White Paper

A multi-scale approach for a digitalised energy system transformation

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Introduction

The European Commission launched on 18 October 2022 the Action Plan on Digitalisation of the Energy Sector with the general objective to leverage the potential of the digital transformation, which is a key enabler for reaching the Green Deal objectives. The Commission acknowledges the role of digital technologies for the green transition and the importance of Europe's digital sovereignty.

Based on a consultation launched in the beginning of 2022 main barriers to the full exploitation of digital technologies and an accelerated digitalisation of the energy system were identified. This document is meant to become the new sectorial EU digital initiative and technological framework enabling trustful and digitally enabled interactions.

Digital and sustainable transformation of the energy system across the EU is considered also essential to end dependence on Russian fossil fuels, tackle the climate crisis and ensure affordable access to energy as stated by the European Green Deal and REPowerEU Plan. The Commission requires an energy system which is much smarter and interactive; an effort in digitalisation is required to achieve energy and resource efficiency, decarbonisation, electrification, sector integration and decentralisation.

These issues were the focus of a joint workshop jointly organised by E.DSO and the European Commission (DG ENER and DG CONNECT) on 22 November 2022 in Brussels. This event was the first comprehensive effort to depict how digitalisation could transform the energy sector, with a strong emphasis on Distribution System Operators (DSOs). The contributors to the event explored the impact of *digitalisation, data spaces, interoperability, grid edge and grid investments* in the energy sector. They further explored the transformational potential of digitalisation to help create a highly interconnected energy system.

This White Paper identifies the current journey of the digitalistion of the energy sector and provides greater clarity to the opportunities and barriers faced by the industry. It further shed lights on the most pressing solutions and actions from DSOs towards a more secure, sustainable, and smarter future.

1. Digital transformation and data spaces of the energy sector

The digital transformation is a key enabler for the energy transition. All parts of the energy system – *demand, supply, markets, networks* – need to be digitalised to create a 'whole system approach'. The decentralization of generation, customers, prosumers (flexsumer) as new participants in flexibility markets, sector coupling, and the use of new storage technologies are leading to a massive increase in complexity in the planning and operation of energy systems. Data provision and exchange within the system operation of electricity grids is key due to its central role in the sector. To cope with these complexities, the automation of operational processes and the use of data analytics in the energy system is becoming important.

In this regard, the upcoming Energy Data Space should be regarded as a decentralised and regulated solution of exchanging and sharing data and bringing value to all participants. This Space can enable the digitalisation of the energy transition by providing an architecture to make data available to increase the efficiency in asset and system operation. More importantly, the integration of data from

the smart meter rollout could as well be imbedded onto Energy Data Space technology. It does not come as a surprise that data spaces have been developed under the umbrella of Gaia-X, which creates domain-specific data spaces and for their interconnection in a European data and infrastructure ecosystem that is characterised by sovereignty and interoperability.

Along with concerns about implementation timelines, internal and external transformation costs, and the readiness of Distribution System Operators (DSOs) to adopt new technologies, industry representative's point out the lack of a skilled workforce. Being overshadowed by focusing predominantly on technology, this already existing deficit will create bottlenecks in the implementation, if not tackled in time.

Strong emphasis was placed on the general lack of trust in technology as fundamental barrier to the acceptance of cloud services (below 26%) and other technologies in Europe. Europe is faced with the dilemma of the highest technology with the lowest level of trust and workforce. To trigger a shift in people's mindsets towards a digital economy, especially the use of coordinated platforms, bringing together multiple stakeholders will be a necessary action. The sector has already taken good strides to overcome these barriers, but much more needs to be done.

Similarly, partnerships would promote seamless communication along the value chain and leverage the success of precursor examples to overcome barriers that currently impede "real" transition. A reoccurring example would be the improvement to connection times, current creating deadlocks due to long waiting periods.

Prioritising observability and controllability of distribution grids is a must to ensure resilience. With growing shares of Renewable Energy Sources (RES), the grid is not evolving at the same pace as the requests. Clear definitions of data requirements and use cases based on best practices are therefore important to place necessary equipment (such as sensors) on the infrastructure and deliver the necessary information. The speed and concreteness of this planning play an important role in the process.

