directive (§39, art. 17)*
			A consistent regulatory framework for aggregators	Obligation for MSs to foster participation of demand response through aggregation and establish a transparent and non-discriminatory access of both aggregators and customers to wholesale and retail markets. Obligation for TSOs and DSOs to treat market participants engaged in the aggregation of demand response in a non-discriminatory manner, in the procurement of flexibility services, alongside producers based on their technical capabilities - *Electricity Directive (art. 17)*
			The role of suppliers in promoting aggregators	Right of customers to be free to purchase and sell electricity services including aggregation independently from their electricity supply contract and the consent of electricity undertakings. Suppliers shall be prevented by imposing discriminatory technical and administrative requirements, procedures or charges to consumers on the basis of whether they have a contract with a market participant engaged in aggregation - *Electricity Directive (art. 13, art. 17)*
			The right of customers in the engagement with aggregators	Right of active customers to a non-discriminatory treatment – in the form of "disproportionate or discriminatory technical requirements, administrative requirements, procedures and charges, and not cost-reflective network charges - *Electricity Regulation (art. 12)*
10	1	**The access to consumption and production data**	The right of customers to access data	Obligation for Member States to ensure the right to customers to be entitled to receive all relevant demand response data or data on supplied and sold electricity at least once per year" and free of charge. Right of customers to receive metering data on their electricity input and off-take via a local standardised communication interface and/or remote access, or to a third party acting on their behalf, in an easily understandable format and able to allow the comparison of deals on a like-for-like basis – *Electricity Directive* (art. 13, art. 20)
			The access to data by third eligible parties	Right for third eligible parties to access data with the explicit consent of final customers – *Electricity Directive* (art. 23)

UC	KI #	Key issue	Topic	Policy action
			The adoption of interoperability standards	Obligation for Member States to define interoperability standards a transparent procedure for eligible parties to have access, in a transparent and non-discriminatory way, to the data on metering and consumption data as well as data required for customer switching, demand response and other services - *Electricity Directive* (art. 23)
14	1	**Customer privacy and data protection**	GDPR and e-Privacy rules	Progress in the opinion adopted by the European Data Protection Authorities (DPAs) on the interplay between the e-Privacy Directive and GDPR on e-communication data
			Qualification of final customer energy related data.	Adoption across MS of different interpretations about which smart meter data, for which purposes and under which restrictions should be used in compliance with GDPR.
			Smart meters data management and allocation of responsibilities	Application of relevant definitions and allocation of the roles and responsibilities related to data management at MS level.
			Rights of the data subject	Adoption at MS level of the data protection measures required as a set of minimum functionalities to be integrated in all smart metering systems.
12	3	**Interoperability between connected devices**	Interoperability between energy management and smart metering systems	Adoption at MS level of standards and best practices to guarantee smart metering systems interoperability, in particular with consumer energy management systems and with smart grids - *Electricity Directive* (Art. 19 (3))
			Interoperability requirements and procedures for access to data	Development of national strategies aimed at facilitating the full interoperability of energy services within the EU - *Electricity Directive* (Art. 24 (1))
14	2	**Cybersecurity of ICT products**	Supervisory role of national competent authorities	Member States have to designate one or more national competent authorities to monitor the application of the NIS Directive at national level
			Management of incidents	Member States shall have well-functioning Computer security incident response teams (CSIRTs) to deal with incidents and risks and ensure efficient cooperation at Union level
			The reinforcement of ENISA's role	The Cybersecurity Act reinforces the role and responsibilities of ENISA as the EU's centre of advice and expertise with regard to cybersecurity matters

UC	KI #	Key issue	Topic	Policy action
			EU cybersecurity certification	The creation of an EU certification framework with a view to creating a digital single market for ICT products, ICT services and ICT processes
9	2	**Cybersecurity of energy critical infrastructures**	Common definition of OES	Definition of the criteria for their identification and this includes energy critical infrastructures
			The security and notification requirements	Essential services operators shall take appropriate technical and organisational measures to manage the risks posed to the security of network and information systems, which they use in their operations
			Common Cybersecurity schemes	To create European cybersecurity certification schemes information systems used by operators of essential services should be taken into consideration
			Data security and smart meters	MSs have to implement smart metering systems in accordance with European standards and the security of the smart metering systems to ensure the highest level of cybersecurity protection while bearing in mind the costs and the principle of proportionality
			The Cybersecurity code	The Commission can adopt delegated acts in the form of network codes or guidelines on cybersecurity
			The role of an EU DSO entity on cybersecurity	Close cooperation with transmission system operators and ENTSO for electricity to establish a European entity of distribution system operators in the Union ("EU DSO entity"). Amongst its tasks there are data management, cyber security and data protection

