Energy Institute Hrvoje Požar
Croatia

Technical support to the Energy Community and its Secretariat to assess the candidate Projects of Energy Community Interest in electricity, smart gas grids, hydrogen, electrolysers, and carbon dioxide transport and storage, in line with the EU Regulation 2022/869

- Analysis Techniques' Guidance Document -

TEN-E (PECI) Groups meeting – 3rd joint meeting of the "Electricity" and "Gases" Groups

12 March 2026

Contents

1. Analysis Techniques' Guidance Document
2. Methodologies and techniques for the project's evaluation
3. Scenarios and assumptions
4. Input data
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Analysis Techniques' Guidance Document

Analysis Techniques' Guidance Document

Contents

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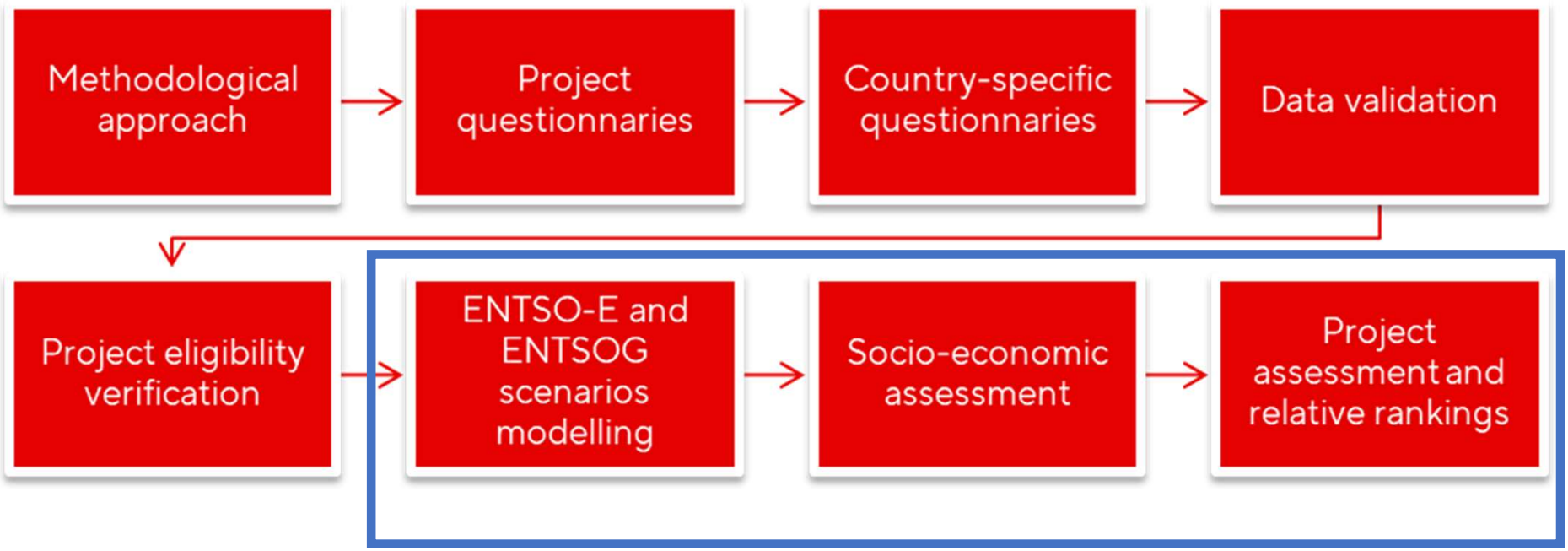
Main project activities

Activities during the project implementation



- *Preliminary eligibility verification is followed by **scenarios modelling** to enable **socio-economic assessment** based on modelling results*

Work plan and deliverables

1. **Inception Report**

   Description of activities, work plan, approach, presentation of project-specific and country specific questionnaires

2. **Data Validation and Scenario Report**

   Report on the collected project and country data, data validation process and compliance of the data with the proposed analysis, results of the project eligibility verification. description of defined scenarios

3. **Analysis Techniques' Guidance Document**

   Final description of the data, scenarios, applied methodologies and techniques, sensitivities to be carried out, and structure of results and indicators

4. **Final Report**

   Summary of the applied methodology, scenarios, data and assumptions and detailed presentation and interpretation of the results for each analysed project in all scenarios and sensitivities

No	Activity
1	Kick-off meeting
2	**Inception Report** preparation and submission ✓
3	1st Groups' meetings
4	Data Collection
5	**Data Validation and Scenario Report** ✓
6	2nd Groups' meetings
7	Data and Scenario Finalization
8	**Analysis Techniques' Guidance Document** ✓
9	3rd Groups' meetings
10	Project Assessment
11	Assessment Results Consultation with the Secretariat
12	4th Groups' meetings
13	**Final Report** preparation and submission

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(Pre)eligible projects for CBA and MCA

- Project eligibility verification resulted in **eight (pre)eligible projects** that will go into further analysis, i.e. CBA and MCA analyses
- All the projects refer to **electricity infrastructure**, seven to overhead lines and one to energy storage

E01: Construction of the new interconnection, OHL 400 kV Gacko (BA) - Brezna (ME)
E02: Trans Balkan Corridor: Double OHL 400 kV Bajina Basta (RS) - Visegrad (BA)/Pljevlja (MN)
E03: New 400 kV interconnection between Montenegro and Bosnia and Herzegovina, 400kV overhead line Brezna-Sarajevo with construction 400/220 kV substation Piva's mountain
E04: Rehabilitation of existing 220 kV lines Trebinje (BA) – Perućica (ME) – Podgorica (ME) - Vau Dejës (AL)
E05: 400 kV interconnection corridor East- West
E12: Moglice Extension Pumped-Storage Hydropower Plant (PS Moglice Extension)
E13: Reconfiguration of 400kV grid and new 400 kV interconnection Albania-Kosovo
E15: 330 kV OHL Balti (MD) - Dnestrovsk HPP-2 (UA)

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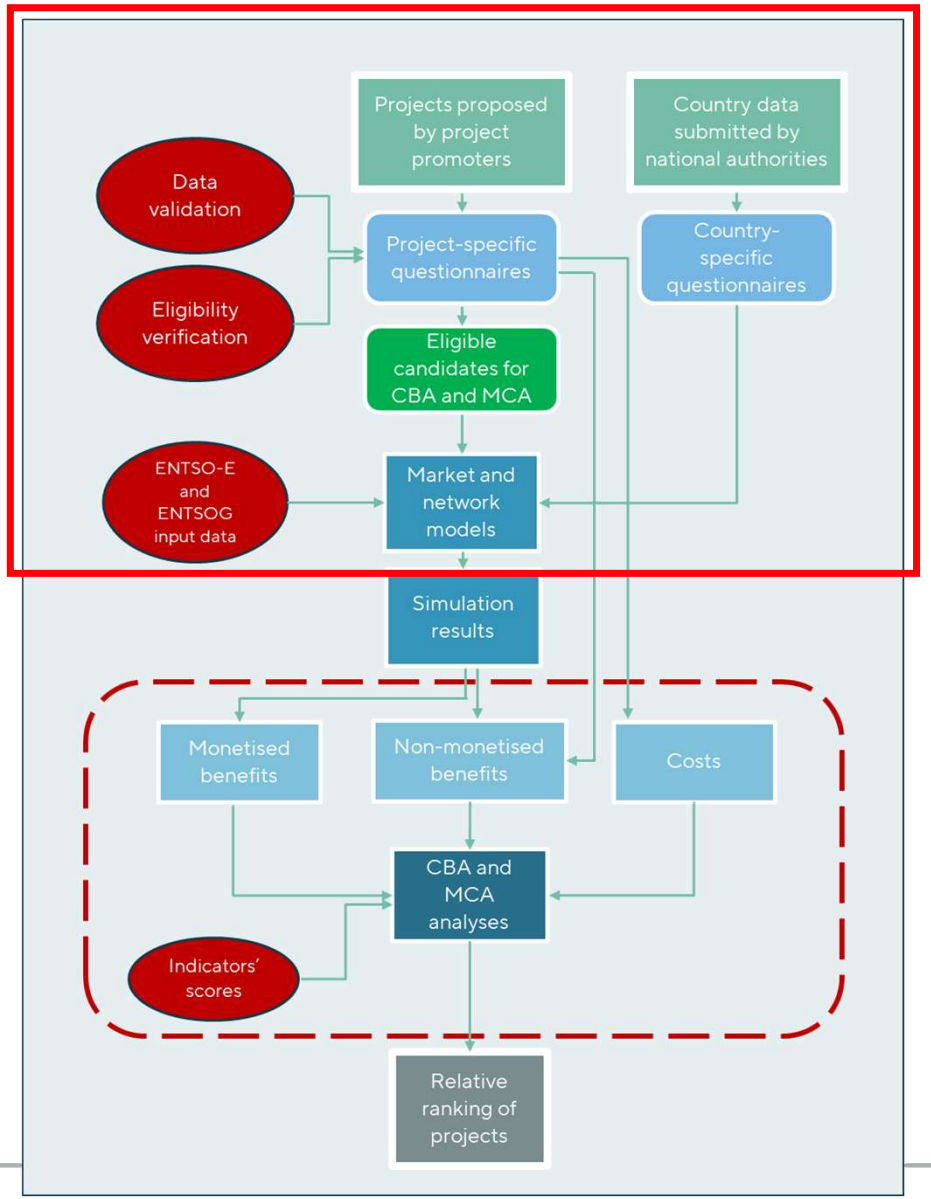
Methodologies and techniques for the project's evaluation

