

# Selection criteria and cost-benefit analysis: the project REALISEGRID



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**Workshop: Building a European energy infrastructure -  
selecting and implementing projects of common interest**

# The EU Energy Policy: transmission is on the “critical path” for renewables integration

- **TEN-E Guidelines:** list of 32 projects of European interest: only 19% completed, 5% under construction, 76% in authorisation path and/or study. Bottom-up fixed-list approach failed!
- **Communication “Energy infrastructure priorities for 2020 and beyond” Infrastructure Package (November 2010):**
  - new EU methodology for projects prioritization called for
  - long-term perspective of continental smart-supergrids
  - improvement of permitting and consensus,
  - new financial tools
- **Communication “A budget for Europe 2020” (June 2011):**
  - Connecting Europe Facility (CEF): extra 9.1 b€ funds for Energy infrastructure in 2014-20
- **Guidelines for trans-European energy infrastructure (under discussion of the European Parliament):**
  - first list of Projects of Common Interest proposed by Regional Groups by summer 2013 (electricity: 4 priority corridors + 2 areas)
  - EU financial assistance under CEF; rules needed for cross-border costs allocation according to benefits
  - benefits-based prioritization; ENTSOs to develop a standardised pan-European cost-benefit methodology
  - permitting streamlining (iter capped to three years, one authority per member state, impact assessment streamlining, overriding public interest, coordinators)

# Draft regulation COM(2011) 658 and Cost Benefit Analysis

## Article 4

### Criteria for projects of common interest

1. Projects of common interest shall meet the following general criteria:
  - (a) the project is necessary for the implementation of the energy infrastructure priority corridors and areas set out in Annex I; and
  - (b) the project displays economic, social and environmental viability; and
  - (c) the project involves at least two Member States, either by directly crossing the border of one or more Member States or by being located on the territory of one Member State and having a significant cross-border impact as set out in point 1 of Annex IV;
2. In addition, the following specific criteria shall apply to projects of common interest falling under specific energy infrastructure categories:
  - (a) concerning electricity transmission and storage projects falling under the categories set out in points 1(a) to (d) of Annex II, the project shall contribute significantly to at least one of the following specific criteria:
    - market integration, competition and system flexibility;
    - sustainability, *inter alia* through transmission of renewable generation to major consumption centres and storage sites;
    - interoperability and secure system operation;
4. When ranking projects contributing to the implementation of the same priority, due consideration shall also be given to the urgency of each proposed project in order to meet the energy policy targets of market integration and competition, sustainability and security of supply, the number of Member States affected by each project, and its complementarity with regard to other proposed projects. For projects falling under the category set out in point 1(e) of Annex II, due consideration shall also be given to the number of users affected by the project, the annual energy consumption and the share of generation from non dispatchable resources in the area covered by these users.

## Article 12

### Energy system wide cost-benefit analysis

1. Within one month of the entry into force of this Regulation, the ENTSO for Electricity and the ENTSO for Gas shall submit to the Agency and the Commission their respective methodology, including on network and market modelling, for a harmonised energy system-wide cost-benefit analysis at Union-wide level for projects of common interest falling under the categories set out in points 1(a) to (d) and 2 of Annex II. The methodology shall be elaborated in line with the principles laid down in Annex V.

### Selected PCIs should:

- belong to given categories (Annex II): high-voltage overhead lines, highways, storage
- be necessary and economically, socially, environmentally viable,
- significantly impact on cross-border sections (Annex IV: at least 500 MW extra cross-border capacity)

• The choice should be done on the basis of costs and benefits, not of increase of transmission (is the new transmission really useful?)

• Also, the usage of new technologies (FACTS, HVDC, smart cables...) should be addressed.

- contribute to the three EC policy pillars

### Criteria set in Annex IV:

- 1 – impact on cross-border capability
- 2 – amount of transmitted green energy
- 3 – impact on loss-of-load.

• These criteria are vague, hardly measurable and not targeted: what amounts is the system impact (costs and benefits), not extra capacity and green energy dispatch

- Precedence to urgent projects complementary to other projects

- ENTSO-E to submit within 1 month methodology in accordance to principles in Annex V

• This timing is not compatible with the results of the FP7 Highway project (available only by 2015). The two methodologies risk to diverge.

