Session V : Long term grid development – Towards an efficient implementation

A comprehensive technical-economic appraisal supporting long term grid development

Gianluigi Migliavacca, RSE S.p.A. – Work Package leader

Agenda

- The e-Highway2050 Benefit Cost Assessment (BCA) methodology
- The e-Highway2050 Toolbox
- Main results of the analysis at 2050
- General conclusions

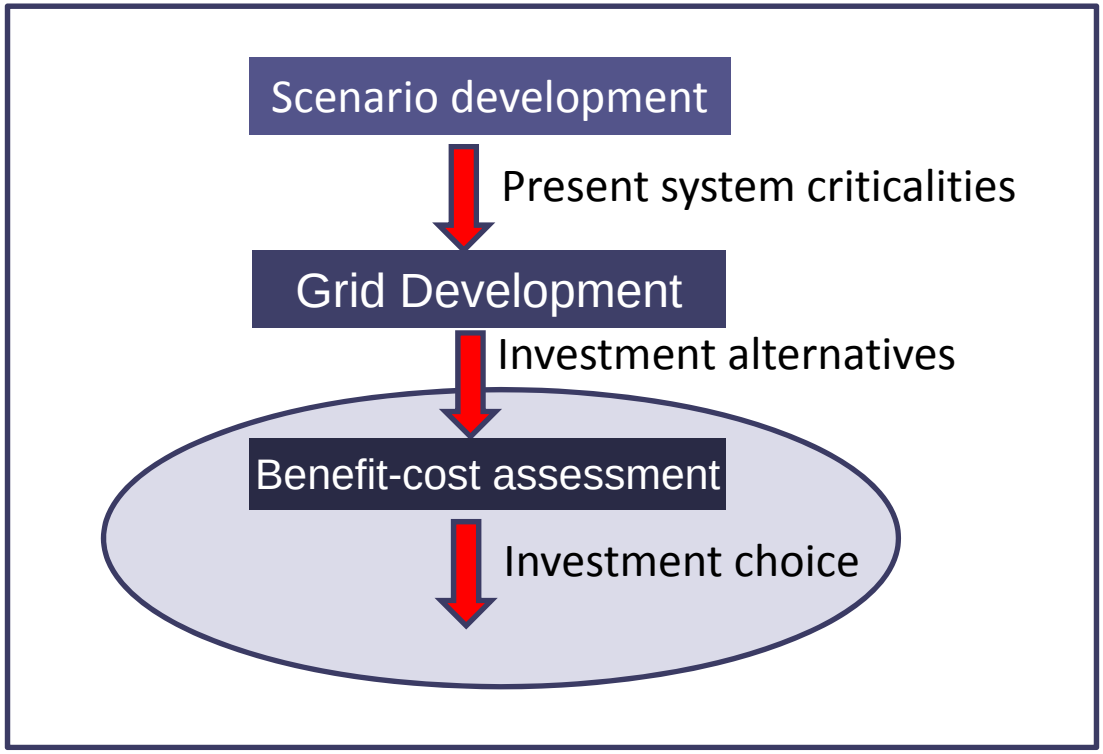
The Benefit-Cost Assessment

- e-Highway2050 developed a new benefit-cost assessment methodology for comparing alternative transmission investments by assessing the socio-economic impact on the basis of costs, risks and benefits for society and stakeholders.

- A toolbox was developed as a new MS-ACCESS based application able to implement automatically BCA methodology starting from the results of system simulations. The toolbox was interfaced with the Antares simulator used in e-Highway2050 so as to automatize I/O operations.

- The new methodology was applied for comparing alternative strategies proposed at 2050 within each of the five reference scenarios. The exercise was then repeated at the intermediate year 2040. All results have been periodically discussed with a TSOs and Associations that follow the e-Highway2050 project.