Consistent Governance Scenario

Policy actions by 2030

UC	KI #	Key issue	Topic	Policy action
10	2	**The cooperation between TSOs and DSOs**	The obligation to consult on the implementation of the Regulation (EU) 2017/2195	Adoption of NRA decisions establishing the areas for which the cooperation between DSOs and TSOs is required with respect to the implementation of the Regulation 2017/2195, the role and responsibilities of both DSOs and TSOs to this aim and the processes to be implemented to ensure a consistent and effective cooperation.
			The elaboration of a joint methodology for the allocation of costs resulting from the provision of active power reserves	Adoption of NRAs' decisions regulating the following aspects: type of costs to be considered in the allocation process; guidelines for the definition of the methodology to be applied for the allocation and the settlement procedure.
			The monitoring of implementation of the network codes and guidelines	Adoption of NRAs' decisions regulating the following aspects: criteria, role and responsibilities, activities and frequency of the joint monitoring of TSOs and DSOs.
			The cooperation in the network planning and operation	Adoption of NRAs' decisions regulating the following aspects: role and responsibilities of DSOs and TSOs in the definition of the network plan; the types of information to be exchanged between DSOs and TSOs; the activities for which the exchange is required; timing and frequency of the exchange of information and possible common standards in the exchange of information.
			The coordination between DSOs, TSOs (and Significant Grid Users) in the definition of the applicability and scope of data exchange concerning distribution-connected demand facilities.	Adoption of NRAs' decisions aimed at making operational the provisions of the KORRR according to national and regional specificities of the markets involved by the information exchange. NRAs' decision can concern aspects as: frequency and granularity of the data exchange; formats and templates to be used for the data exchange; possible differentiations in the frequency and granularity of data exchange according to the dimension of the concerned demand and power generating facilities; role and responsibilities of DSOs and TSOs in the collection of data from distribution-connected facilities and consequent role and responsibilities in the exchange between the two system operators.
			The coordination between DSOs and TSOs with respect to the delivery of active power reserves	
			Key Organisational Requirements, Roles and Responsibilities	

UC	KI #	Key issue	Topic	Policy action
			(KORRR) relating to Data Exchange	
			The cooperation in the provision of flexibility services	Consultation processes and expert groups involving relevant stakeholders to: collecting knowledge on the state of the art of the regulation, the market design and possible pilot projects ongoing in Member States with respect to the procurement of flexibility services at the distribution level; developing guidelines for the development of pilot projects at the Member State level; developing common knowledge and guidelines for the development of a coordinated approach between TSOs and DSOs in the procurement of flexibility services at the distribution level, according to different possible models.
			The coordinated access to resources connected at the distribution level	
10	1	**A more active role of DSOs in the provision of flexibility services**	The adoption of a regulatory framework covering all the reasonable costs of DSOs for the procurement of flexibility services from all the existing resources	Adoption of NRAs' decisions establishing guidelines on the remuneration of the distribution network: methodology for the identification of Capex to be included in DSOs' RAB; methodology for the remuneration of the RAB.
			The adoption of an incentive-based regulatory framework for DSOs to procure flexibility services	Adoption of NRAs' decisions establishing guidelines on the remuneration of the distribution network: methodology for the identification of Opex to be subject to a RPI-X regulation and of the main features of an output-based building block of regulation; goals and standard of performances with respect to different goals included flexibility.
			The adoption of a long-term network development plan	Adoption of NRAs' decisions establishing guidelines on the remuneration of the distribution network: obligation for DSOs to adopt network plans with a time-horizon of duration from five to ten years with a common format for the development of network plans across EU countries; obligation to perform a Cost-Benefit-Analysis to justify the choice of the investment actions included in the plan; obligation to provide a justification for the link between investments planned and outputs set within the output-based regulatory framework.