## ANNEX V

### ENERGY SYSTEM-WIDE COST-BENEFIT ANALYSIS

- (4) The cost-benefit analysis shall be based on a harmonised evaluation of costs and benefits for the different categories of projects analysed and cover at least the period of time referred to in point 1.
- (5) The cost-benefit analysis shall at least take into account the following costs: capital expenditure, operational and maintenance expenditure over the technical lifecycle of the project and decommissioning and waste management costs, where relevant. The methodology shall give guidance on discount rates to be used for the calculations.
- (6) For electricity transmission and storage, the cost-benefit analysis shall at least take into account the impacts on the indicators defined in Annex III. In line with the methods applied for the elaboration of the latest available ten-year network development plan in electricity, it shall in addition notably take into account the impacts of the project on the following:
- Competition in terms of market power of different operators and the convergence of prices between different Member States;
  - Costs of electricity generation, transmission and distribution, including the costs for power plant self consumption and those related to greenhouse gas emissions and transmission losses over the technical lifecycle of the project;
  - Future costs for new generation and transmission investment over the technical lifecycle of the project;
  - Operational flexibility, including optimisation of regulating power and ancillary services;
  - System resilience, including disaster and climate resilience, and system security, notably for European critical infrastructures as defined in Directive 2008/114/EC.

- *Harmonised evaluation of costs and benefits*

- *Costs: capital, O&M during lifecycle and decommissioning have to be included*

- *Compatible with indicators in Annex III (IV?) and TYNDP*

- *Already commented in previous slide*

*Consider*

- *market power*
- *generation costs, CO<sub>2</sub> costs, losses*
- *operational flexibility*
- *system resilience*

- *Except second point, these aspects are difficult to assess. It requires the result of the FP7 Highway project, that will come by 2015.*

# 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 (IT), Coordinator & WP3
- Politecnico di Torino (IT), WP2
- Technische Universiteit Delft (NL)
- Technische Universität Dortmund (DE)
- Technische Universität Dresden (DE)
- EC Joint Research Centre - Inst. Energy
- Univerza v Ljubljani (SL)
- The University of Manchester (UK)
- Observatoire Méditerranéen Energie (FR)
- R&D Center for Power Engineering (RU)
- Technische Universität Wien, EEG (AT)

