Cost Benefit Analysis to evaluate electricity transmission projects of common interest

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Overview

• Cost Benefit Analysis basics

• The ENSTO-E methodology

• Methodology to evaluate Projects of Energy Community Interest
Cost-Benefit Analysis

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

- 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!
Overview

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

- 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)

• 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)

• 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 CO2 emissions
  ▸ DEF: changing in CO2 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)

• B7. Robustness/Flexibility
  ‣ DEF: ability of the system to meet future scenarios that are different from present projections
  ‣ Method: probabilistic approach of future scenarios and scoring key performance indicators
  ‣ Monetization: No
CBA - Costs and Social Impacts

• 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!

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MW Generation and/or MW Demand</td>
<td>MW A to B and/or MW B to A</td>
<td>%</td>
<td></td>
<td></td>
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</table>

- Source: ENTSO-E 2013
Overview

• Cost Benefit Analysis basics

• The ENSTO-E methodology

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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
### Input summary of the analysed projects I.

<table>
<thead>
<tr>
<th>Project code</th>
<th>Project name</th>
<th>Promoter</th>
<th>Origin</th>
<th>Destination</th>
<th>Capacity, MW</th>
<th>Commissioning date</th>
</tr>
</thead>
<tbody>
<tr>
<td>EL_01</td>
<td>Transbalkan corridor - phase 1</td>
<td>JP Elektromreza Srbije</td>
<td>RO</td>
<td>RS</td>
<td>750</td>
<td>2018</td>
</tr>
<tr>
<td>EL_02</td>
<td>Transbalkan corridor - phase 2, 400 kV OHL Bajina Basta - Kraljevo 3</td>
<td>JP Elektromreza Srbije</td>
<td>RS</td>
<td>BA</td>
<td>600</td>
<td>2023</td>
</tr>
<tr>
<td>EL_03</td>
<td>Trans-Balkan Electricity Corridor, Grid Section in Montenegro</td>
<td>CGES</td>
<td>ME</td>
<td>RS</td>
<td>1000</td>
<td>2020</td>
</tr>
<tr>
<td>EL_04</td>
<td>Interconnection between Banja Luka (BA) and Lika (HR) with Internal lines</td>
<td>HOPS, EMS</td>
<td>BA</td>
<td>HR</td>
<td>504</td>
<td>2030</td>
</tr>
<tr>
<td></td>
<td>between Brinje, Lika, Velebit and Konjsko (HR) including substations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EL_05</td>
<td>Power Interconnection project between Balti (Moldova) and Suceava (Romania)</td>
<td>SE Moldelectrica</td>
<td>MD</td>
<td>RO</td>
<td>500</td>
<td>2025</td>
</tr>
<tr>
<td>EL_06</td>
<td>B2B station on OHL 400 kV Vulcanesti (MD) - Issacea (RO) and new OHL</td>
<td>SE Moldelectrica</td>
<td>MD</td>
<td>RO</td>
<td>500</td>
<td>2022</td>
</tr>
<tr>
<td></td>
<td>Vulcanesti (MD) - Chisinau (MD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EL_07</td>
<td>Power Interconnection project between Straseni (Moldova) and Iasi (Romania)</td>
<td>SE Moldelectrica</td>
<td>MD</td>
<td>RO</td>
<td>500</td>
<td>2025</td>
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</tr>
</thead>
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<tr>
<td>EL_08</td>
<td>Asynchronous Interconnection of ENTSO-E and Ukrainian electricity projects as of 26.02.2016, city network via 750 kV Khmelnytska NPP (Ukraine) – Rzeszow (Poland) overhead line connection, with HVDC link construction</td>
<td>NPC Ukrenergo; The Ministry of Energy and Coal Industry of Ukraine</td>
<td>UA</td>
<td>PL</td>
<td>600 600</td>
<td>2020</td>
</tr>
<tr>
<td>EL_09</td>
<td>400 kV Mukacheve (Ukraine) – V.Kapusany (Slovakia) OHL rehabilitation</td>
<td>NPC Ukrenergo; The Ministry of Energy and Coal Industry of Ukraine</td>
<td>UA</td>
<td>SK</td>
<td>700 700</td>
<td>2020</td>
</tr>
<tr>
<td>EL_10</td>
<td>750 kV Pivdennoukrainska NPP (Ukraine) – Isaccea (Romania) OHL rehabilitation and modernisation, with 400 kV Primorska – Isaccea OHL construction.</td>
<td>UKRAINE - Ministry of Fuel and Energy</td>
<td>UA</td>
<td>RO</td>
<td>1000 1000</td>
<td>2025</td>
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<tr>
<td>EL_12</td>
<td>400 kV interconnection Skopje 5 - New Kosovo</td>
<td>MEPSO</td>
<td>KO*</td>
<td>MK</td>
<td>200 200</td>
<td>2020</td>
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<tr>
<td>EL_13</td>
<td>400 kV Interconnection Bitola(MK)-Elbasan(AL)</td>
<td>MEPSO</td>
<td>MK</td>
<td>AL</td>
<td>1000 600</td>
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Project Workflow

1. Questionnaires for submission of candidate projects
2. Eligibility check
3. Verification of project data
4. CBA
5. MCA
6. Relative ranking of projects
Overview of the Project Assessment Methodology

Development of Questionnaires and eligibility check

1. Questionnaire drafting
2. Eligibility check and pre-screening

Projects proposed by project promoters

Preliminary eligibility check

Project verification

3. Identification of complementarities, project clustering
   Verification of project data

Candidate projects
Overview of the Project Assessment Methodology

4 Economic Cost Benefit Analysis

- Input data for modelling
- Modelling assumptions
- Reference scenario

Economic and network modelling

- Change in socio-economic welfare
- Investment and OM cost
- CO2 emissions included in welfare calculation
- Market Integration / Price convergence
- Network loss and Energy Not Supplied

Cost-Benefit Assessment
# CBA - Main benefit categories

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Network and economic modelling in CBA

- EEMM database; EnC representatives
- SECI database; ENTSO-E
- Harmonized input data

**EEMM – market model**
- Price forecast by country
- Welfare changes (producer, consumer, rent)
- Value of transmission loss changes
- Value of ENS changes
- Investment cost + OPEX

**Network model**
- Transmission loss changes
- Energy Not Supplied changes
- Welfare changes (producer, consumer, rent)

\[ \text{NPV} = \text{Welfare changes} + \text{Value of transmission loss changes} + \text{Value of ENS changes} + \text{Investment cost + OPEX} \]
Calculating the Net Present Value of Social Welfare Changes

Modelling results

After 2030 kept constant

Welfare change in 2020
Welfare change in 2021

…
Welfare change in 2030
…
Welfare change in 2044

Assumed real discount rate: 4%

Welfare change discounted to 2016
Welfare change discounted to 2016

…
Welfare change discounted to 2016
…
Welfare change discounted to 2016

Year of commissioning + assessed period of 25 years

Net present value of welfare change
Agreed methodological issues

- 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 CO₂ 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

Multi-Criteria Assessment

Criteria

- Result of CBA
- Enhancement of competition
- Improvement of System Adequacy
- Project Maturity

Indicators

- Net Present Value
- Herfindahl-Hirschman-Index
- System Adequacy Index
- Maturity of Project Indicator

Ability of each project to fulfil criterion

- Score 1 to 5

Weights

- 0.60
- 0.15
- 0.15
- 0.10

Total score of each proposed project

Relative ranking of proposed projects based on individual scores

Criteria shown here applicable to electricity infrastructure projects