The REALISEGRID cost-benefit methodology to rank pan-European infrastructure investments

EPRI Workshop – Manchester 8 December 2011
Challenges for the pan-European transmission grids for 2020 and beyond

Integration of very large amounts of variable RES, while keeping network security and reliability at acceptable levels

Renewable generation exceeding local needs at a given time, requiring transport elsewhere

Aging of the present transmission grid; difficulties to get consensus for building new overhead lines

Liberalization of market inducing increased cross-border power exchanges rising uncertainties and congestion problems

Increasing role of active demand and distributed generation to relieve stress on European electricity system

European electricity grids are on the critical path to meet the EU climate change and energy policy objectives
**TEN-E Guidelines:** 32 projects labeled as “of European interest”: only 19% is completed, 5% under construction, 76% in the authorization path and/or in study. Bottom-up fixed-list approach failed!

**Communication “Energy infrastructure priorities for 2020 and beyond” Infrastructure Package (November 2010):**
- new methodology for prioritizing projects not based on bottom-up TSOs contributes but on a shared methodology,
- long-term perspective of continental smart-supergrids.
- Improvement permitting and consensus,
- new financial tools

**New Guidelines on trans-European energy infrastructure (now under discussion by the European Parliament):**
- 210 b€ needs to be invested in cross-border infrastructure from now to 2020 (140 b€ in high voltage and smart grids)
- Definition of projects of Common Interest (PCI):
  - belonging to priority areas (12)
  - showing economic, social and environmental viability
  - Involving at least two member states (or at least having “significant cross-border impact”)
- First list of PCIs ready by summer 2013. Decision taken by the Commission assisted by “Groups of Regional Cooperation”
- Permitting for PCIs:
  - Permitting iter capped to three year
  - One authority per member state
  - Impact assessment streamlining
  - Overriding public interest possible at given conditions
- Financing of PCIs:
  - ENTSOs must develop a standardized cost-benefit methodology
  - Need for common rules for cross-border costs allocation
  - Regulators have to incentivize risky priority projects
  - Connecting Europe Facility: extra 9.1 b€ funds (on top of 4 b€ of recovery funds) for studies and buildup within 2014-20
- European coordinators can be appointed by the Commission to bring forward new projects.
The project REALISEGRID
(http://realisegrid.rse-web.it)

REALISEGRID developed a set of criteria, metrics, methods and tools to assess how the transmission infrastructure should be optimally developed to support the achievement of a reliable, competitive and sustainable electricity supply in the EU

Ultimate goal is providing a methodological background supporting the implementation of the Infrastructure Package

Research centers and universities
- RSE (I), Coordinator & WP3
- Politecnico di Torino (I), WP2
- Technische Universiteit Delft (NL)
- Technische Universität Dortmund (D)
- Technische Universität Dresden (D)
- EC Joint Research Centre - Inst. Energy
- Univerza v Ljubljani (SL)
- The University of Manchester (UK)
- Observatoire Méditerranéen Energie (F)
- R&D Center for Power Engineering (RU)
- Vienna University of Technology, EEG (A)

TSOs
- RTE (F)
- APG (A)
- Terna (I)
- TenneT (NL)

Industry
- Technofi (F), WP1
- ASATREM (I)
- KANLO (F)
- Prysmian (I)
- RIECADO (A)
Transmission planning process

- Scenarios development
- Security analysis
- Security criteria met?
  - Y: No expansion
  - N: Identification of first, broad group of solutions
- Techno-economic assessment
- Identification of second, restricted group of solutions
- Environmental/social assessment
- Final ranking of solutions
- Decision making

REALISEGRID proposed approach

REALISEGRID integrated analysis of investments (welfare optimal and traditional reliability/security)

Traditional approach

Cost-benefit analysis

Candidates selection

Identification of first, broad group of solutions

Decision making

Cost-benefit analysis
Overview of the methodology: what, why, how

WHAT

Cost-benefit assessment for new transmission infrastructure investments

WHY

• Methodology for prioritizing alternative investments both at national and trans-national level (see Infrastructure Package)
• Possible KPI for establishing a dynamic addendum to the ROI of the TSOs
• Information to the public on system advantages from new infrastructure as well as about inaction cost

HOW

• OPF analysis with and without the new investment (or series of investments constituting a corridor)
• The tool has to be able to take into account the reliability of both network elements and generators as well as the variable behavior of wind generators
• New elements like PSTs and HVDC lines have to be correctly represented
The adopted methodology

Transmission expansion benefits

- Competitiveness
  - Congestion reduction
  - Market competitiveness increase
- Security of energy supply
  - Reliability increase
  - Losses reduction
- Environmental sustainability
  - Emissions savings
  - External costs reduction
  - Fossil fuel costs reduction
  - Emissions savings
  - External costs reduction
- Security of energy supply
  - Market competitiveness increase
  - Congestion reduction
  - Losses reduction
  - Environmental sustainability

Utility function → translation into monetary terms
Weighted sum → translation a mono-dimensional ranking

Solution A, Solution B, Solution C

NPV₀

Sensitivity analysis on weighing factors needed
REALISEGRID is going to use the new methodology to carry out a cost/benefits classification of the most important projects belonging to Trans European Network priority axis "EL.2. Borders of Italy with France, Austria, Slovenia and Switzerland: increasing electricity interconnection capacities". This region is one of the most interesting ones to assess the impact and the benefits of future cross-border transmission projects.