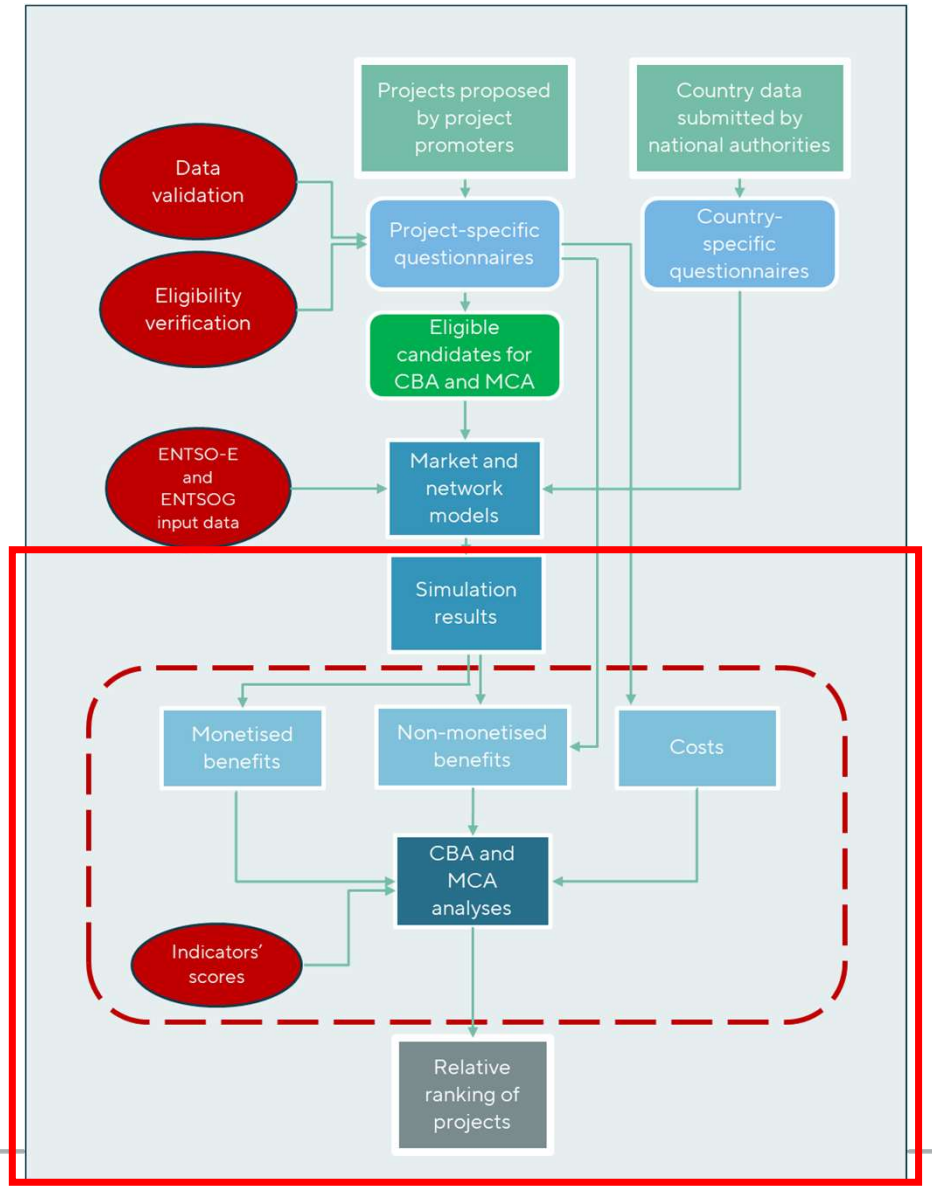
Project assessment approach

- **Data collection** – project-related data and country-specific data
- **Data validation** – several iterations were made to clarify delivered data or to submit additional data by project promoters
- **Projects' eligibility verification** – the final list of (pre)eligible projects for CBA and MCA according to the general and specific criteria assessment
- **Market and network models development**
  - Input data primarily based on the **collected data** regarding candidate projects and regarding country-specific data of the Contracting Parties
  - **ENTSO-E and ENTSOG TYNDP 2026** data as other input data (e.g. fuel prices, external market prices…)



Project assessment approach

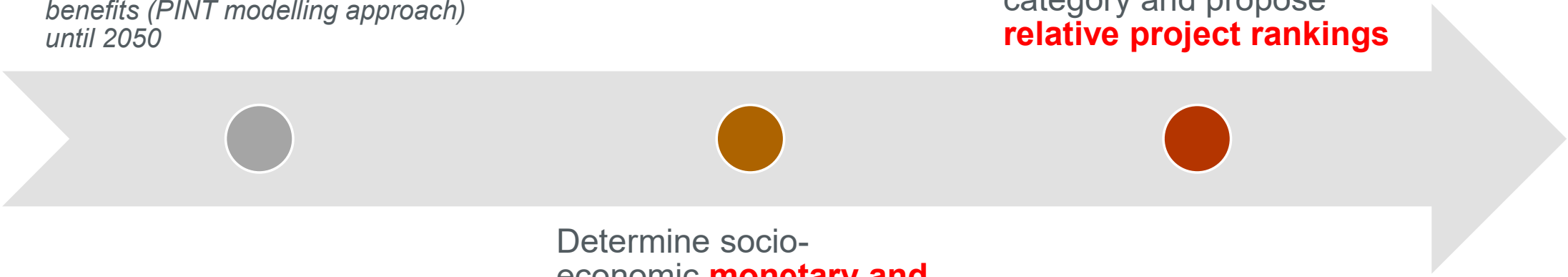
- **Simulation results** – will be used to determine monetised and non-monetised benefits for each project
- **CBA and MCA analyses** – based on the **benefits** (determined by modelling and using delivered data by project promoters) and **costs** provided by project promoters
  - *The main objective is to determine if the potential overall benefits of the project outweigh its costs (general eligibility criteria of theTEN-E Regulation)!*
- **Relative ranking of projects** – indicators will be **scored** to enable comparison of individual project assessment results between projects in the same project category



Project assessment approach

Develop a **reference scenario** against which all projects will be assessed

- *Each project will be added to the reference scenario to determine its benefits (PINT modelling approach) until 2050*



Determine socio-economic **monetary and non-monetary benefits** and costs for each project (project-specific CBA and MCA)

Compare individual project assessment results between projects in the same project category and propose **relative project rankings**

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Project assessment approach

- **PLEXOS** – tool for project assessment
  - enables modelling and analyses of **both electricity and gas/hydrogen markets**
  - The objective of the optimization function is to **minimize total system costs** by taking into account various characteristics and constraints of the system and market
- **PSS/E** – additional tool for electricity network analyses
- EIHP has developed a **detailed regional electricity market model of SEE countries (including WB6**) in PLEXOS and PSS/E, and a regional **gas market model** of SEE in PLEXOS
- application of PLEXOS and PSS/E **in PECI 2024 assessment**