UC	KI #	Key issue	Topic	Policy action
			The obligation to procure flexibility services from all the existing resources	Modifications to DSOs' license to introduce the obligation to procure flexibility services from all the existing resources.
10 3 3	2 3 4	**Specifications of products for flexibility services**	The settlement of imbalances	Adoption of a further secondary legislation amending the (EU) Regulation on electricity balancing: establishment of the single pricing as the methodology for the settlement of imbalances.
			Characteristics of products for flexibility services	Adoption of a further secondary legislation amending the (EU) Regulation on electricity balancing: principle of non-discriminatory treatment of all market participants connected at the distribution level with respect to the provision of balancing services in each electricity market; guidelines on the characteristics of the balancing services that can be provided.
			Efficiency in congestion management	Adoption of a further secondary legislation amending the (EU) Regulation on electricity balancing: guidelines and standards with respect to actions and regulatory provisions needed to mitigate the impact of congestions and redispatching measures.
			Prequalification criteria for the provision of flexibility services	Adoption of a further secondary legislation amending the (EU) Regulation on electricity balancing: technical requirements, and other necessary or appropriate requirements, that all market participants connected at the distribution level shall respect to provide balancing services. Requirements shall respect the principle of non-discriminatory treatment.
10	3	**The role of independent aggregators in procuring flexibility services**	The role of independent aggregators	Adoption of a Regulation (EU) establishing guidelines on independent aggregators: detailed and comprehensive definition of independent aggregators.
			A consistent regulatory framework for aggregators	Adoption of a Regulation (EU) establishing guidelines on independent aggregators: detailed definition of the concept of "independence" for aggregators; principles to be followed in the definition of the regulatory framework for the operations of aggregators; rights and obligations and aggregators; criteria for eligibility to operate as aggregators, and their relations with other market participants and network operators.

UC	KI #	Key issue	Topic	Policy action
			The role of suppliers in promoting aggregators	Adoption of regulatory provisions at the Member States' level establishing the obligation for suppliers to not impose discriminatory technical and administrative requirements, procedures or charges to consumers on the basis of whether they have a contract with a market participant engaged in aggregation.
			The right of customers in the engagement with aggregators	Adoption of regulatory provisions at the Member States' level ensuring the right for customers to enter into a contract with an independent aggregator independently from their electricity supply contract and the consent of electricity undertakings and without being subject to undue payments, penalties or undue contractual restriction as well as other discriminatory technical, administrative requirements by their supplier.
10	1	**The access to consumption and production data**	The right of customers to access data. The access to data by third eligible parties The adoption of interoperability standards	Adoption of regulatory provisions at the Member States' level: obligation for suppliers and DSOs to allow final customers to receive all relevant demand response data or data on supplied and sold electricity at least once per year and free of charge. Adoption of regulatory provisions at the Member States' level: identification of third parties entitled to access consumption and production data; definition of prerequisites and conditions to access data; adoption of the principle of non-discriminatory and transparent access to data. Adoption of regulatory provisions at the MS level: adoption of common standard communication interface/or remote access protocols/standards to allow data access for third eligible parties; adoption of interoperability standards and a transparent procedure for eligible parties to have access, in a transparent and non-discriminatory way, to the data on metering and consumption; the right for consumers to obtain metering data on the energy injected and consumed in/from the grid standardised communication interface.
14	1	**Customer privacy and data protection**	GDPR and e-Privacy rules	The Commission should guarantee consistency between e-Privacy and the GDPR rules to secure a high level of privacy protection for customers and legal clarity for businesses.

