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Position Paper

Energy System Integration Strategy by DSOs

June 2021

Synopsis

- All future scenarios for the energy transition require large investments in electricity networks but cross-sector integration between electricity, gas, hydrogen, heat, and transport is in particular necessary where fully electrified solutions are not viable and harder to abate.

- The concept of **'integrated energy systems' for electricity DSOs** include examples for coordination & interface between DSOs (electricity/gas/other infrastructure operators) for grid planning and operation, highlighting their benefits.

- **Digitalisation and smart grids** would be one of the main means to improve such a coordination.

- **The concept of DSOs as System Integration Facilitators** implies that the energy transition must be structured through integrated energy systems with the customer in the focus, where DSOs are the natural proactive enablers.

- This entails striving for decarbonization mainly through electrification and trying to find the connection with other technologies when a more efficient solution is achieved.

- Working on a clarification of **"sector coupling" and "sector integration"** while providing examples at local level for the latter.

1 Introduction

The EU Energy System Integration Strategy will be paramount to achieve a cost-effective decarbonisation of the EU economies. In this transition, DSOs have a relevant role in building a more flexible, decentralised, and digital energy system. However, the implementation measures and solutions will likely follow different pathways in each member state, depending on their respective starting points and policy choices.

Representing more than forty electricity Distribution System Operators (DSOs) across Europe, E.DSO is at the core of the energy transition and, with this paper aims to present a set of key messages on how the different energy vectors and technologies can interact to accelerate the transition towards a more integrated energy system.

Energy system integration can be defined as the coordinated planning and operation of different energy systems with associated infrastructures to which end users are connected (see also ITRE report, published on November 2020). This is a form of integration in which different systems and infrastructures can exist next to each other. The need for system integration results from increased electrification and enhanced volatility in both the demand (electrification) and the supply of energy (wind and solar) and is intended to guarantee safe, affordable, and sustainable energy supply under all (future) circumstances.

All future scenarios for the energy transition require large investments in electricity networks; in multiple regions a doubling, tripling or even more of the existing capacity is necessary.

Short- and long-term measures are possible to make the energy system of the future function cost-effective. In the short term, electricity grids will have to be enlarged and strengthened and extra sub-stations added. In addition, extensive reliance on conversion is envisaged. This is not only necessary for absorbing surpluses in sustainable capacity (electrolysers, batteries), but also for situations with little supply of sustainable energy. However, in various Member States electricity, gas/hydrogen and/or heat grids are and will continue to be operated in parallel. In these cases, new forms of cooperation and system integration and at a local and regional level may be developed and implemented, preserving a level playing field among alternatives and at the same time enabling the most cost-effective solutions.

2 Integrated energy systems for electricity DSOs

The design of system integration must first and foremost take place at a local or regional level, because of the large differences between urban, rural, and industrial structures. The starting point is that solutions must contribute to limit the organizational and technical complexity preventing unnecessary energy transport and providing added value and social acceptance to the local customers.

Batteries are therefore installed at decentralized level and power-to-X installations could be installed near locations with high input from renewable energy, such as wind parks, and large-scale solar power or alternatively close to the X consumption, depending on which solution is more cost-effective. The spatial location of supply and demand developments have a major impact on the regional and national need for energy transport and on required system combinations. The exact locations of the possible developments are uncertain today because they are related to future social, spatial, economic, and political considerations. Grid operators through integrated infrastructure development support concrete, public plans, roadmaps and/or frameworks from the local level to the regional level.

As the existing system of centralised energy supply will turn to a **more decentralised system** in the upcoming years, the main features of a truly integrated climate neutral energy system will be the following:

> The design of system integration must first and foremost take place at **local or regional level**