The digitalized energy system needs appropriate deployment of the infrastructure, processes, technologies, and skills. DSOs are really willing to take on their part of the digitalisation challenge and build a strong foundation for data and digitalisation to tackle climate change and benefit both the system and customers. Digitalisation will enable better visibility of renewable energy sources and other flexible resources such as electric vehicles and storage for system operators, and help markets to signal to users when it is more efficient to use the system. We need substantive, interoperable data spaces in industry and science that can be flexibly interlinked, based on demand and the respective business models, and enable reliable and sustainable data-driven economic activity.

Action from DSOs

DSOs will strongly cooperate with TSOs and other actors to deliver a vision about the energy data space governance and setting up. E.DSO will come forward with a proposal in the upcoming Data for Energy (D4E) taskforce (expected to be officially established in Q1 2023).

2. Model of operation and development of distribution network using distributed energy resources – Grid observability for flexibility.

The launch of the Action Plan on the Digitalisation of the Energy Sector marks an important vision to harness the power of responsible data use by positioning the EU as the forerunner of the next wave of innovation achieving net zero. The Action Plan empowers citizens and at the same time leads to benefits through positive market competition and the use of cutting-edge technologies. The crucial role of interoperability and in this respect, open-source technology, is also acknowledged. There is a significant uptake of appliances of which energy usage can be controlled remotely. Standards for data access and use and interoperability are key here since it prevents the market from further fragmentation.

To overcome challenges of the industry to get from prototype pilots to industrial solutions, upcoming legislation should set higher milestones. Examples referred to the creation of a registry for energy assets using cutting edge technologies. This could facilitate the coordination of data rooms and make them collaborative.

Equally, the **Common European Reference Framework for Energy** (CERF)[1] for the Energy App should envision more than cost saving. Features could entail demand response and thus encourage customers' active participation on the market, by optimizing their experience as energy market participant.

In this sense, the announced experimental platform for energy communities does not yet demonstrate enough ambition. Instead, efforts should aim at creating Key Performance Indicators (KPIs) that guidelines pilot projects must achieve. The dissemination of these models must be more strongly promoted.

In fact, DSOs are willing to play an active role in promoting flexibility markets and supporting active customers. To take on this role, access to data is pivotal, as only this way they can understand what tools are needed to plan and operate this new environment, locate consumption, and manage the grid.

Further, in the future decentralised energy system, data from the grid edge will become very important: data from smart meters but also data from "behind" the smart meters like data from smart inverters, EV charging points, heat pumps, sub meters etc. This kind of approaches will lead to an optimal use of the system, with a more integrated view. Access to relevant energy data coming from the grid edge should be possible for all eligible actors and should be based on either a legal obligation, in case they are entitled to participate in the provision of flexibility services, or customer consent. Simultaneously, as real time requirements emerge, processing of data will also start to take place at the edge, requiring edge computing capabilities such that can connect with the grid: standardized,

[1] It refers to a common reference framework including an opensource reference implementation for a consumer application that allows them to make voluntary reductions in energy consumption and helps them in reducing their energy costs.

open, and interoperable to different cloud platforms, in the same way that they are already proposing the new smart distribution network architectures.

Similarly, the high level of system integration will not be possible without profound digitalisation. The consequence of digitalisation is the need for proper management of operational data used in the processes by DSOs, which is the main element of **grid observability**[2].

Actions from DSOs

The market is really preparing for delivering flexibility to DSOs for mitigating congestion and keeping the system in balance. However, a key requirement is that DSOs can communicate their flexibility markets needs on a regular basis identifying where, when and to what extent they expect congestion in their LV, MV and HV grids.

To that end, DSOs should also have access to data coming from the edge (e.g. *resources willing to participate in flexibility provisioning)* and would develop short-medium-long term load forecasting and predictive load flow capabilities for their LV, MV and HV grids for the Day Ahead and intraday time frame in 15 min. granularity.

