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South-East Europe Electricity Roadmap

Cost Benefit Analysis to evaluate electricity transmission projects of common interest

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SEERMAP training

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Overview

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- Cost Benefit Analysis basics
- The ENSTO-E methodology
- Methodology to evaluate Projects of Energy Community Interest

Cost-Benefit Analysis

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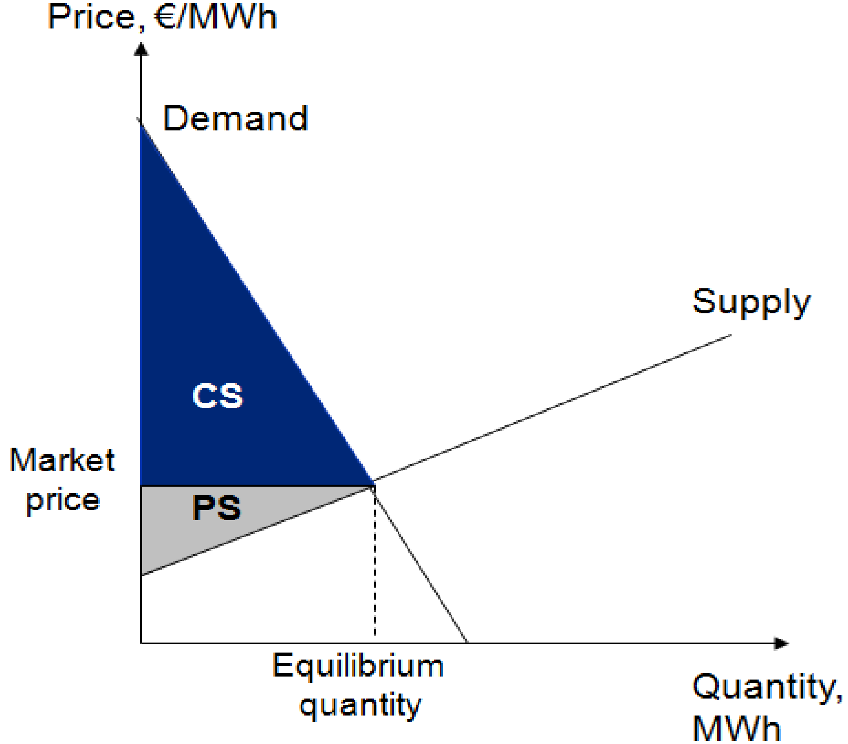
An investment project would be beneficial to the investigated stakeholder group if the cost-benefit analysis provides a positive net benefit (i.e. a positive NPV)

- Costs and benefits of a project are assessed in the economic analysis by the Net Present Value (NPV)
- Calculation of the Net Present Value (NPV) of economic costs and benefits includes
  - the monetary costs and benefits of the investor
  - the costs and benefits to other stakeholders and the society as a whole affected by an investment project
- (Economic) NPV is the difference between the discounted total social benefits and costs
- Economic assessment of a project is positive if the NPV is positive (NPV > 0)

Social Welfare components

Welfare Components



Consumer surplus (CS):

Consumer surplus is the difference between the maximum price a consumer is willing to pay and the actual price they do pay.

Producer surplus (PS)

Market price multiply by the equilibrium quantity decreased by the total variable cost of production

Rent

Price differentiate between two market multiply by the traded quantity

Total welfare

CS+PS+RENT

Aims of CBA in evaluating transmission projects

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- ENTSO-E applies it in the Ten-Year Network Development Plan (TYNDP) which aims to consistently assess the proposed transmission projects of the 42 European TSOs
- Identify those transmission projects that bring robust benefits to society in a wide variety of future scenarios
- There is a huge demand for transmission capacity increase in the EU
  - increasing renewable generation capacities and smart grid developments increase the demand for additional transmission investments
- CBA is the most suitable tool to do the necessary project appraisal
- BUT! No ranking of transmission projects by ENTSO-E!

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ENTSO-E approach for the CBA methodology

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- ENTSO-E uses a combination of CBA methodology with multi-criteria assessment in the new TYNDP-2014:
  - Need to use more scenarios and sensitivity analysis
  - Provides specification of data sources to be used and time horizon of assessment ⇒ cover lifetime of projects
  - Guidance on project clustering, calculation of residual values, and discount rates ⇒ region specific and single reflecting return of planned investment
  - Greater transparency on calculation methodologies
  - Guidance on quantification and monetization (see later for details)
  - Guidance on surplus analysis