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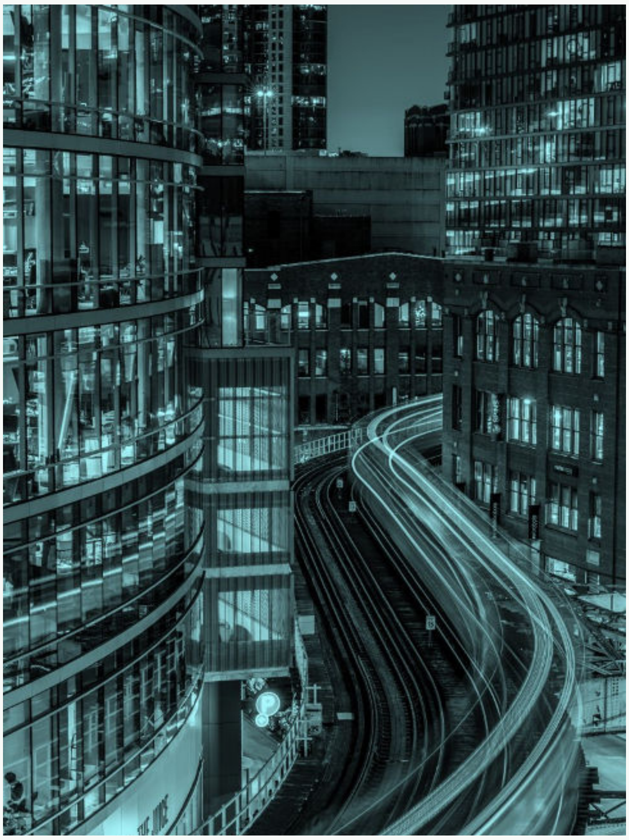
2.1 Structure of the energy transition

Increasing electrification of all sectors, including transport and heating, will be to take advantage of electricity from renewables and sufficient options for storage of energy to cope with volatilities. However **efficient cross-sector integration** between electricity, gas (natural and bio), hydrogen, heat, and transport are particularly necessary where fully electrified solutions are not viable and harder to abate, such as aviation, maritime transport and high temperature industrial processes. Challenges for increased electrification persist and differ per sector and across regions and Member States



The **energy transition must be structured through integrated energy systems** of different sizes and characters. From active customers through energy communities and contracting to integrated electricity/gas/heat distribution systems, such energy systems enable to manage the in-creasing complexity and to encourage acceptance through direct participation. These energy systems should not be realised in all cases, but wherever the integration is beneficial for customers cost-effective, achievable, and sustainable.

A bottom-up approach and increasing electrification are key for the Energy System Integration Strategy to be successful in Europe.

2.2 Components of system integration

One important element of integrated energy systems is **coordinated planning and operations of the grids** for electricity, gas/hydrogen, and heat (where applicable). However, integration encompasses more. It should also extend to **third parties** by identifying possibilities for sector coupling, e.g., linking the systems on the energy supply (PtX/XtP) or consumption side (hybrid solutions). In addition, energy efficiency incentives can be differentiated locally to help stabilise integrated energy systems.

Developing socially accepted planning capacities within this future integrated energy system will be pivotal as for demand and supply to match as much as possible. Benefits will result from **optimised infrastructure planning and development**, and efficiency gains from competition between different energy carriers, considering the principles of “energy efficient first", zero emissions, and avoiding stranded assets.

For optimised infrastructure planning and development, the following principles have to be assigned and the interfaces should be designed according to the following criteria. This requires European harmonisation of at least:

- Obligation for Member State responsible authorities to synchronize the infrastructure planning periods
- Coordination of infrastructure planning on distribution and transport level according to the Member State rules
- Incorporation of infrastructure planning in spatial planning procedures

As the energy system integration progresses, a deeper coordination of the systems' operation will be required for the sake of optimization while at the same time maintaining the high standards security of supply. Coordination of the energy system integration also needs innovative tools. Enhanced investments in digitalization, interoperability and smart grids would be one of the main means to improve such a coordination. Coupling trans-sectoral data can bring benefits to consumers and enhance their active participation to the energy transition e.g., by means of providing energy platforms. Multi sectorial data also allow all operators for an optimized network planning.

For optimised infrastructure operation, the following responsibilities have to be assigned and the interfaces should be designed according to the following criteria. This requires a European harmonisation of at least:

- Definition of operational responsibilities of DSOs in their role as neutral market facilitators
- Require Member State responsible authorities to define operational interfaces between DSOs from different sectors
- Role of NRA in ensuring coordinated system operation across regulated sectors where applicable

As a matter of fact, energy operators are facing technical and technological changes incurred by higher amounts of data which are transforming the whole energy system. Making data available allows for implementing new strategies and policies such as energy efficiency or RES integration. Data management provides for smarter systems and more performing installations: energy operators can develop smart networks with more efficient tools to measure, control, regulate and manage energy while increasing possibilities. As an example: data enable generation and consumption measurements to build new system management models and the best practices to reduce energy consumption.