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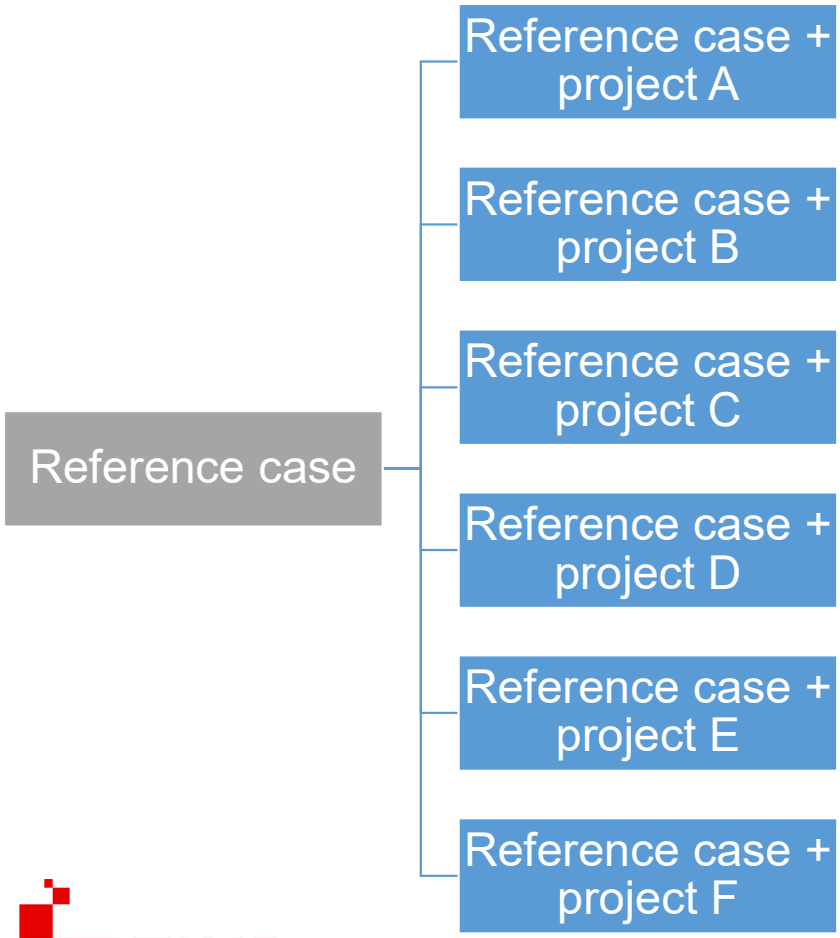
Project assessment approach



- **Main objective:** to determine if the potential **overall benefits of the project outweigh its costs**
  - Results are used to determine project **benefits** according to the relevant methodologies
  - **Costs** are determined based on the submitted project data by project promoters
- **Put IN one at the Time (PINT)** considers each new project on the given network structure one-by-one and evaluates the **results** with and without the examined network investment/project reinforcement
- For **mutually interdependent projects** (project clusters), where the CBA result is positive, the **TOOT (take-out-one-at-a-time)** approach will additionally be applied to assess the individual contribution of each project under the joint implementation of multiple projects

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Socio-economic assessment

- **Objective**
  - to assess the socio-economic **benefits and costs** of the project
- **Cost-benefit and multi-criteria analysis**
  - CBA evaluates project impact on costs and benefits **at the level of society**
  - MCA assesses non-monetised project impacts
  - Integrated CBA and MCA approach to ensure **a full assessment of all benefits**, both monetised and non-monetised

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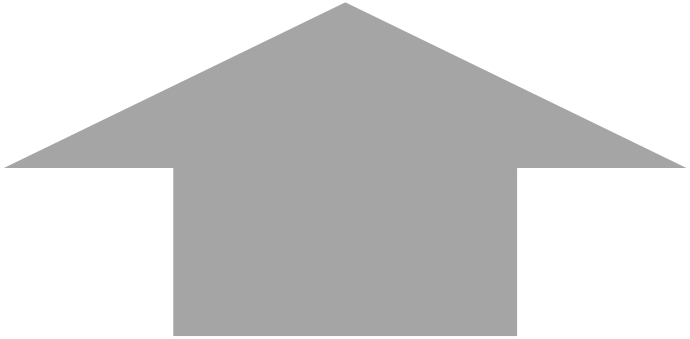
Socio-economic assessment

Benefits

- Indicators calculated **using market and network models**, and
- Indicators determined based on **the data delivered by the project promoters**, depending on specific assessment criteria set out in the methodologies



Costs

- Verified investment costs **(CAPEX)** and operation and maintenance costs **(OPEX)** delivered by the project promoters

Methodologies for project evaluation

- **CBA Methodologies of the ENTSO-E and ENTSOG**
  - *4th ENTSO-E Guideline for Cost-Benefit Analysis of Grid Development Projects, April 2024*
    - The *TYNDP-specific CBA Implementation Guidelines* as an accompanying document of the *4th ENTSO-E CBA Guideline (draft TYNDP 2026 CBA Implementation Guidelines available)*
  - *2nd ENTSOG Methodology for Cost-Benefit Analysis of Gas Infrastructure Projects, February 2019*
- **Methodologies developed and published by the European Commission**
  - *Harmonised System Wide Cost-Benefit Analysis for Candidate Electrolyser Projects, May 2023*
  - *Harmonised System Wide Cost-Benefit Analysis for Candidate Energy Storage Projects, May 2023*
  - *Harmonised System Wide Cost-Benefit Analysis for Candidate Hydrogen Projects, May 2023*
  - *Harmonised System Wide Cost-Benefit Analysis for Candidate Smart Gas Grid Projects, May 2023*
  - *Harmonised System Wide Cost-Benefit Analysis for Candidate Smart Electricity Grid Projects, May 2023*
  - *Harmonised System Wide Cost-Benefit Analysis for Candidate Cross-Border Carbon Dioxide Network Projects, May 2023*
- **Other methodologies developed by the EU Commission** (like *Methodology for assessing the electricity and offshore infrastructure candidate PCI and PMI 1st Union PCI-PMI list 2023*) and previously developed methodology at the Energy Community level **used for the selection of PECI projects in 2024**

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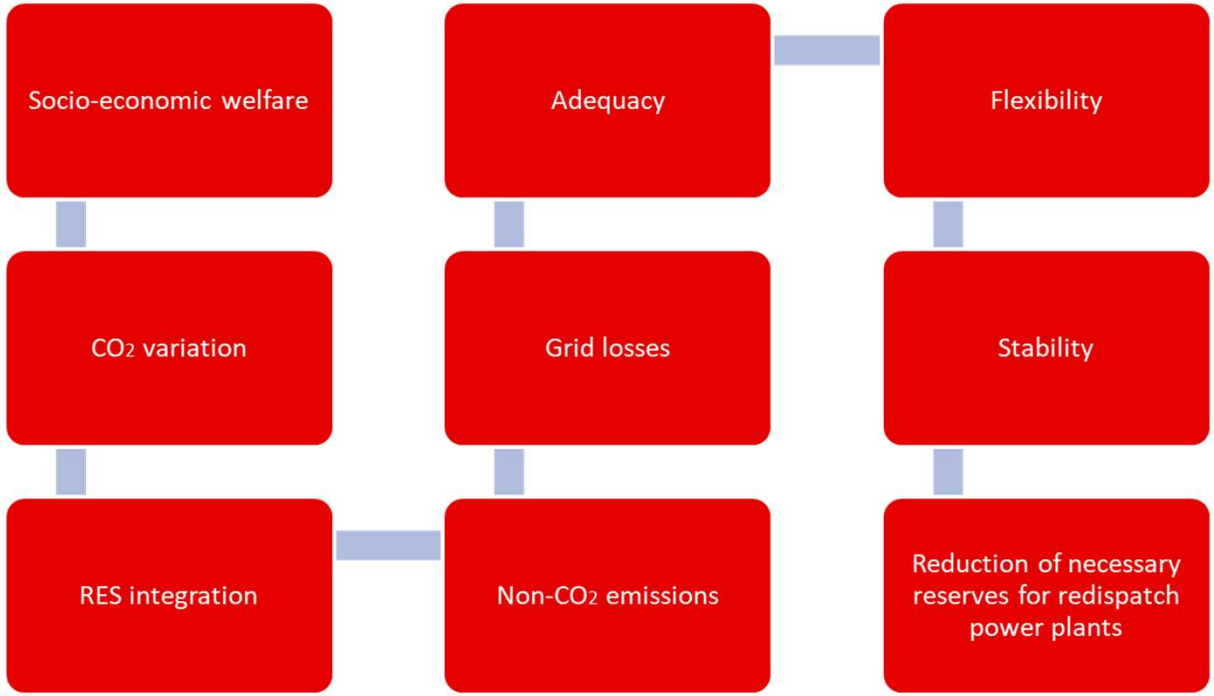
Project evaluation methodology for electricity projects