Combined cost benefit and multi-criteria framework

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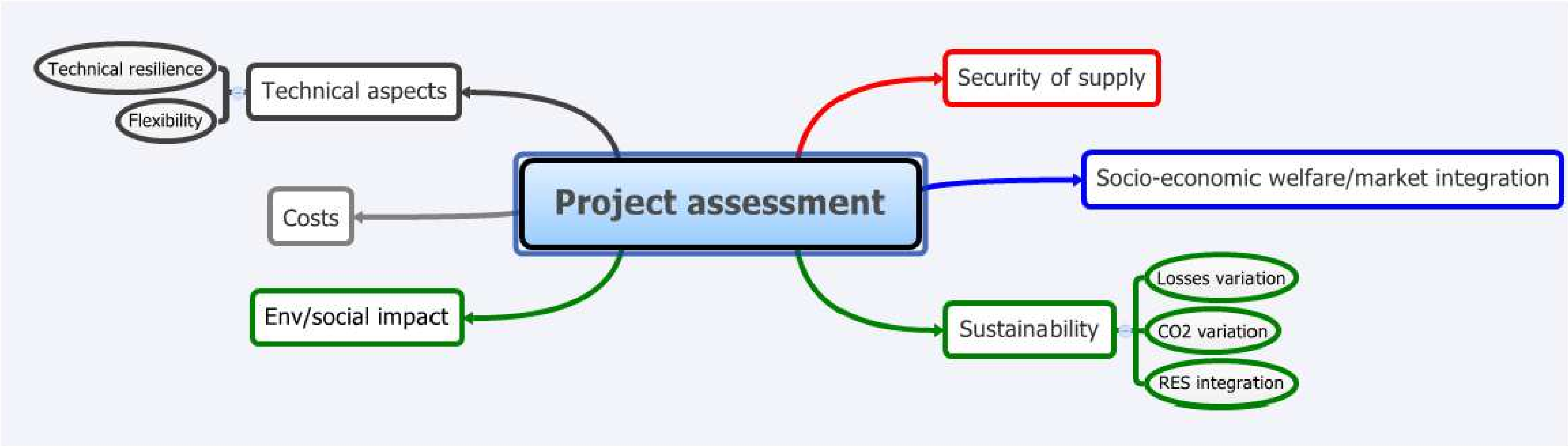
- Quantified elements:



- Not all monetized, but some measured in physical units!
- No weighting scheme of the various items ⇒ no final ranking of projects
- Source: ENTSO-E CBA, 2013

CBA - Main benefit categories (1)

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- B1:Security of Supply:
  - DEF: provision of secure supply of electricity in normal conditions
  - Method: Expected Energy Not Supplied (EENS) or Loss of Load Expectancy (LOLE) calculation by network/market models
  - Monetization: Only EENS (VOLL - Value of Lost Load – calculation is difficult)
- B2: Socio-Economic Welfare
  - DEF: Increase trading opportunity by increased GTC and reduced total system cost
  - Method: Calculating consumer and producer surplus and congestion rents by market models
  - Monetization: Market models already provide monetary values

CBA - Main benefit categories (2)

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- B3. RES Integration:
  - DEF: measures reduction in RES curtailment and increased RES generation connectability
  - Method: avoided curtailment and network modelling on possible increase in RES generation connection
  - monetization: not monetized, savings in avoided curtailment included in generation cost saving (B2)
- B4. Variation in Losses (Energy Efficiency)
  - DEF: savings arising from reduced thermal losses
  - Method: network and market simulation tools estimate saving in losses that reduces production requirements
  - Monetization: market study gives value of loss (e.g. market value/price)

CBA - Main benefit categories (3)

- B5. variation in CO_2 emissions
  - DEF: changing in CO_2 emissions due to the changing trade and production patterns
  - Method: using market and network models and accounting for standard emission rates socio-economic welfare category (B2) includes it already
- B6. Technical Resilience/System Safety Margin
  - DEF: Contribution to system security during extreme situations
  - Method: scoring key performance indicators (e.g. Steady state, voltage collapse criteria)
  - Monetization: No

CBA - Main benefit categories (4)

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- B7. Robustness/Flexibility
  - DEF: ability of the system to meet future scenarios that are different form present projections
  - Method: probabilistic approach of future scenarios and scoring key performance indicators
  - Monetization: No

CBA - Costs and Social Impacts

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- C1: Total Project Expenditure
  - DEF: Total investment cost + maintenance costs
  - Method: accounting for the entire lifetime of equipments
- Social impacts
  - S1. Environmental impacts: assessment of local impacts, e.g. length of line run through environmentally sensitive areas
  - S2. Social impacts: assessment of local impacts, e.g. length of line run through socially sensitive areas

Summary table

- Serves to highlight all benefits, costs and social assessment according to the multi-criteria framework applied
- But: no weighting scheme is applied presently ⇒ No ultimate ranking of projects!

