

ACCOMPANYING DOCUMENT TO 4TH ENTSO-E GUIDELINE FOR COST-BENEFIT ANALYSIS OF GRID DEVELOPMENT PROJECTS

Version for ACER/EC/MS opinion | 24 April 2023

ENTSO-E Mission Statement

Who we are

ENTSO-E, the European Network of Transmission System Operators for Electricity, is the association for the cooperation of the European transmission system operators (TSOs). The 39 member TSOs, representing 35 countries, are responsible for the secure and coordinated operation of Europe's electricity system, the largest interconnected electrical grid in the world. In addition to its core, historical role in technical cooperation, ENTSO-E is also the common voice of TSOs.

ENTSO-E brings together the unique expertise of TSOs for the benefit of European citizens by keeping the lights on, enabling the energy transition, and promoting the completion and optimal functioning of the internal electricity market, including via the fulfilment of the mandates given to ENTSO-E based on EU legislation.

Our mission

ENTSO-E and its members, as the European TSO community, fulfil a common mission: Ensuring the security of the inter-connected power system in all time frames at pan-European level and the optimal functioning and development of the European interconnected electricity markets, while enabling the integration of electricity generated from renewable energy sources and of emerging technologies.

Our vision

ENTSO-E plays a central role in enabling Europe to become the first climate-neutral continent by 2050 by creating a system that is secure, sustainable and affordable, and that integrates the expected amount of renewable energy, thereby offering an essential contribution to the European Green Deal. This endeavour requires sector integration and close cooperation among all actors.

Europe is moving towards a sustainable, digitalised, integrated and electrified energy system with a combination of centralised and distributed resources. ENTSO-E acts to ensure that this energy system keeps consumers at its centre and is operated and developed with climate objectives and social welfare in mind.

ENTSO-E is committed to use its unique expertise and system-wide view – supported by a responsibility to maintain the system's security – to deliver a comprehensive roadmap of how a climate-neutral Europe looks.

Our values

ENTSO-E acts in solidarity as a community of TSOs united by a shared responsibility.

As the professional association of independent and neutral regulated entities acting under a clear legal mandate, ENTSO-E serves the interests of society by optimising social welfare in its dimensions of safety, economy, environment, and performance.

ENTSO-E is committed to working with the highest technical rigour as well as developing sustainable and innovative responses to prepare for the future and overcoming the challenges of keeping the power system secure in a climate-neutral Europe. In all its activities, ENTSO-E acts with transparency and in a trustworthy dialogue with legislative and regulatory decision makers and stakeholders.

Our contributions

ENTSO-E supports the cooperation among its members at European and regional levels. Over the past decades, TSOs have undertaken initiatives to increase their cooperation in network planning, operation and market integration, thereby successfully contributing to meeting EU climate and energy targets.

To carry out its legally mandated tasks, ENTSO-E's key responsibilities include the following:

- › Development and implementation of standards, network codes, platforms and tools to ensure secure system and market operation as well as integration of renewable energy;
- › Assessment of the adequacy of the system in different timeframes;
- › Coordination of the planning and development of infrastructures at the European level (Ten-Year Network Development Plans, TYNDPs);
- › Coordination of research, development and innovation activities of TSOs;
- › Development of platforms to enable the transparent sharing of data with market participants.

ENTSO-E supports its members in the implementation and monitoring of the agreed common rules.

ENTSO-E is the common voice of European TSOs and provides expert contributions and a constructive view to energy debates to support policymakers in making informed decisions.

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COHERENCE WITH REGULATION(EU) 2022/869

This chapter describes how the 4th CBA methodology corresponds with the requirements posed by Article 4(32), Annex IV and Annex V of Regulation (EU) 2022/869. Stakeholders worked with ENTSO-E experts to define a complete set of robust and replicable indicators, capturing fairly all costs and benefits determined in the Regulation.

The Regulation is intended to ensure a common framework for cost-benefit analysis (CBA) for TYNDP projects, which are the sole base for candidate projects of common interest (PCI) and projects of mutual interest (PMI). Moreover the CBA guideline is recommended to be used as the standard guideline for project specific CBA as required by Regulation (EU) 2022/869 Article 16(4)(a) for the CBCA process. In this regard all projects (transmission projects) and promoters (either TSO or third party) are treated and assessed in the same way.