2.3 DSOs as System Integration Facilitator

We, as electricity Distribution System Operators (DSOs), pay close attention to consumers' expectations and are committed to meet their needs, and convinced that efficient energy systems are beneficial for the consumers involved. An enhanced focus on our customers implies that DSO facilitate solutions in the interest of them wherever possible. With the exception of very small integrated energy systems, it will be extremely challenging to physically integrate energy systems comprising electricity, renewable gas, heat, and other forms competitive market-based mechanisms respecting the established competitive energy market, whenever feasible.

Integration of energy systems will therefore foremost consist of the co-ordination of planning, development and operation within different co-existing systems. Integrated systems need a responsible and socially accepted co-ordination in the common interest of consumers, which is a role that should be neutral and regulated in order to achieve decarbonization in a cost-effective way. The System Integration Facilitating role is overarching to the particular interests of the different actors involved (operators, citizens communities, aggregators, retailers, service companies, local authorities), but also promotes the vision on how to accelerate the transition towards a more integrated energy system, in support of clean energy and a climate neutral economy while strengthening security of energy supply, protecting health and the environment, and promoting growth. Certain conditions must be fulfilled for this role to become a reality: Where relevant, the co-ordination, and the interface between existing DSOs for electricity and gas (and where applicable for heat) must be clearly defined. The role of **"System Integration Facilitators"** should be assigned to an existing DSO as part of their regulated business as long as it is also clearly defined.

One must consider that the role of System Integration Facilitator is a new role, born out of the necessity to combine the possibilities of existing and new energy systems in order to be as cost-effective as possible in the process of customer-centric transition development.

As central part of such a role, co-ordination will be based on as much actual and available local data concerning amongst others:

- Installed and foreseen PV installations and EV-charging facilities
- Installed and foreseen heat pumps and other heating installations
- Installed and foreseen batteries and other storage facilities.
- Available flexibility options for households and companies
- Available, nearby heat sources
- Technical life-cycle of existing cables, transformers, gas-pipes, pressure-stations and others
- Topologies, hierarchies and load-profiles of existing networks
- Available, nearby infrastructure backbones
- Energy-efficiency indicators of existing dwellings and commercial real estate
- Available sites for spatial development.
- Adequacy to the National Energy and Climate Plans
- Grid smartness status (e.g. smart meters)

DSOs have already acknowledged the need for adequate data in supporting decision-making in the process of energy transition. For the role of System Integration Facilitator, we want to underline the need to support decision-making in a careful, transparent way in order to serve the interest of all parties involved. We think that responsible decisions are taken on basis of all relevant information available and that system integration will be dependent on a sensible combination and dissemination of different data-streams. In some EU Member States, different data initiatives are already in place that can be used in building a system integration facilitating role. In France and the Netherlands there are examples of such initiatives* while these apparently do not yet entail all data needed for the role as described above. It is clear that the relevant data must – in compliance with data protection standards – be made available to all possible public and market parties involved, by means of digital platform technology.

*Agence ORE in France is an open data platform which gathers data from electricity and gas DSOs. It proposes free services such as multi-energy data visualisation to accompany both private and public actors to plan energy transition at local level https://www.agenceore.fr/ In the Netherlands there is the open GOPACS platform initiative to confront flexibility demands of DSOs and TSOs with possible flexibility solutions of customers https: //www.gopacs.eu/.