Internal Grid Transfer Capability Increase	Cross-border Grid Transfer Capability Increase	Contribution to 10% Intercon-nection	Social and Economic Welfare [€]	Security of Supply [MWh]	RES Integration [MWh]	CO2 emissions variation [kt]	Losses variation [€]	Technical Resilience (++/--)	Flexibility (++/--)	Costs [€]	Environmental Impact	Social Impact
MW Generation and/or MW Demand	MW A to B and/or MW B to A	%									Km	Km

- Source: ENTSO-E 2013

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Projects submitted by categories

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	Electricity trans-mission	Electricity storage	Gas trans-mission	Gas Storage	LNG	Smart Grid	Oil	Total
Submitted projects	13	0	16	0	1	3	1	34
Eligible projects	12	-	16	-	1	0	1	30
Submitted investment cost	Ca.1200 million €		Ca. 2350 million €			13 million €	490 million €	Ca.4053 million €

- Out of the 13 submitted electricity transmission projects one electricity did not meet the criteria of the adopted Regulation
- Out of the 3 submitted smart grid projects none of them meet the criteria of the adopted Regulation
- Submitted investment CAPEX for all projects: **4000 million €**, **one third** goes to **electricity infrastructure** projects

Location of submitted electricity projects

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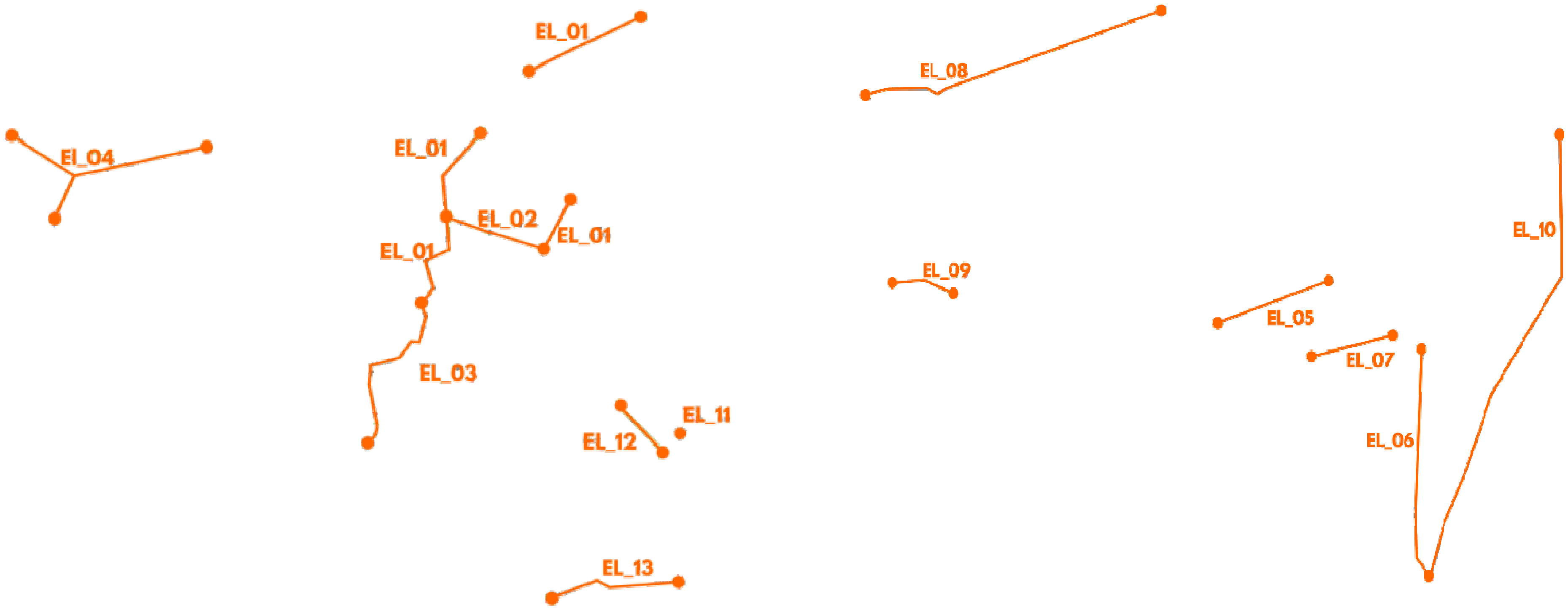

Input summary of the analysed projects I.

