

Electricity transmission and distribution “smart-grid” performance indicators - an ACER-CEER guidance paper

June 2024

Context

As increasingly evident, also emphasised in the European Commission communication about an EU Action Plan for Grids¹, interconnected and stable electricity grids are the backbone of a well-functioning European energy market. Europe's electricity networks are more than ever confronted with new and significant challenges, e.g. to serve growing demand linked to clean mobility, heating and cooling, as well as to integrate a significantly increasing share of renewable energy.

Properly coping with these challenges requires an expansion of the electricity networks, while maximising the opportunities to deploy innovative but proven technological solutions, especially when they are “faster” and “cheaper” than conventional grid solutions.

In this context, the action of energy regulators is focused on favouring a just transition, i.e. limiting the necessary increase of network expenditures and consequently network tariffs and stimulating the network operators to a proper deployment of all network technologies in order to maximise the value for network users and the energy system as a whole. While these future-proof regulatory actions can take different forms, they are very likely based on monitoring the status of the electricity networks and of the services they are delivering to network users.

Following up on Conclusion 9 of the 2023 Energy Infrastructure Forum, which requested ACER and CEER to develop technical discussion papers on smart grid key performance indicators for electricity transmission and distribution networks, the purpose of this guidance paper is to set out joint ACER-CEER principles on “smart-grid” performance indicators to be monitored in order to foster grid performance and efficiency to the final advantage of network users.

This paper aims to set the framework of smart-grid performance indicators and foster the discussion with all stakeholders on the proposed guiding principles and concepts. It provides a recap of energy policy objectives, network operators' tasks and the possible uses of network performance indicators to support them. As the discussion to identify specific indicators is expected to be complex as many details, potentially different from country to country, both regarding performances and costs, will have to be considered, the paper provides a first contribution by (i) identifying dimensions of network performances, (ii) clarifying the role of input indicators and output indicators, as well as the responsibilities to define them and (iii) providing a practical example to concretely explain what is an input indicator and what is an output indicator.

With a view to further discussions about the identification of specific network performance indicators, stakeholders are invited to provide further inputs as explained in the last chapter of the paper.

¹ European Commission, COM(2023) 757 final, eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52023DC0757

Legislative framework on network performance indicators

In short: the legal framework requires National Regulatory Authorities to monitor and evaluate network performance indicators. ACER-CEER sees this requirement in the wider regulatory remit of promoting network performance and quality while ensuring economic efficiency.

According to Article 59(1)(l) of Directive (EU) 2019/944 of June 5, 2019 concerning common rules for the internal electricity market and amending Directive 2012/27/EU, National Regulatory Authorities (NRAs) monitor and evaluate the performance of transmission system operators and distribution network operators with regard to the development of a smart grid that promotes energy efficiency and the integration of the energy produced from renewable sources, based on a limited set of indicators, and are to publish a national report every two years, including recommendations.

The corresponding recital (83) of the Directive explains that NRAs should ensure that transmission system operators and distribution system operators take appropriate measures to make their network more resilient and flexible. To that end, they should monitor those operators' performance based on indicators such as the capability of transmission system operators and distribution system operators to operate lines under dynamic line rating, the development of remote monitoring and real-time control of substations, the reduction of grid losses and the frequency and duration of power interruptions.

As a matter of fact, assessing the performance of network operators, in all aspects of their tasks, is the focus of National Regulatory Authorities. It is worth emphasising that regulatory frameworks are designed to provide the necessary incentives to optimise network performance and quality of supply while ensuring economic efficiency.

The regulatory provisions also welcome innovations and technical developments that help to improve the services provided by network operators, whether as part of sandbox projects or justified cost-benefit analyses, or more broadly as part of the processes for setting maximum authorised revenues and investment plans.

That is why article 59(1)(l), should be considered as one of the key aspects of holistic regulatory actions, and not as an end in itself.

European energy policy objectives and network operators' tasks

In short: the EU policy objectives of affordable, secure, low carbon and energy-efficient electricity and the TSO/DSO tasks of facilitating markets, contributing to security of supply and efficiently developing networks are essential elements when setting network performance indicators.