In some cases, some elements presented in the Regulation are related to the TYNDP or to the PCI selection process rather to the CBA itself (this CBA is not only intended for one TYNDP, but should rather include strong principles that would stand for a longer time). In a few other cases, the elements presented in the Regulation cannot currently be captured through replicable, robust and fair indicators. All these elements are reported in this chapter.

Article 4 – Regulation EU 2022/869

Article 4(3)(a) describes several specific criteria that PCI candidates for electricity must significantly contribute to in order to be eligible to the PCI status (in addition to general criteria specified for PCI in Article 4(1) and PMI in Article 4(2) which are not addressed in the CBA, but for which the information is available in the TYNDP).

3. The following specific criteria shall apply to projects of common interest falling within specific energy infrastructure categories:
 - (a) for electricity transmission, distribution and storage projects falling under the energy infrastructure categories set out in point (1)(a), (b), (c), (d) and (f) of Annex II, the project contributes significantly to sustainability through the integration of renewable energy into the grid, the transmission or distribution of renewable generation to major consumption centres and storage sites, and to reducing energy curtailment, where applicable, and contributes to at least one of the following specific criteria:
 - (i) market integration, including through lifting the energy isolation of at least one Member State and reducing energy infrastructure bottlenecks, competition, interoperability and system flexibility;
 - (ii) security of supply, including through interoperability, system flexibility, cybersecurity, appropriate connections and secure and reliable system operation;

Figure 1 - Article 4(3)(a) – taken from Reg (EU) 2022/869

The 4th CBA methodology includes specific indicators to capture these criteria:

Criteria for PCI (article 4(3) Regulation 2022/869)	4th CBA Methodology Indicator
Market Integration	B1 (Socio-Economic Welfare)
Sustainability/Energy efficiency	B2 (CO2 variation)
	B3 (RES Integration)
	B4 (non-CO2 emissions)
	B5 (Grid losses)
Security of Supply	B6 (SoS - System Adequacy to meet demand)
	B7 (SoS - System Flexibility)
	B8 (SoS - System Stability)
	B9 (Redispatch Reserves)

Table 1 – overview of the three main categories the CBA should address following Reg (EU) 2022/869

Article 4(3)(a): Sustainability benefits are reported by CBA indicators B2 (CO₂ variation), B3 (RES Integration), B4 (non-CO₂ emissions) and B5 (grid losses), which indicates the extent to which a project contributes to decrease CO₂ and non-CO₂ emissions, integrate RES into the system and decrease grid losses. They are described in sections 5.2, 5.3, 5.4 and 5.5.

Article 4(3)(a)(i): Market integration benefits are reported by CBA indicator B1 (socio-economic welfare), which is a measure of the ability of a project to lift constraints that limit the competition (ability to exchange power) between the market zones of a pair of Member States. It is described in section 5.1 of the CBA guideline.

In the event of market imperfections, transmission projects may also contribute to reducing market power of one or more players in a specific area and, hence, improve competition. Although impact on market power is recognized as an important benefit this effect is not captured by the set of indicators defined in the Guideline. This is due in particular to the difficulty of currently available market modelling tools to represent imperfect market competition, and to the extreme sensitivity of this indicator to future regulatory and market designs.

Article 4(3)(a)(ii): Security of supply is reported by four CBA indicators and encompasses different aspects. A suite of indicators (B6 System adequacy, B7 System flexibility, B8 System stability and B9 Redispatch Reserves) have been designed to show the contribution of a project to security of supply. These are described in section 5.6, 5.7, 5.8 and 5.9.