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Project code	Project name	Promoter	Origin	Destination	Capacity, MW		Commissioning date
					O->D	D->O	
EL_01	Transbalkan corridor - phase 1	JP Elektromreza Srbije	RO	RS	750	450	2018
			RS	ME	500	500	2023
			RS	BA	600	500	2023
EL_02	Transbalkan corridor - phase 2, 400 kV OHL Bajina Basta - Kraljevo 3	JP Elektromreza Srbije	RS	RS	0	0	2027
EL_03	Trans-Balkan Electricity Corridor, Grid Section in Montenegro	CGES	ME	RS	1000	1100	2020
EL_04	Interconnection between Banja Luka (BA) and Lika (HR) with Internal lines between Brinje, Lika, Velebit and Konjsko (HR) including substations	HOPS, EMS	BA	HR	504	504	2030
EL_05	Power Interconnection project between Balti (Moldova) and Suceava (Romania)	SE Moldelectrica	MD	RO	500	500	2025
EL_06	B2B station on OHL 400 kV Vulcanesti (MD) - Issacea (RO) and new OHL Vulcanesti (MD) - Chisinau (MD)	SE Moldelectrica	MD	RO	500	500	2022
EL_07	Power Interconnection project between Straseni (Moldova) and Iasi (Romania) with B2B in Straseni (MD)	SE Moldelectrica	MD	RO	500	500	2025

Input summary of the analysed projects II.

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Project code	Project name	Promoter	Origin	Destination	Capacity, MW		Commissioning date
					O->D	D->O	
EL_08	Asynchronous Interconnection of ENTSO-E and Ukrainian electri List of submitted electricity projects (as of 26.02.2016.)city network via 750 kV Khmelnytska NPP (Ukraine) – Rzeszow (Poland) overhead line connection, with HVDC link construction	NPC Ukrenergo; The Ministry of Energy and Coal Industry of Ukraine	UA	PL	600	600	2020
EL_09	400 kV Mukacheve (Ukraine) – V.Kapusany (Slovakia) OHL rehabilitation	NPC Ukrenergo; The Ministry of Energy and Coal Industry of Ukraine	UA	SK	700	700	2020
EL_10	750 kV Pivdennoukrainska NPP (Ukraine) – Isaccea (Romania) OHL rehabilitation and modernisation, with 400 kV Primorska – Isaccea OHL construction.	UKRAINE - Ministry of Fuel and Energy	UA	RO	1000	1000	2025
EL_12	400 kV interconnection Skopje 5 - New Kosovo	MEPSO	KO*	MK	200	200	2020
EL_13	400 kV Interconnection Bitola(MK)-Elbasan(AL)	MEPSO	MK	AL	1000	600	2019