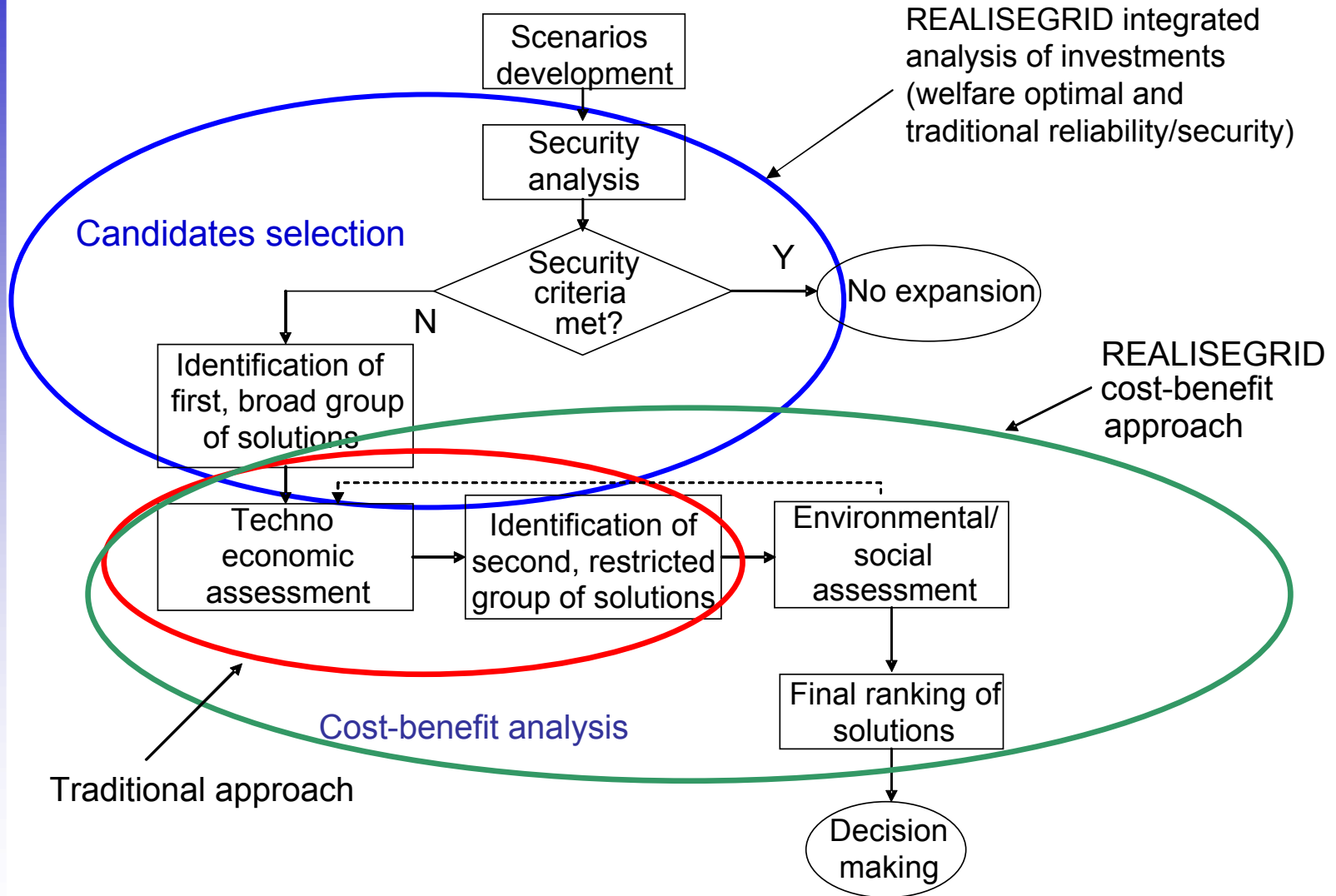
## TSOs

- RTE (FR)
- APG (AT)
- Terna (IT)
- TenneT (NL)

## Industry

- Technofi (FR), WP1
- ASATREM (IT)
- KANLO (FR)
- Prysmian (IT)
- RIECADO (AT)

# Transmission planning process



# Overview of the methodology: what, why, how

## WHAT

Cost-benefit assessment for new transmission infrastructure investments



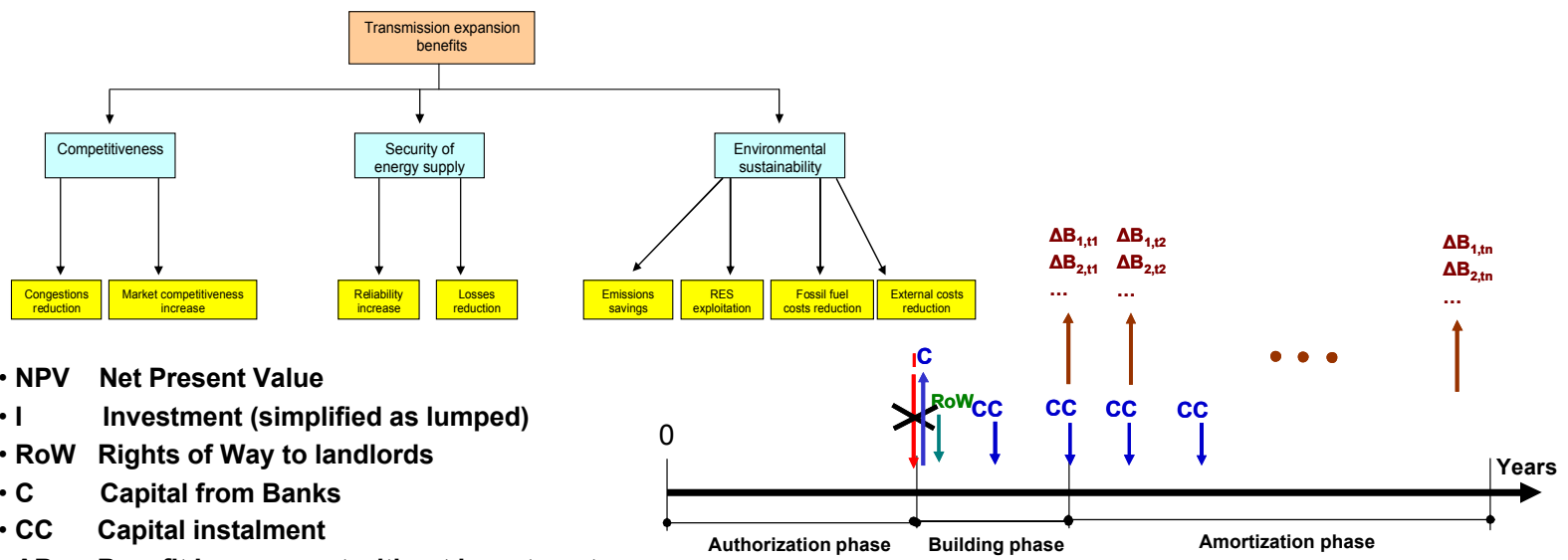
## WHY

- Methodology for prioritizing alternative investments both at national and trans-national level (see Infrastructure Package)
- Possible Key Performance Indicator (KPI) for establishing a dynamic addendum to TSOs Return on Investment (ROI)
- 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 Phase Shifter Transformers (PST) and High Voltage Direct Current lines (HVDC) have to be correctly represented