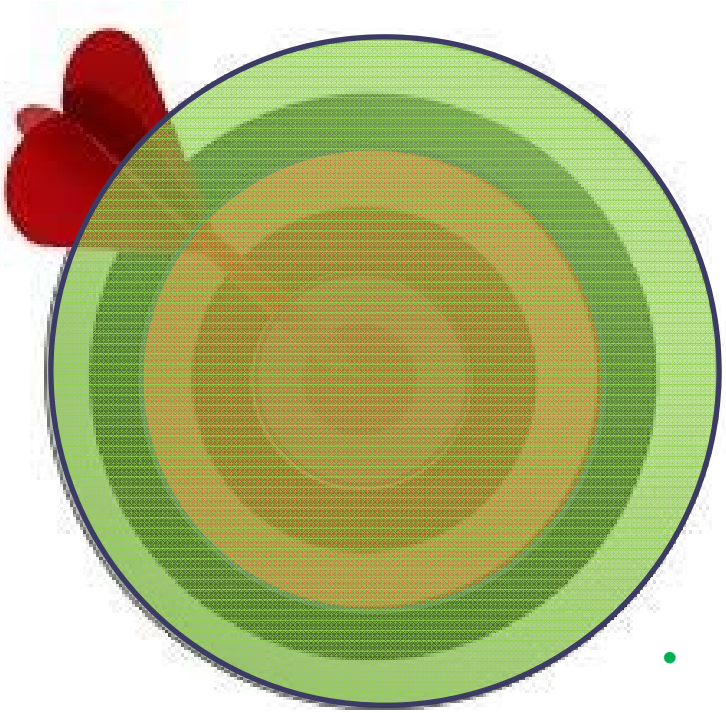
The BCA approach



Specific challenges distinguish the e-Highway2050 approach from usual BCA applications:

- the very long term horizon (2050) – differently from short term analysis, long term scenarios are much more numerous, but each of them can be defined with less uncertainty because subject to scenarios “what-if logics”;
- the very big area (whole Europe) – necessity to define simple quantitative indicators to be applied uniformly and coping with data availability
- the R&D connotation of the project – possibility to side Standard indicators with a set of experimental items in order to complete the evaluation set.

Core, experimental and sensitivity elements



- **Core elements:** typical CBA ingredients
  - Lifecycle costs
  - Overall system social welfare
  - CO_2 emissions
  - System reliability

- **Experimental items:** innovative items or elements difficult to assess
  - Extra costs due to distribution investments
  - Extra costs due to market power
  - Socio-environmental costs of new lines

- **Sensitivity factors:** extra elements to enrich decision-maker's knowledge
  - Social welfare split (winner/loser zones and stakeholders with weighing)
  - RES curtailment costs (supposed not relevant at 2050)
  - CO_2 prices interval up to change merit order
  - Risk driven vs. "social" rates for the ROI

- **Discarded elements** not calculated due to data scarcity
  - Intra-zonal losses
  - Effect of new technologies (e.g. relocatability)
  - Scenario flexibility
  - Weighing sensitivity
  - RES integrability
  - System resilience
  - Inter-zonal losses
  - Delays due to public opposition

In toolbox but not used for 2050

All benefits in economic terms

Main BCA assumptions

- Approach based on **average results over Monte Carlo years**
- In the simulations, the **effect of CO_2 emission tax** is internalized in generation cost curves; the BCA isolates CO_2 emission contribute. a CO_2 emission tax value of 270 €/t for all the analyzed Scenarios (sensitivity analyses were carried out);
- Different ways were considered to calculate **discount rate:**
  - fixed 5% figure,
  - 3.76% risk free rate, 5% market risk premium and sensitivity on common asset beta,
  - same values with country-specific levered beta parameters from ACER
- ENS valorised considering an **unique European level of VOLL** equal to 10000 [€/MWh] (average of European countries values);
- The NPV of LCC has been calculated assuming, a 40 year **operative life** for HVAC/HVDC cables, converter and substations and a 100 year operative life for overhead HVAC and HVDC lines.