Annex IV: “Significant cross-border impact”

ANNEX IV

RULES AND INDICATORS CONCERNING CRITERIA FOR PROJECTS

- (1) A project of common interest with a significant cross-border impact shall be a project on the territory of a Member State and shall fulfil the following conditions:
 - (a) for electricity transmission, the project increases the grid transfer capacity, or the capacity available for commercial flows, at the border of that Member State with one or several other Member States, having the effect of increasing the cross-border grid transfer capacity at the border of that Member State with one or several other Member States, by at least 500 Megawatts (MW) compared to the situation without commissioning of the project, or the project decreases energy isolation of non-interconnected systems in one or more Member States and increases the cross-border grid transfer capacity at the border between two Member States by at least 200 MW;

Figure 2 - Significant cross-border impact for projects of common interest – taken from Reg (EU) 2022/869

Annex IV(1)(a) describes that PCI candidates must increase the capacity between the border of two Member States with at least 500 MW, compared to the situation without the project in order to be considered as having a '*significant cross-border impact*'. To easily determine whether a project meets the requirements to be considered as a project of common interest, section 3.2.3 of the 4th CBA guideline provides a methodology to determine the transfer capacities of transmission projects and requires that these transfer capacities must be reported.

- (2) A project of mutual interest with significant cross-border impact shall be a project and shall fulfil the following conditions:
 - (a) for projects of mutual interest in the category set out in point (1)(a) and (f) of Annex II, the project increases the grid transfer capacity, or the capacity available for commercial flows, at the border of that Member State with one or more third countries and brings significant benefits, either directly or indirectly (via interconnection with a third country), under the specific criteria listed in in Article 4(3), at Union level. The calculation of the benefits for the

Figure 3 - Significant cross-border impact for projects of mutual interest – taken from Reg (EU) 2022/869

Annex IV(2)(a) describes that PMI candidates must add capacity between a Member State and one or more third countries, and bring significant benefits at Union level. In order to easily determine whether a project meets the requirements to be considered as a project of mutual interest, section 3.2.3 of the 4th CBA guideline provides a methodology to determine the transfer capacities of transmission projects and requires that these transfer capacities must be reported. Basically all indicators from the 4th CBA Guideline contribute to indicate whether a project brings benefit on Union level.

The methodology refers to the conditions mentioned in the Regulation through the Net Transfer Capacity, which is related to the potential for market exchanges of electricity resulting in a power shift of dispatch from one bidding zone to another.

Annex IV(3): Criteria from Article 4

- (3) Concerning projects falling under the energy infrastructure categories set out in point (1)(a), (b), (c), (d) and (f) of Annex II, the criteria listed in Article 4 shall be evaluated as follows:
- (a) transmission of renewable energy generation to major consumption centres and storage sites, measured in line with the analysis made in the latest available Union-wide ten-year network development plan in electricity, in particular by:
 - (i) for electricity transmission, estimating the amount of generation capacity from renewable energy sources (by technology, in MW), which is connected and transmitted due to the project, compared to the amount of planned total generation capacity from those types of renewable energy sources in the Member State concerned in 2030 according to the National Energy and Climate Plans submitted by Member States in accordance with Regulation (EU) 2018/1999;
 - (ii) or energy storage, comparing new capacity provided by the project with total existing capacity for the same storage technology in the area of analysis as set out in Annex V;
 - (b) market integration, competition and system flexibility, measured in line with the analysis made in the latest available Union-wide ten-year network development plan in electricity, in particular by:
 - (i) calculating, for cross-border projects, including reinvestment projects, the impact on the grid transfer capability in both power flow directions, measured in terms of amount of power (in MW), and their contribution to reaching the minimum 15 % interconnection target, and for projects with significant cross-border impact, the impact on grid transfer capability at borders between relevant Member States, between relevant Member States and third countries or within relevant Member States and on demand-supply balancing and network operations in relevant Member States;
 - (ii) assessing the impact, for the area of analysis as set out in Annex V, in terms of energy system-wide generation and transmission costs and evolution and convergence of market prices provided by a project under various planning scenarios, in particular taking into account the variations induced on the merit order;
 - (c) security of supply, interoperability and secure system operation, measured in line with the analysis made in the latest available Union-wide ten-year network development plan in electricity, in particular by assessing the impact of the project on the loss of load expectation for the area of analysis as set out in Annex V in terms of generation and transmission adequacy for a set of characteristic load periods, taking into account expected changes in climate-related extreme weather events and their impact on infrastructure resilience. Where applicable, the impact of the project on independent and reliable control of system operation and services shall be measured.