The combination and dissemination of relevant data by means of easily accessible platforms that are managed in neutral way can be seen as a first step in building this role. Tentatively looking at other elements, we foresee the following sequence of possible steps:

1. **Providing relevant information on shared platforms to all parties involved through added-value combinations of existing data-streams.**

2. **Developing alternative options for the integration of energy sources form different energy systems (wind, solar, heat) including the necessary investments in infrastructure maintenance and development (storage facilities, extra lines, new substations).**

3. **Supporting legal authorities in spatial planning processes on the basis of strategic development plans**

4. **Supporting different co-operating parties in building operational plans and business plans for taking part in building integrated energy systems on local levels.**

2.4 Next steps at European level

As there is no generally acknowledged definition, sector coupling in our understanding is the process of interconnecting electricity, renewable gases, heat and possibly others while sector integration is the interaction of these sectors, which through coordinated planning, operation and incentives ensures optimal integrated systems. Sector coupling will be another important form of flexibility for an efficient joint operation of electricity and gas when there is no possibility to use any of the available storage technologies. It is important that the conditions for the **provision of flexibility are sufficiently harmonised on a European level** through a dedicated Network Code on Distributed Flexibility following the provisions of the Clean Energy Package. This will enable considerable cost savings while also allowing sufficient options for the specific situation in different Member States. In the case of highly available sector coupling solutions, a cross sectoral flexibility market can be established, supported by a tailored data management.

However, it should be considered that one of the main barriers to deliver an integrated energy system is the **alignment of legislation**: there are different regulatory systems per energy system. Heating and cooling, but also the transport sector, are often treated differently, while they are an integral part of the energy system and linking them with electricity networks will reduce the cost of the energy system – to the benefit of consumers. This alignment can be seen as addition to other legislative improvements that stimulate an efficient use of separate energy systems, notably by means of comparable price signals. A common legislative framework covering different energy systems could ensure a fair level playing field to all those sectors which aim to be more and more integrated.

3 Case studies projecting system integration at local level

Following the first section presenting the needs for system integration to be efficient and beneficial for the European energy system, this section aims to propose several examples to illustrate what energy system integration could be at local level.

To contextualise the issues addressed by this position paper to the technicality and reality of the local energy infrastructures, in the event of a temporary high demand for electricity during the day, back-up solutions, such as gas plant or a hydro-pump station will need to be previously available to provide their flexibility in due time (T-1 / T / T+1).

In other cases, solution such as batteries placed in distribution grids will be able to store electricity in sufficient quantity. In addition of providing its flexibility, the solution shall allow customers with flexibility products (solar PV panels, storage, electric vehicles, etc) to store and withdraw their surplus, as a more efficient alternative to customers installing individualized batteries Behind-the-Meter (BTM).

As a result, for the objectives of this strategy to be fulfilled, such options shall be considered and defined in order to properly engage the consumers, especially those that cannot afford to store their excess generation. This specific issue highlights the necessity to include the right overview from local aspects in this strategy thanks to a bottom-up approach, especially echoing the increasing needs of coordinated planning and operations and the related investments (for digitalization, interoperability, and smart grids), as presented in the Section 1.2.

Therefore, considering these issues might certainly occur at local level while being as close as possible to the consumers/prosumers, and thus the citizen themselves, the possible solutions to be defined or at least incentivised by this strategy shall take the following study cases into account.

Case No. 1

Case study of Amsterdam

In 2019, the Dutch government published the National Climate Agreement on basis of a commitment of 76 national associations for government authorities, civil society organizations, sector organizations and enterprises in different sectors. The aim is to reduce CO2 emissions in the Netherlands by half in 2030 compared to 1990 by means of 35 Terawatt hours of sustainable energy production. Part of the agreement is the formation of 30 energy regions. These regions were formed through a bottom up process by local municipalities and provinces. These regions are investigating where and how best to accommodate wind and solar energy production (on land and larger installations on roofs >15KWp) and create a regional strategy for utilization of heat sources. Each region is responsible for this complex puzzle between their quantitative goals and three more qualitative concerns: public and political support, integration in the high-density Dutch landscape and in the energy system.

So, the RES is a tool for regionally based choices for the generation and accommodation of renewable electricity and using available heat sources for the built environment, including the required investments in storage and (additional) energy infrastructure. The RES is also a way to facilitate cooperation between all regional parties in preparation for concrete projects arising from the RES. In addition, the RES is a product that describes the strategy used by the RES region to determine and achieve local/regional energy objectives. The RES has a horizon of 2030 with a view towards 2050. By the end of 2020, all regions had adopted their draft RES; the first definitive RES document will be published in July 2021.