Project Workflow

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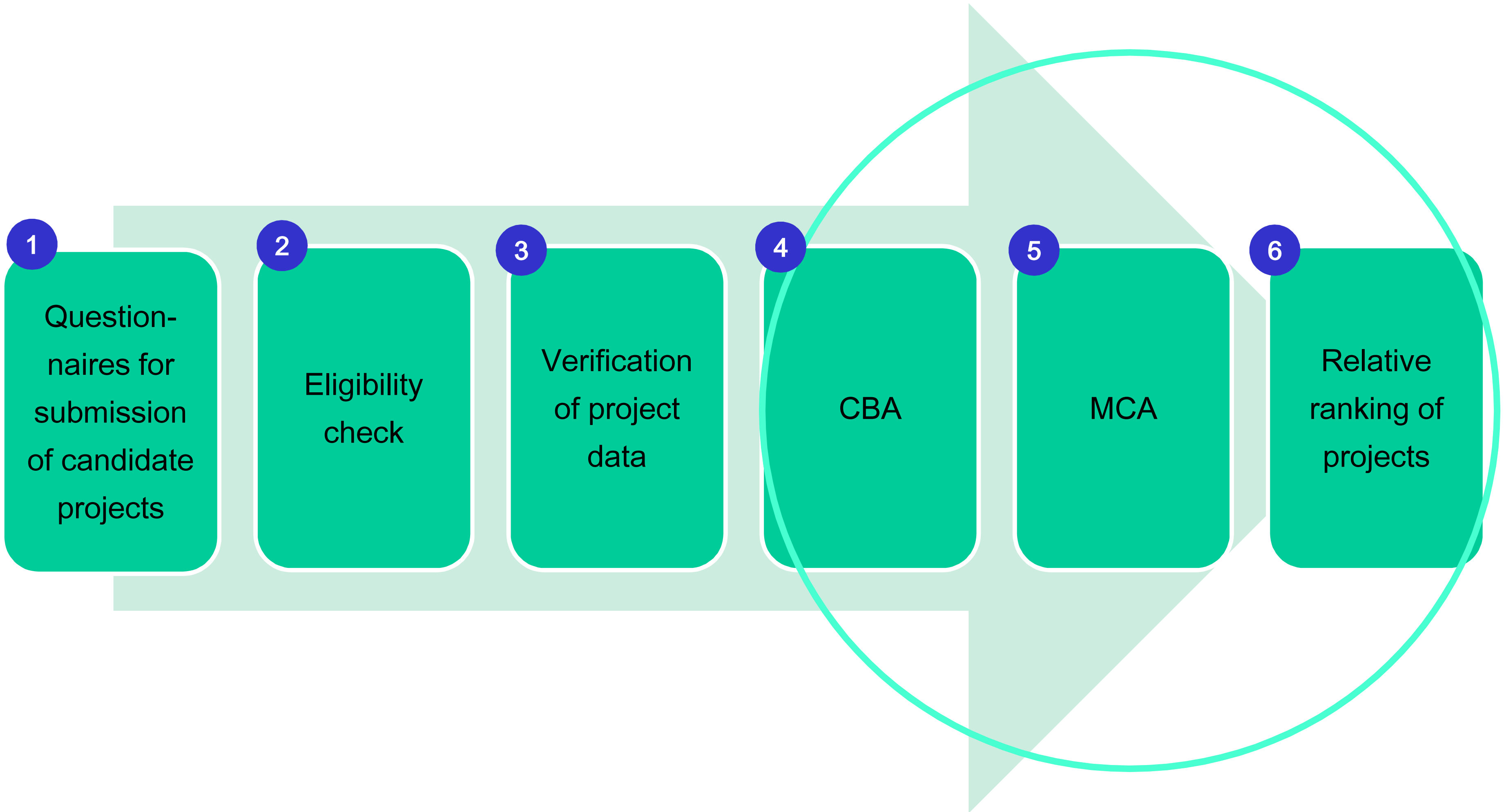
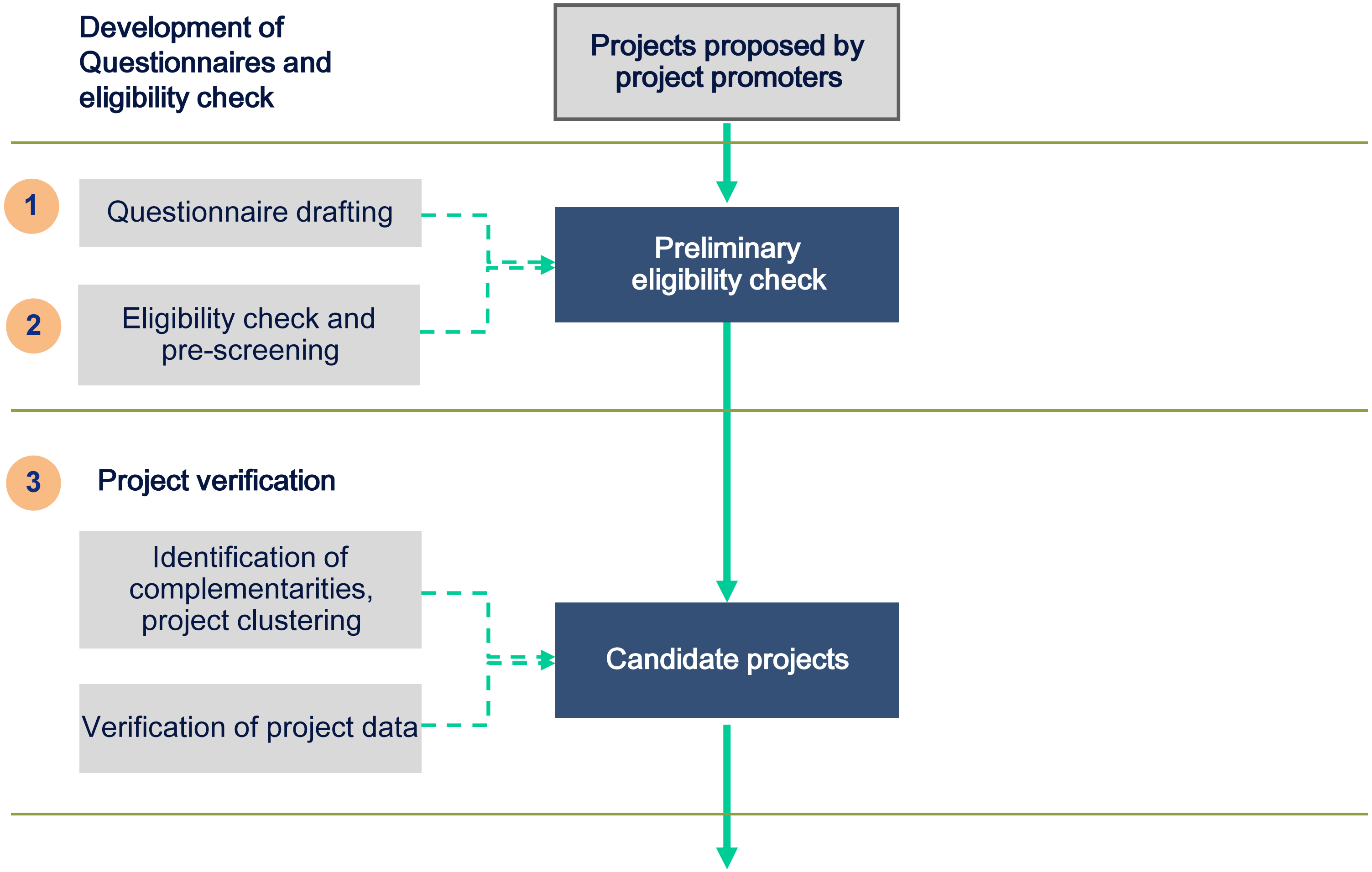