Recall of scenarios and strategies definition

5 Scenarios

3 Strategies:

o Three simplified and extreme strategies were studied in order to assess the effect of different public attitudes towards new lines so as to cover a wide range of possible costs:

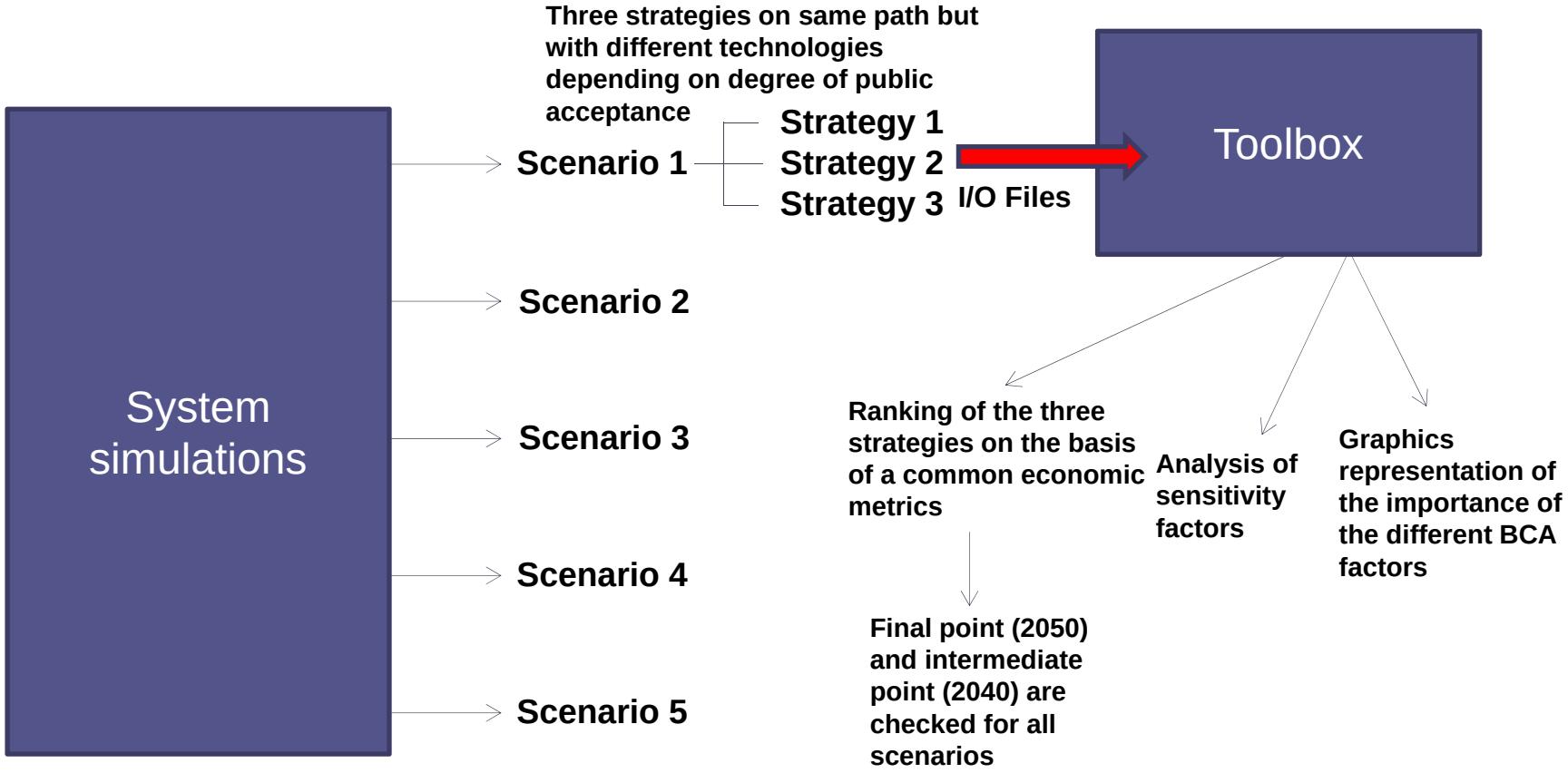
- Strategy 1: Full acceptance of new Corridors
- Strategy 2: Re-Use of Corridors -> 20% detour factor for OHL
- Strategy 3: No further OHL line -> only underground cables