3. Standards for data and interoperability

Digital technologies and the standards that underpin them will drive the future energy system. New services will be possible by opening multi-directional access to the components of an integrated and digitalised energy system and its data to the rest of the economy. This cross-sectoral sharing and layering of data will integrate markets and create greater cohesion of products and services for customers. This could be facilitated by new tools such as digital twins which can be used to find innovative ways to foster cost-efficient use of the resources and to promote interoperability by design, creating more capacity from existing infrastructure and improve the services they were created to deliver.

The current energy system rarely treats data as an asset. Even where stakeholders are aware of what data exists and where, the sector does not have cohesive or coordinated standards and infrastructure to facilitate easy data exchange. This is a critical barrier as the value of data increases significantly when it is accessible and is joined with other data. Hence, the promotion of interoperability is also an indispensable step in the digitalisation of the energy sector: services and building blocks will rely on different data sources coming from different sectors and different actors.

The need for component exchanges in the network, for example, must not lead to interruptions in the digital chain or cause vendor locking. In this context, component certifications were presented as a guarantee for the functionality. Such certificates could be issued by companies already active in this field, or as a commercial company, if these are independent entities.

[2] Observability in the grid means the ability to observe how conditions are in different places in the grid. This is done mainly by measuring current and voltage but also other types of sensors i.e., status, temperature etc. Increased observability will give better knowledge about the grid and its behavior and the ability to analyze it to make de right decisions.

The complexity of standards is considered as an ongoing barrier for system operators. An overarching system covering all vertical categories of standards could provide greater transparency. However, it should cover a broader range of categories, including AI, cybersecurity, and more. In terms of standards development, panellists called for an alignment with the pace of technology development to take full advantage of its benefits.

As mentioned in the context of previous discussion, also the development of standards for data and interoperability requires a strong cooperation among industry stakeholders. This will ensure a targeted identification of market gaps as well as a seamless implementation. Project, such as Int:net, Horizon or CEF need to enhance activities. However, transferability of centralised ideas about standards to all implementation levels must not be forgotten in the process.

Actions from the DSOs

DSOs are willing to define and implement in 2023/2024 data interoperability in close cooperation with stakeholders in the markets and standardisation bodies.

4. Grid edge data and (smart) metering

While some data is already available through smart meters, changing circumstances require better access to more information to achieve the desired speed of transformation. In this context, a mapping of the entire metering value chain could help to understand existing and new data as well as functionalities better. At the same time, this could provide information on most cost-effective ways to store data (local or centralized), since clouds are not always considered the best solution.

With the right information accessible, load forecasting and predictive load flow analysis for the intraday and day-ahead timeframes at 15-minute granularity will be made possible. This impacts DSOs ability to communicate with the market and better understand consumption patterns and intervention needs.

For the right promotion of these developments, however, the energy sector must refrain from thinking in silos when it comes to data (from the meter to behind the meter). The problem lies in the organization behind and in front of the meter and is not connected to the device itself. The enormous change and a new environment are already driving DSOs into digitization: for the next steps, however, access to open-source data was defined as an essential prerequisite. As in the future data from the grid edge will play a more important role in system stability, the communication between the system operators (TSO and DSO) with the grid edge will increase.

In strong connection to this, the system should strive to self-balancing at the different levels, starting from the edge. This means that, first of all, customers must act in a responsible manner, leaving to flexibility the ability to solve what is not possible to solve in a more natural way. Pushing for price signals gives the impression customers will only cooperate in case they are rewarded.

Once EVs or other flexibility services come into play, remuneration must be made possible. In this respect, it was stressed that citizens need to understand the role of energy in the future, as the system is reverting to a decentralized system. Empowering customers is important, what in turn requires additional attention and support for the role of DSOs as market facilitators.

Actions from the DSOs

DSOs will engage with the national/EU Data Protection Authorities in developing a code of conduct for using smart meter and edge data for LV/MV/HV grid management purposes.