4th ENTSO-E Guideline for Cost-Benefit Analysis of Grid Development Projects, April 2023

- defines nine categories of possible benefits for overhead transmission lines



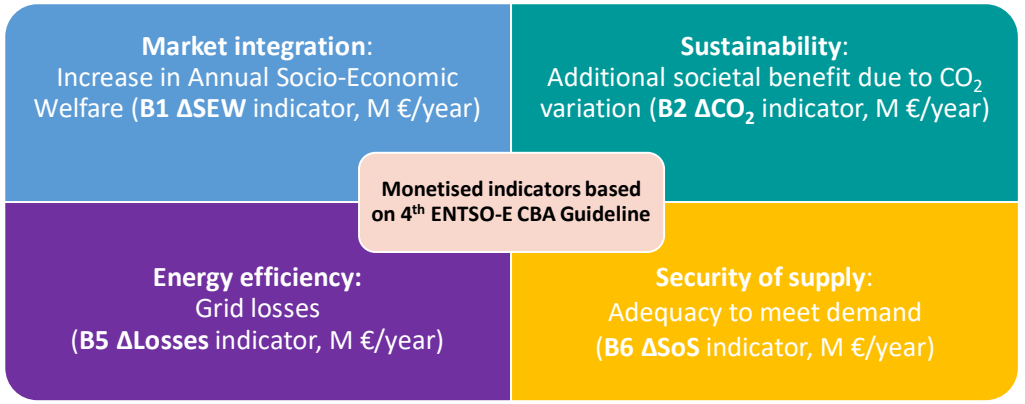
Some project benefits can be quantified and monetised, while others can only be qualitatively described.

Project evaluation methodology for electricity projects

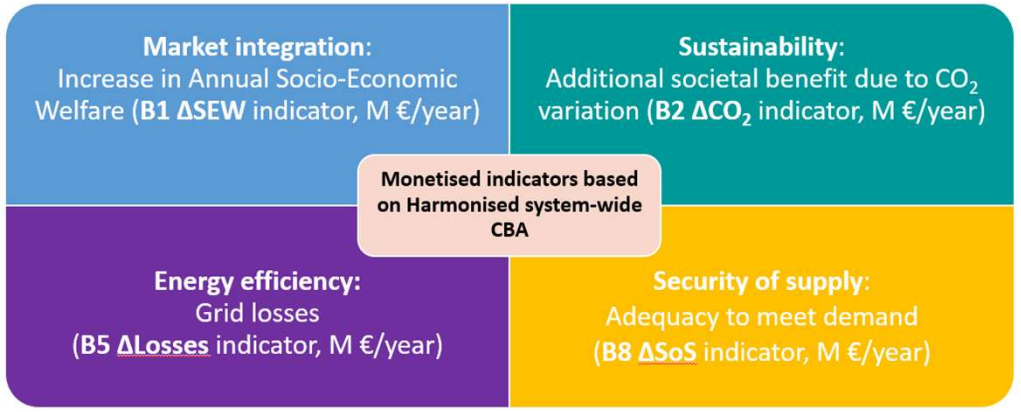
Based on the TEN-E eligibility criteria for electricity **transmission and storage projects** the project has to contribute significantly to:

- **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 to **at least one** of the following specific criteria:
  - **market integration**, including through lifting the energy isolation of at least one Contracting Party and reducing energy infrastructure bottlenecks, competition, interoperability and system flexibility
  - **security of supply**, including through interoperability, system flexibility, cybersecurity, appropriate connections and secure and reliable system operation.

Monetised benefits for transmission projects



Monetised benefits for energy storage projects



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Project evaluation methodology for electricity projects

Benefits monetised using synchronised market and network models

Indicator	Where calculated	Monetisation
Socio-economic welfare (SEW)	Market model: generation costs	Δ generation costs
CO_2 variation	Market model: CO_2 emissions	CO_2 variation × (societal cost – ETS price)
Security of supply (SoS)	Market model: unserved energy	Unserved energy × Value of Lost Load (VoLL)
Grid losses	Network model: grid losses Market model: marginal prices	Losses × marginal electricity price

All indicators are calculated at the level of the Energy Community Contracting Parties, reflecting impacts at the system level.

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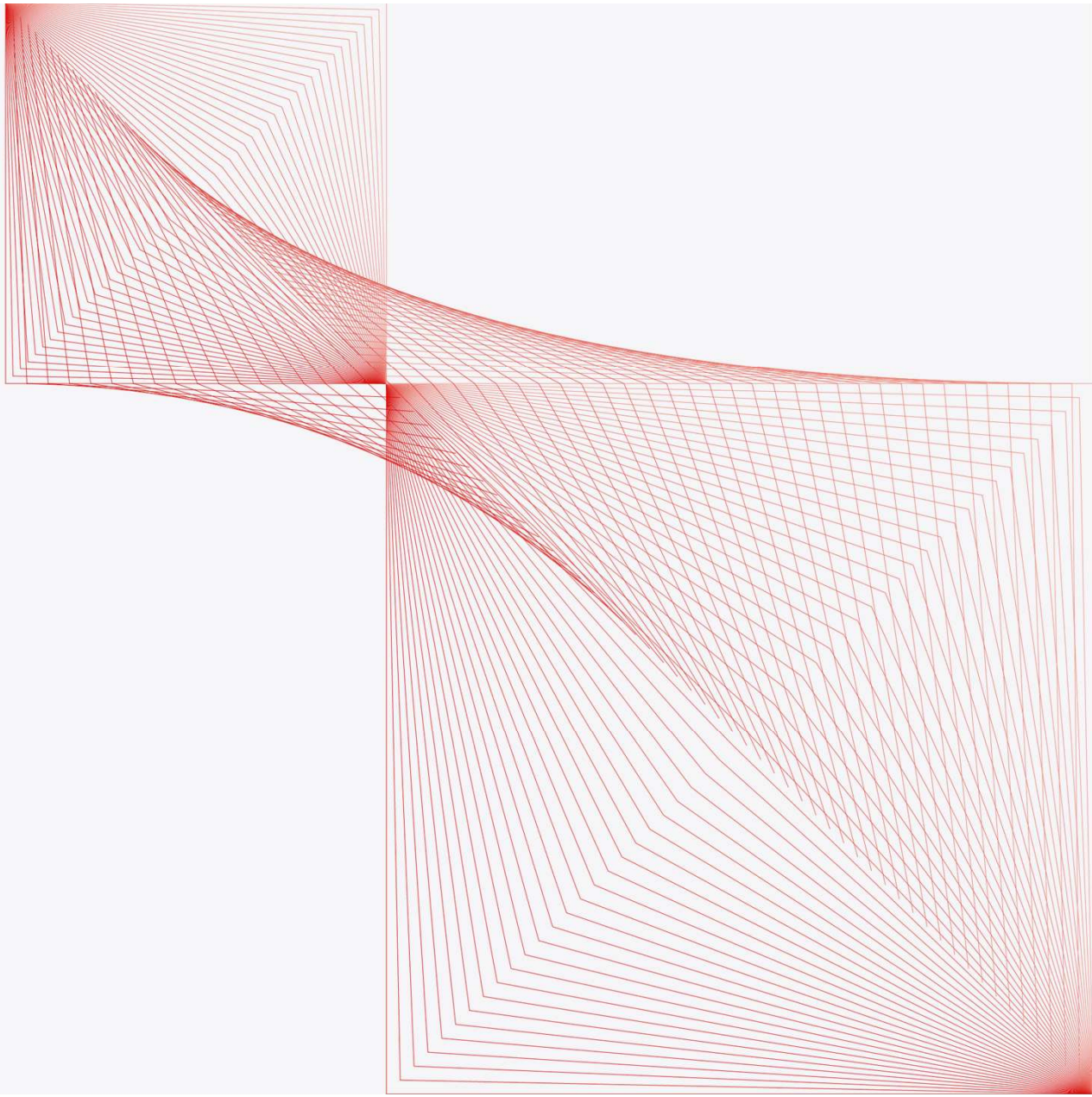
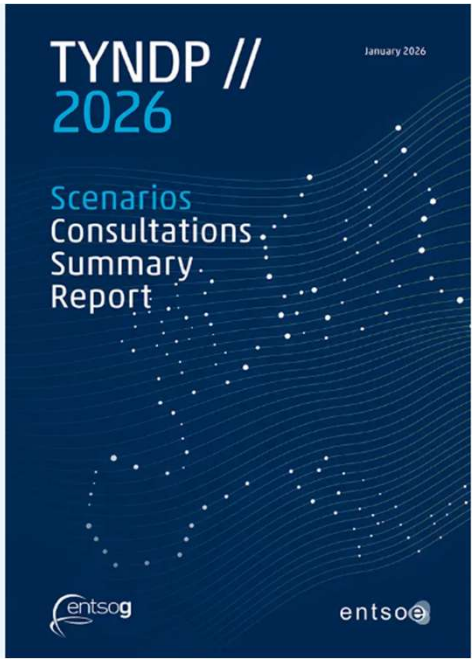
Scenarios and assumptions