UC	KI #	Key issue	Topic	Policy action
			Qualification of final customer energy related data.	The Commission should provide a clear definition of energy related data, specifying which of them fall under the scope of GDPR in order to ensure a consistent interpretation across Member States. Then, the Commission should assess the implications on national energy markets.
			Smart meters data management and allocation of responsibilities	The Commission should define a clear guidance at EU level for the allocation of GDPR roles and responsibilities to all actors involved in smart metering systems personal data processing.
			Rights of the data subject	The Commission should define guidelines for MSs in order to guarantee that the "*data protection by design*" principle under the GDPR is respected in the smart metering systems deployment. The guidelines should envision how to integrate the provisions about information and access to metering data in all smart metering systems.
1 2	3	**Interoperability between connected devices**	Interoperability between energy management and smart metering systems	Provide common guidelines to MSs for the adoption of standards and best practices for smart metering systems interoperability.
			Interoperability requirements and procedures for access to data	Provide common guidelines to MSs on how to facilitate the full interoperability of energy services within the EU
			Common language for smart appliances	Support the adoption of the standard reference language SAREF by massive dissemination actions.
1 4	2	**Cybersecurity of ICT products**	Supervisory role of national competent authorities	The new (EU) Implementing Act shall establish a good level of coordination with ENISA through: ▪ Periodical workshops to facilitate the exchange of best practices ▪ Allocation of responsibilities according to the matter (e.g. cross-border issues addressed by ENISA)
			Management of incidents	The new Implementing Act on cybersecurity measures should foresee ENISA to intervene when Member States have not developed national CSIRTs. To regulate the intervention: ▪ Deadline of compliance with the Directive before having ENISA intervening

UC	KI #	Key issue	Topic	Policy action
				▪ Ad hoc working group of ENISA and the National Competent Authority
			The reinforcement of ENISA's role	The new Implementing Act on cybersecurity measures should set guidelines to establish: ▪ Competence areas of ENISA ▪ frequency of monitoring of Member State's actions ▪ Periodical workshops to facilitate capacity building on cybersecurity
			EU cybersecurity certification	The new Implementing Act on cybersecurity measures should provide indications for the harmonisation with existing standards at the national level through workshops and consultations with national competent authorities and establish of a roadmap to deliver a common certification for each relevant area.
9	2	**Cybersecurity of energy critical infrastructures**	Common definition of operators of essential services	The Cybersecurity network code for critical infrastructures shall be based on information systems used by operators of essential services
			The security and notification requirements	New guidelines shall set common procedures for essential operators notification requirements: deadlines, responsible bodies (stronger role of ENISA), format, and definition of a common standard at the European level with respect to the information to be exchanged
			Data security and smart meters	The Cybersecurity network code for critical infrastructures shall provide indications on minimum requirements to guarantee data security of smart meters
			The role of an EU DSO entity on cybersecurity	New guidelines shall define the modalities of collaboration between the EU DSO with National Competent authorities, CSIRTs and ENISA

Reinforced Legislation Scenario

Policy actions by 2030

UC	KI #	Key issue	Policy action
10	2	**The cooperation between TSOs and DSOs**	Adoption of an Implementing act containing guiding principles for the design and operations of possible models of coordination between TSOs and DSOs for the procurement of flexibility services from distribution-connected demand and power generating facilities. Adoption of a new Directive on the internal electricity market addressing: the characterisation of the level playing field principle in the development of P2P trading platforms and VPPs; role and responsibilities of the relevant stakeholders concerned by P2P trading platforms and development and operation of VPPs; the characterisation of the principle of non-discrimination with respect to the role and responsibilities of TSOs and DSOs in the procurement of flexibility services at the distribution level according to different models of procurements; the characterisation of the principle of the level playing field in the development and operation of flexibility platforms..
10	1	**A more active role of DSOs in the provision of flexibility services**	Adoption of a Regulation (EU) on guidelines for electricity balancing addressing: ▪ the policy issues of the CG scenario ▪ additional domains as: the objectives and principles which shall address the evolution of the regulatory framework concerning electricity distribution; the role, responsibilities and functions of DSOs to acknowledge a more sustainable and digitalised energy sector; the roles of ENTSO-E, the EU DSO, ACER and NRAs to promote the evolution of MSs' regulatory framework; further changes in the regulatory methodology to acknowledge the role of P2P and VPPs; the milestones for the enforcement of a full harmonisation of the regulatory frameworks across Member States and the governance of the transition period occurring form the approval of the Regulation and alignment of the regulatory framework across Member States.
10 3 3	2 3 4	**Specifications of products for flexibility services**	Adoption of a new Directive on the internal market for electricity addressing: ▪ the policy issues of the CG scenario ▪ additional domains as: the definition in each Member State of an implementation model concerning the coordination of TSOs and DSOs in the procurement of balancing services; the activities concerning the procurement of balancing services for which a coordination between TSOs and DSOs is needed; the roles and responsibility of ACER and NRAs in enforcing provisions of the Directive with respect to balancing services; impact of P2P and VPPs on the design of balancing markets; impact of P2P and VPPs on imbalance settlement; impact of P2P

