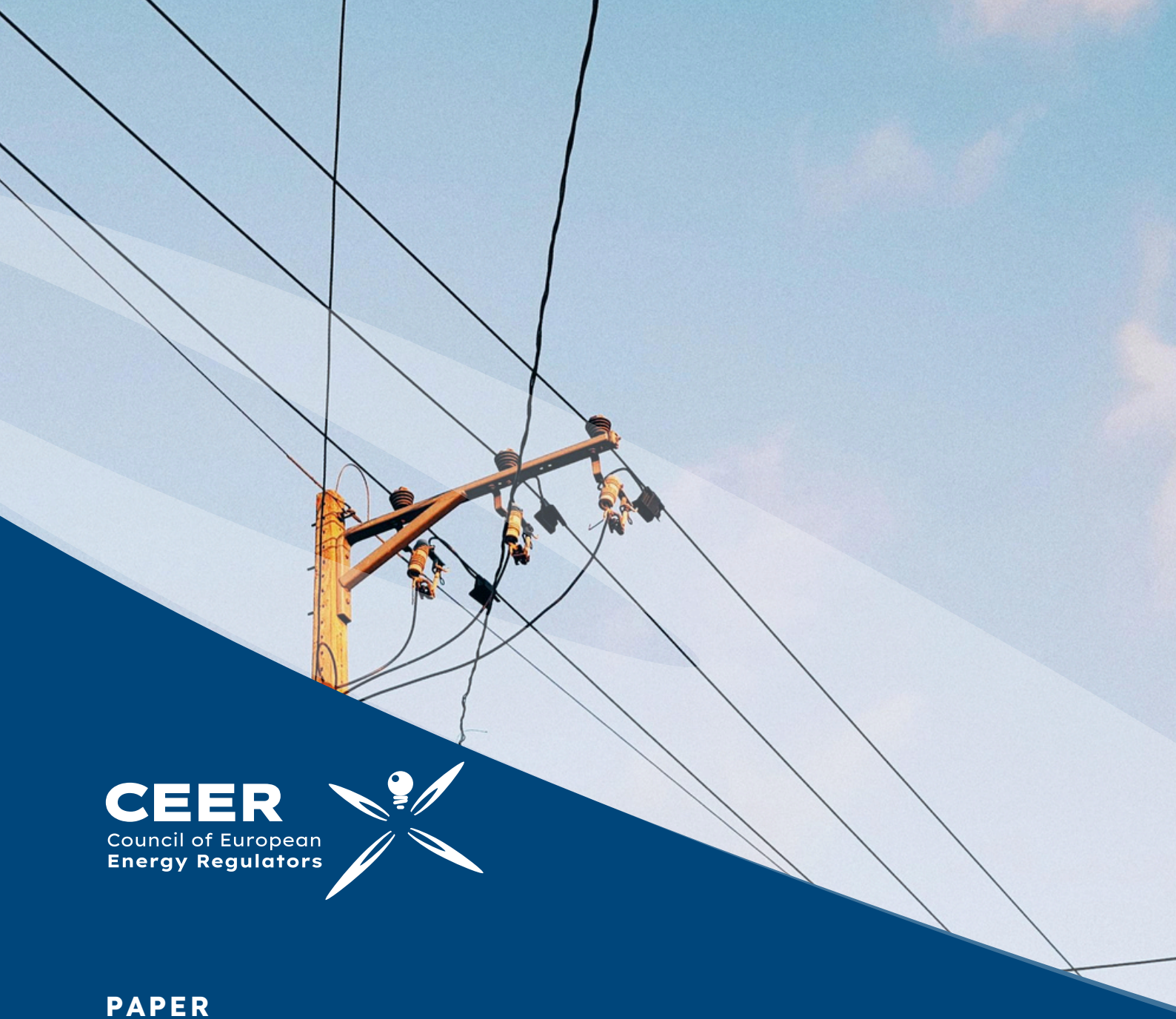


CEER
Council of European
Energy Regulators

PAPER

Electricity “Smart Grid” Performance Indicators

08.01.2026

CEER
Council of European Energy Regulators

Electricity "Smart Grid" Performance Indicators

Distribution System Working Group

Ref: C25-DS-98-7.1

08.01.2026

Council of European Energy Regulators ASBL
Cours Saint-Michel 30a, Box F – 1040 Brussels, Belgium
Arrondissement judiciaire de Bruxelles – RPM 0861.035.445

Information page

Abstract

This document (C25-DS-98-7.1) follows up on the ACER – CEER guidance paper about electricity transmission and distribution “smart-grid” performance indicators of June 2024.

The paper discusses measures of technical and economic efficiency using network performance indicators, identifies seven output dimensions, and proposes a limited set of network output indicators to support National Regulatory Authorities (NRAs) in overseeing electricity networks.

