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Smart Regulation for Smart Grids

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Highlights

- **The European Union** set ambitious objectives for the year 2020 in terms of increase of renewable generation, energy savings and reduction of GHG emissions. These objectives lead Europe towards a complete decarbonisation of the electricity system
- **There is a key role** to be played by grids in facilitating the required transformation and this implies they need to become "smart"
- **In practical terms**, making grids smart means deepening the energy system integration and grid users participation. Grids have to reconfigure notably for the integration of distributed generation (DG), the integration of massive large-scale renewable (RES), and for the integration of facilitating demand response
- **Smarter grids need a smarter regulation**. A smart regulation reconfigures the incentives and coordination tools of grid companies and grid users and aligns them towards the new policy objectives
- **Some of the incentives** provided to grid companies and grid users by the existing regulation must be corrected and some additional mechanisms must be conceived and experienced

[1] Meeus L., Saguan M., J.M. Glachant and R. Belmans (2010): 'Smart Regulation for Smart Grids' http://hdl.handle.net/1814/14043

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Florence School of Regulation

The Florence School of Regulation (FSR) was founded in 2004 as a partnership between the Council of the European Energy Regulators (CEER) and the European University Institute (EUI), and it works closely with the European Commission. The Florence School of Regulation, dealing with the main network industries, has developed a strong core of general regulatory topics and concepts as well as inter-sectoral discussion of regulatory practices and policies.

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Background

The European Union set up ambitious objectives for the year 2020 in terms of increase of renewable generation, energy savings and reduction of GHG emissions. Even more ambitious objectives are being discussed and developed for 2050.

These objectives lead Europe towards a complete decarbonisation of the electricity system, a high priority in the European context. Decarbonisation requires energy supply, energy consumption as well as the overall electricity system in Europe to undergo a deep and complex transformation.

There is a key role to be played by grids in facilitating the required transformation and this implies they need to become "smart".

What makes grids smart?

In practical terms, making grids smart means deepening the energy system integration and grid users participation. Grids have to reconfigure notably for the integration of distributed generation (DG), the integration of massive large-scale renewable (RES), and for the integration of facilitating demand response (Box 1).

The distribution grids till today didn't have to be so smart because they are mainly supposed to "passively" connect the load to dedicated power exit points on the transmission grid. Distribution grids will then have to deeply reconfigure to become smart.

The transmission grids are already "active" and therefore relatively smarter than distribution grids, but they will face new challenges both to balance massive intermittent generation and to evacuate power from remote new areas of generation.

Box 1 - System integration to the purpose of decarbonisation

1. Distributed Generation: medium and small-scale RES (Renewable Energy Sources) and CHP (Combined Heat and Power) generation technologies located close to the load being served

What does the integration of DG imply?

- Efficient grid planning and development
- Participation of distributed generators and aggregators to grid planning and development
- More flexibility in connection and access services
- Participation in ancillary services and wholesale markets
- Incorporation of new technologies

2. Demand Response: processes of advanced energy demand management

What does the integration of demand response imply?

- More flexibility of grid services
- Bigger use of information to coordinate and optimize grid operations
- Incorporation of new technologies (such as smart information services) and communication infrastructure
- Communication of more information to consumers
- Incentives to consumers to use this information

3. Large-scale RES: large-scale renewable generation sets

What does the integration of large-scale RES imply?

- Massive grid reinforcements
- Dealing with increased coordination and balancing costs
- Incorporation of new technologies
- Participation to grid planning and development

In order for grids to get enough of the "smartness" required by the new energy policy goals, the regulatory framework for grids should also be smartened. A smart regulation reconfigures the incentives and coordination tools of grid companies and grid users and aligns them towards the new policy objectives.

What makes regulation smart?

The deep process of transformation of the European electricity grids into smart grids is going to be a challenge for grid companies and users. There are three main issues:

A. Costs are likely to increase: The integration of DG, demand response and large scale RES should increase certain grid costs, especially system operation costs and service quality costs. Furthermore, grid companies will not be willing to make significant new investment (e.g., grid reinforcement, voltage control, specific maintenance, or smart meters) without a guaranteed adjusted remuneration

B. Revenues are likely to shrink: At the same time, integrating more DG and more demand response should reduce the amount of energy to be distributed (or transmitted) trough the grid. So that overall several aspects of integration should work against the grid company revenues

C. Incentives are likely to be lacking: The first two issues with costs and revenues can be dealt with by correcting the distortion of incentives in the existing regulatory framework. However there is a need for introducing further incentives for both grid companies and grid users. The implementation of new incentivising mechanisms (such as "output regulation") is able to correct the lack of incentives for certain new output (as "renewable hosting capacity", "openness and robustness of information or control systems)"). Output regulation can define some output metrics to measure and stimulate the performance of grid companies.

Box 2 illustrates smart regulations that have already been applied to deal with these issues.

Box 2 - Three case studies

1. Integration of DG: The Orkney Isles

The case

The Orkney Isles in the north of Scotland are well-known for their attractive RES potential. At the same time, they represent a typical rural distribution setting with very low demand, relatively weak distribution grid and very limited connection capacity with the transmission grid.

In order to improve the grid hosting capacity without upgrading the connection with the mainland, the distribution company is implementing an innovative solution. The so-called Active Network Management (ANM) controls electricity output of new generators to match the available capacity of the network in real time. Thanks to this innovative solution, 21 MW of additional DG can be connected to the grid.

Which regulatory tools were implemented?