			and VPPs on the characteristics of the products to be offered in balancing markets; impact of P2P and VPPs with respect to the coordination between VPPs, TSOs and DSOs.
10	3	**The role of independent aggregators in procuring flexibility services**	Adoption of a new Directive on the internal market for electricity addressing: ▪ the policy issues of the CG scenario ▪ additional domains as: the objectives of the Directive with respect to independent aggregators; the obligation for TSOs, DSOs and suppliers to share relevant data with aggregators to allow for the provision of more efficient ancillary; the roles of National Regulatory Authorities in promoting the integration of independent aggregators in the electricity market; establishment of the obligation to cooperate between VPPs and aggregators; exchange of information between VPPs and aggregators; rules governing the coordination between VPPs and of both with DSOs and TSOs.
10	1	**The access to consumption and production data**	Adoption of EU binding guidelines on: ▪ the Definition of EU common standard communication interface/or remote access protocols/standards across Member States; interoperability standard and a transparent procedure for eligible parties to have access, in a transparent and non-discriminatory way, to the data on production and consumption data; standardised communication interface and/or remote access to allow comparisons by customers in an easily understandable format
12	3	**Interoperability between connected devices**	Creation of a new legislation that is evidence-based, verifiable and regulating measurable, with the introduction of relevant parameters, avoiding overlapping double regulation of products and parts. EC adoption of interoperability requirements and transparent procedures for access to data by means of implementing acts. MSs ensuring that electricity companies comply with such interoperability requirements, while granting industry the necessary freedom to design innovative products, while keeping a good balance with progressive legislation
14	2	**Cybersecurity of ICT products**	The new EU Regulation on Cybersecurity shall define the creation of EU cybersecurity certifications for different areas with mandatory standards and sanctions: ▪ Ad hoc minim requirement for relevant operators ▪ Role of the National competent authorities and CSIRT ▪ ENISA makes random checks of compliance and can request National authorities to provide information at any time
9	2	**Cybersecurity of energy critical infrastructures**	The Cybersecurity network code for critical infrastructures should fall under a new Regulation, which foresees the establishment of a set of common certification standards divided per area. Furthermore, the new Regulation shall better address the role of the EU DSO, an entity whose establishment is foreseen in the Recast Electricity Regulation without specific references on how it should act in the context of cybersecurity.

Active Digitalisation Policy Scenario

Investments by 2030 (MFF 2021-2027)

UC	KI #	Key issue	Investments
10	2	**The cooperation between TSOs and DSOs**	▪ CEF ▪ Horizon Europe
10	1	**A more active role of DSOs in the provision of flexibility services**	▪ CEF ▪ Horizon Europe
10 ; 3	2 ; 3,4	**Specifications of products for flexibility services**	▪ No action
10	3	**The role of independent aggregators in procuring flexibility services**	▪ CEF
10	1	**The access to consumption and production data**	▪ No action
1 ; 2	3	**Interoperability between connected devices**	▪ Digital Europe Programme
1 ; 4	2	**Cybersecurity of ICT products**	▪ Digital Europe Programme
9	2	**Cybersecurity of energy critical infrastructures**	▪ Digital Europe Programme ▪ CEF