Modelling scenarios

- Modelling scenarios have to be in line with the latest **ENTSO-E and ENTSOG scenarios** developed under TYNDP 2026
- The necessary TYNDP 2026 data is provided by ENTSO-E to the Energy Community Secretariat for the purposes of this analysis
- Under the TYNDP 2026 Scenarios Framework, **the Central scenario (National Trends+)** reflects the latest updated national energy and climate plans (NECPs), national and EU policies
  - The Central scenario will be available for 2030, 2035, 2040 and 2050
  - In addition to the Central scenario, there are two economy variants scenarios, as stress-tests of the Central scenario, available for 2035 and 2040 horizons



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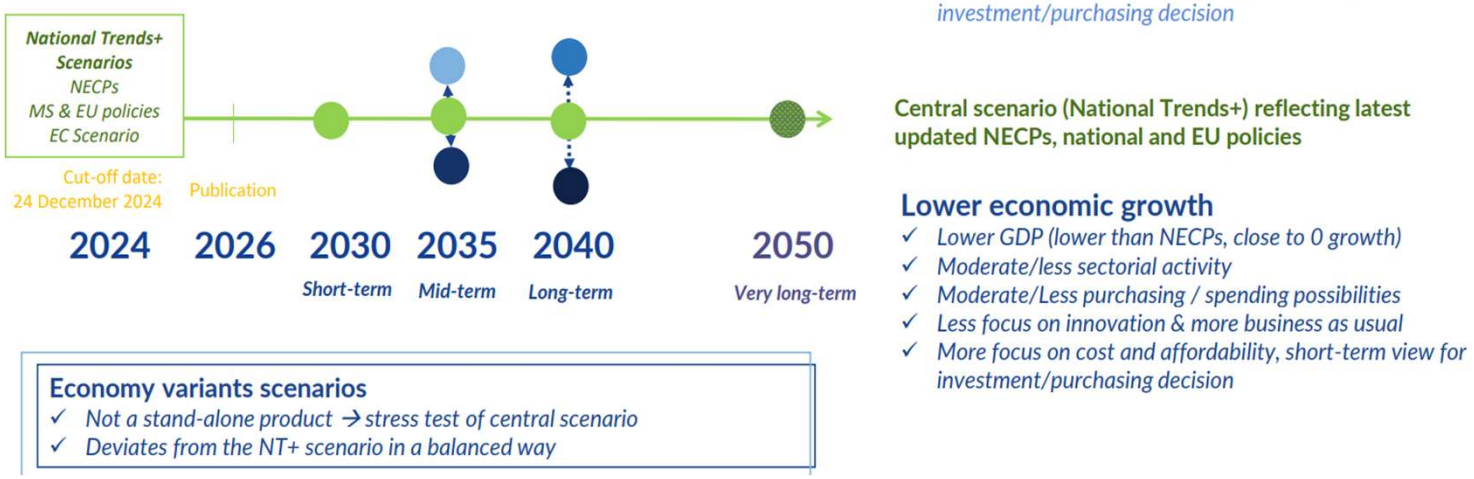
Modelling scenarios