Target audience

Consumer representative groups, distribution system operators, electricity industry, National Regulatory Authorities, network users, policymakers, researchers, and other interested parties

Keywords

Electricity distribution networks, performance indicators, regulation, regulatory oversight

If you have any queries relating to this paper, please contact:
CEER Secretariat
Tel. +32 (0)2 788 73 30
Email: brussels@ceer.eu

Related documents

CEER Documents

- CEER status review of regulatory approaches to smart electricity grids, Ref: C11-EQS-45-04, 6 July 2011 https://www.ceer.eu/publication/ceer-status-review-of-regulatory-approaches-to-smart-electricity-grids/
- 7th CEER-ECRB benchmarking report on the quality of electricity and gas supply, 2022. https://www.ceer.eu/publication/7th-ceer-ecrb-benchmarking-report-on-the-quality-of-electricity-and-gas-supply/
- Electricity transmission and distribution "smart-grid" performance indicators - an ACER-CEER guidance paper, 21 June 2024 https://www.acer.europa.eu/sites/default/files/documents/Position%20Papers/ACER_CEER_Network_Grids_Performance_Indicators.pdf
- 3rd CEER Report on Power Losses, 11 February 2025, https://www.ceer.eu/publication/3rd-ceer-report-on-power-losses/

External Documents

- Position Paper on Smart Grids An ERGEG Conclusions Paper Ref: E10-EQS-38-05 10 June 2010 https://www.ceer.eu/publication/position-paper-on-smart-grids-an-ergeg-conclusions-paper/

Table of contents

List of tables

Executive Summary

Background

As also indicated in the European Parliament Resolution of 19 June 2025, electricity networks are the backbone of the European energy system. They are essential to achieve the clean energy transition and to deliver renewable energy while supporting economic growth. Significant investments are required, along with appropriate regulatory oversight, to expand the electricity infrastructure, ensuring a decarbonised, flexible, more decentralised, digitalised and resilient electricity system.

To further strengthen the regulatory oversight on electricity grids and to support the NRA monitoring of electricity network performances, CEER, the Council of European Energy Regulators, in cooperation with the European Union Agency for the Cooperation of Energy Regulators (ACER), issued a guidance paper “Electricity transmission and distribution “smart-grid” performance indicators” in June 2024.

Objectives and contents of the document

The present document is a follow-up to the guidance paper, aiming to provide additional contributions to the ongoing debate and to identify a limited set of indicators which could be used by National Regulatory Authorities to monitor and assess the performance of system operators in relation to the development of a smart grid that promotes energy efficiency and the integration of energy from renewable sources, as required by Article 59(1) of Directive (EU) 2019/944.

Conclusions

The performance evaluation process and its output and input indicators enable NRAs to assess historical performance and its evolution, establish the current situation and adopt a prospective vision to set desired targets and objectives.

Therefore, the performance evaluation framework should leverage network development plans and system operator business plans.

The proposed indicators and the performance evaluation framework could further constitute a sound basis for incentive regulation purposes, acknowledging the fact that it is the NRA’s prerogative to select the best instruments to ensure efficiency while delivering the most value to markets and customers.

More specifically, the paper proposes the following **14 output indicators, in 6 dimensions,** to support monitoring and assessing the performance of system operators in developing a smart grid as a starting point for each NRA to consider.

Dimension 1 - Integration of renewable energy generation
Overgeneration/curtailment of renewable energy sources
Average connection time for new generation (per voltage level)
Grid hosting capacity for renewable energy sources (injection)
Dimension 2 - Integration of increased electrification of energy uses
Average connection time for new/increased loads (per voltage level)
Grid hosting capacity for offtake (withdrawal)
Dimension 3 - Continuity of supply and resilience to extreme events
Duration and frequency of long interruptions
Frequency of short interruptions
Risk-based indicator of the expected impact of extreme events
Dimension 4 - Other quality of supply objectives
Type and amount of voltage quality events
Average time to manage customers' requests for intervention
Availability of individual network assets
Dimension 5 – Energy efficiency
Distribution losses
Dimension 6 - Data made available to market participants
Online access to individual consumption and/or injection data
Availability of 15-minutes withdrawal-injection network user data (from the smart metering system to suppliers/aggregators)

The proposal of output indicators related to the 7th dimension identified in the 2024 ACER-CEER paper (transmission-related market integration) is addressed by an ACER work published in a coordinated way with this paper.

This paper acknowledges that some of the proposed indicators feature an open and broad scope. Besides the possible lack - in some instances - of precise metrics at this stage, the rationale of this approach considers that similar but slightly different indicators may already be in use across countries. The intended contribution of this paper is to provide a holistic overview of the whole spectrum of network performances across the selected dimensions. More detailed definitions of some indicators, including their possible harmonisation, should better be addressed by activities tailored to a single dimension, such as the regular CEER reports on power losses and on benchmarking the quality of electricity supply for instance.

1 Introduction

As also indicated in the European Parliament Resolution of 19 June 2025, electricity networks are the backbone of the European energy system. They are essential to achieve the clean energy transition and to deliver renewable energy while supporting economic growth. Significant investments are required, along with appropriate regulatory oversight, to expand the electricity infrastructure, ensuring a decarbonised, flexible, more decentralised, digitalised and resilient electricity system.

To further strengthen the regulatory oversight on electricity grids and to support the NRA monitoring of electricity network performances, CEER, the Council of European Energy Regulators, in cooperation with the European Union Agency for the Cooperation of Energy Regulators (ACER) issued a guidance paper "Electricity transmission and distribution "smart-grid" performance indicators" in June 2024.

The paper set out joint ACER-CEER principles on "smart-grid" performance indicators to be monitored to foster grid performance and efficiency to the final advantage of network users. The ACER-CEER paper provided 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 an input indicator is and what an output indicator is. Finally, the ACER-CEER paper called for stakeholders' feedback on the guiding concepts presented and further input to the ongoing work.