References

- 5G-PPP, *5G empowering vertical industries* – 5G Vertical Sectors
- 5G-PPP, *White Paper on Energy Vertical Sector*, October 2015
- ABB, *Digitalisation and power generation*, 2017
- ACER/CEER, A*nnual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2017* – Consumer Empowerment Volume, 2018
- Alfen, *Pilot project "Smart charging"*, 11 February 2017
- BEUC, *Fit for the consumer? Do's and don'ts of flexible electricity contracts*, 2019
- Birk, M., Chaves-Ávila, J., Gómez, T., & Tabors, R., *TSO/DSO coordination in a context of distributed energy resource penetration*. CEEPR WP, 2017
- Blockchain Commission for Sustainable Development, White paper: *The future is decentralised - Block chains, distributed ledgers & the future of sustainable development*, 2018
- Bloomberg New Energy Finance, *Vehicle-to-Grid: the Slow Roll from Demonstration to Commercial Projects*, 2018
- Bloomberg New Energy Finance, *Digitalisation of Energy Systems*, 2017
- Bloomberg New Energy Finance, *24x7 Clean Energy: The next frontier for corporations*, 2018
- BPIE, *Is Europe ready for the smart Buildings revolution?*, 2017
- BPIE, *Smart buildings in a decarbonized energy system*, 2016
- CEER, *Review of Current and Future Data Management Models*, 2016
- CEER, *PEER to PEER collaboration on consumer rights*, 2017
- CEER, *Guidelines of Good Practice on Comparison Tools in the New Energy Market Design*, 2017
- CEER, *Smart Technology Development*, 2018
- CEER, *Consultation on Dynamic Regulation to enable Digitalisation of the Energy System*, 2019
- CEER, *Key positions on the New Deal for Consumers*, 9 October 2018
- Puthal D., Malik N., Mohanty S.P., Kougianos E., Yang C., *The Blockchain as a Decentralised Security Framework*, IEEE consumer electronics magazine, 2018
- Daniele L., Strabbing W., *Study on ensuring interoperability for enabling Demand Side Flexibility*, 2018
- Danish Energy Association; Danish Intelligent Energy Alliance; Energinet; Confederation of Danish Industry, *Market models for aggregators - activation of flexibility*. Presentation, 2017

- de Heer, H., White Paper: *Flexibility Platforms*, USEF, 2018
- DELTA-ee, *Energy insights part 2: Tools for customer engagement from energy suppliers*, 2017
- DELTA-ee, *Monetising smart meter data*, 2018
- DELTA-ee, *Smart meter benefits - cost savings households could make within a smart energy future*, 2019
- DELTA-ee, *State of Home Energy Management (HEM) in Europe*, 2017
- Mengelkamp E., Gärttner J., Rock K., Kessler S., Orsini L., Weinhardt C., *Designing microgrid energy markets A case study: the Brooklyn Microgrid*, Appl Energy, 2018
- ElaadNL, Slimme meters.
- Lahmar E., *Local flexibility markets*, 2018
- Energinet, *Prequalification of units and aggregated portfolios*, 2018
- ETIP Wind (European Technology and Innovation Platform on wind energy), *When wind goes digital*, 2016
- EU Blockchain Observatory and Forum, *Blockchain innovation in Europe*, August 2018
- European Commission, COM 2014/15 – A policy framework for climate and energy in the period from 2020 to 2030, 22 January 2014
- European Commission, COM 2015/192 - Digital Single Market Strategy for Europe, 06 May 2015
- European Commission, COM 2015/339 - A New Deal for Energy Consumers, 15 July 2015
- European Commission, COM 2015/634 - Proposal for a Directive on certain aspects concerning contracts for the supply of digital content, 9 December 2015
- European Commission, COM 2015/635 - Proposal for a Directive on certain aspects concerning contracts for the online and other distance sales of goods, 9 December 2015
- European Commission, COM 2016/176 – ICT Standardisation Priorities for the Digital Single Market, 19 April 2016
- European Commission, COM 2016/178 – European Cloud Initiative - Building a competitive data and knowledge economy in Europe, 19 April 2016
- European Commission, COM 2016/180 – Digitising European Industry Reaping the full benefits of a Digital Single Market, 19 April 2016
- European Commission, COM 2016/410 – Commission Communication on Strengthening Europe's Cyber Resilience System and Fostering a Competitive and Innovative Cybersecurity Industry, 5 July 2016
- European Commission, COM 2016/587 – Connectivity for a Competitive Digital Single Market - Towards a European Gigabit Society, 14 September 2016