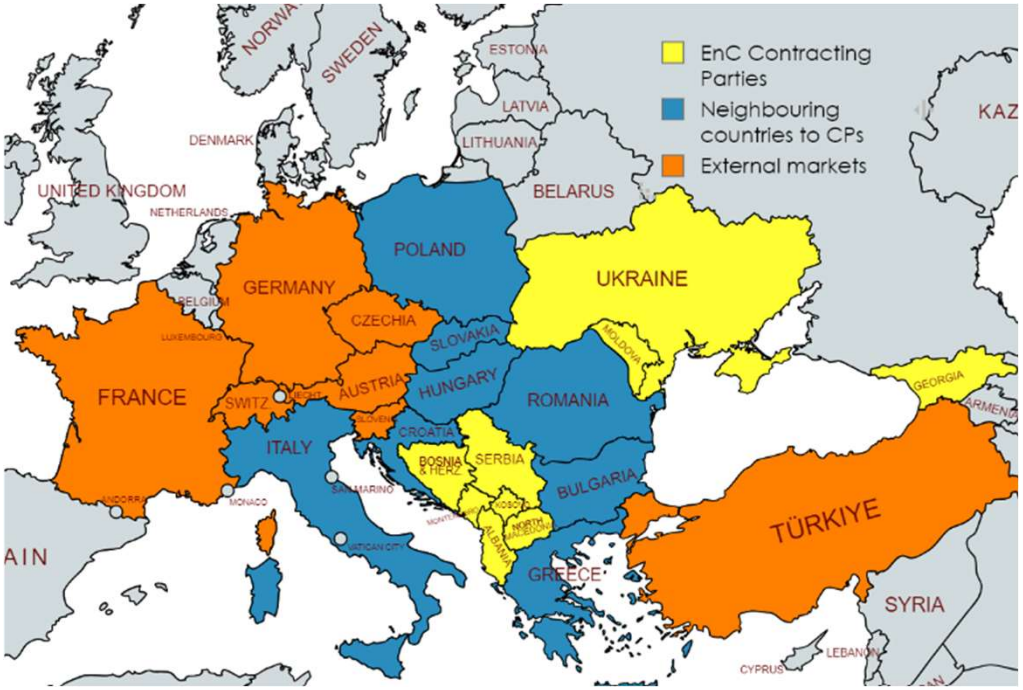


TYNDP 2026 Scenario Framework

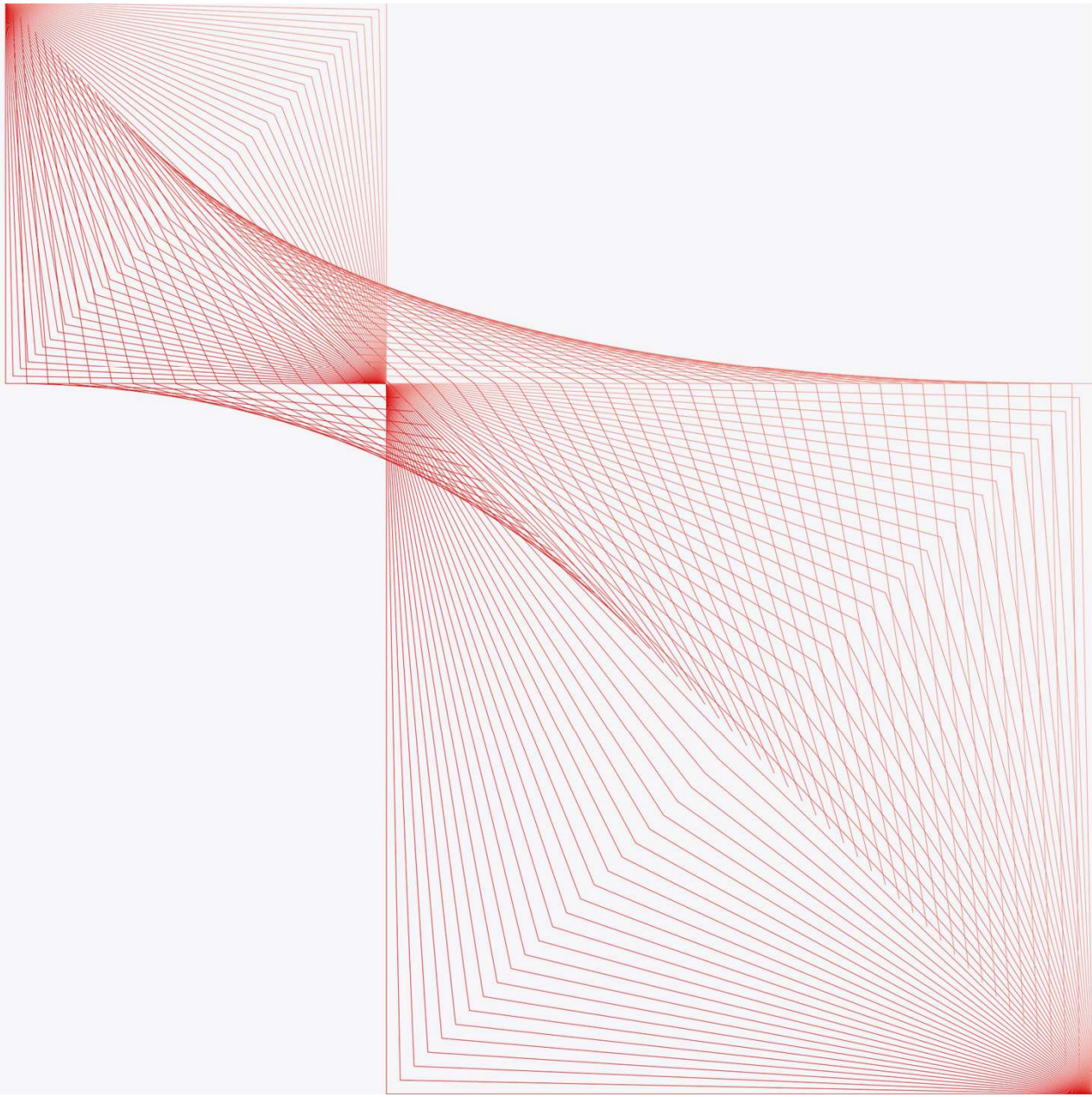
- For the project assessment purposes under the PECI process. the **Central scenario (National Trends+) will be modelled for the horizon until 2050,** and the two economy variants scenarios shall not be considered
- The NT+ scenario reflects the most up-to-date NECPs and policy assumptions and therefore represents the **best-estimate baseline** for socio-economic project assessment

Modelling assumptions

- **Geographical scope**: Albania, Bosnia and Herzegovina, Georgia, Kosovo*, Moldova, Montenegro, North Macedonia, Serbia and Ukraine
- **Approach for neighbouring countries**: use of the best available data and models (ENTSO-E and ENTSOG TYNDP 2026, EIHP in house data sets and developed models)
  - Unit-by-unit level or fuel/technology level
  - Power systems of other countries, that have borders with neighbouring countries of CPs, such as Austria, shall be considered in regional PLEXOS model as **spot markets**
- **Time horizon:** 2030/2035/2040/2050
- **Modelling tools:** PLEXOS Energy Modelling Software, PSS/E

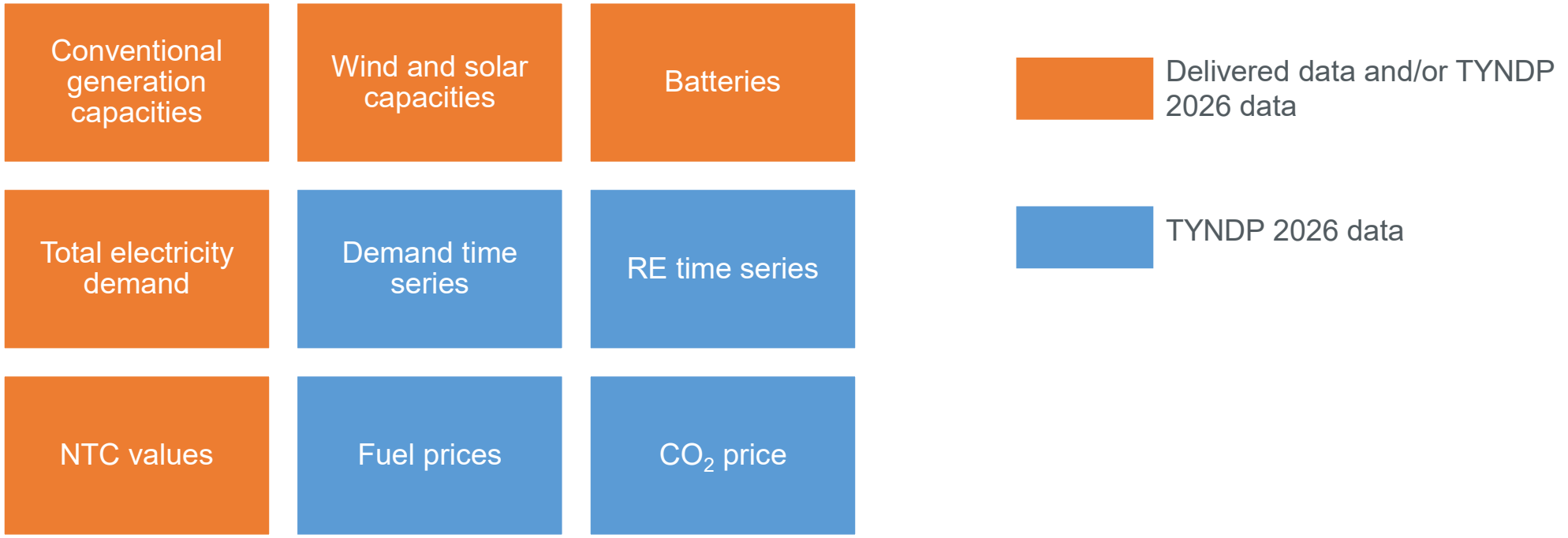


Input data



Input data sources

- Input data for the **reference scenario** (without projects) based on the delivered country-specific data and **TYNDP 2026 NT+** scenario:



Submitted country-specific data

Sector	AL	BA	GE	MD	ME	MK	RS	UA	XK
Electricity	✓	✓		✓	✓	✓	✓	✓	✓
Gas	✓	✓				✓	✓		

Input data – generation capacities

- **Generation capacities**
  - **Generation capacity data for CPs** were collected from national authorities (based on TYNDP 2026)
    - Some differences exist between the collected data and the TYNDP 2026 data
  - Proposal by the Secretariat and the Consultant:
    - ✓ **Use generation data provided by national authorities for market model development.**
    - The modifications of the provided input data were made where necessary **to ensure carbon neutrality in 2050 by decommissioning all coal-fired thermal power plants** without any exception, and by eventually assuming the application of CCS technology for gas-fired power plants or their usage of clean gases including hydrogen.