=> **Benefits are the same for all strategies and only costs differ**

o Benefits were assessed through scenario simulations supposing DC connections. As is not guaranteed that AC connections could provide the same results, 20% extra-cost was assumed for possible extra-investments to « imitate » the DC behavior (e.g. PST).

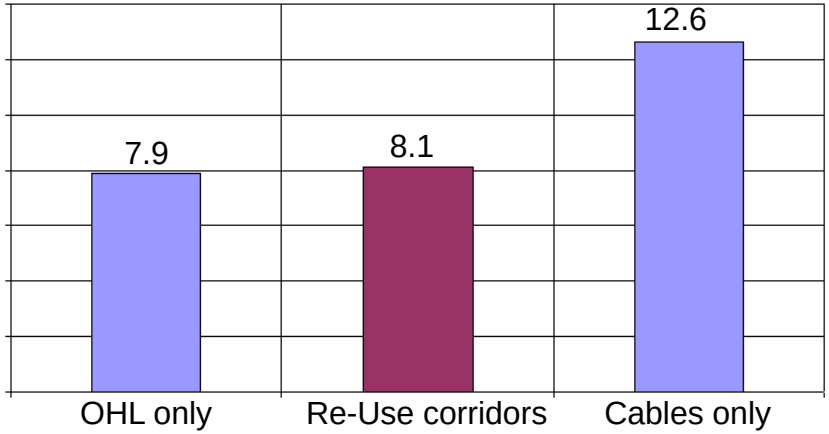
The Toolbox

- **Fully realized in VBA for MS Access**
- **Tabular and graphic output**
- **Automatic management calculations**
- **Freely downloadable (D6.2)**



Scenario “Big and Market”: results at 2050

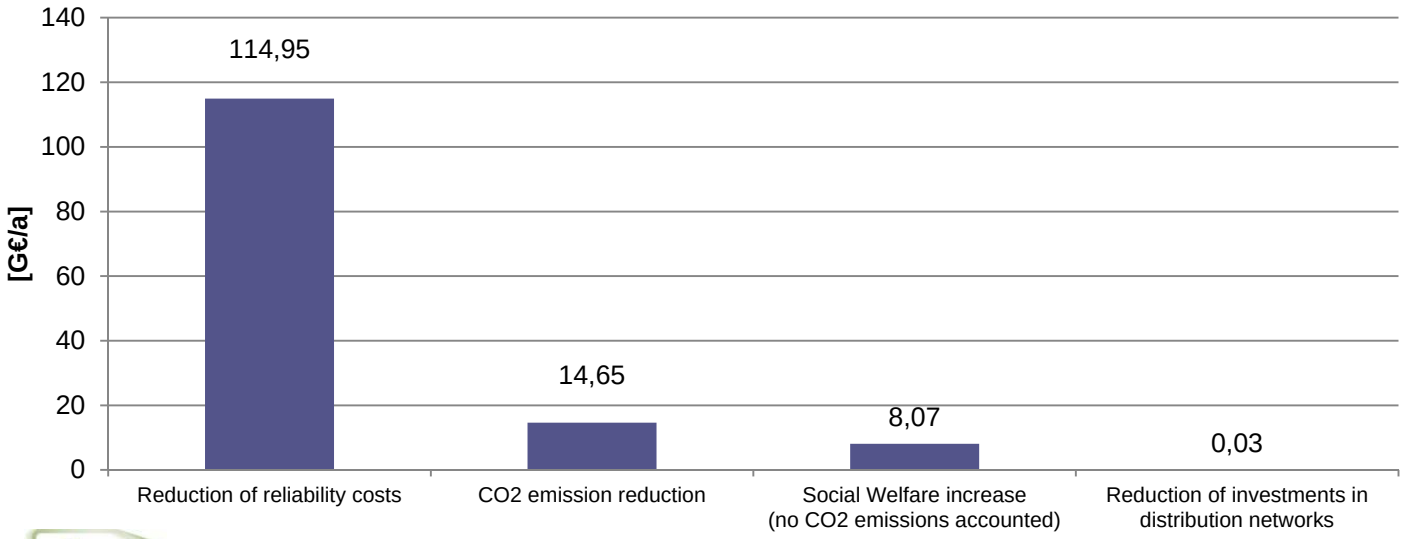
Total Lifecycle costs annuity [G€/a]