The present document is a follow-up to the guidance paper, aiming to provide additional contributions to the ongoing debate and to identify a limited set of indicators which could be used by National Regulatory Authorities to monitor and assess the performance of system operators in relation to the development of a smart grid that promotes energy efficiency and the integration of energy from renewable sources, as required by Article 59(1) of Directive (EU) 2019/944.

The paper is structured as follows:

- Section 2 discusses the framework for evaluating network performance, as an element of a wider set of regulatory activities about network development and operation, which include network development plans and business plans;
- Section 3 refines the list of dimensions to measure network performance, which were presented in the 2024 guidance paper, taking into account the stakeholders' feedback and the outcomes of discussions which took place in 2025 with ACER, ENTSO-E, the EU-DSO Entity and the European Commission;
- Section 4 proposed a limited set of indicators for all dimensions which mainly pertain to electricity distribution;
- Last, Section 5 draws the main conclusions and recommendations.

2 Measuring technical and economic efficiency using performance indicators

The energy transition and the electrification of our societies imply an increase in energy flows, an increase in the capacity required on the networks and an increase in the probability of simultaneous use, which is responsible for peaks and potentially congestion on the networks.

This creates a need to increase and optimise the level of use of existing infrastructure, unlock flexibility potential and invest wisely in the development of smart grids. It also means evolving grid management activities to effectively address these challenges, particularly through digitalisation.

Even outside of any incentive regulation framework, for any analysis to be meaningful, it must be anchored into the specific context of the activity.

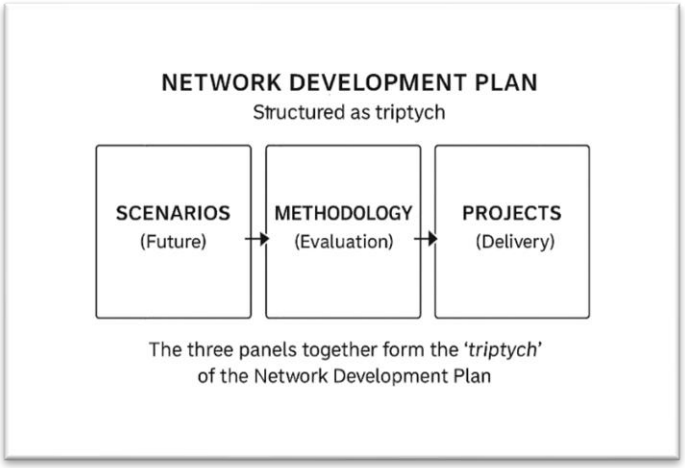
Therefore, system operators as well as regulators should construct a holistic picture based on three key elements: a comprehensive network development plan, a corresponding system operator business plan and finally a performance evaluation framework.

2.1 The network development plan

Whether implicit or explicit, network development plans' objectives can be directly linked to the seven dimensions to measure the network performance identified in the 2024 ACER-CEER guidance paper which included outputs applicable to distribution and transmission.

The network development plan should be viewed as a triptych comprising:

1. a section devoted to scenarios developed to imagine the future,
2. a section setting out the methodology for planning and technical and economic evaluation of the solutions considered,
3. and a portfolio of projects resulting from the application of the methodology to the selected scenario.



The core of the first element of the triptych is the construction and assessment of reference scenarios for the evolution of network requirements and operating conditions.

Therefore, a baseline situation, a characterisation of existing networks, should be the starting point for analysing the impact of the envisaged developments; that baseline situation should be established by describing the network in terms of network capacity, load factors, production level, consumption level, Smart Grid deployment etc..

Next, the network development plan (NDP) needs to look ahead to the future to identify scenarios for changes in needs and behaviours that will have an impact on the network, its operation and its development.

In an ideal world, these scenarios should ultimately represent the vision shared by all stakeholders regarding expected developments.

This part is key to identifying and quantifying the challenges as well as the driving factors.

Once the challenges have been identified, the second element of the triptych calls for an extensive description of methodologies and criteria used by system operators in exercises involving sizing, planning, prioritisation and cost-benefit analysis of investments and/or alternatives to them.

The aim here is to set out all the elements which, when applied precisely in the context of development scenarios, make it possible to set objectives, identify and select the most appropriate solutions for improving network performances.

This point, therefore, goes beyond a simple statement or reference to technical requirements. Nor is it a question of limiting oneself to stating the minimum criteria. It involves setting out in detail all the methodologies and criteria actually used by the network operator in implementing the plan, which enable the scenarios to be translated into terms of network needs, and then the identification and selection of the most appropriate solutions (technically and economically optimal) to be implemented in order to meet those needs.

Finally, the last element of the triptych should consist of a comprehensive network action plan consisting of the comprehensive list of actions, and corresponding objectives, which have been selected to cope with the challenges.

It is paramount that operators and regulators strive to enlarge the scope to consider all adequate responses and build a comprehensive network action plan encompassing all adequate solutions, evaluated and selected after applying the methodologies and criteria: infrastructure investments, Smart Grid Solutions (including investments in information technology IT) as well as all relevant alternatives (Operational Expenditures - OPEX, flexibility, etc).

In an ideal world, a smart and efficient grid results from the successful integration of an electrical system, a telecommunications system and an information technology system.