Figure 4 - Provision from Annex IV(3) – taken from Reg (EU) 2022/869

Annex IV(3) elaborates on how the criteria listed in Article 4 of the Regulation should be evaluated.

a) Transmission of renewable energy generation

The B3 (RES integration) indicator, which measures the spilled energy of renewable generation avoided by the project, directly corresponds to the definition of the Regulation

for transmission projects. As the CBA focuses on reporting project benefits and costs at a pan-European level, the geographic scope considered is the entire TYNDP area as for all other indicators.

b) **Market integration**

The impact on grid transfer capability and the contribution to the minimum interconnection targets are addressed in the CBA through the NTC .

The B1 (Socio-Economic Welfare) indicator gives the direct measures for the monetary benefit enabled by increasing the commercial exchanges so that electricity market can trade power in a more efficient manner.

c) **Security of supply**

The B6 indicator (System Adequacy to meet demand) encapsulates the impact of a project on the loss of load expectations. Currently this indicator includes stochastic calculations considering a large variety of weather events and outages of generation assets, assessing in this way the loss of load expectations under a large number of samples.

The impact from one project on the capability of an electric system to handle the system balancing needs in the context of high penetration levels of non-dispatchable electricity generation (in order to maintain secure system operation) is characterised by indicator B7 - System flexibility. However, this indicator is defined within the CBA Guideline as a non-mature indicator for which additional future improvements are needed for its full implementation.

Indicator B8 - System Stability characterises the project's impact on the power system stability for a given operating condition, to regain a state of operating equilibrium after being subjected to a physical disturbance. However, this indicator is addressed using four separate sub-indicators .

Additionally, the B9 indicator describes the impact of projects on the need for allocating redispatch power plants.

(Articles IV(43), IV(54), and IV(65) and IV(7) are not related to electricity transmission and therefore not discussed here)

Annex V: Energy System-Wide Cost-Benefit Analysis

- (1) the area for the analysis of an individual project shall cover all Member States and third countries, on whose territory the project is located, all directly neighbouring Member States and all other Member States in which the project has a significant impact. For this purpose, ENTSO for Electricity and ENTSO for Gas shall cooperate with all the relevant system operators in the relevant third countries. In the case of projects falling under the energy infrastructure category set out at point (3) of Annex II, the ENTSO for Electricity and the ENTSO for Gas shall cooperate with the project promoter, including where it is not a system operator;
- (2) each cost-benefit analysis shall include sensitivity analyses concerning the input data set, including the cost of generation and greenhouse gases as well as the expected development of demand and supply, including with regard to renewable energy sources, and including the flexibility of both, and the availability of storage, the commissioning date of various projects in the same area of analysis, climate impacts and other relevant parameters;
- (3) they shall establish the analysis to be carried out, based on the relevant multi-sectorial input data set by determining the impact with and without each project and shall include the relevant interdependencies with other projects;
- (4) they shall give guidance for the development and use of energy network and market modelling necessary for the cost-benefit analysis. The modelling shall allow for a full assessment of economic benefits, including market integration, security of supply and competition, as well as lifting energy isolation, social and environmental and climate impacts, including the cross-sectorial impacts. The methodology shall be fully transparent including details on why, what and how each of the benefits and costs are calculated;
- (5) they shall include an explanation on how the energy efficiency first principle is implemented in all the steps of the Union-wide ten-year network development plans;
- (6) they shall explain that the development and deployment of renewable energy will not be hampered by the project;
- (7) they shall ensure that the Member States on which the project has a net positive impact, the beneficiaries, the Member States on which the project has a net negative impact, and the cost bearers, which may be Members States other than those on which territory the infrastructure is constructed, are identified;
- (8) they shall take into account, at least, the capital expenditure, operational and maintenance expenditure costs, as well as the costs induced for the related system over the technical lifecycle of the project as a whole, such as decommissioning and waste management costs, including external costs. The methodologies shall give guidance on discount rates, technical lifetime and residual value to be used for the cost- benefit calculations. They shall furthermore include a mandatory methodology to calculate benefit-to-cost ratio and the net present value, as well as a differentiation of benefits in accordance with the level of reliability of their estimation methods. Methods to calculate the climate and environmental impacts of the projects and the contribution to Union energy targets, such as renewable penetrations, energy efficiency and interconnection targets shall also be taken into account;
- (9) they shall ensure that the climate adaptation measures taken for each project are assessed and reflect the cost of greenhouse gas emissions and that the assessment is robust and consistent with other Union policies in order to enable comparison with other solutions which do not require new infrastructures.