5. Investments in digital electricity infrastructure

The right level and targeted allocation of investments to foster the improvement of observability and controllability of the distribution networks must be achieved (especially in the short-term). In the long run, investments should be targeting flexibility of the system. Through cloud data services, pattern recognition or forecasting technologies about upcoming RES connections, increased numbers of data giving information about actors' activities or reserve capacities, for example, will contribute to the proper functioning of the grid. In parallel, this would provide information about parts of the grid monitored, where data is note available with proper level of detail and granularity. In this respect, legislators must develop efficiency-enhancing regulation to appropriately support these systems.

In line with the Commission's Action Plan, DSOs believe that bidirectional charging is as important future investment opportunity. EVs will increase total capacity by around 30%, although these figures may vary locally. To steer investment flows in the right direction, however, also individual investments by small units (purchase of a car, smart infrastructure, etc.) must be incentivized appropriately by the legislators. In principle, it should be ensured that those incentives go only towards profitable storage.

Further, the great importance of standardisation for the requirements of final investments decisions is equally important. In the case of EV charging stations, failing to achieve a certain level of openness at an early stage could result in a lack of the right distribution of investment incentives. Some players, such as car manufacturers, might have larger investment incentives. Concerning drivers of capital growth, the return on investment is considered a key factor. Contributors of the workshop conveyed the message that EU policymakers need to set the right conditions in an adequate regulatory framework. This does equally apply to the need of DSOs to increasingly rely on smart grids including the use of flexibility, as this will significantly increase their OPEX share.

Actions from the Regulators

While new investments in the past usually generated less OPEX demand, the increased share of digital solutions in the grid operation will inevitably increase the OPEX share of the DSOs' investments. Solutions as the technical enabling of flexibility measures, operationalisation of data hubs, backend-systems for sensors monitoring the gird operation, AI systems supporting the analysis of grid state, etc. need to be addressed in the investment schemes as well. Hence, NRA must support DSOs by designing appropriate OPEX incentives in legislation to drive digitalization forward.

End note: Our vision

By 2030 and beyond DSOs will have a better visibility of all energy assets by getting access to appropriate data, making planning, forecasting and operations quicker, more accurate and cheaper compared to a base scenario where the energy transition assured through investments mainly on infrastructure. On the other side, greater data access in the marketplace will support new business models and services developing and new market entrants participating in the energy sector.

A digital energy system will provide a modern platform for all actors to revolutionise how we interact with and conceive the energy system and how it integrates with the wider EU infrastructure and services. These capabilities will underpin a secure decarbonised energy system, create market opportunities for information services and insights, provide confidence to investors, support research and benefit customers from new products and services.

The volumes of data produced by smart devices are exponentially increasing. Making use of these amounts of data bears a huge value potential. One must bear in mind that energy data is not only valuable to the energy sector, but across many other sectors of the economy; all sectors rely on the energy system to function, and data easily crosses borders. The success of actions is enhanced by their ability to be interoperable across many different sectors.

The way forward:

There are many grids and grid owners, and many new resources providing flexibility services, but there is only one integrated system, composed of other interconnected systems. Working jointly with other market players on data sharing to accommodate good overall observability and fast correct and automated responses is a must. In the future, a long-scale grid model (e.g., digital twins) might be required to jointly be developed algorithms who intervene on the system level. The smart meters need to be complemented by other interoperable devices to solve the emerging challenges our power grids are facing. The smart meters provide the necessary basis for data-driven grid operation. The data stemming from them should be enhanced by further grid data. Any smartification efforts require a holistic approach to data mining, handling, and analysis.

A decentralised energy system, in which not only energy generation is decentralised, but also data processing is ensured, is unavoidable. The market is changing: the emerging local markets, energy sharing, local and renewable energy communities, are leading to a new and enhanced regulation; multiple actors are being simultaneously active on one connection. This entails that there is need for more data and data processing capabilities, also in real time for balancing and managing congestions.

In this spirit. DSOs should develop a roadmap on the metering value chain, including:

- the role of the existing smart meter,
- the use of relevant submeter data,
- the ability to communicate control signals,
- the distributed computing capacity and interoperable solutions
- the ability to communicate with a controlling equipment (e.g., physical or virtual HEMS) and other energy relevant appliances.

The above Roadmap shall lead to a well-balanced federated IoT open and interoperable edge-cloud-system architecture.