As an example, the municipality of Amsterdam was the first municipality to announce its commitment to the Concept RES for the region of North-Holland-South with its ambition for large-scale adaptation of wind and solar energy. The capital offered to generate 0.7 Terawatt hours (663GWh) of sustainable electricity by 2030. With this, Amsterdam expects to be able to supply 80 percent of households' electricity demand with renewable energy.

The DSO and Amsterdam have together performed a study on the impact of the RES and other developments on the electricity network. The study consisted of **three tracks**:

1) Investigating the processes of spatial development projects and to look at how these can be matched with, for example, the construction of additional substations or a short-term increase in medium voltage capacity.

2) Building scenarios using five different themes (space, heat, sun, mobility and industry/data centers). These scenarios are input to calculate the impact on existing infrastructure.

3) Designing a joint development strategy for the coming years. Based on the results of track 1 & 2, one may agree on how the developments and energy transition will be managed.

The impact study entails an assessment of the system-efficiency of different infrastructure options and uses an extensive set of input data regarding the actual situation on the ground (use of wind, solar, natural gas and existing infrastructure). The process of how to build a RES and how to perform the necessary studies are described in a handbook for common use.

Case No. 2

Case study of Antwerp, Belgium

The city of Antwerp has signed the Covenant of Mayors, which sets climate objectives. The city is committed to being climate neutral by 2050 and therefore to no longer use fossil fuels. A recent emissions inventory shows that currently 95% heating is done by fossil fuels. It is important to find solutions for how the energy supply can remain affordable, reliable and sustainable. This study focuses entirely on the supply of sustainable heat via alternative sources.

No sustainable technology on its own is currently able to meet the entire heat requirement in a reasonable manner. The key lies in combining the available local heat sources and using them as optimally as possible. By tackling the heat supply collectively, the local potential and available heat sources can be better exploited. The transport movements between source and conversion are also reduced. The heat source that is most available in Antwerp is residual heat from the Port, which includes the largest European chemical cluster. Residual heat is not renewable heat, but a smartly deployable source: energy is recovered that would otherwise be discharged into the environment. In this way, the need for heat generation is reduced. The use of residual heat is preferably done in accordance with the cascade principle: high pressures and temperatures are used in the first instance for the processes that require this, and then the more low-grade heat is used in applications such as space heating and domestic hot water.

In order to further map out where heat networks are the best choice and where alternative heat sources such as heat pumps and renewable gas are more optimal, the Strategic Energy Vision Antwerp project was carried out, a collaboration between the city of Antwerp and Fluvius. The study is a spatial analysis that provides a framework for long-term energy policy by 2050 with regard to heat supply. It is a starting position, as the energy transition is a dynamic trajectory where stakeholders must be able to deal in a flexible way. This translates into a “heat zoning map”, which provides direction for heat policy and forms a well-founded basis for further energy policy development.

Case No. 3

Smart Cities, Spain

World Population is growing quickly in urban areas. It is set to grow by 32% by 2050 combined with enormous demand density increase in urban areas. On one side, cities must be prepared to deal with population growth but also to improve their utilisation of energy, reduce emissions, improve air quality and, in summary, become a friendlier space to live. On the other side, citizens are at the centre of the transition and are making fundamental changes in their attitude by becoming increasingly engaged, active and aware of the challenges. Thus, cities are undergoing a deep transformation process. In this context, the role of DSOs is of utmost importance in empowering citizens to become active participants of the energy system for building smarter cities and communities. In the past, electricity networks only provided top-down electricity. Now, DSOs must operate their grids bi-directionally in a safe and reliable way.

Electric vehicles, DER connected to all voltage levels, services that use the distribution network as a platform, coupling of different energy vectors, micro-grids, etc. are emerging and they are inherent to the Smart Cities. Smart Cities are a cross cutting concept, affecting major aspects of the daily life in our cities and among them energy. For this reason, i-DE has developed an ambitious implementation plan to improve quality of energy service levels experienced by stakeholders. This initiative already works on with a number of Municipal Councils and Autonomous Regions, including several important cities in the regions where it operates as distributor.