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Input data – generation capacities

2030	Nuclear	Thermal-gas	Thermal-lignite/coal	Hydro	Wind	Solar	Batteries
AL	-	170	-	2393.1	400	1000	-
BA	-	-	1518	2309.7	1047	1957	225
XK	-	-	1010	100.7	677	550	170
MD	-	1717.6	21[1]	64.5	390	560	86.4
ME	-	-	225	961.4	318	750	210
MK	-	759.5	150	769	170	1741.9	80
RS	-	390.9	4062.8	2989.7	1770	1729	604.5

2040	Nuclear	Thermal-gas	Thermal-lignite/coal	Hydro	Wind	Solar	Batteries
AL	-	470	-	3003.1	800	1400	-
BA	-	-	1518	2309.7	1300	2500	225
XK	-	-	1010	100.7	950	950	170
MD	-	1717.6	21	64.5	900	900	86.4
ME	-	-	225	961.4	318	750	210
MK	-	759.5	-	1102	274	2121.9	80
RS	-	390.9	3399.8	3564.7	3067	3929	604.5

2035	Nuclear	Thermal-gas	Thermal-lignite/coal	Hydro	Wind	Solar	Batteries
AL	-	470	-	3103.1	1300	1800	-
BA	-	-	1518	2309.7	1500	3000	225
XK	-	-	1010	100.7	1275	1340	170
MD	-	1717.6	21	64.5	1700	960	86.4
ME	-	-	-	961.4	318	2976	210
MK	-	759.5	-	1292	410	2141.9	200
RS	-	390.9	3399.8	3564.7	3117	7357	604.5

2050	Nuclear	Thermal-gas	Thermal-lignite/coal	Hydro	Wind	Solar	Batteries
AL	-	470	-	3103.1	1500	2100	-
BA	-	-	-	2309.7	2500	5000	0
XK	-	-	-	100.7	1873	1938	170
MD	-	1717.6	21	64.5	2600	1200	86.4
ME	-	-	-	961.4	1212	5514	210
MK	-	759.5	-	1480.5	410	2141.9	200
RS	-	390.9	-	3564.7	7969	18 495	604.5

[1] *In Moldova thermal is not lignite/coal but other non-renewable thermal capacity*

Input data – electricity demand

- **Electricity demand**
  - **Data on electricity demand for CPs** collected from national authorities (based on the TYNDP 2026)
  - National authorities mainly provided annual demand values, while TYNDP 2026 includes weather-based scenarios
  - Approach
    - Combine national annual demand projections with a representative weather-adjusted demand profile based on TYNDP 2026

Country	2030	2035	2040	2050
AL	8800	9200	9500	10 100
BA	11 800	12 150	12 500	13 100
XK	7557	8076	9316	10 602
MD	7000	7843	8787	11 031
ME	3200	3160	3044	2867
MK	9702	10 804		
RS	39 555	41 400	44 844	62 832

Input data – NTCs

- **NTCs**
  - NTC data for CPs were collected from national authorities
  - Differences exist between values submitted by CPs for the same border, and in some cases compared to the TYNDP 2026 reference grid
  - **NTC values must not include candidate projects**, as their impact will be assessed via NTC increase in the model!
  - Proposal by the Secretariat and the Consultant:
    - To **use the TYNDP 2026 reference NTC values** for borders where submitted data differ
    - Objective: to ensure a **consistent baseline for project assessment** across countries

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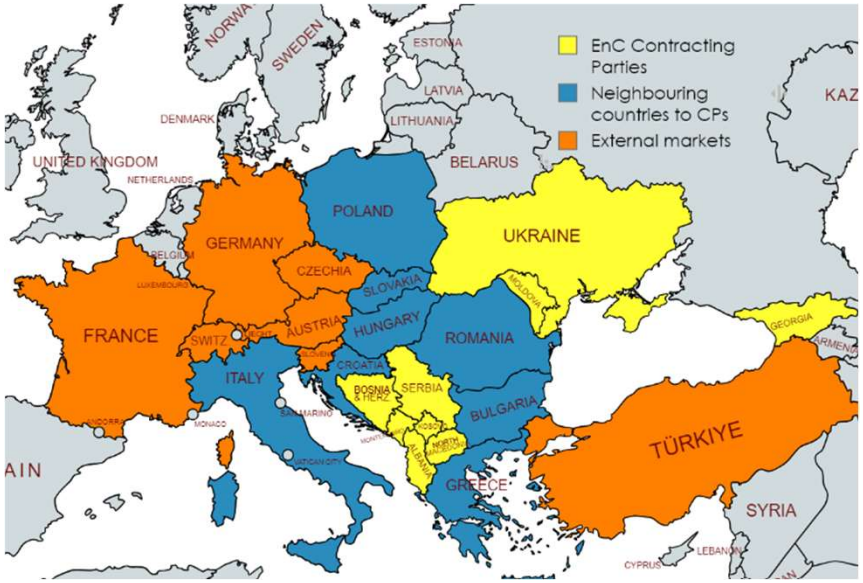
Input data for neighbouring countries to CPs

- For countries **neighbouring to the CPs** and **external electricity markets** input data is **provided by ENTSO-E** (as the full set of TYNDP 2026 data is not yet publicly available):
  - PEMMDB2.5 data (with installed capacities for electricity generation for all technologies)
  - Electricity demand
  - Reference grid NTC values
  - Hourly electricity prices (for external markets)
  - Commodity prices (fuels and CO_2) – *for all countries included in the model*