As the system progresses towards maturity, three stages can be identified. The first stage focuses on building knowledge, requiring investment in a critical mass of data acquisition, processing, and management infrastructure. The second stage involves enabling action, notably through the deployment of remote control equipment that allow operations to be performed remotely. Once maturity has progressed and systems have evolved, the next stage would require anticipating by developing predictive models of network flows and status over time intervals that gradually evolve closer to real time.

That is why the NDP alone needs to be completed by a corresponding business plan to help build the full picture.

2.2 The business plan

Although it could be considered as a tool for some regulatory frameworks, the purpose the business plan serves here is to build a comprehensive Total Expenditure (TOTEX) view of what is referred to as network action plan in the section above, collecting all cost elements useful for the evaluation of the actions (infrastructure investments, non-infrastructure investment, OPEX alternatives, other alternatives etc) and corresponding impact.

Moreover, the business plan should not be restricted to financial and cost metrics; it should integrate all relevant dimensions and metrics.

Electricity System Operation and network management is set to evolve towards greater integration, forecasting and digitalisation. Technological developments and the need to invest in smart grids will only bear fruit if network operators are able to exploit their full potential and enable market players to benefit from them.

Consequently, it seems straightforward to not only consider historical expenditure and metrics for reference but also a forward-looking approach that clearly sets out the challenges for the coming period and objectivises the relation between the pursued goals and the solutions to be mobilised to achieve them.

The level of resources to be mobilised must, of course, always remain proportionate and justifiable for the community, considering the objectives pursued by the system operators and the desired level of quality and efficiency set by the regulatory framework.

The value of such an exercise lies mainly in making explicit and transparent the objectives to be achieved and the solutions (inputs) to be mobilised to achieve them, placing as much emphasis as possible on efficiency and monitoring of achievements (outputs), as well as to raise awareness of the impact of the choices and developments envisaged in terms of prices for network users.

The guiding principles for building the business plan should allow for an evolutive, pragmatic approach, designed to increase performance levels over time.

The business plan should present the economic rationale for the decisions made, provide the necessary data for cost-benefit analysis, demonstrating the technical-economical optimum of each choice and help set concrete targets and corresponding metrics.

2.3 The performance evaluation framework

It is important to remember that analysing performance indicators, particularly those intended to evaluate the performance of system operators regarding the development of a smart network that promotes energy efficiency and the integration of renewable energies, represents only one piece of the regulatory puzzle.

The first crucial goal of the performance indicator framework is to establish the relation between the objectives, measured by the output indicators, and the pertinent functionalities to achieve them (inputs).

The priority is therefore to identify all the functionalities that can potentially contribute to the achievement of an objective and then assess which of these functionalities are the most relevant to implement. It is within this assessment of input alternatives that (more or less detailed) cost-benefit analyses are carried out to ensure the optimal technical and economic solution is identified and implemented. Subsequently, it is also essential to measure the extent to which the operator implements these functionalities as efficiently as possible.

In this respect, one must bear in mind that conventional solutions must always be considered. Indeed, investing in network capacity remains one of the relevant solutions.

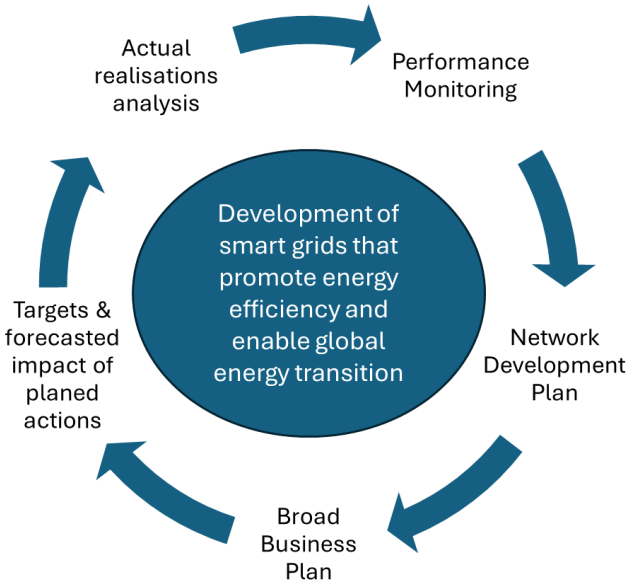
The adoption of innovative technologies allows to pursue more targeted investments, invest better and potentially invest less. Above all, technology makes it possible to gradually transition towards a more dynamic and predictive management of networks and to make data available to network users according to time frames that make it increasingly possible to act directly on behaviours and markets.

This is why, when it comes to assessing efficiency, all the alternatives should be considered. The assessment of the techno-economic efficiency of those functionalities also depends on the context, the particularities of the network and the level of maturity of the operator and/or the technology considered.

As a rule, one should consider the cost of inaction, the cost of conventional investments and finally the cost of proactively implementing innovative technological solutions.