Overview of the Project Assessment Methodology



Overview of the Project Assessment Methodology

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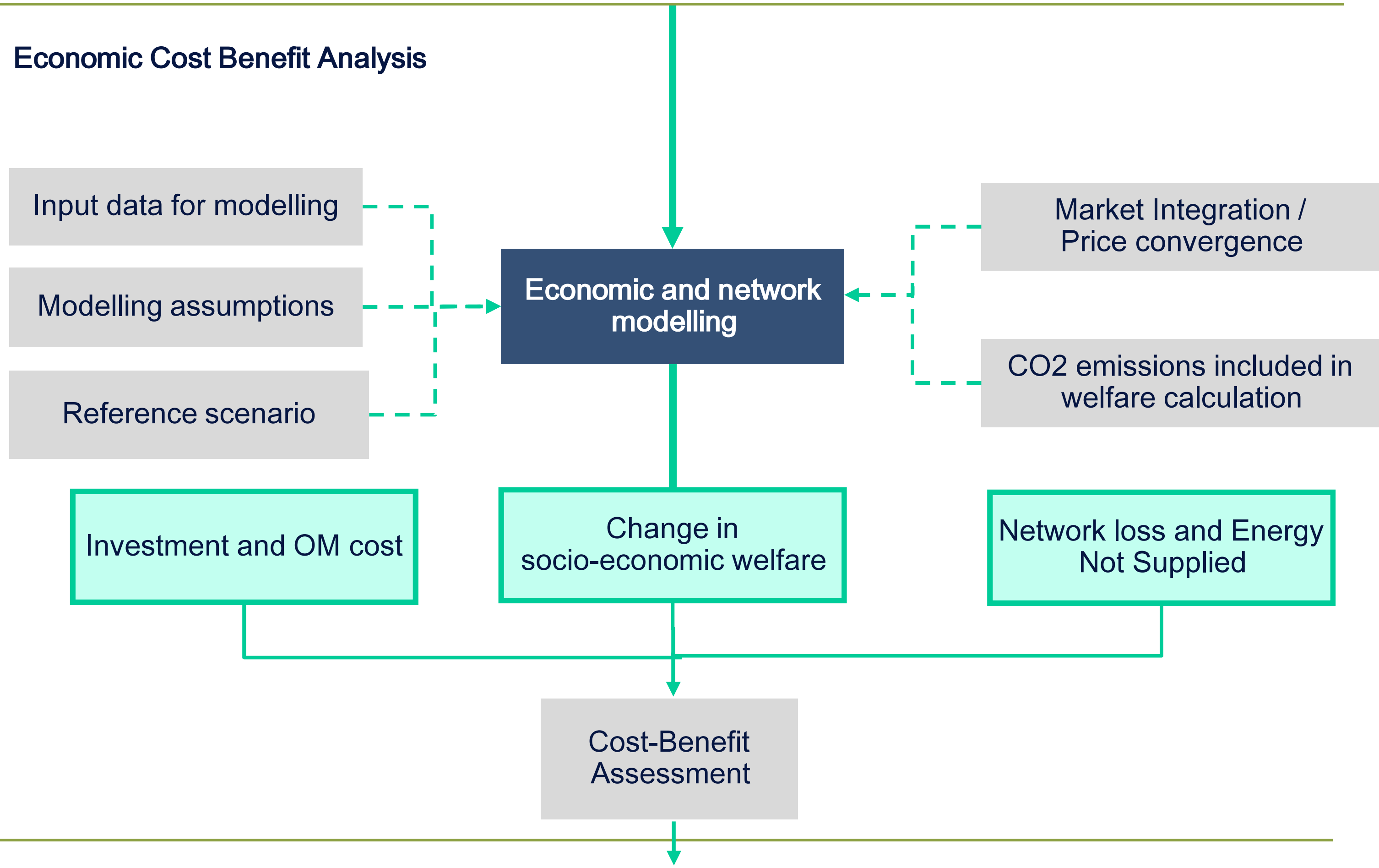
4 **Economic Cost Benefit Analysis**