# The adopted methodology

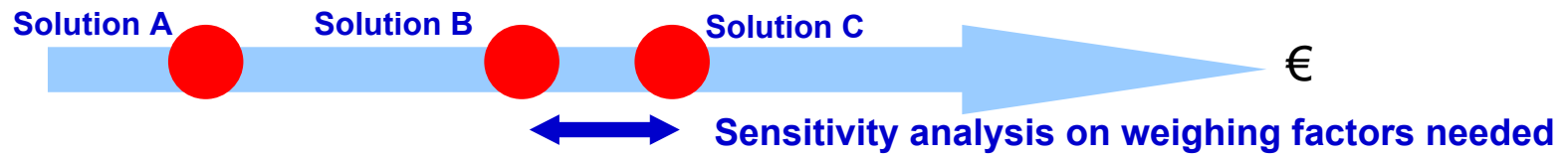


- NPV Net Present Value
- I Investment (simplified as lumped)
- RoW Rights of Way to landlords
- C Capital from Banks
- CC Capital instalment
- ΔB Benefit Increase wrt without investment



Utility function → translation into monetary terms

Weighted sum → translation a mono-dimensional ranking





# Cost-benefit analysis: test bed

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

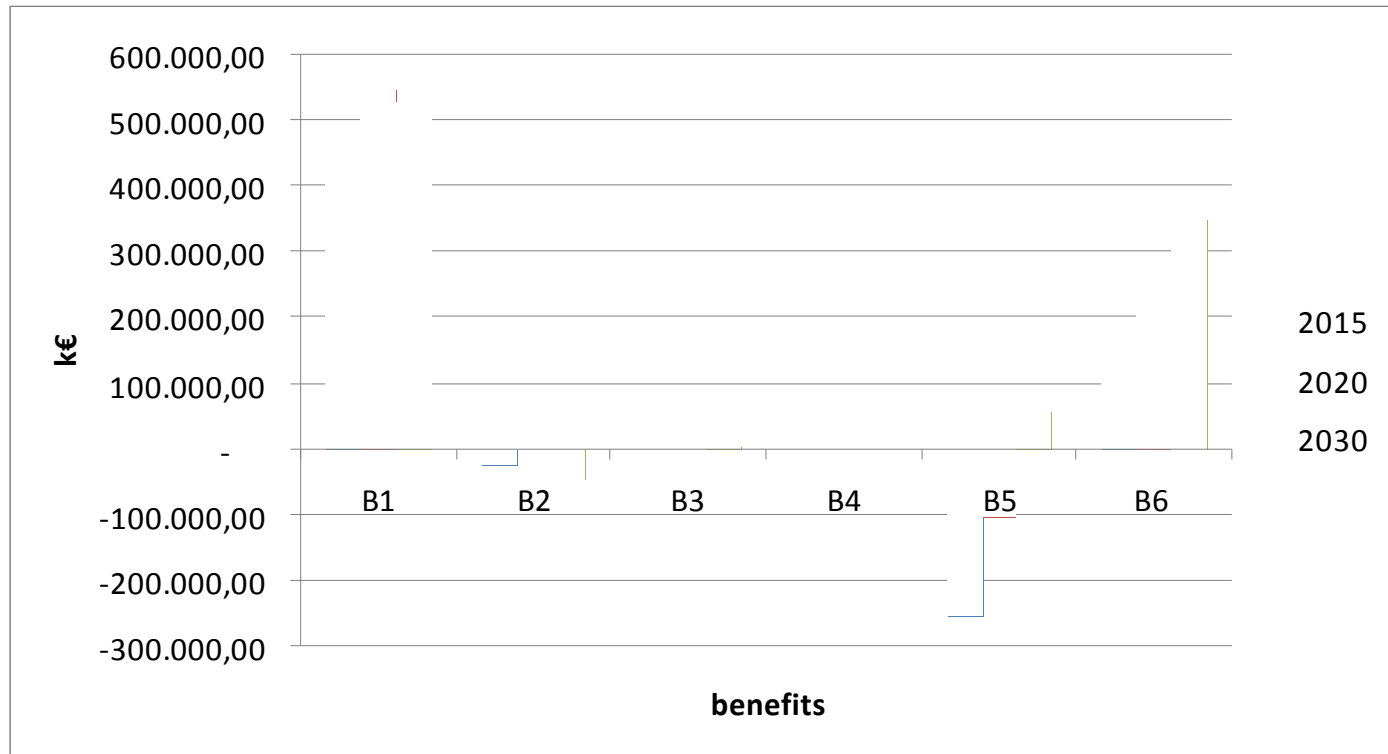
- 1. social welfare** - Congestion means lower market efficiency: substitution effect: more efficient generators replace less efficient
- 2. reduction of losses** - translated into money by valorising them at market price (opportunity cost). New corridors increase the overall transit and losses might grow (cost, not benefit)
- 3. reduction of wind curtailment** - translated into money by multiplying by a remuneration factor to wind owners (market price), new corridors increase overall transit and losses might grow (cost, not benefit)
- 4. reduction of load shedding** - 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 CO<sub>2</sub> emissions** - 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 market power of incumbent fuel monopolists