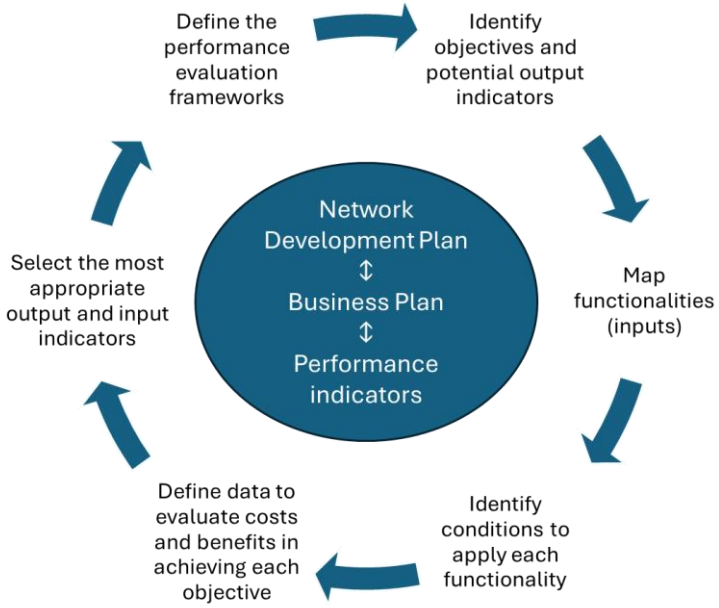
This is why developing an indicator capable of encompassing all these aspects while remaining understandable and relevant is not an easy task.

For this reason, CEER proposes implementing a structured and iterative process, considering NDP and Business Plan, intended to develop a set of indicators that will enable the evaluation of performance.



2.4 A six-stage process for developing performance indicators

Beyond the indicators themselves the process through which they are defined is key. It needs to be a recurring process considering a learning curve and the necessity of frequent interactions and iterative refinement. CEER therefore proposes a six-stage process to ensure coherence, transparency, and adaptability in the development of performance indicators.



The **first stage** consists of identifying objectives and potential output performance indicators associated with the objectives to be achieved and the 7 dimensions from the 2024 ACER-CEER guidance paper. This stage is driven by the NRA.

The **second stage** focuses on the mapping of all the measures and potential functionalities (input) that could be mobilised to enable the achievement of the objectives or contribute to their improvement. While still bearing the full responsibility, the NRA should encourage and welcome the input of the national operators. The same principles would apply to the third and fourth stages.

The **third stage** would be to identify the prerequisites and conditions under which each of the functionalities can be applied in a relevant manner.

The **fourth stage** would concern the identification and definition of relevant data used for the evaluation of the achievement of those objectives, the contribution (cost and benefits) of the functionalities, and the efficiency in the execution/implementation.

The next two stages embody the ultimate prerogative of each NRA.

The **fifth stage** entails the selection of the most appropriate output and corresponding input indicators regarding the considered objectives and mobilised functionalities.

The **sixth stage** entails the definition of the performance evaluation frameworks: revenue regulation, incentive regulation, regulatory reporting, etc, and where appropriate, the selection and definition of specific cost-benefit evaluation models.

When considering new indicators, the holy grail would be to define a clear and comprehensible measurement framework able to assess the three fundamental aspects of performance:

1. improvement of the objective (output),
2. efficiency in the choice of the best functionality (input) that achieves the technical-economic optimum,
3. efficiency in implementation and execution.

3 Dimensions to measure network performance

The 2024 ACER-CEER guidance paper, as a preliminary work for future discussions on indicators, proposed a set of 7 dimensions related to policy objectives and network operators' tasks:

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

ACER and CEER proposed a few questions for stakeholders' feedbacks by end July 2024, including comments on the proposed dimensions of output measures.

CEER received 13 feedbacks[1] to the call for inputs: 4 from distribution system operators (DSOs) and DSO associations, 3 from research/consulting, 2 from manufacturers and solution providers, 2 from energy utilities, 1 from the public sector, 1 from a transmission system operator.

Briefly:

- 6 answers agreed with or supported the proposed output dimensions;
- 3 answers suggested additional aspects to be considered or to deepen some dimensions; however, the aspects suggested in at least 2 answers are already included in one of the proposed dimensions, e.g. service quality, harmonics and power quality in dimension 4, energy efficiency in dimension 5, data availability in dimension 6, while consumer engagement may not be deemed a (controllable) output by network operators, and if deemed so, it would be covered by dimension 6; "observability" is not an output dimension or indicator, and "integration with other energy sectors" seems a too broad concept;
- 2 answers suggested priorities across the output dimensions;
- 2 answers commented on other aspects (e.g. some proposal for indicators; call for precise definitions of indicators; DSO controllability of outputs; potential use of output indicators for incentives; transmission vs. distribution-related dimensions) and not directly on the choice of the output dimensions.

Between November 2024 and June 2025, some discussions took place with ACER, ENTSO-E, the EU-DSO Entity, and the European Commission. These discussions helped in fine-tuning the description of the output dimensions, which are presented in Table 1.

[1] Annex 2 – Respondents to the June 2024 call for inputs

Table 1 - Dimensions to measure network performance

Dimension	Name
D1	Integration of renewable energy generation
D2	Integration of increased electrification of energy uses
D3	Continuity of supply and resilience to extreme events
D4	Other quality of supply objectives
D5	Energy efficiency
D6	Data made available to market participants
D7	Market integration (for transmission)

Compared to the 2024 draft list, amendments are proposed to delete the connection aspects from D2, because connection pertains to both dimension 1 (regarding generation) and dimension 2 (regarding load), and to delete the limitation due to referring only to “cross-border” market integration for D7, as integration inside a country is also relevant.

4 Network performance indicators

Already 15 years ago, at the time of the 2009-2010 ERGEG public consultation on smart grids, there was strong support for the regulators' proposal for the smart grid user-centric approach and focus on outputs. Output relates to an outcome, the achievement of a goal or the value for network users created (or maximized) by network development and operation.