It is relatively easy to lose sight of the fundamentals when it comes to implementing new technical solutions integrating many players and implementing new technologies. The risk is that we end up confusing the end and the means.

That is why it is important to recall the fundamental objectives. Directive (EU) 2019/944 and the wider set of EU energy and climate policies aim to ensure:

- Affordable, transparent energy costs for consumers (P1)
- A high degree of security of supply (P2)
- A smooth transition towards a sustainable low-carbon energy system (P3).
- Promoting energy efficiency (P4)

It is also important that monitoring the performance of system operators correlates first and foremost with their tasks, as each policy objective can be linked to at least one of the TSO/DSO tasks:

1. Facilitating the market development and, for transmission, market integration (P1, P3, P4)
2. Ensuring the long-term ability of the system to meet reasonable demands for transmission/distribution of electricity and, for transmission, contributing to Security of Supply (P2)
3. Developing - under economic conditions - secure, reliable and efficient networks, with due regard to the environment (P1, P2, P3, P4)

Regulators' work on network performance indicators and their possible uses

In short: For over a decade, the European Energy Regulators (as ERGEG, CEER and ACER) have been working on the concepts of performance-based regulation and related key indicators to support the EU energy and climate policy objectives and a more efficient implementation of network operators' tasks. These works discussed the use of indicators for monitoring purposes as well as for incentive mechanisms.

Targeting the EU energy policy objectives of affordability, security of supply, sustainability and the TSO/DSO tasks via improved performance of electricity networks is not a new activity for the European Energy Regulators.

Already 15 years ago, the European Energy Regulators initiated a discussion, including a public consultation on smart grids and potential performance indicators (cfr. ERGEG 2009-2010 consultation and conclusions paper on smart grids²; CEER 2011 and 2014 status review reports³ on smart grid developments).

Regarding performance indicators and targets, the first paper of the smart grid series underlined that clear and transparent measurement rules are crucial to make possible to observe, quantify and verify such targets. Performance targets must be strictly related to the pursued objectives and should therefore be cleansed of external effects outside the control of network operators.

The consultation document observed that indicators should be benchmarked at national or international level to define expected performance targets. As a consultation outcome, there were contradicting opinions on the opportunity to have a European benchmarking of some selected performance indicators, especially due to national differences and factors affecting the indicators. ERGEG concluded that it was to be further evaluated whether the possible benchmarking of other performance indicators (beyond the long-standing quality of supply benchmarking reports) would have been cost-benefit effective.

The paper also acknowledged that “the indicators that will be the best ones to consider can vary from country to country”.

Ideally, indicators should only measure the achievement of a goal or the effectiveness of a feature. In other words, measuring an outcome regardless of the manner or technology used to achieve it.

Later, CEER published a Status Review Report on Regulatory Frameworks for Innovation in Electricity Transmission Infrastructure. The 2020 survey among NRAs revealed that innovation is mostly promoted indirectly via the general regulatory framework and/or some specific features regarding incentives for network performance, also called output-based regulation. In addition, specific actions for innovation have been adopted in several countries, as listed in that report⁴.

In 2021, ACER published a Position Paper on incentivising smart investments to improve the efficient use of electricity transmission assets⁵. The paper focused on incentivising the efficient use of infrastructure, which can be considered as one of the measurable effects of innovation. By properly incentivising efficiency, ACER observed that the regulatory environment would create new opportunities for innovation to prosper. In addition, the aim of increasing efficiency

² <https://www.ceer.eu/documents/104400/-/-/3cf25df7-88cb-3ce3-f838-aa2d012ac45c>

³ <https://www.ceer.eu/documents/104400/-/-/eb88c212-491a-6aa8-274f-772ba68282fc>

⁴ <https://www.ceer.eu/documents/104400/-/-/8c2aace7-5601-8723-4d45-337073af38d5>

⁵

<https://www.acer.europa.eu/sites/default/files/documents/Position%20Papers/Position%20Paper%20on%20infrastructure%20efficiency.pdf>

would trigger a wide deployment of efficient and often innovative solutions, bringing their benefits to consumers and other network users.