The Orkney distribution company has benefited from two UK innovation funding mechanisms: IFI (Innovation Funding Incentive) - covering R&D costs - and RPZ (Registered Power Zone) – rewarding R&D outputs, which in this case of Orkney Isles is the connection of new DG via the ANM innovation.

Main lessons learned

A smart regulation, based on incentives and output regulation as well as on ad hoc funding mechanisms, could provide the right incentives to the innovation of the grid technology.

2. Integration of demand response: Italy

The case

Italy is well-known to be a frontrunner in smart metering: it has the largest smart metering system in the world, with 90% of low voltage customers having such a meter.

A recent Government Decree establishes that distribution companies should also install a visual display for electricity and energy customers. The so-called "Smart Info" device is an innovative solution considered by Enel Distribuzione to comply with this new legislation. The device has a USB connection and can make the meter accessible from any plug in a house. This device would not only allow distribution companies to comply with the new legislation concerning the visual display, but also improve third party access to smart metering, since third parties might develop new services via the USB connection.

Which regulatory tools were implemented?

Electricity distribution in Italy is regulated through a price cap tariffs system reviewed every 4 years. Price cap regulation provides incentives to distribution grids to reduce operational costs and smart meters can indeed help reducing costs in many ways (e.g., logistic costs, field operations costs, customer services costs). The regulation of electricity distribution activities in Italy also includes service quality regulation, therefore companies have incentives to improve service quality and use smart meters to record the quality of supply.

Starting from 2004, metering activities have been subjected to a specific and separated tariffs regulation with stronger incentives to cut costs and get efficiency gains.

Moreover, the Italian Energy Authority has recently issued a competitive procedure to incentivise active grid projects that can be supplemented with experimental demand response schemes. The selected project will be allowed an extra WACC (+2%) for a period of 12 years. Finally, user participation on the demand side in Italy has also been incentivised through white certificates and ToU (Time-of-Use) prices.

Main lessons learned

Several regulatory tools have been implemented to promote user participation on the demand side. More positive outcomes will be fully achieved with the improvement of the access to smart meters.

3. Integration of a large-scale off-shore park: The Kriegers Flak area

The case

The Kriegers Flak area in the Baltic Sea was recognised a potential generation capacity of 1600 MW to be developed through offshore wind plants across the three regions included in the Danish, German and Swedish territories. The three correspondent TSOs are considering an innovative combined solution to connect the wind farms to their transmission grids, instead of separate solutions. The big advantages associated to a combined solution would be at least two. First, the pooling of the connection capacity means that the energy produced by one wind farm can escape via the connection of another wind farm in case there are problems with its connection. Second, the pooling allows the capacity that is not used by the wind farms to be used to transfer energy from a low price zone to a high price zone. This would guarantee a more efficient and more reliable use of the connections for the wind farms as well as the promotion of market integration.

The innovative solution (multi-terminal High Voltage Direct Current Voltage Source Converter system, HVDC VSC) would be the first large scale implementation of this kind. This technology is considered to be exactly what Europe needs to realize its vision of a super trans-national grid to unlock the large scale RES potentials.

Which regulatory tools were implemented?

The integration case of the Kriegers Flak area clearly requires a very high level of coordination among the three TSOs. A feasibility study published in a joint report shows that the combined solution generates net benefits relative to the separate solution. Nevertheless, the current regulation in force is not incentivising coordination. TSOs are subject to regulations that are mainly national in scope and they have no incentive to enable the integration of large scale offshore wind or to increase the interconnection capabilities with neighbouring countries.

Moreover, the specific regulation for the connection of renewable plants can be quite different in the three countries. For instance, the German TSOs must connect all renewable plants (regardless of their capacity) and undertake the due investments to reinforce the grid. As opposed to Sweden, where the plant owner is in charge of the connection from the off shore wind park to the online grid.

As a result, a separated solution is currently being established for the first wind park that will be connected in Germany, before the combined solution can be ready. Meanwhile, the Swedish wind park has been postponed and the Danish wind park has been reduced from 400 MW to 300 MW.

Main lessons learned

The implementation of an international cooperative solution is affected by the lack of deep coordination among TSOs and regulators. The regulation of wind farms development and grid expansion are too different regarding support schemes, connection costs, technology choices, and investment scheduling and balancing rules. Massive European renewable penetration will not succeed if countries do not duly cooperate.

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Recommendations

Making grid smarter is absolutely not an objective in itself. Making grid smarter is mainly a fundamental step towards the achievement of the European policy objective of decarbonisation of the electricity system. It targets higher energy efficiency and a more responsive demand; a higher proportion of distributed generation and a massive penetration of renewable. Grids will however only be smart if grid companies develop the corresponding new services based on certain grid technology innovations. It will work only if grid users participate in this ongoing grid innovation, adopt the complementary technologies and use the services that will be derived from the grid technology innovation.

Smarter grids need a smarter regulation. Some of the incentives provided to grid companies and grid users by the existing regulation must be corrected and some additional mechanisms must be conceived and experienced (Box 3).

Box 3 - Regulation gets smarter when it…

Recognises the new grid service requirements and their respective costs

Includes these service outputs in the revenue drives of grid companies by defining and measuring new services

Allows grid users to participate at this definition so that they can value the services they ask for

Addresses grid technology innovation separately

Extends output regulation over several regulatory periods

Establishes specific additional incentivising regulatory mechanisms to ensure the transition from R&D to value for money grid services

Identifies and ranks the beneficiaries of the technology innovation

Provides for public money to contribute to ensure the electric system transformation process

Considers the regulatory framework as a whole and identifies the existing regulation which may possibly work against grid innovation

Experiments and ensures that learning loops will take place