# Scenario hypotheses

- **Three reference years:** 2015, 2020, 2030
- **Two scenarios** considered:
  - o Optimistic: emission target reached in 2020
  - o Pessimistic: emission target reached in 2030
- **Fuel prices:** from World Energy Outlook 2009 (published by the International Energy Agency)
- The **perimeter of the test-bed model** includes: France, Germany, Switzerland, Austria, Italy, Slovenia and Croatia and western Balkans
- **Basic model for grid, load and generation:** Winter Peak Study Model 2008 released by UCTE (Union for the Co-ordination of Transmission of Electricity)
- **Grid updates:** Ten Year Network Development Plan 2010 ENTSO-E (European Network of Transmission System Operators for Electricity) + System Adequacy Forecast + info by Terna/Austria Power Grid

# Benefits figures in the three tab-years

Corridor 1 (optimistic scenario)



- B1 Social welfare
- B2 Losses
- B3 Load shedding
- B4 Wind generation curtailment
- B5 CO<sub>2</sub> emissions
- B6 Extra-EU fuel import

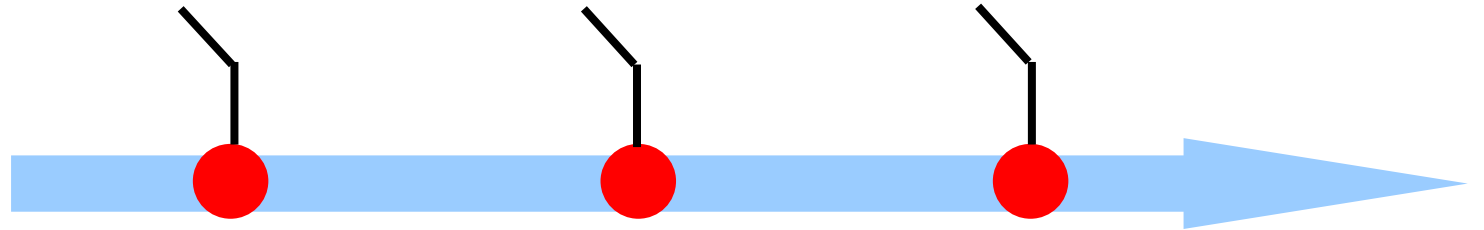
# Cost-benefit ranking of the three corridors (NPV)

Wie Immer Ohne Gewähr

C2: (Friuli – Slovenia)

C1: (Veneto- Austria)

C3: (Brennerpaß)



Benefits-costs [M€]

With benefits B1÷B6 Optimistic case

	Corridor 1	Corridor 2	Corridor 3
NPV	3223.	2533	4682
IP=NPV/IC	15	12	5

Pessimistic case

	Corridor 1	Corridor 2	Corridor 3
NPV	3658	2882	4845
IP=NPV/IC	18	13	6

With benefits B1÷B5 Optimistic case

	Corridor 1	Corridor 2	Corridor 3
NPV	1728	1342	2208
IP=NPV/IC	8	6	3

Pessimistic case

	Corridor 1	Corridor 2	Corridor 3
NPV	2105	1470	2059
IP=NPV/IC	10	7	2

- NPV = Net Present Value
- IC = Investment Cost
- IP = Profitability Index

## Conclusions (1/2)

- **The benefits are usually able to recover the costs just after two years of operation (this is evident from the cash flows).**
- **The Social Welfare benefit is prevailing, but fuel import reduction is very impacting too.**
- **Better interconnecting Germany with Italy reduces dispatching costs and prices difference between the two markets.**
- **CO<sub>2</sub> emissions may grow due to the replacement of Italian gas power plant with cheap German coal (not North Sea RES, due to bottlenecks in Germany and insufficiency of wind production).**