While some output indicators were identified also for transmission networks e.g. energy not supplied, transmission losses, transfer capacity and redispatching costs, this section presents output indicators with a focus on distribution networks. Transmission-related indicators related to the 7th dimension (market integration) are assessed by ACER in a separate work, published in a coordination way with this paper.

The identification of the proposed set of performance indicators was based on:

- The long-standing work of ERGEG on smart grid indicators and its 2011 follow-up CEER status review paper, which selected nine performance indicators;
- an initial review of indicators in use (as of mid-2024) across CEER member countries, which allowed collecting about 350 indicators (related to both inputs and outputs) used across Europe, see Table 2;
- discussions with ACER, ENTSO-E, the EU-DSO Entity, and the European Commission which took place in the first half of 2025.

Table 2 – Input and output indicators in use across CEER member countries, by dimension

Dimension	Name	Number of indicators collected
D1	Integration of renewable energy generation	36
D2	Integration of increased electrification of energy uses	56
D3	Continuity of supply and resilience to extreme events	95
D4	Other quality of supply objectives	38
D5	Energy efficiency	38
D6	Data made available to market participants	27
D7	Market integration (for transmission)	53
All	**Total number of reviewed indicators**	**343**

The review of existing indicators did not aim to be complete, and it is acknowledged that the definition of indicators was not fully harmonised (e.g. one NRA was reporting more indicators as "one element", while another NRA provided each individual indicator; a bunch of all "voltage quality indicators" was provided as a single element). However, completeness and full harmonisation was not actually needed for the purpose of supporting the discussion and identification of a limited set of indicators.

It is also acknowledged that some of the proposed indicators intentionally feature an open and broad scope. Besides the possible lack - in some instances - of precise metrics at this stage, this choice considers that similar but slightly different indicators may be already in use across countries.

4.1 Dimension 1: Integration of renewable energy generation

Three indicators were identified for dimension 1, as summarised in Table 3.

The **first indicator** is about the "excess generation" with respect to the network capabilities and can be measured by the restrictions to the connection of new generation and/or by the actual generation curtailments, where this is technically feasible. For a better understanding of the network constraints, the generation curtailments due to TSO decisions and those due to DSO decisions should be counted separately. Last, while they are different than curtailments, the flexibility needs and the modified behaviour of generation sources within a flexibility scheme could also be separately counted, as also these metrics provide an indication about limited network capabilities.

The **second indicator** is about average connection times and also takes into account the provisions of Article 59(1) of Directive (EU) 2019/944, which requires NRAs to monitor the time taken by system operators to make connections. Besides voltage levels, the indicator could be further differentiated based e.g. on the power plant size. It should also be considered that the "total time" for connection may be determined by processes on which network operators have limited control, e.g. permitting and other administrative processes.

The **third indicator** is about the hosting capacity for injections, for which a standardised definition does not exist yet at the European level. However, it is generally agreed that the hosting capacity (injection) is the amount of injection which determines reaching a network constraint (e.g. a thermal/current limit or a voltage limit). About this indicator, it is observed that it could be defined both regarding the "actual" hosting capacity (i.e. a recent value) and a forward-looking hosting capacity (e.g. 3-years ahead expected capacity at HV/MV busbars). The variation of hosting capacity with time and/or due to operating network conditions is also important, as further discussed by two examples in the next section.

Table 3 - Network indicators for dimension 1

Dimension 1 - Integration of renewable energy generation
Overgeneration/curtailment of renewable energy sources
Average connection time for new generation (per voltage level)
Grid hosting capacity for renewable energy sources (injection)

4.2 Dimension 2: Integration of increased electrification of energy uses

Two indicators were identified for dimension 2, as summarised in Table 4.

The proposed indicators mirror two of the generation-related indicators presented above in dimension 1. Similar considerations apply to these load-related indicators.

The definition and the interpretation of results regarding hosting capacity indicators can become somewhat complex, especially in the absence of comprehensive load curves analysis. Hosting capacity indicators can be complemented by indicators regarding the utilisation of distribution assets (and the complementary, so-called "spare capacity" of the assets), as it is the currently the case in some countries, to provide useful indications about the state of the grid.

However, these indicators (especially when based on yearly energy flows or consumptions) should be applied with prudence and interpreted with caution. Local specificities regarding (extreme) peak demand compared to the yearly average demand should be characterised and cautiously analysed. Adequately serving the heating or cooling needs during (short) periods of extreme temperatures, or the seasonal high peak consumption due to tourism in resort areas for example remain a priority for electricity grids and may determine a lower asset usage in other periods of the year. In other words, correctly identifying and characterising the situation is paramount to identify the best set of responses (investment, innovative network operation or devices : DLR,PST, etc.)

Table 4 - Network indicators for dimension 2

Dimension 2 - Integration of increased electrification of energy uses
Average connection time for new/increased loads (per voltage level)
Grid hosting capacity for offtake (withdrawal)

4.3 Dimension 3: Continuity of supply and resilience to extreme events

Three indicators were identified for dimension 3, as summarised in Table 5.