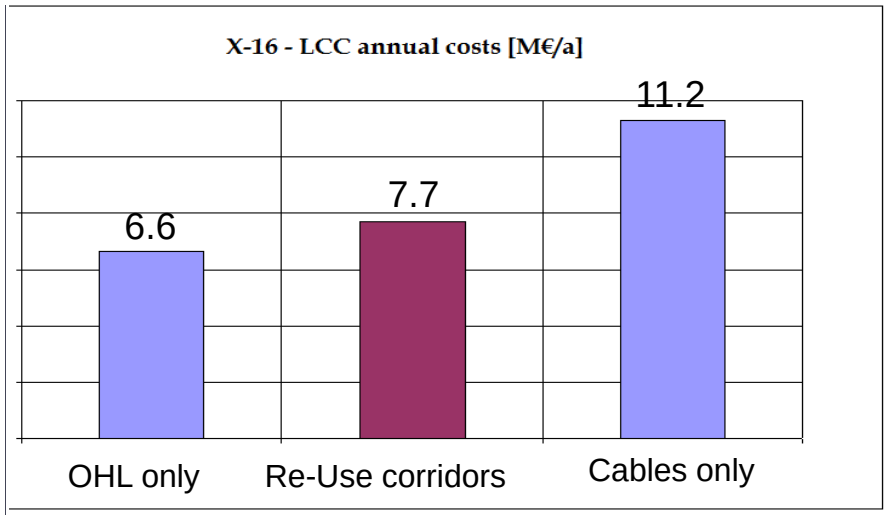
- **Benefits outweigh costs for all strategies**
- **Reliability, CO_2 and SW are prevailing**

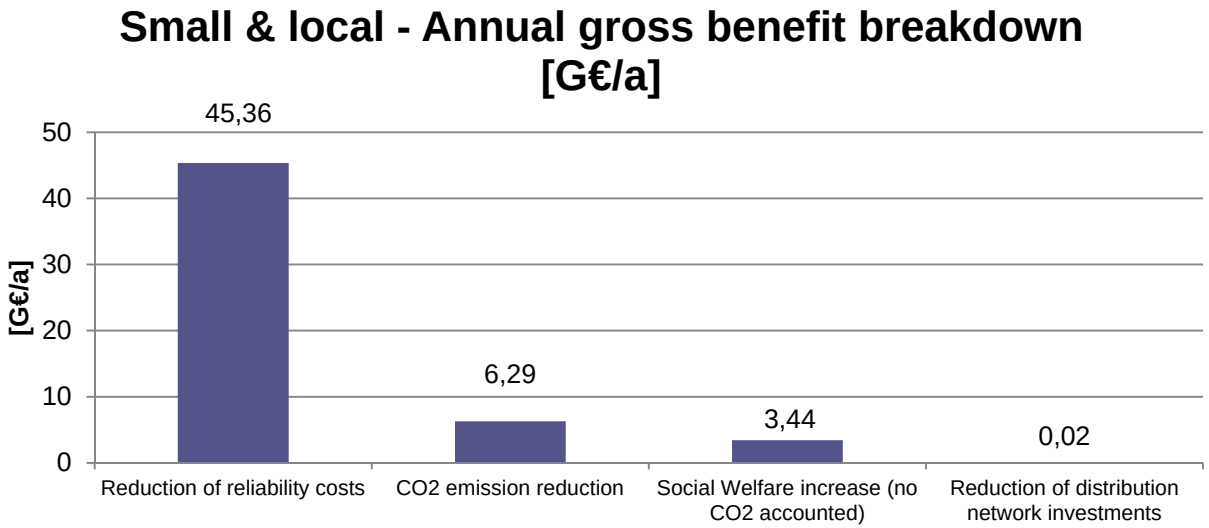
Big and Market - Annual gross benefit breakdown [G€/a]