## Conclusions (2/2)

- Losses are generally increased by opening new corridors.
- Benefits by load shedding reduction are 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.
- An extension of the model to a fully pan-European case would not present particular additional criticalities, but the availability of real data is the key element for drawing reliable evaluations. In any case, while some data unavailability concerning the network setup and the generation set don't allow to draw any conclusion from the test case 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.**

# Thank you for your attention...

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# Annex

## Selection criteria (Article 4)

*Concerning electricity transmission, selected PCIs should:*

- *belong to given categories (Annex II): high-voltage overhead lines, highways, storage*
- *be necessary and economically, socially, environmentally viable,*
- *significantly impact on cross-border sections (Annex IV: at least 500 MW extra cross-border capacity)*
- *contribute to the three policy pillars, measured by (Annex IV):*
  - *1 – the amount of power with significant cross-border impact*
  - *2 – the amount of transmitted green energy*
  - *3 – the impact on loss-of-load.*

*Precedence is given to urgent projects complementary to other projects.*

## **Is the selection criteria set out in Article 4 appropriate? Is the criteria detailed enough?**

The Guidelines criteria are too vague. A more technical proposal is necessary (ENTSO-E + new FP7 project on highways). The indicators in Annex IV are difficult to measure and there is no indication on the characteristics of the tool providing these assessments. They are also questionable: the significance of an investment has to be measured on the basis of costs and benefits. A net extension of a cross-border capacity is not per se a benefit if it is not shown how much the system will profit in terms of reduction of the dispatching cost. Quantities (1) and (2) are difficult to assess and again what matters is the value for the system (e.g. on the value attached to CO<sub>2</sub>, that is reflected in the cost of the Emission Trade Certificates)

## **Should the Regulation be more prescriptive when it comes to the selection criteria, and ranking of PCIs?**

The criteria should be based on the overall trade-off of costs and benefits (evaluated in economical terms) for the pan-European system.

**Would it be appropriate to add a criterion concerning interoperability-compatibility with existing infrastructure?**

Interoperability is an important selection criterion of the modality to implement new investments rather than a criterion of PCI selection.

Investments in new technologies increasing the performance of existing grids should be considered too. This aspect seems to be neglected by the Guidelines.

**Does the proposed criteria allow for an objective comparison within the Regional Groups and across Regional Groups?**

The set of criteria should be common among the Groups, consistent and uniform.

**Would it be appropriate to set up a hierarchy between the different criteria or to assign weights to the different criteria in order to be able to rank projects?**

This is possible, but very dangerous (weights evaluations are always very subjective). This is the reason behind REALISEGRID's choice to match the benefits with an economic appraisal, so as to be able to add them up algebraically.

**Is there a risk that the criteria 'the project displays economic, social and environmental viability'(Article 4 paragraph 1.(a)) might exclude projects which are vital to connecting energy islands and removing bottlenecks?**

Yes, but public opposition can generate significant delays and increase approval costs. This could also vanish, reduce or delay the benefits and has to be included into the cost-benefits appraisal.

### Cost benefit analysis (article 12)

*Cost-benefit analysis methodology, proposed by ENTSO within one month after the Guidelines enter into force and approved by the Commission after consulting ACER. It should be in accordance to Annex V principles*

### **Would it be appropriate to use the cost-benefit analysis (article 12) in the selection process of projects of common interest?**

For sure: yes! However, the strict time shown in Ar.12 is not compatible with the finalization of the process in ENTSO-E. There is a two-speeds mechanism between PCIs and highways: for the latter, the results of an ad-hoc FP7 project are awaited by early 2015. The two sets of criteria risk to diverge without a serious reason. Quantifying some aspects (impact of market power, flexibility and resilience) as requested in Annex V is challenging and will only result from the FP7 project above.

### **Should the CBA be built on the consultation of stakeholders?**

It should be thoroughly discussed with all stakeholders. This will happen for the highways CBA. Questionable if this is possible within the strict timing fixed for PCIs proposal.

### **How to ensure a full independent scrutiny of the CBA?**

Here, the technical role of ENTSO-E, the regulatory role of ACER and the Commission and the thorough consultation of the stakeholders play a key role.