

The Cyber Physical System for the Energy Transition

Digitalisation Challenges, Opportunities and Projects
from TSOs and ENTSO-E

Executive Summary



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Digitalisation is central to Transmission System Operators (TSOs) as they have to manage a fast-evolving power system 24/7 while keeping the lights on. Today, they are required to overcome a variety of new challenges, such as the increased amount of variable generation, sector coupling, power and transport connected through e-mobility, increasing electrification and, in particular, heating and cooling, as well as the rise of the Energy Internet of Things and the many flexibility opportunities and needs. Digitalisation also contributes to further market facilitation and enables new actors and new roles, centred around prosumers and active system management.¹

A cyber physical grid is in the making. This is composed of the physical part on the one hand – towers, cables, wires, substations etc. – and the increasing Digital Grid on the other. The Digital Grid will allow for the integration of models, tools, platforms and information. It will enable not only automated and coordinated decision-making inside the business units of TSOs and between them, but also enable it in the future with Distribution System Operators (DSOs) and all the other parties that constitute the electricity value chain.

ENTSO-E and its TSOs' members decided to investigate the cyber physical grid, along with its challenges, opportunities and projects that have already been undertaken on a national, regional and European level by TSOs and their

organisations. This work was undertaken by ENTSO-E's Research Development and Innovation Committee (RDIC) and supported by Pöyry Management Consulting.

The present report provides a state of play based on real world examples and next step requirements. It is a unique effort, as more than 100 digital projects within the TSOs and ENTSO-E have been gathered and discussed. It focuses on the role of TSOs in the transition towards the Digital Grid; other actors have also published reports and positions on digitalisation and their respective roles, such as DSOs' European associations. ENTSO-E and its members are committed to exchanging information and engaging in discussions with all the stakeholders of the energy system on this matter, in order to share and build a vision together.

Key findings and 100 projects

The analysis has shown that the European TSOs are already widely using digitalisation technologies. We have organised the projects according to the TSO activity area – here referred to as a layer – that they relate to. The contribution of the digitalisation is explained layer by layer.

Of the 100 projects, more than half address the physical layer and data management layer, while the same proportion is deployed for system operation purposes. Only a small number of projects consider the market layer, and even fewer the sector coupling layer.

1 **Physical layer:** The impact of digitalisation on the asset management function leads to reduced maintenance costs and extending the lifetime of high voltage assets. Digitalisation could also lead to increased reliability and lower outage times.

2 **Data layer:** TSOs have already been gathering data during operation for years, but nowadays digitalisation enables improvements in the forecast and the opening-up for additional sources of data.

¹ TSO-DSO report: An integrated approach to active system management. https://www.entsoe.eu/Documents/Publications/Position%20papers%20and%20reports/TSO-DSO_ASM_2019_190416.pdf

- 3 **System operation layer.** Digitalisation will enable the development of a new set of tools in control rooms that can offer the operator a whole new level of hyper-vision and automation, from two days ahead up to real time, to face a context of an increasing number of uncertainties and interlinkages.
- 4 **Market layer.** With more digital additions to the grid and the system, more information can be gathered from more parties (including consumers and prosumers), processed and shared much more efficiently and securely using a range of digital technologies. The TSOs therefore

need to play a leading role in the digitalisation of power markets.

- 5 **Sector coupling layer and cross border dimension:** Sector coupling requires digitalisation so as to connect across two currently largely disconnected energy sectors. Meanwhile, the cross-border dimension is not only addressed by neighbouring TSO countries or Regional Security Coordinators (RSCs) but also at the pan-European level, which is why ENTSO-E has been driving numerous parts of the digitalisation agenda.

What are the challenges, risks and opportunities related to digitalisation?

Our survey sheds light on how TSOs see the risks and opportunities associated with digitalisation. The most relevant challenges for TSOs are design strategy and regulation, but also market design, cost effectiveness and cyber security.

tem and grid cost efficiencies, risk management, system security and sector coupling.

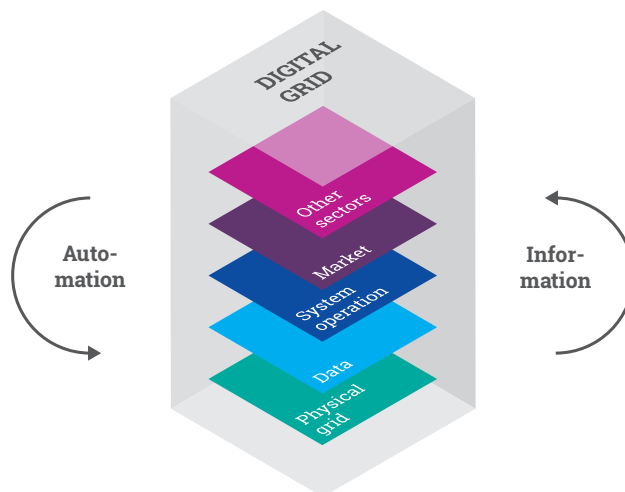
New technologies are game changers for the TSOs, and this includes in particular artificial intelligence, machine learning, digital twin, the Internet of Things and 5G.

Opportunities provided by digitalisation are the overall sys-

The way ahead: More R&D, more projects everywhere and a regulatory framework incentivising the cyber physical grid

The report shows that TSOs consider all the dimensions when developing projects: local, national, regional/cross-border and pan-European. However, the results of the survey indicate that not all TSOs are actively pursuing digitalisation projects. A further reason for this is a regulatory framework that does not incentivise them to seek low-risk.

long asset lifetime solutions. ENTSO-E therefore urges the policy makers and regulatory agencies to use their tools to support the rise of the cyber physical grid. It goes without saying that to achieve the vision of the Digital Grid, R&D investments need to increase substantially.



The 5 layers of the Digital Grid concept

About ENTSO-E

ENTSO-E, the European Network of Transmission System Operators for Electricity, represents 43 electricity transmission system operators (TSOs) from 36 countries across Europe.

ENTSO-E was established in 2009 and was given legal mandates by the EU's Third Legislative Package for the Internal Energy Market, which aims to further liberalise the gas and electricity markets in the EU.

Any question? Contact us:

@ENTSO_E | info@entsoe.eu | +32 2 741 09 50 | www.entsoe.eu