The **first and the second** proposed output indicators build on long-standing CEER practice in monitoring the continuity of electricity supply. Starting in 2001, CEER prepared seven editions of its benchmarking report. The most used continuity of supply indicators are SAIDI and SAIFI for long interruptions and MAIFI for short interruptions. While the possible harmonisation of the indicators was favoured across the years, the 7th edition, published in 2022, finds that "there are differences in continuity of supply indicators and the way they are calculated". More specifically, there are variations in weighting methods, in inclusion/exclusion of some causes of interruptions and in the definitions of exceptional events, and in treatment of multiple subsequent interruptions, which might either be treated as separate interruptions or aggregated into one. All these differences can affect the comparability of indicator values. It is also worth noting that the use of multiple indicators enables the collection of more information and offers more possibilities to observe trends. When indicators were already defined and applied in a country, the change of details in the metrics may affect the comparability with data of the previous years.

The **third proposed indicator** is related to the increasing relevance of low-frequency, high impact interruption events due to extreme weather conditions. While the impact of these events can be monitored as a subset of the SAIDI-SAIFI continuity of supply (and via asset unavailability, see Dimension 4), it is important for the purpose of network development plans (and business plans) to complement the actual monitoring with metrics referring - to the extent possible - to the potential evolution of these impacts in the coming years.

Table 5 - Network indicators for dimension 3

Dimension 3 - Continuity of supply and resilience to extreme events
Duration and frequency of long interruptions
Frequency of short interruptions
Risk-based indicator of the expected impact of extreme events

4.4 Dimension 4: Other quality of supply objectives

Three indicators were identified for dimension 4, as summarised in Table 6.

The **first and second** proposed indicators (related to voltage quality and to customers' requests) build on the CEER benchmarking reports on the quality of electricity (and later energy) supply, which, besides continuity of supply, addressed voltage quality and the so-called commercial quality. The commercial quality deals with the quality of all processes involving transactions between consumers and energy companies.

The first indicator is a group of indicators rather than a standalone indicator. The formulation proposed here is intentionally left open, as the most impacting voltage quality phenomena may differ from country to country (and from one area to another one, inside the same country) due to the features of the electricity network and/or of the connected network users.

Among several commercial quality indicators, the proposed indicator refers to the average time for a distribution system operator to manage the request for a physical intervention (e.g. meter verification / replacement).

The proposals presented here for a possible application in all countries are without prejudice to the use of existing and more detailed already in place across the European countries.

The **third indicator** refers to the availability of network assets. It is acknowledged that this indicator is less "output-oriented" with respect to other indicators, however it can provide important information on the risks and costs associated to unavailability of some network assets (e.g. when an asset in a radial distribution network is out of operation, there could be additional risks in supplying electricity via network reconfiguration or additional costs in emergency supply by dedicated power stations)

Table 6 - Network indicators for dimension 4

Dimension 4 - Other quality of supply objectives
Type and amount of voltage quality events
Average time to manage customers' requests for intervention
Availability of individual network assets

4.5 Dimension 5: Energy efficiency

One indicator was identified for dimension 5, as summarised in Table 7.

System losses measure all losses that occur during the transmission and distribution of electricity from generating stations or points of purchase to end-use customers. Losses equal the difference between the power (GWh) supplied within the area/voltage level and the power (GWh) withdrawn by network users. The main components of system losses are "Technical Losses" (e.g. heat or copper losses, magnetic losses, or transformation losses) and "Non-technical Losses" (e.g. meter failure, meter tampering or fraud, un-metered or illegal connections). Reporting technical and non-technical losses separately can improve interpretability, as they stem from different drivers and relate to different mitigation tools.

The latest (third) edition of regular CEER Reports on Power Losses observed that the definition of losses is not standardised and can vary from country to country. In most cases, losses are understood to be the difference between the energy flowing into and out of a grid, but there are countries that do not use this approach. The lack of harmonised definitions and rules regarding the components included in losses presents an obstacle to straightforward benchmarking across Europe. Because structural factors such as network topology, customer density and distributed generation differ significantly between systems, normalisation may also be needed for meaningful benchmarking. Monitoring trends over time, rather than focusing only on absolute levels, can makes the indicator more robust and reduce the influence of such structural differences.

Losses reduction strategies include dynamically reconfiguring the grid to find the most efficient paths, using more efficient hardware like low-loss transformers and high-capacity conductors, and leveraging demand response to shift load away from peak times. Increasing digitalisation enable losses to be calculated with higher temporal resolution (e.g. hourly), which helps identify when and where losses occur. Because losses are an indirectly derived metric, transparent and consistent data-quality requirements are also essential to ensure reliability and comparability.

Table 7 - Network indicator for dimension 5

Dimension 5 – Energy efficiency
Distribution losses

4.6 Dimension 6: Data made available to market participants

Two indicators were identified for dimension 6, as summarised in Table 8.

The **first indicator** measures the accessibility of individual consumption and/or injection data to the network users, according to the metrics defined by the NRA or other national competent authority.

The **second indicator** measures the percentage of 15-minutes (or another time granularity defined by the NRA or other national competent authority) consumption-injection data which are effectively made available by the DSO's smart metering system to authorised parties interested in receiving them, such as suppliers, flexibility service providers during a predefined period (e.g. one month or one year). The indicator applies only to network users served by a smart meter.

Table 8 - Network indicators for dimension 6

Dimension 6 - Data made available to market participants
Online access to individual consumption and/or injection data
Availability of 15-minutes withdrawal-injection network user data (from the smart metering system to suppliers/aggregators)

4.7 Considerations on the publication of monitoring results

While a more detailed review of national practices on monitoring performance indicators is currently considered by CEER to take place after the publication of the present paper, CEER carried out a quick review of current practices across EU countries.