Figure 5 - Provision from Annex V – taken from Reg (EU) 2022/869

- (1)** The definition of the required geographical scope is given in Section 3.2.4
- (2)** Instructions how to perform sensitivity analysis are given in Methodology Section 2.6.
- (3)** A general treatment on multi-sectorial assessment is given within Sections 2.4.5, 5.1 and Annex II.
- (4)** Guidance on network, market and redispatch modelling is given within section 2.4
- (5)** How the energy efficiency first principle is considered in the TNYDP process is describe in Section 2.1
- (6)** This criterion is currently not implemented in the 4th CBA Guideline

(7) The 4th CBA Guideline, Section 3.2.4, gives the requirement that costs and benefits have to be given in for the full model perimeter but might, if needed, also be given only on EU Member State level by excluding costs and benefits arising in third countries

(8) The 4th CBA Guideline, sections 3.2.5, 5.10 and 5.11 gives guidance on the usage of the discount rates, lifetimes, residual values, CAPEX and OPEX and benefit-over-cost ratios. How to evaluate projects' contributions to the Union targets are described in Section 6.1.

(9) A requirement that the project promoters have to indicate how their projects are considering specific climate adaptation measures is given in Section 6.5.

MAIN CHANGES BETWEEN THE 3RD AND 4TH CBA GUIDELINE

Regulation (EC) 347/2013 mandated ENTSO-E to draft the European Cost Benefit Analysis methodology which shall be further used for the assessment of the ENTSO-E Ten-Year Network Development portfolio. ENTSO-E has drafted the first official CBA methodology during 2013 and 2014, which was consequently approved and published by the European Commission on 5 February 2015.

The 1st CBA Guideline was used in TYNDP 2014 (unofficially) and TYNDP 2016 (officially) for project assessments. Based on the experience gained from these two applications as well as the feedback received from external stakeholders, including the European Commission and ACER, ENTSO-E worked during 2015 and 2016 on improving the official 1st CBA Guideline leading to the 2nd CBA Guideline approved by the European Commission on 27.09.2018.

The updated draft 3rd CBA Guideline was presented to the stakeholders during an open workshop on 8 November 2019 and released for public consultation on 9 November 2019. The Guideline has been officially submitted to ACER 11 February 2020. ACER delivered their official opinion on the 3rd CBA Guideline 6 May 2020. ENTSO-E received the partial rejection of the 3rd CBA Guideline from the European Commission 24 March 2022. After additional amendments based on the direct feedback from the Commission ENTSO-E has re-submitted the 3rd CBA Guideline on 27 October 2022. The 3rd CBA Guideline was used unofficially for the TYNDP 2020 and TYNDP 2022.

During the second half of the 2022 year and beginning 2023 ENTSO-E focused the work on updating the 3rd CBA Guideline to a fourth version together with ACER and the European Commission. The updated draft CBA 4.0 Guideline was out for public consultation 15 December 2022 to 15 February 2023, and presented to the stakeholders during an open workshop on 17 January 2023 in Brussels. After the consultation ENTSO-E amended the 4th CBA Guideline based on the comments and feedback received by ACER, the public and the European Scientific Advisory Board for Climate Change. The Guideline has been officially submitted to the Commission, Member States and ACER on 24 April 2023.

Overview of main changes

Based on the 3rd CBA Guideline ENTSO-E worked on improving the project assessment during TYNDP 2022 implementation that then acted as direct input for the 4th CBA Guideline together with general error, consistency and clarity changes.