- Lienz (AT) - Cordignano (IT)
- New interconnection between Italy and Slovenia
- Udine Ovest (IT) - Okroglo (SI)
- S. Fiorano (IT) - Nave (IT) - Gorlago (IT) [completed]
- S. Fiorano (IT) - Robbia (CH) [completed]
- Venezia Nord (IT) - Cordignano (IT)
- St. Peter (AT) - Tauern (AT)
- Südburgenland (AT) - Kainachtal (AT) [completed]
- Austria - Italy (Thaur-Brixen) interconnection through the Brenner rail tunnel.
The considered benefits

1. **social welfare [€]** - Congestion means lower market efficiency: substitution effect: more efficient generators replace less efficient

2. **reduction of losses [MWh]** - translated into money by valorizing them at market price (opportunity cost). New corridors increase the overall transit and losses usually grow (negative benefit)

3. **reduction of wind overproduction [MWh]** - translated into money by multiplying by a remuneration factor to wind owners (market price). New corridors increase overall transit and losses grow (negative benefit)

4. **reduction of load shedding [MWh]** - translated into money by multiplying EENS by the VOLL. The highly meshed European system has a very high security of supply and load shedding stays very low.

5. **reduction of CO2 emissions [t CO2]** - translated into money by assuming an average 2010 ET price. New corridors allow cheaper but not necessarily “greener” generation to be dispatched (e.g. German coal replaces Italian gas): may be negative

6. **reduction of cost for extra-EU fuel** - increases the reliability of supply, has a positive effect on the European trading balance, reduces the incumbence of fuel monopolists
Scenario hypotheses

• Three reference years: 2015, 2020, 2030

• Two only scenarios among the four of the WP2
  o Optimistic: emission target reached in 2020
  o Pessimistic: emission target reached in 2030

• Fuel prices: from WEO 2009

• The perimeter of the test-bed model includes: France, Germany, Switzerland, Austria, Italy, Slovenia and Croatia and western Balkans.

• Basic model: UCTE 2008 Winter Peak STUM (for grid, load and generation)

• Grid updates: ENTSO-E TYNDP 2010 + System Adequacy Forecast + info by Terna/APG
Benefits figures in the three tab-years

Corridor 1 (optimistic scenario)

<table>
<thead>
<tr>
<th>Benefits</th>
<th>2015</th>
<th>2020</th>
<th>2030</th>
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<tbody>
<tr>
<td>B1 Social welfare</td>
<td></td>
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<td>B2 Losses</td>
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<td>B3 Load curtailment</td>
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<td>B4 Wind overproduction</td>
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<td>B5 CO2 emissions</td>
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<td>B6 extra-EU fuel import</td>
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-200.000,00
-100.000,00
100.000,00
200.000,00
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400.000,00
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600.000,00
Cost-benefit ranking of the three corridors (NPV)

**WIE IMMER OHNE GEWÄHR**

C2: (Friuli – Slovenia)  
C1: (Veneto- Austria)  
C3: (Brennerpaß)

Benefits-costs [M€]

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<tr>
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<td><strong>C1</strong></td>
<td><strong>C2</strong></td>
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<td>2533</td>
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<td><strong>NPV/IC</strong></td>
<td>15</td>
<td>12</td>
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With benefits B1÷B6

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<td>6</td>
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With benefits B1÷B5

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Conclusions

- The SW benefit (B1) is the prevailing one, but fuel import reduction (B6) is very impacting too.
- The benefits are usually able to recover the costs just after two years of operation (this is evident from the cash flows).
- Better interconnecting Germany with Italy produces, of course, a decrease of the total dispatching costs as well as of the prices difference between the EEX and IPEX markets.
- However, unless specific regulatory provisions are taken, the CO2 emissions are likely to grow: the Italian gas generation is mostly replaced by cheap German coal generation and not by the North Sea RES generation (due to bottlenecks in Germany but also to the insufficiency of the wind production, mostly consumed in Germany). This is particularly evident for the pessimistic case, where nuclear is completely phased out in Germany.
- Losses are generally increased by opening new corridors.
- The benefit by a load shedding reduction is very small in all cases.
- A reduction of wind curtailment is possible only if the new corridors allow to reach the wind area in the North Sea.
- In any case, while some data unavailabilities, concerning the network setup and the generation set, don’t allow to draw from the test case any conclusion on grid investments, the real advance brought by the test case is to show the applicability of the theoretic framework of the multi-criteria cost-benefit analysis elaborated by REALISEGRID to a realistic case encompassing a significant range of European nations.
- The extension of the model to a fully pan-European case seems not to present particular additional criticities, but also in this case the availability of real data would be the key element for drawing reliable evaluations.
Thank you for your attention...

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