It was observed that two approaches are used or planned to deal with the provisions of Article 59(1) of Directive (EU) 2019/944:

- The publication of a stand-alone monitoring report on smart grid performances;
- The inclusion of smart-grid performance monitoring in the NRA annual report.

Considering that the same Article 59(1) requires each NRA to monitor the time taken by system operators to make connections and repairs and to set or approve standards and requirements for quality of service/supply (which is typically based on monitored performances), CEER sees the inclusion of the smart grid performance monitoring as a possibility which would facilitate a more holistic view of network performances.

5 Conclusions and recommendations

Based on the 2024 work and the feedback from the call for inputs, the paper refined the seven dimensions for measuring network performance.

The 2024 paper also acknowledged that “the indicators that will be the best ones to consider can vary from country to country”.

ACER and CEER deemed that: - A few indicators should be used in all Member States; - A wider basket of optional indicators could be used at the national level, depending on national circumstances.

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.

Output indicators should be prioritised given the specific situation and objectives of the national energy systems, while **inputs** should be selected considering both optimal performance and overall costs.

The performance evaluation process and its output and input indicators enable NRAs to assess historical performance and its evolution, establish the current situation and adopt a prospective vision to set desired targets and objectives.

Therefore, the **performance evaluation framework** should leverage network development plans and system operator business plans.

The proposed indicators and the performance evaluation framework could further constitute a sound basis for incentive regulation purposes, acknowledging the fact that it is the NRA’s prerogative to select the best instruments to ensure efficiency while delivering the most value to markets and customers.

More specifically, the paper proposes 14 output indicators to support monitoring and assessing the performance of system operators in developing a smart grid as a starting point for each NRA to consider.

Annex 1 – List of abbreviations

Term	Definition
CEER	Council of European Energy Regulators
NRAs	National Regulatory Authorities
ACER	European Union Agency for the Cooperation of Energy Regulators
DSO	Distribution System Operator
ENTSO-E	European Network of Transmission System Operators for Electricity
ERGEG	European Regulators' Group for Electricity and Gas
EU-DSO Entity	European entity for distribution system operators
MAIFI	Momentary Average Interruption Frequency Index
MS	Member States
NDP	Network development plan
OPEX	Operational Expenditures
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
TOTEX	Total Expenditures

Annex 2 – Respondents to the June 2024 call for inputs

Heading	Heading	Heading
CurrENT	Solution provider (association)	CurrENT
Danish Energy Agency	Government/policymaker/regulator	Danish Energy Agency
E-REDES	Distribution system operator	E-REDES
EDF	Utility	EDF
EDP	Utility	EDP
EERA Joint Programme on Smart Grids	Research/consulting	EERA Joint Programme on Smart Grids
Enedis	Distribution system operator	Enedis
ENODA	Solution provider	ENODA
EU DSO Entity	Distribution system operator (assoc.)	EU DSO Entity
GEODE	Distribution system operator (assoc.)	GEODE
RAP (Regulatory Assistance Project)	Research/consulting	RAP (Regulatory Assistance Project)
Red Eléctrica	Transmission system operator	Red Eléctrica
RSE (Ricerca sul Sistema Energetico)	Research/consulting	RSE (Ricerca sul Sistema Energetico)

Annex 3 – About CEER

The Council of European Energy Regulators (CEER) is the voice of Europe's national energy regulators. CEER’s members and observers comprise 38 national energy regulatory authorities (NRAs) from across Europe.

CEER is legally established as a not-for-profit association under Belgian law, with a small Secretariat based in Brussels to assist the organisation.

CEER supports its NRA members/observers in their responsibilities, sharing experience and developing regulatory capacity and best practices. It does so by facilitating expert working group meetings, hosting workshops and events, supporting the development and publication of regulatory papers, and through an in-house Training Academy. Through CEER, European NRAs cooperate and develop common position papers, advice and forward-thinking recommendations to improve the electricity and gas markets for the benefit of consumers and businesses.

In terms of policy, CEER actively promotes an investment-friendly, harmonised regulatory environment and the consistent application of existing EU legislation. A key objective of CEER is to facilitate the creation of a single, competitive, efficient, and sustainable Internal Energy Market in Europe that works in the consumer interest.

Specifically, CEER deals with a range of energy regulatory issues including wholesale and retail markets; consumer issues; distribution networks; smart grids; flexibility; sustainability; and international cooperation.

CEER wishes to thank in particular the following regulatory experts for their work in preparing this report: Frédéric Marijsse, Riccardo Vailati, Alberto Fardin, Antoine Desbordes, Antonio Candela, Miguel Alves, Rémi Machard. The contribution and comments by Andreas Graf and Jan Kostevc are acknowledged.

More information is available at www.ceer.eu.

Learn more about us

Our public documents are available for download from www.ceer.eu or can be obtained from the CEER Secretariat upon request.

Each month we dispatch a free electronic newsletter, CEER Newsletter, directly to the e-mail inbox of interested subscribers. You can sign up at www.ceer.eu/news-media/newsletters/

Council of European Energy Regulators
Cours Saint-Michel 30a, box F - 1040 Brussels - Belgium
Tel. +32 (0)2 788 73 30 | brussels@ceer.eu

WWW.CEER.EU