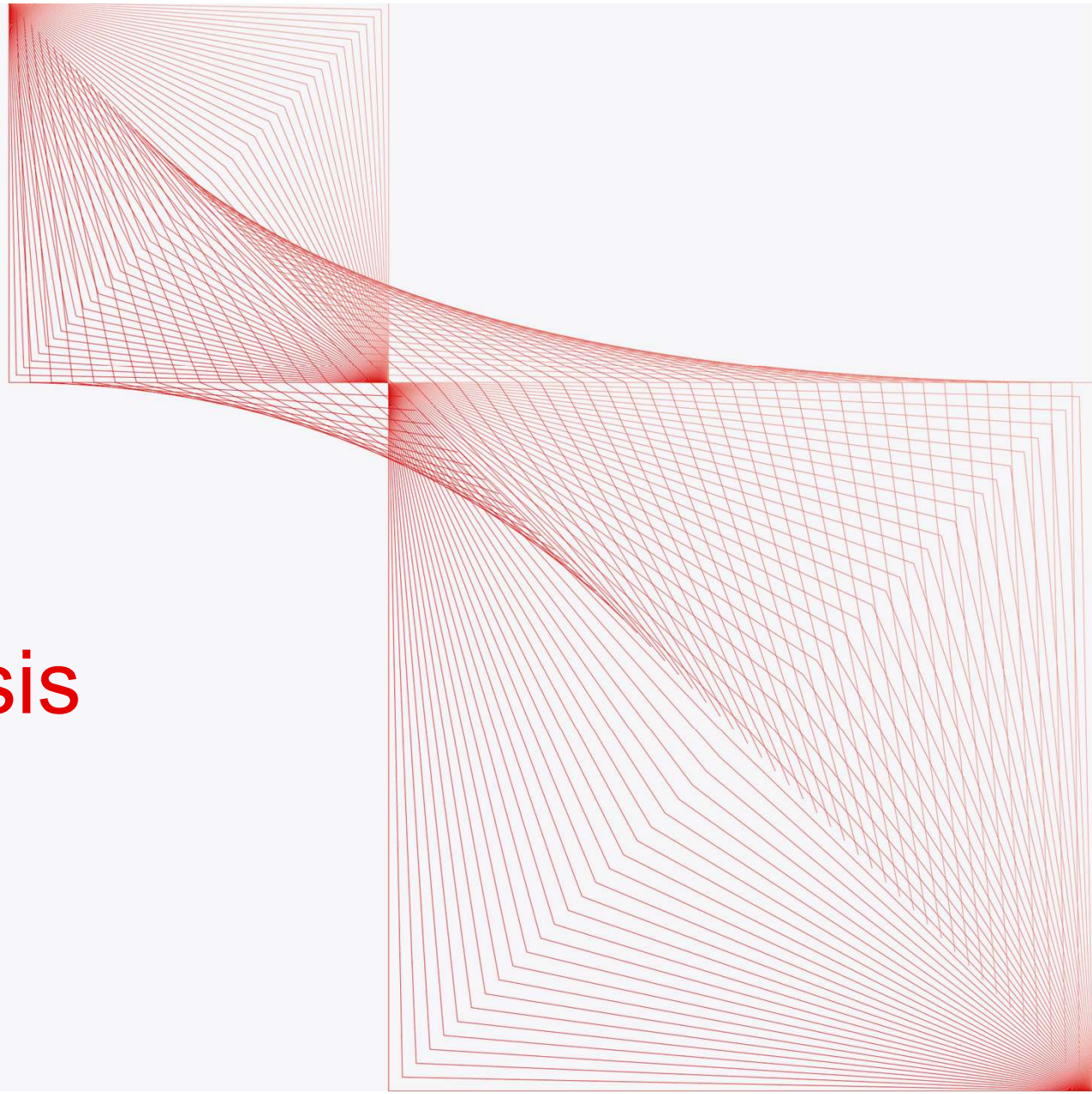


Input data based on the TYNDP NT scenario

- **Fuel and CO_2 prices**

		2030	2035	2040	2050
Nuclear	*€/net GJ*	0.6	0.6	0.6	0.6
Lignite G1 (BG - MK - CZ)		1.9	1.9	1.9	1.9
Lignite G2 (SK - DE - RS - PL - ME - UKNI - BA - IE)		2.4	2.4	2.4	2.4
Lignite G3 (SL - RO - HU)		3.1	3.1	3.1	3.1
Lignite G4 (GR - TR)		4.1	4.1	4.1	4.1
Hard coal		4.1	4.0	3.9	4.1
Hydrogen		15.8	17.8	19.7	21.5
Natural Gas		9.2	8.4	10.4	9.8
Biomethane		13.9	14.0	14.1	13.9
Synthetic Methane		32.8	31.3	29.8	28.0
Gas		9.6	9.4	11.8	14.2
Crude oil		14.3	15.2	16.2	20.2
Light oil		18.3	19.5	20.7	25.9
Heavy oil		15.0	16.0	17.0	21.2
Oil shale		2.3	2.8	3.3	4.8
CO_2 price	*€/ton*	97.5	197.5	297.5	502.7

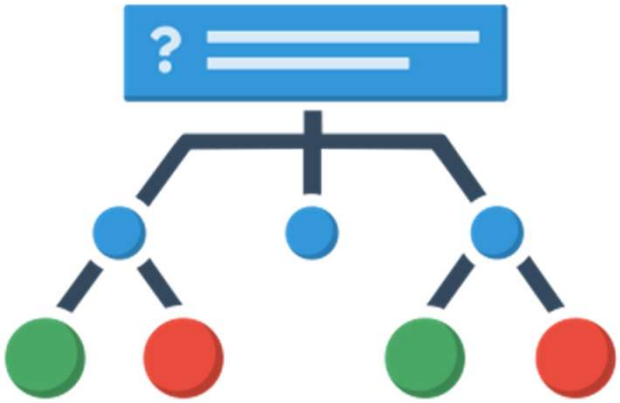
Sensitivity analysis



Regulatory basis for Sensitivity analysis

EU Regulation 2022/869 (revised TEN-E), Annex V

(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;*



4th ENTSO-E Guideline for Cost-Benefit Analysis of Grid Development Projects

- *For each CBA study, sensitivity analysis should be conducted to increase the validity of the CBA results*
- *Sensitivity analysis can be performed to observe how the variation of parameters, either one parameter or a set of interlinked parameters, affects the model results*
- *The aim of a sensitivity analysis is not to define complete new sets of scenarios but quick insights in the system behaviour with respect to single (few) changes in specific parameters*
- *In general,* ***a sensitivity analysis must be performed on a uniform level****, i.e. the sensitivity needs to be applied to all projects under assessment in the respective study*

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Sensitivity analysis

- *4th ENTSO-E Guideline for Cost-Benefit Analysis of Grid Development Projects*
  - Examples of sensitivities based on the experiences in the previous TYNDP processes:
    - Fuel and CO_2 price
    - Long-term societal cost of CO_2 emissions
    - Climate year
    - Load
    - Technology phase-out/phase-in
    - Must-run
    - Installed generation capacity (including storage and RES)
    - Flexibility of demand and generation
    - Availability of storage
    - The commissioning date of various projects

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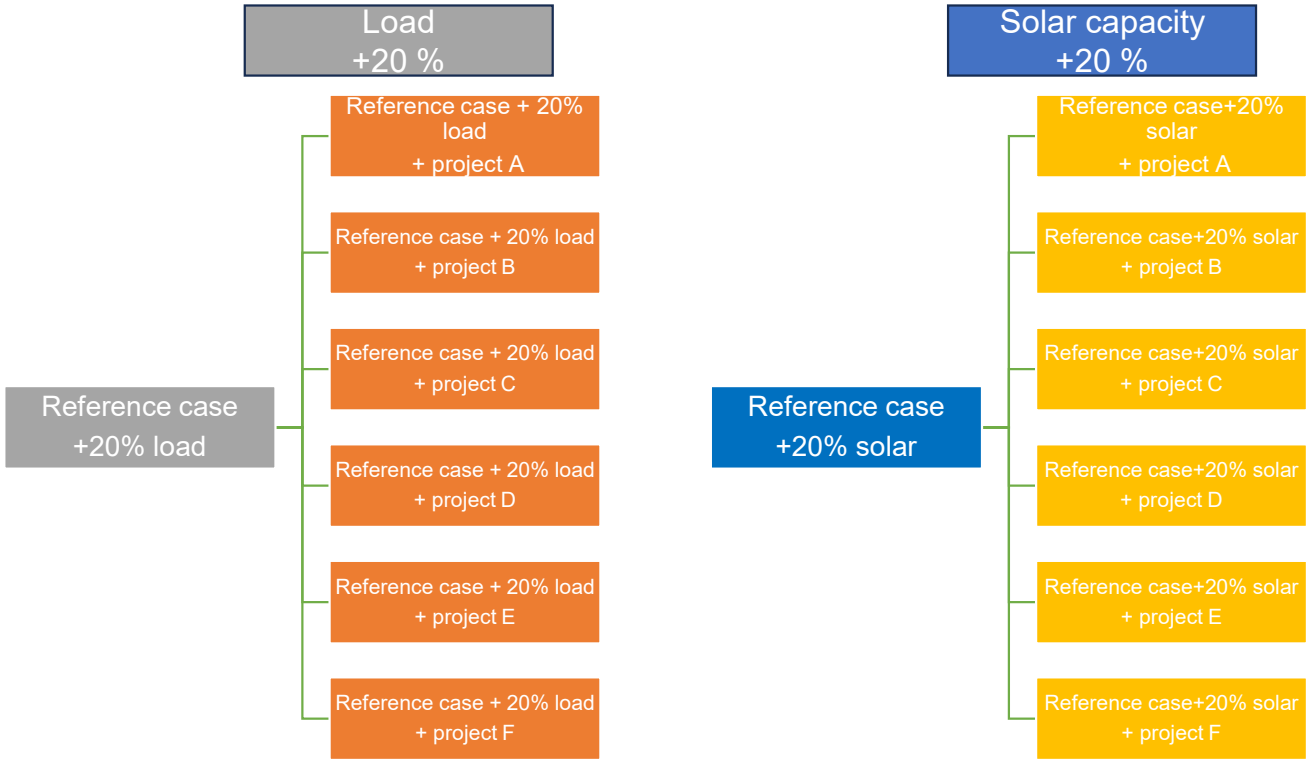
Proposed parameters for sensitivity analyses

- Proposed parameters for sensitivity analyses for CBA under PECI 2026 process (in line with the PECI 2024 process):
  - **Load** – it is expected that an increasing number of applications will be electrified in the future (e.g. e-mobility. heat pumps. etc.), which would cause an increase in load and the necessary generation and therefore possibly affect several CBA indicators such as SEW
  - **RES** – amendments to the national RES goals, which could occur frequently in the observed horizon, could lead to dominant impacts on the results of the CBA assessment

Proposed parameters for sensitivity analyses

- Proposed values for sensitivity analyses for CBA under PECI 2026 process:



Thank you for your attention

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