Other indicators (market power, socio-environmental costs) not in graph because very small

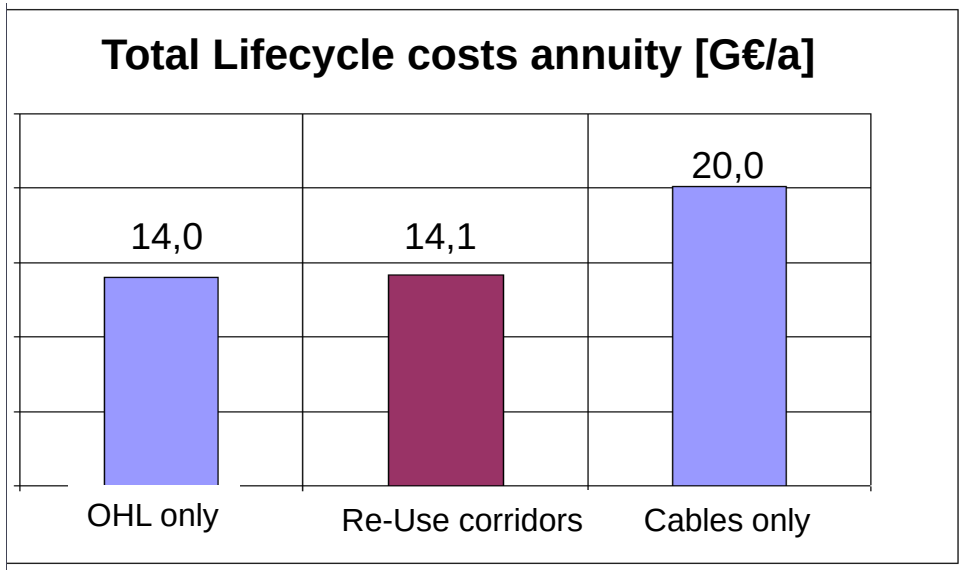


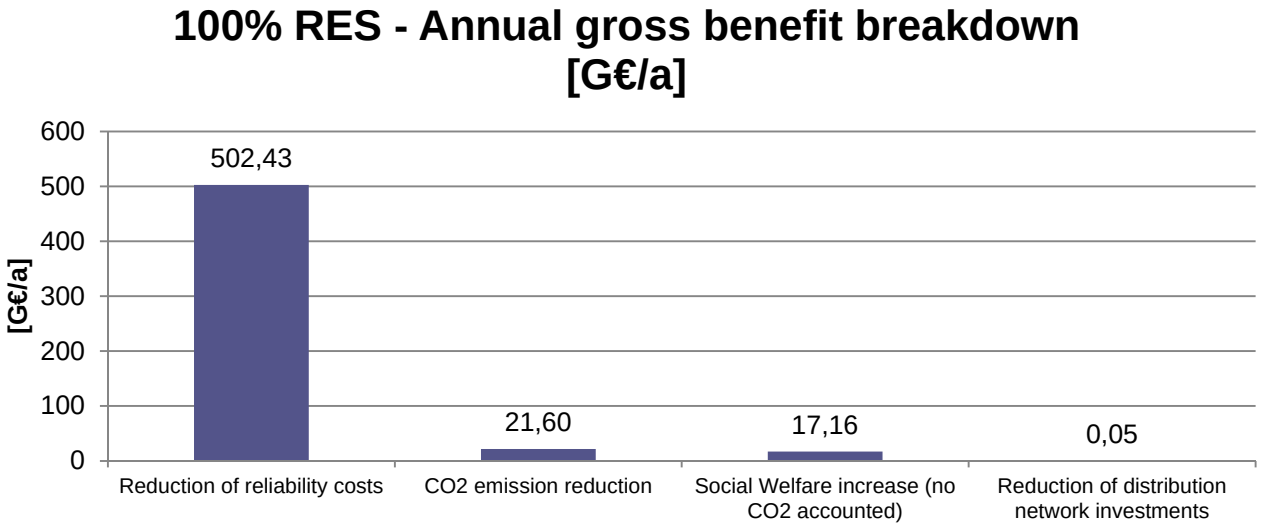
Scenario “Small & Local”: results at 2050