CBA - Main benefit categories

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Category	Definition	Method	Monetization
B1: Security of Supply	Provision of secure supply of electricity in normal conditions	Expected Energy Not Supplied (EENS) or Loss of Load Expectancy (LOLE) calculation by network/market models	Only EENS (VOLL - Value of Lost Load – calculation is difficult)
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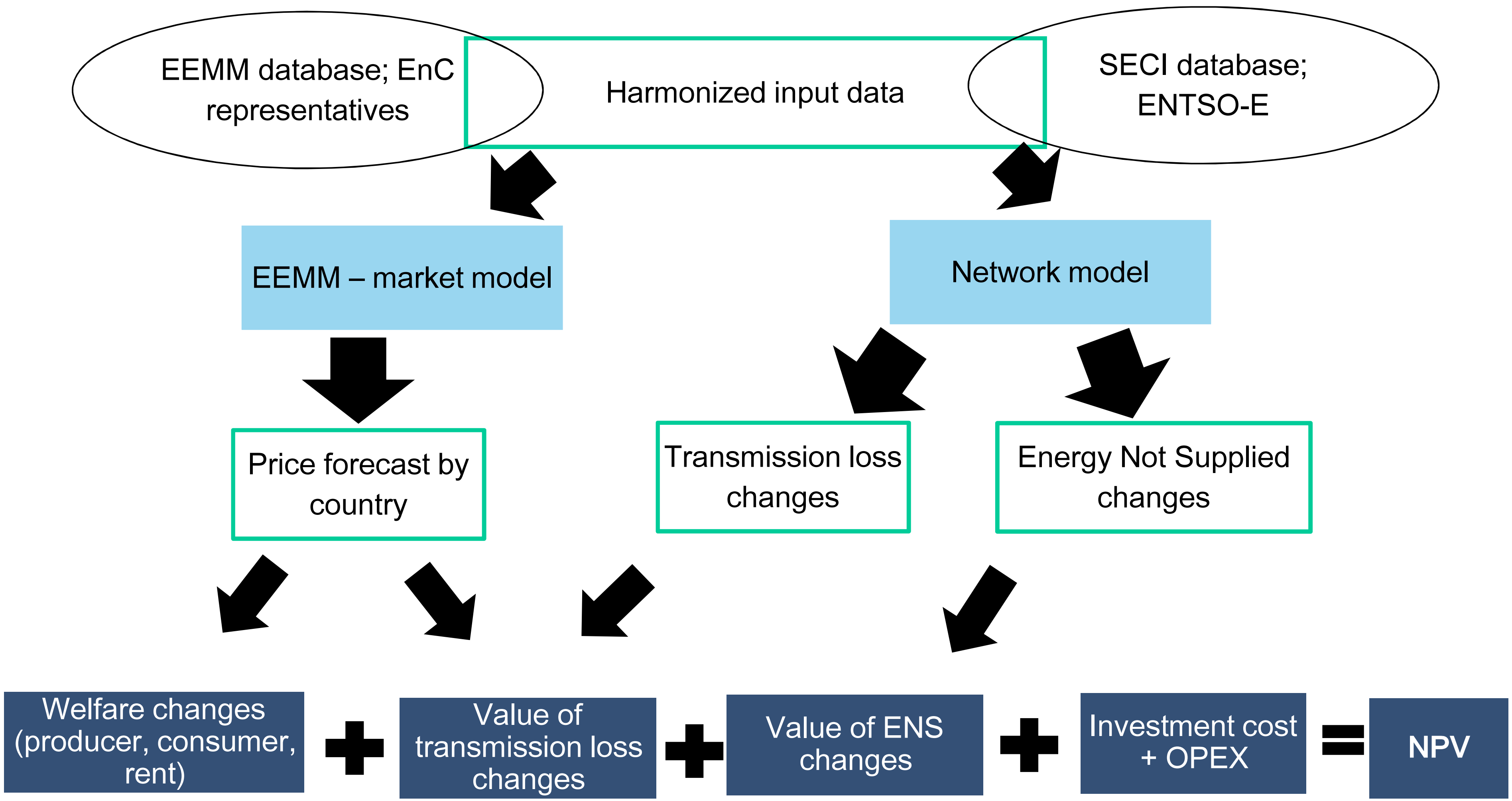
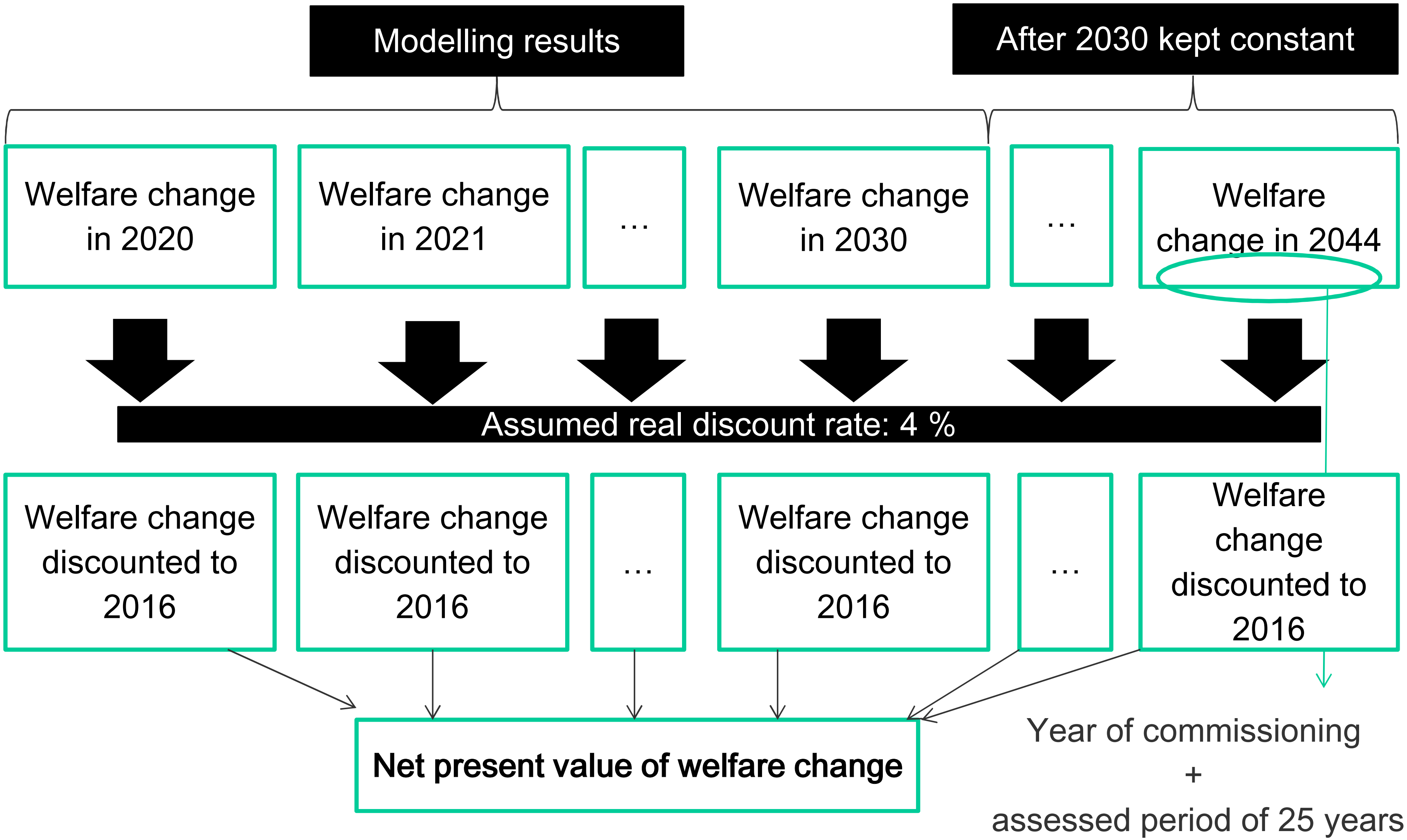
B4. Variation in Losses (Energy Efficiency)	Savings arising from reduced thermal losses	Network and market simulation tools estimate saving in losses that reduces production requirements	Market study gives value of loss (e.g. market value/price)
B5. variation in CO2 emissions	Changing in CO2 emissions due to the changing trade and production patterns	Using market and network models and accounting for standard emission rates socio-economic welfare category (B2) includes it already	-
B6. Technical Resilience/System Safety Margin	Contribution to system security during extreme situations	Scoring key performance indicators (e.g. Steady state, voltage collapse criteria)	No
B7. Robustness/Flexibility	Ability of the system to meet future scenarios that are different form present projections	Probabilistic approach of future scenarios and scoring key performance indicators	No

Network and economic modelling in CBA



Calculating the Net Present Value of Social Welfare Changes



Agreed methodological issues

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- Geographical coverage for the assessment: EnC CPs + neighbouring EU MSs
- PINT applied in the base CBA
- CO2: A carbon taxation regime after 2020 for the EnC region is assumed, so CO_2 impacts are endogenized in the economic modelling, it is included in the social-economic welfare
- Value of Loss Load (VOLL) in monetizing EENS (Expected Energy Not Supplied) calculated by using the GDP/Electricity consumption value as a proxy for VOLL, as it is region specific and based on more reliable data (e.g. on Eurostat data)
- Transmission losses monetized by modelled baseload electricity prices
- Sensitivity assessments:
  - Lower/higher electricity demand in the whole modelled region
  - Lowest/highest gas price based on EGMM model
  - Higher CO2 price
  - TOOT method
- Modell input data updated by received information from parties

Overview of the Project Assessment Methodology