- European Commission, COM 2016/588 - 5G for Europe: An Action Plan, 14 September 2016
- European Commission, COM 2016/590 – Proposal for a Directive establishing the European Electronic Communications Code, 3 October 2016
- European Commission, COM 2016/861 – Proposal for a Regulation on the internal market for electricity, 23 November 2016
- European Commission, COM 2016/864 for a Directive on common rules for the internal market of electricity, 23 February 2017
- European Commission, COM 2017/9 - Building a European Data Economy, 10 January 2017
- European Commission, COM 2017/10 - Proposal for a Regulation concerning the respect for private life and the protection of personal data in electronic communications, 10 January 2017
- European Commission, COM 2017/134 on European interoperability framework – implementing strategy, 23 March 2017
- European Commission, COM 2017/228 on the Mid-Term Review on the implementation of the Digital Single Market Strategy, 10 May 2017
- European Commission, COM 2017/476 – Making the most of NIS – towards the effective implementation of Directive 2016/1148 concerning measures for a high common level of security of network and information systems across the Union, 13 September 2017
- European Commission, COM 2017/477 – Proposal for a Regulation on ENISA, the "EU Cybersecurity Agency", and repealing Regulation (EU) 526/2013, and on Information and Communication Technology cybersecurity certification (''Cybersecurity Act''), 13 September 2017
- European Commission, COM 2018/183 – Communication on the New Deal for Consumers, 11 April 2018
- European Commission, COM 2018/184 – Proposal for a Directive for the protection of the collective interests of consumers, 11 April 2018
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- European Commission, COM 2018/434 – Proposal for a Regulation of the European Parliament and of the Council establishing the Digital Europe programme for the period 2021-2027, 6 June 2018
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- European Commission, COM 2018/630 – Proposal for a Regulation establishing the European Cybersecurity Industrial, Technology and Research Competence Centre and the Network of National Coordination Centres A contribution from the European Commission to the Leaders' meeting in Salzburg on 19-20 September 2018
- European Commission, COM 2018/773 – A Clean Planet for all: A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy, 28 November 2018
- European Commission, COM 2018/795 – Coordinated Plan on Artificial Intelligence, 7 December 2018
- European Commission, COM 2019/168 – Building Trust in Human-Centric Artificial Intelligence, 8 April 2019
- European Commission, Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings
- European Commission, Directive 2013/37– Public Sector Information (PSI) Directive, 26 June 2013
- European Commission, Directive 2016/1148 – concerning measures for a high common level of security of network and information systems across the Union, 6 July 2016
- European Commission, Directive 2018/1972 establishing the European Electronic Communications Code, 11 December 2018
- European Commission, Directive 2018/2001 on the promotion of the use of energy from renewable sources, 21 December 2018
- European Commission, Directive 2018/2002 on energy efficiency, 21 December 2018
- European Commission, Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency
- European Commission, Implementing Decision 2019/235 on amending Decision 2008/411/EC as regards an update of relevant technical conditions applicable to the 3400-3800 MHz frequency band, 24 January 2019
- European Commission, Implementing Decision 2019/784 on harmonisation of the 24,25-27,5 GHz frequency band for terrestrial systems capable of providing wireless broadband electronic communications services in the Union, 14 May 2019

- European Commission, JOIN 2013/1 – Cybersecurity strategy of the European Union: an Open, Safe and Secure Cyberspace, 7 February 2013
- European Commission, JOIN 2017/450 – Joint Communication to the European Parliament and the Council "Resilience, Deterrence and Defence: Building strong cybersecurity for the EU", 13 September 2017
- European Commission, Recommendation 2014/724 on the Data Protection Impact Assessment Template for Smart Grid and Smart Metering Systems, 10 October 2014
- European Commission, Recommendation 2017/1584 on coordinated response to large-scale cybersecurity incidents and crises, 13 September 2017
- European Commission, Recommendation 2019/553 on cybersecurity in the energy sector, 3 April 2019
- European Commission, Regulation 2013/526 – the European Union Agency for Network and Information Security (ENISA) and repealing Regulation 460/2004, 21 May 2013
- European Commission, Regulation 2015/1222 establishing a guideline on capacity allocation and congestion management, 24 July 2015
- European Commission, Regulation 2016/679 – General Data Protection Regulation (GDPR), 27 April 2016
- European Commission, Regulation 2017/1485 establishing a guideline on electricity transmission system operation, 2 August 2017
- European Commission, Regulation 2017/2195 establishing a guideline on electricity balancing, 23 November 2017
- European Commission, Regulation 2018/1807 on a framework for the free flow of non-personal data in the European Union, 14 November 2018
- European Commission, Regulation 2018/1999 on the Governance of the Energy Union and Climate Action, 21 December 2018
- European Commission, Roadmap for completing the digital single market, 18 March 2019
- European Commission, SWD 2016/110 – Advancing the Internet of Things in Europe, 19 April 2016
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- European Commission, SWD 2019/1 - Energy prices and costs in Europe, 9 January 2019
- European Parliament and Council, Decision 2017/899 on the use of the 470-790 MHz frequency band in the Union, 17 May 2017