32% Growth of World Population in urban areas by 2050

The work of i-DE, in collaboration with local and regional administrations, is centred on 4 strategic areas for a smart city, which include electric mobility, grid infrastructures, efficient energy use and raising public awareness:

1 Mobility

A great proportion of the required carbon footprint reduction comes from the electrification of transport. However, the lack of a sufficient recharging infrastructure, notably public infrastructure, remains as the key barrier, especially in the largest cities where many people live downtown and do not have a private garage. DSOs are the natural ally of cities to establish an adequate strategy for the rollout of the recharging infrastructure at minimum grid cost.

2 Infrastructure

Smart Cities will implement advanced energy solutions to meet the local energy requirements using innovative techniques. Such smarter electricity networks will be the backbone to provide a flexible platform for advanced system services. DSOs are the key actors to optimise existing infrastructure and ensure an efficient use of the network.

3 Active role of prosumers

Distribution networks can no longer remain passive, it is needed to take an active role in coordinating both the network and customers. This can be achieved by extending the current role from network operators to energy system operators thanks to improved engagement, control and a mutual understanding of the needs between networks, prosumers and distributed resources. The previous is key to make real the empowerment of the citizens, improve customer service, manage losses and optimise investment whilst enabling the flexibility to facilitate low carbon technologies.

4 Culture

Informed citizens that make informed decisions are the heart of Smart Cities. Key to success is to be close to customers, show the impact of their energy habits, understand their needs, innovate and be flexible, all with a pace that satisfies customers' needs and in a way that they can understand and appreciate.

Collaboration with Local Authorities includes technical support in the implementation of state-of-the-art local energy solutions based on innovative technologies and the integration of distributed resources managed through the DSO platform.

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Case No. 4

Use case - Agence ORE, France

Created in 2018, Agence ORE is an open data platform which gathers 170 electricity and gas DSOs in France. The platform makes available yearly consumption data at local and regional level. The three main missions of Agence ORE are:

- Being a data hub: with reliable and available data from different sectors and stakeholders (gas and electricity)
- Facilitating data analysis and decision making for public and private actors
- Facilitating the functioning of the energy markets: Agence ORE provide tools to smaller DSOs to collect and generate data flows in order to meet regulatory market requirements

For instance, thanks to its data visualisation tools, Agence ORE provides local authorities with multi-sectoral data to plan their energy transition at local level. Open data allows them to plan their investments, organize and manage their territory while having relevant information on local generation, consumption and distribution of energy. This multi-sectoral vision gives them an energy mapping to better plan investments.

AGENCE ORE
OPÉRATEURS DE RÉSEAUX D'ÉNERGIE

Considering their experience as trusted and neutral parties in managing consumers' data, DSOs have effectively a significant role to play.

Case No. 5

Digital twin of the City of Essen, Germany

Using existing gas networks to transport green gas such as hydrogen in the future is the most cost-effective and socially balanced solution for the energy transition in the heating sector. That's the conclusion of a modeling study conducted by E.ON (for the electricity DSO) and the municipal utility Stadtwerke Essen (for the gas and district heating DSO). The companies used the DigiKoo data platform to create a digital twin of the city of Essen to model different future heat supply scenarios.

Overall, the modelling is based on five different scenarios, including a gradual switch to green gas in the existing natural gas grid. This switch is the option that will put less pressure on people's wallets and also allow urban areas to meet climate targets as efficiently as possible.

Other options explored with the digital twin of the city of Essen included the switch to heat pumps, further densification of district heating, the use of direct electric space heating as well as hybrid heat pumps. The results for Essen in all scenarios show that a solution entirely without gas is not realistic and, in many cases, will shift the costs of the energy transition to low-income neighborhoods, whose residents would be forced to shoulder excessive financial burdens as a result.

An analysis such as the one carried out by E.ON and Stadtwerke Essen for the city of Essen can be of great value to municipalities, distribution system operators and real estate companies in Germany and internationally. The digital twin allows the major, overarching climate protection goals to be broken down regionally – down to each individual building. This helps municipalities to find the right strategies for cutting carbon emissions and to implement them together with their citizens.

E.DSO is a European association gathering leading electricity distribution system operators (DSOs) shaping smart grids for your future.

www.edsoforsmartgrids.eu