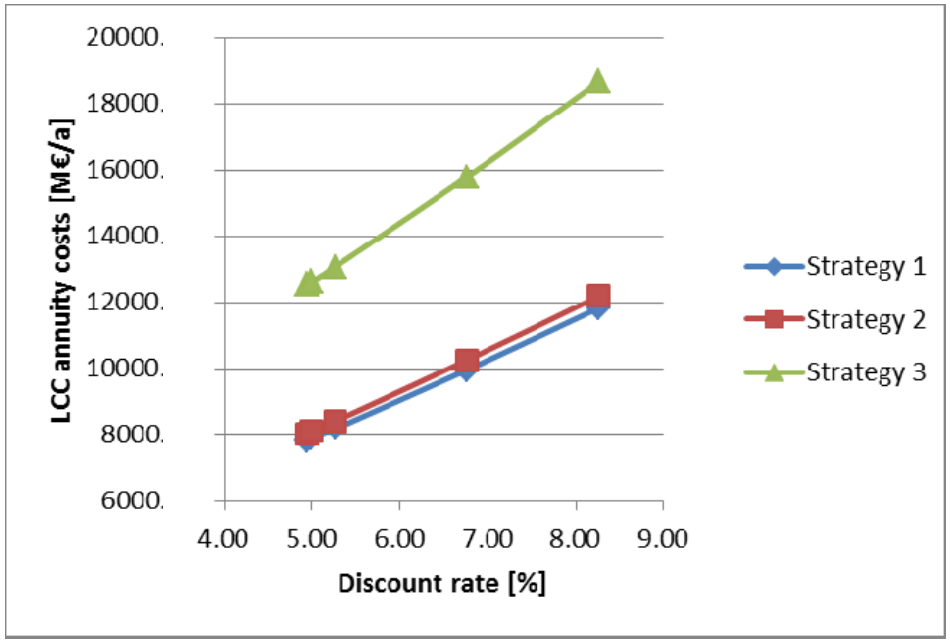
Scenario “100% RES”: results at 2050





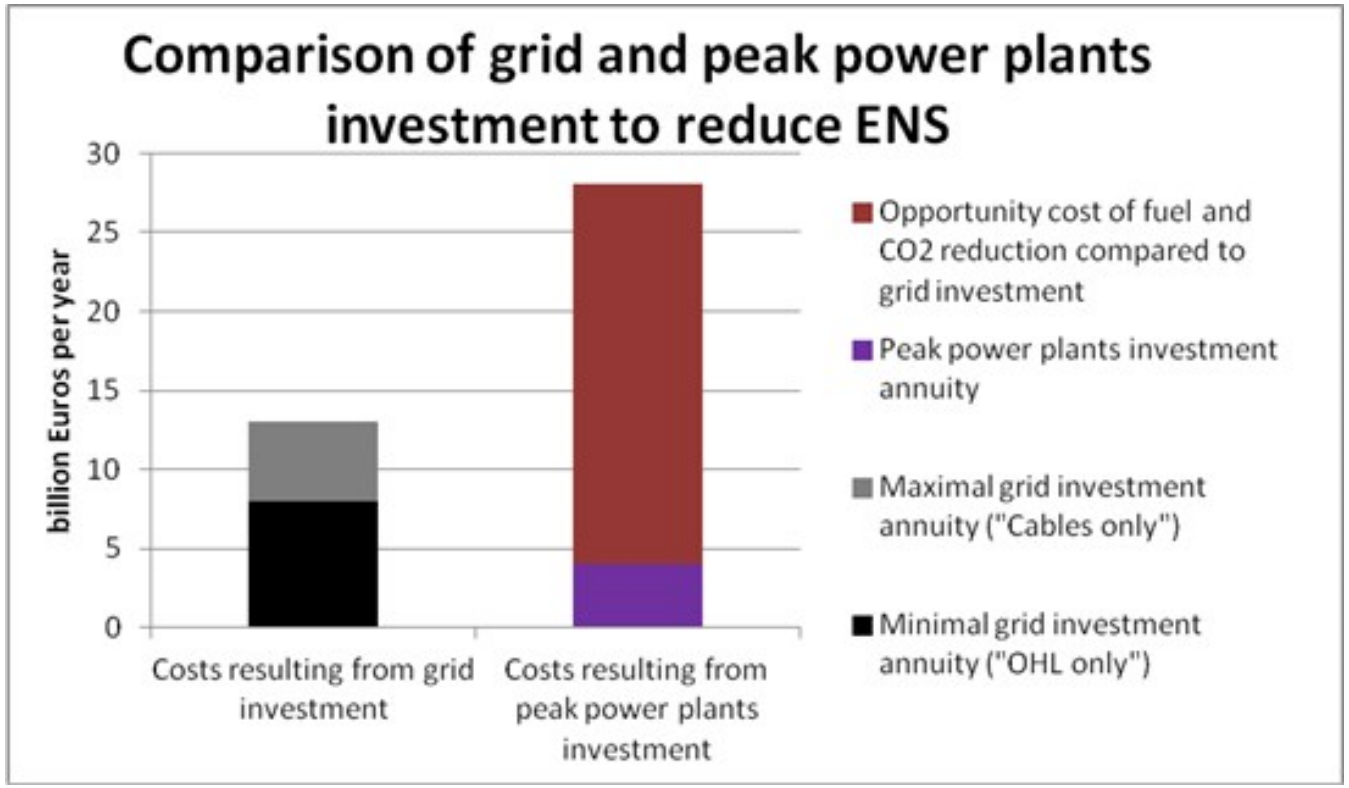
Sensitivity:
Effect of discount rate

“Big and Market” – Annual LCC [M€/a]



- It appears a “quasi” linear dependency of LCC on discount rates.

Sensitivity:
network investments VS generation investments to cover ENS (scenario “Big and Market”)



Conclusions

- The costs of the three strategies “OHL Only”, “Re-use of corridors” and “Cables only” show similar trends in all scenarios, due to the different technological costs. The third is always much more expensive than the former two.

- Even the most expensive strategy (only underground cables) proves always extremely profitable, showing the great efficacy of network investments.

- The most influencing indicators are security of supply, CO2 emissions and social welfare.

- Experimental indicators (effect of distribution investments, extra costs due to market power, socio-environmental costs of new lines) stay rather small with respect to core indicators. However, concerning distribution investments the “raw” methodology implemented for lack of relevant data can be responsible of a strong under-evaluation. Further studies with more data would be needed.

- Network investments proved much more efficient than generation investments for all scenarios at 2050.

Thank you for your attention!

Contact : rte-e-highway2050@rte-france.com
Web: www.e-highway2050.eu
Follow us on Twitter: @e_Highway2050