Study of the European Regulatory Framework for Smart Grid Solutions in Future Distribution Systems

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(article starts on next page)

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Abstract: Electric distribution systems in Europe are facing significant challenges due to climate change goals, changing market frameworks and technological innovations, which will significantly impact the role of the distribution system operators. The nature and scale of these challenges are strongly driven by the European vision and strategies on climate and energy. This study identifies which policies can become barriers for distribution grid innovation and the implementation of advanced smart grid solutions developed within the UNITED-GRID project. After an extensive review of new policy priority areas within the energy and climate framework and electricity market design, and subsequent discussions with three partner distribution system operators, five priority barriers are identified. The results show that ambitious decarbonisation targets and changing expectations on the distribution system operators' role in the energy system would require more flexible and efficient network management. However, binding income frameworks, lacking incentives for innovation and regulatory uncertainties hinder modernisation in distribution systems. It can be concluded that these concerns increase the risks for distribution system operators and have to be considered by research projects and developers of smart grid solutions in order to implement and achieve market uptake of the developed solutions within the next 5–10 years.

1 Introduction

While the foundation of the European energy policy framework was established during the 1980s and 1990s when the sector was liberalised, new priority areas in the last decade have shaped the energy transition. These areas will have a significant impact on the distribution system operator (DSO), who will hold a central role in future distribution systems.

The 2011 European Commission (EC) energy roadmap 2050 [1] outlines the necessary transition of the energy system to comply with the greenhouse gas reduction target of 80–95% by 2050 (when compared to 1990 levels). For the period between 2020 and 2030, the Energy Union (EU) strategy [2] focuses on creating a fully integrated internal energy market to comply with the EU – wide targets and policy objectives, which are based on the 2030 Framework for climate and energy [3] and the EU's Paris agreement commitments [4]. This strategy resulted in a set of non-legislative initiatives as well as legislative proposals called the clean energy for all Europeans package [5] (also known as winter package) in 2016. The winter package includes the obligation for the member states to submit integrated national energy and climate plans for the period between 2021 and 2030 by 31 December 2019 as well as legal provisions for empowering European consumers to become fully active players in the energy transition. It also comprises a new binding target of at least 32% renewable energy for the EU by 2030, which played an important part in the EC's long-term strategy [6] of 2018. This strategy sets more stringent goals for 2050 and emphasises the central role of the power sector in this transformation. The recently introduced European green deal [7] is even more ambitious, aiming at zero net emissions of greenhouse gases by 2050. This will again require a revision or enforcement of existing key policies and strategies, increased targets for greenhouse gas emission reduction by 2030 as well as new pieces of legislation, such as the first European climate law.

The transformation of the power sector, which started in 2009 with unbundling rules from the third energy package and smart grid obligations in the third electricity directive [8], was completed by new regulations on the EU electricity market design in the winter package. The new electricity market regulation [9] and amending electricity market directive [10] push forward an internal electricity market with a focus on consumers, new loads, and improved flexibility, with an important role for the DSO. They also extend the content and rules for network codes, along with guidelines and specify that data access shall comply with the general data protection regulation (GDPR) [11].

After an extensive review of the legislative documents mentioned above, this paper identifies five regulatory barriers that could potentially have an impact on the uptake of smart grid solutions developed in UNITED-GRID, and in a broader perspective on innovations in future distribution systems. The barriers identification is based on a policy indicator study and future-readiness assessment [12], followed by discussions with three partner DSOs, i.e. Göteborg Energi (Sweden), SOREA (France), and ENEXIS (the Netherlands) and experts from the UNITED-GRID project consortium.

The rest of the paper is organised as follows: Section 2 explains the relevance of the regulations for the smart grid solutions developed in the UNITED-GRID project, Section 3 presents the details of identified policy barriers along with their impact on DSOs and smart grid solutions and Section 4 presents the concluding remarks.

2 Relevance of regulations for UNITED-GRID solutions

Within the fast-changing policy landscape described above, with new challenges such as high levels of distributed energy sources,

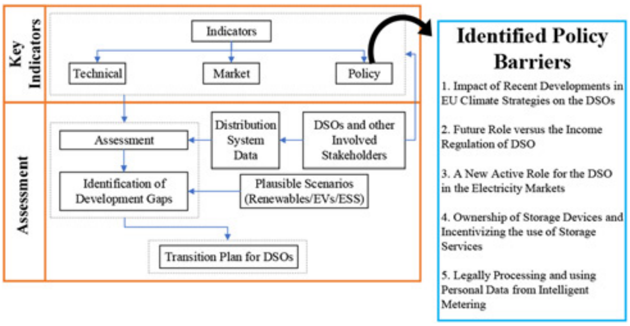

Fig. 1 *Connection diagram of the European regulatory study with UNITED-GRID future-readiness assessment framework*

electrification, and evolving energy markets, new competitive services and technologies are needed for future active intelligent distribution grids. The UNITED-GRID project [13] finds possible pathways for DSOs to implement smart grid solutions based on technical and regulatory factors as well as on their own existing infrastructure. The project will deliver a toolbox that can be integrated with existing SCADA/distribution management systems. The tools and services include advanced generation and load forecast, congestion forecast and management solution, and voltage control with distributed energy resources. The developed tools and services will have commercial and technical potential to support new business models and technical system changes.