The general main changes can be summarised as follows:

- Inclusion of a text on how the Energy Efficiency First principle is considered in the assessment process
- Additional sensitivities have been added as required in the Regulation (EU) 2022/869
- Methodologies for “Contribution to Union Energy Targets” have been included
- A methodology for assessing the commissioning year has been included
- The Black Start Service indicator has been reworked and generalised
- Further elaborated parts about generalized multi-sectorial modelling have been included
- A Methodology for assessment of hybrid/radial projects has been included
- The section on Grid Transfer Capacity has been deleted as it is not applied in TYNDP
- The section on Assessment of Storage has been deleted as the methodology is to be provided by the European Commission.
- Added the methodology on the assessment of the B8.1 – Frequency Stability (energy aspect) indicator.
- Updated the list of requirements for data, methodological details and additional description and information to be given within the study specific Implementation Guidelines
- Deleted the outdated table of VOLL as it will be given within the study specific Implementation Guidelines
- Added a section on how to consider the “Climate adaptation measures”

STAKEHOLDER ENGAGEMENT

Public consultation:

During the public consultation from 15 December 2022 to 15 February 2023 that was explicitly also sent out to all relevant stakeholders, eight stakeholders responded to ENTSO-E's proposed draft 4th CBA Guideline (of which three requested to remain anonymous and not publishing their comments):

- EDF
- Copenhagen School of Energy Infrastructure
- Ørsted
- currENT Europe
- WindEurope

These stakeholders had the chance to provide their opinion regarding pre-defined aspects of the CBA, as well as share with ENTSO-E their broader vision on the draft released for public consultation.

Exchange with EC, ACER and ESABCC:

During the improvement phase in the second half of 2022 ENTSO-E organised together with ACER the Commission and the ESABCC several meetings where the main changes were discussed in detail. Additional discussions on general updates needed to be implemented in the 4th CBA Guideline took place in the respective meetings as well.

On 14 November 2022 ENTSO-E sent a draft working version of the 4th CBA Guideline to ACER. After having received the preliminary feedback from ACER, ENTSO-E has worked on updating the 4th CBA Guideline in accordance with the feedback received.

On 15 March 2023 ENTSO-E received the ESABCC recommendations on the 4th CBA Guideline, which were discussed in a call between the two parties 23 March 2023. Since these recommendations came late in the process of updating the CBA 4 Guideline, many of the recommendations could not be implemented before submitting it to the EC, ACER and MS. ENTSO-E will continue working to improve the Guideline based on these recommendations.

ORGANISATION AND STRUCTURE OF THE DOCUMENT

It is to be noticed that the 4th CBA guideline continues to have a more general approach and assumes that the project selection and definition, along with the scenarios' description is within the frame of the TYNDP and therefore not defined in detail in the assessment methodology. ENTSO-E aims with this approach to develop a CBA methodology that can be used not only for one TYNDP but rather to include strong principles that would stand for a longer time. All other additions, details and clarifications are then described within the TYNDP study specific Implementation Guidelines. The Implementation Guideline provides complementary information to the 4th CBA guideline. It does not replace it. Only together, both documents combined deliver the needed information to practically perform a project CBA in the ENTSO-E Ten-Year Network Development Plan (TYNDP).

The 4th CBA Guideline continues using a modular approach. The purpose of the modular approach is to enable more efficient updates of the guideline by allowing stakeholders to better focus on specific content without necessarily impacting the whole document.

The 4th CBA Guideline is structured in six main chapters that are supported by a number of detailed sub-sections. The sections are used to provide a full description of the indicator. They discuss the methodology to be used and describe the principles and requirements to properly assess the relevant indicator.

OUTLOOK AND PLANNED FUTURE UPDATES

ENTSO-E envisages further directions on the development towards a harmonized energy system-wide cost benefit analysis. The current state of play refers to single sector methodologies. We believe that an integrated multi-sector approach complements a single sector approach and enables us to capture system-level benefits which mitigates the risk of double counting. Under a system-wide assessment the introduction of common indicators allows us to compare projects across sectors and would improve the coherency with other CBA methodologies. Indicators that cannot be harmonized as common indicators should remain as sector specific. Those relate then to the corresponding single sector methodology.