- European Parliament and Council, Regulation 2017/2394 on cooperation between national authorities responsible for the enforcement of consumer protection laws, 12 December 2017
- European Commission, European Smart Grids Task Force, Final report: Demand Side Flexibility. Perceived barriers and proposed recommendations, 2019
- Everoze and EVConsult, *V2g global roadtrip: around the world in 50 projects*, 2018
- Ferwerda R., *Advancing E-Roaming in Europe: Towards a Single "Language" for the European Charging Infrastructure*, World Electric Vehicle Journal, 2018
- Fortum. *Business services*, 2019
- GOPACS, *Grid operator platform for congestion solutions*, 2019
- EECSP, *Cyber security in the energy sector recommendations for the European Commission on a European strategic framework and potential future legislative acts for the energy sector*, February 2017
- IDC, *European Data Market study, SMART 2013/0063*, 2017
- IEA, *Digitalisation and Energy*, OECD, 2017
- ISO 15118-8:2018. Retrieved from International Organization for Standardization, 2018
- Mattila J., *The blockchain phenomenon-the disruptive potential of distributed consensus architectures*, 2016
- Litman T., *Autonomous Vehicle Implementation Predictions, Implications for Transport Planning*, 2019
- Andoni M., Robu V., Flynn D., Abram S., Geach D., Jenkins D., McCallum P., Peacock A., *Blockchain technology in the energy sector: A systematic review of challenges and opportunities,* 14 October 2018
- Kshetri N., *Blockchain's roles in strengthening cybersecurity and protecting privacy*, November 2017
- NERA, *Blockchain in Electricity: A Call for Policy and Regulatory Foresight*, 2018
- Nissan Newsroom Europe, *Nissan, Enel and Nuvve operate world's first fully commercial vehicle-to-grid hub in Denmark*, 2016
- ODI, *Delivering blockchain's potential for environmental sustainability*, 2018
- Open Charge Alliance, Open smart charging protocol 1.0., 2019
- PÖYRY, *Independent aggregator models*, 201
- PwC, *Clarity from above- Leveraging drone technologies to secure utilities systems*, 2017
- PwC, *Innovative digital platforms to support Field Service Optimization*, 2018
- PwC, *Drone Powered Solutions. Digital Twin powered asset management transformation for transmission and distribution grid operators*, 2018
- Refe, Mercados, Indra, *Study on tariff design for distribution systems*, 2015

- Shakelford S., Myers S., Block-by-Block: *Leveraging the Power of Blockchain Technology to Build Trust and Promote Cyber Peace*, Yale Journal of Law and Technology, 2017
- SEDC, *The importance of smart charging*, 2017
- SETIS, *Digitalisation of the Energy sector*, 2018
- Smartcitiesconnect, *University of Warwick Demonstrates Vehicle-to-Grid Technology*, 2017
- SmartEn, *The smartEn Map European Balancing Markets Edition*, 2018.
- Tractebel, Ecofys, *Identifying energy efficiency improvements and saving potential in energy networks and demand response, in support of the implementation of Article 15 of the Energy Efficiency Directive (2012/27/EU*, 2015
-)Tractebel, PwC, Navigant, Sweco, *Benchmarking Smart Meter deployment in EU-28*, 2019
- Tractebel, Internal studies, 2018
- Transport & Environment, *Roll-out of public EV charging infrastructure in the EU*, 2018
- USEF, *Workstream on aggregator implementation models - recommended practices and key considerations for a regulatory framework and market design on explicit demand response*, 2017
- V2G clarity, *What Is ISO 15118?*, 2019
- V2G clarity, *Standardizing the Management of Electric Vehicle (Dis-)Charging Infrastructures*, 2017
- WEF, *The future of electricity – New Technologies Transforming the Grid Edge*, March 2017

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