ACER also concluded that lower cost investments could be incentivised by granting network operators a fair share of the monetised benefits which the specific investment brings.

From a monitoring requirement to improved network performance

In short: the pattern to an improved network performance should include a definition of smart grid indicators linked to increased grid efficiency and benefits for consumers at low cost, the identification of a limited set of KPIs which could be used in all Member States and which are easily understood by stakeholders.

Next to the definition of “smart” grid indicators, article 59(1)(l) requires a recurring process of interaction between the regulator and operators regarding performance metrics and streamlined processes of data collection.

The possible definition of “smart grid” was addressed by a CEER survey to National Regulatory Authorities in 2020. The 2020 CEER status review report concluded that there seemed to be a broad common understanding of innovation in electricity transmission across the NRAs, innovation being mostly correlated with developments that increase grid efficiency and benefits for consumers at the same (or even lower) cost.

The applicability of the term “smart-grid” as an objective of a system operator was also discussed in ACER’s 2021 position paper on smart investments. In the paper, ACER focused on efficient use of infrastructure as a measurable effect of innovative, smart solutions. ACER recognised the potential contribution of network key-performance indicators (KPIs) in measuring the impact and benefits of TSO investments and consequently of KPI-based incentives. Some major KPIs could be implemented in all Member States to facilitate harmonised setting of metrics and to allow, to a certain degree, comparable results.

There is also a pedagogic value to the indicators that should be leveraged to raise awareness, involvement and understanding of all stakeholders. Therefore, it is also paramount that indicators, and the objectives they monitor, can easily be understood by all stakeholders.

Dimensions to measure network performance

In short: the identification of dimensions to measure the network performance would help in preparing a list of indicators. ACER and CEER suggest a combination of a few indicators to be used in all Member States and a wider basket of options to be used at national level, depending on national circumstances.

In this section, as a preliminary work for future discussions on concrete indicators (which are likely to differ between transmission and distribution), we reflect on a more detailed set of dimensions that are related to the pursued objectives and the network operators' tasks.

Regulators could consider output indicators related to the following output dimensions (which, in many cases, are applicable to both transmission and distribution):

1. Integration of renewable energy generation.
2. Integration of increased electrification of energy uses and efficient connections.
3. Continuity of supply and resilience to extreme events.
4. Other quality of service objectives.
5. Energy efficiency.
6. Data made available for market participants (including for enabling participation of network users).
7. (For transmission) cross-border market integration

It has to be recalled that Directive (EU) 2019/944 requires a limited set of indicators. Therefore, ACER and CEER deem that:

- A few indicators should be used in all Member States;
- A wider basket of optional indicators could be used at national level, depending on national circumstances.

Regarding the latter, while European countries all share the same goals, national settings could be calling for different priorities and even for different approaches to indicators to better suit their market, pre-existing conditions (level of prices, electricity mix, carbon impact), network configuration, operator types, etc.

Use of input and output indicators and related responsibilities

In short: National Regulatory Authorities are mainly focusing on identifying output indicators. Network operators can identify the best (least cost) inputs to deliver and clearly identify the relationship between inputs and outputs, as a proposal for the NRA decision: ultimately NRAs remain responsible for the selection and monitoring of indicators.

The purpose of this section is to clarify what is meant when talking about input and output indicators and how work could be approached to define them, taking into account that the duty to monitor and assess performance stands on the NRA, pursuant to Article 59(1)(l) of Directive (EU) 2019/944.

While the concepts of inputs and outputs can be broadly defined, they should always be considered with respect to the context in which they are applied.

For example, costs are defined as inputs when considering the production function of network operators, but costs can also be defined as outputs when considering cost optimisation or the cost saving ability of a network feature.

Output relates to an outcome, the achievement of a goal or the value that arise from the effectiveness of a feature.

Input relates to the means, the functionalities that are implemented to achieve a desired outcome.

While NRA's will mainly focus on outputs when it comes to assessing the performance of network operators, there should also be a form of reconciliation between the results and the cost of the means mobilised to achieve those objectives.