In this context, a DSO supports a future-readiness assessment framework, as shown in Fig. 1, along with a baseline description, is proposed in [12], where the relevant indicators for policy, regulation, and standards at the level of the distribution grid and the distribution management system are defined, and three partner DSOs in the UNITED-GRID project are evaluated based on these indicators.

Based on the assessment of the key policy indicators, a detailed regulation review and analysis is done in the UNITED-GRID project and presented in [14].

3 Impact of the regulatory framework on DSOs and smart grid solutions

While the building of the European regulatory framework around energy and climate, as described above, started years ago, their actual transposition and implementation is still ongoing or will have an effect in the near future. These evolutions will have a substantial impact on the planning and operation of the distribution systems and will require a transformation of the DSO business models. For research projects such as UNITED-GRID, the following regulatory concerns could be a major barrier to the implementation of existing or future smart grid solutions.

3.1 Impact of recent developments in EU climate strategies on the DSOs

The global and European visions and strategies for reaching binding climate goals result in policies and regulations that set up a process for member states to decarbonise the power sector. The strategies often have long-term views and targets, but once new frameworks are introduced, stakeholders have to adapt quickly. Recent developments within these strategies (as identified in Section 1) can have a substantial impact on DSOs in the next 10 years. For example, [5] resulted in several revisions of existing directives and regulations, fixing new targets and forcing member states to draft integrated national energy and climate plans. Nations or regions can decide to have even more stringent targets than requested and individual municipalities or cities can, on top of that, have their own decarbonisation goals, which will have a significant impact on the future grids.

The three partner countries in the UNITED-GRID project have ambitious national climate goals: Sweden and France aim for carbon neutrality by 2045 and 2050, respectively, while the Netherlands aims to reduce CO_2 emissions by 80% by 2050 (compared to 1990). In each country, different scenarios are developed to understand possible pathways towards these decarbonisation goals. While the assumptions are based on different patterns in the three countries, the outcomes all indicate that the impact on grids in the future will be substantial. The biggest challenges arise from increased integration of highly volatile and decentralised generation and increased loads due to electrification of transport and heating and cooling. Large investments and a major transition are required by all stakeholders, particularly at the distribution level.

DSOs should aim to secure and optimise the operation of their future active intelligent distribution grids, while efficiently exploiting the opportunities provided by new actors and technologies. However, not all DSOs have sufficiently explored innovative solutions or developed their own long-term strategies adapted to the expected transformation of the energy sector.

3.2 Future role versus the income regulation of DSOs

In the provisions of [8], distribution systems are considered as non-competitive natural monopolies with regulated incomes that are collected via network tariffs. These regulated revenues, along with investments that are usually made on long planning horizons, imply low financial risks for the DSOs. However, while the main task of the DSOs is still securing system operation, the ongoing energy transitions require that the DSO will also use flexibility services and energy efficiency measures to improve operational efficiency.

Because the actual transposition and implementation of the European framework are different in the three countries involved in UNITED-GRID, DSOs have access to different tools for using flexibility to manage their networks. Therefore, the potential (future) savings associated with investments in innovative services and technologies depend on each case. In general, the major concern of the DSOs is that there is a rate of return on the capital expenditure but not on the operating expenditure, resulting in a lack of incentives for innovations which in turn hampers the necessary grid transformation.

Moreover, recently implemented and expected future regulations on operational cost reduction result in a tightening of the authorised income space for the DSOs, who are concerned that with additional flexibility requirements on top of the traditional DSO tasks, the affordability of the energy supply will be impeded. It could be a major economic barrier for several DSOs in the next 10–15 years and could result in negative consequences for the maintenance and development of their grid.

Finally, the concept of cost revenue through regulated incomes has always implied very low financial risks for the DSO, but also low incentives for innovation. Due to the requirements to balance investments in grid reinforcement with innovative digital solutions and implementing new business models, the DSOs will have to take bigger risks. A thorough understanding of the technical and economic impact of new investments on different grid operations is required, and any information asymmetry between network owners (who know more about their networks and how to operate them) and regulators should be removed.

3.3 New active role for the DSO in the electricity markets

The new electricity market design [9, 10] demands a more active role for DSOs in developing, managing, and operating their networks. The DSO should become a neutral market facilitator that coordinates the impact of flexibility operations on its network, irrespective of the flexibility model and the chosen technology. This will also require a transformation of the traditional DSO business model.

Although some changes are already emerging, the DSOs in UNITED-GRID still play a passive role while waiting for more clear guidelines, incentives, business models and technical rules.

They anticipate a large-scale use of smart grid solutions in the very near future and accept that they will have to develop new technologies and planning tools, increase the level of digitalisation of the power grid, improve the necessary control architectures as part of their active system management responsibilities and adapt their business process.

However, the anticipated load growth, the resulting need for investments in flexibility solutions, the availability of flexibility resources and therefore also the benefits associated with investments all have a high degree of uncertainty and may seem far from the DSOs today's operating practice. DSOs are also concerned that these changes in tasks and roles conflict with the fact that they remain regulated entities and they will not be able to manage the network optimally. One consideration is that the market could favour investments that are beneficial in the short term at the expense of long-term solutions. DSOs are also concerned that the activation of flexibility by other market parties will increase the operational challenges in the distribution grid.

The core concern is that the necessary regulatory frameworks for smart management and the incentives towards DSOs for innovation are not in place yet. An example is a delay in the roll-out of smart meters due to high costs in combination with regulatory constraints. For the DSO, taking up the new role as market facilitator is difficult since there are no real markets for grid services yet and there are limited opportunities available in terms of differentiated components in the distribution tariffs. It is also clear that there is not one single solution that would fit all DSOs in Europe. Any solution should be flexible enough to react to developments in each distribution grid and market.

3.4 Ownership of storage devices and incentivising the use of storage services

In the future distribution grid, the relevance of energy storage devices will increase, as a source of flexibility or in terms of seasonal balancing. According to the new electricity market directive [10], storage services should be market-based and competitive. It puts strong restrictions on the ownership and management of storage units by DSOs, with different interpretations of this legislation among UNITED-GRID countries. DSOs can be enabled and incentivised to use services from energy storage and exceptions are allowed in cases such as solving power quality problems, covering security of supply, in innovation projects or as part of a regulatory sandbox. However, these exemptions could be short-term and if alternative solutions turn up in the market. As long as a real service market does not exist, this is perceived as a regulatory gap with large uncertainties that hamper the needed investments in storage. The way to incentivise DSOs will be important in the coming years and it will be part of the regulatory implementation in the member states.

3.5 Legally processing and using personal data from intelligent metering

Smart meters will play an important role in the new market design by facilitating consumers in managing their consumption patterns through flexibility. The full roll-out of smart meters is planned in Sweden by 2025, in France by the end of 2024 and in the Netherlands by 2020. Although specific regulations on implementation, interoperability, data privacy and operational ranges are largely dependent on the member states, they all have to comply with the GDPR data privacy rules [11]. DSOs can only access personal data from smart meters if that is necessary to perform other legal obligations and they should not go beyond the purpose for which these data have been collected. This implies minimising processing activities and defining specific monitoring accuracies. In some cases, such data protection challenges have slowed down the roll-out and deployment of smart meters. Even when smart meters are operational and their performance is increasing, the use of that data could be inefficient due to data privacy issues, leading to the deactivation of certain smart functions. The risk of customers denying access to their data also becomes higher when the DSO loses direct contact with its customers, for example, when another partner will take the role of metering data hub.

4 Conclusions

Increasingly ambitious decarbonisation targets outpace the speed at which DSOs traditionally develop scenarios and pathways, and not all DSOs presently have explored strategies adapted to the expected energy sector transformation. Innovation in services and technologies are hampered by the regulated income framework of DSOs, due to a reduction in operational cost. Further, if additional flexibility requirements have to be balanced with traditional grid reinforcement, the DSOs will face much higher risks. The new electricity market design requires the DSO to play a more active role and act as a neutral market facilitator to coordinate the flexibility resources in its network. However, without the necessary regulations and incentives for innovation and with existing uncertainties on ownership of storage devices and data processing, the DSOs are concerned about the efficient and flexible management of their network. Projects such as UNITED-GRID, which aims at market uptake of innovative products for regulated DSOs, have to be aware of the fast-changing policy landscape. Risks and uncertainties in the context of future scenarios for DSOs must be reduced by having a thorough understanding of the technical and economic properties of each individual distribution system and as well as the availability and benefits of innovative solutions that are emerging through enhanced field testing and the development of viable business models.

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