One could argue that there is value in considering the value chain, the mapping of key functionalities and skills to propose a framework for the evaluation of the effectiveness of smart grid functionalities (inputs), with regards to the desired outcomes, namely energy policy objectives to which all actors must contribute (outputs), while taking into account the costs of those functionalities be it with respect to alternatives (network capacity investment) or with respect to overall economic efficiency.

Therefore, NRAs should consider a top-down approach, first focusing on outputs while considering, based on network operators' input work, the link between the observed results and the new functionalities implemented and leveraged to do so.

Network Operators, on the other hand, should consider a bottom-up approach, focussing on identifying the best inputs, the appropriate new functionalities to be efficiently leveraged to maximise results and the value delivered (input-output relationship with a view to minimise the inputs and maximise the output).

Moreover, given the inherent technological neutrality of the performance framework considered by NRAs, the network operators can propose inputs and provide an objective link

between those inputs and relate observable results (outputs), as a support to the NRA decisions on indicators that best suit NRA's objectives regarding input and output dimensions.

A practical example of input and output indicators: RES integration by increased transfer capacities

Recital (83) of Directive (EU) 2019/944 states, among others, that Regulatory Authorities should monitor those operators' performance based on indicators such as the capability of transmission system operators and distribution system operators to operate lines under dynamic line rating (DLR).

In this section, starting from possible input metrics (monitoring dynamic line rating application), we expand the discussion towards output indicators and we conclude that the same output indicators can be generalised for (all) other technologies and solutions.

Input indicators:

- Number (as an absolute value or in per cent of the total amount of transmission lines) of transmission lines under dynamic line rating
- Length (as an absolute value or in per cent of the total length of transmission lines) of transmission lines under dynamic line rating
- Percentage of capacity-limiting transmission lines under dynamic line rating (meaning the percentage of lines which constrain the capacity across bidding zones, for which DLR is in use)

Throughput indicator:

- Line/asset ampacity using capacity-enhancing technology divided by line/asset standard ampacity (per cent, i.e. A/A)

Output indicators:

- Cross-zonal transfer capacity using capacity-enhancing technology divided by cross-zonal transfer capacity without using any enhancing technology (per cent, i.e. MW/MW)
- Total cost of an enhancing technology divided by total cost of a standard technology providing the same capacity increase (per cent, i.e. $M€/M€$)
- Unitary investment cost or unitary total cost of capacity increases (e.g. $Meur/MW$)

In addition, when looking at transfer capacities as an output, one should consider that these capacities are closely linked to the activation of redispatching actions: the higher the transfer capacity, the higher the need for redispatching actions (or other costly measures).

Therefore, a complementary output indicator should be considered:

- Total cost of redispatching actions divided by the expected cost of redispatching without the innovative solutions and the capacity increases (% , i.e. M€/M€)

Lastly, the throughput and the output indicators can be calculated not only for a specific input application (e.g. dynamic line rating as highlighted by Directive (EU) 2019/944), but also for any power flow controlling equipment or non-conventional solutions which increase the ampacity of a transmission asset (e.g. high ampacity conductors).

Call for input

ACER and CEER welcome reactions to the guiding concepts presented in this paper and further input to the ongoing work. Every interested party is invited to reflect on the following questions:

1. Do you agree that output indicators are primarily up to National Regulatory Authorities, while input indicators and input-output relationships could better be addressed by network operators? If not, can you explain why you disagree?
2. Do you have comments on the proposed dimensions of output measures?
3. Would you agree with the ACER-CEER proposal to define a very limited set of indicators to be monitored across Europe and a basket of indicators, which could be adopted country by country also to reflect national priorities? If not, why would you disagree?
4. Network performance indicators can be linked to different regulatory actions, such as for instance monitoring performance, setting minimum requirements and applying performance-based incentive regulation. How do you see the balance among these possible actions?
5. Would you like to suggest one key performance indicator for electricity distribution and one for electricity transmission which are the most relevant in your view and explain the reasons behind your suggestions?

Please submit your feedback to diana.ivanova-vanbeers@ceer.eu and to KPI_ESN@acer.europa.eu by 28 July 2024.