TRANSMISSION PLANNING IN EUROPE: FROM CURRENT METHODOLOGIES TO A NEW SYSTEMIC APPROACH

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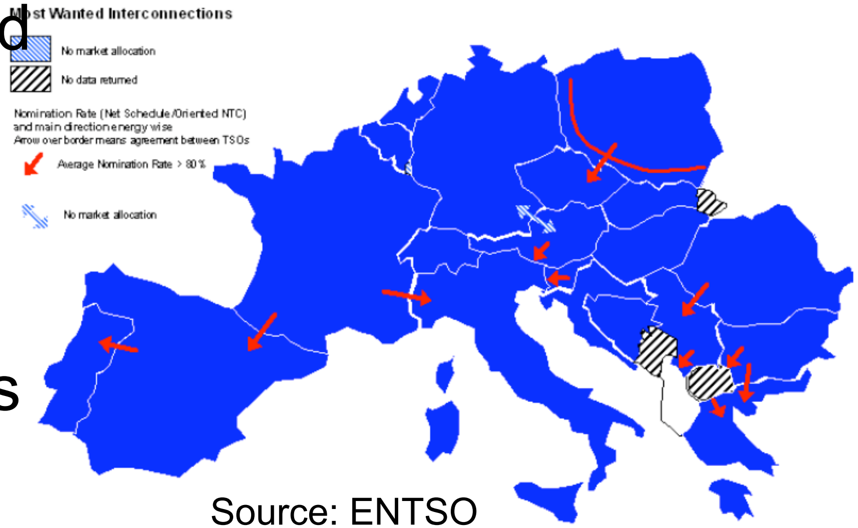
Outline

- CHALLENGES FOR GRID PLANNING
- PLANNING PRACTICES AND NEEDS
- PLANNING METHODS: THEORY
- FOCUS ON COST-BENEFIT ANALYSES
- NEW METHODOLOGY AND TOOL
- CONCLUSIONS

Recent trends on power grids

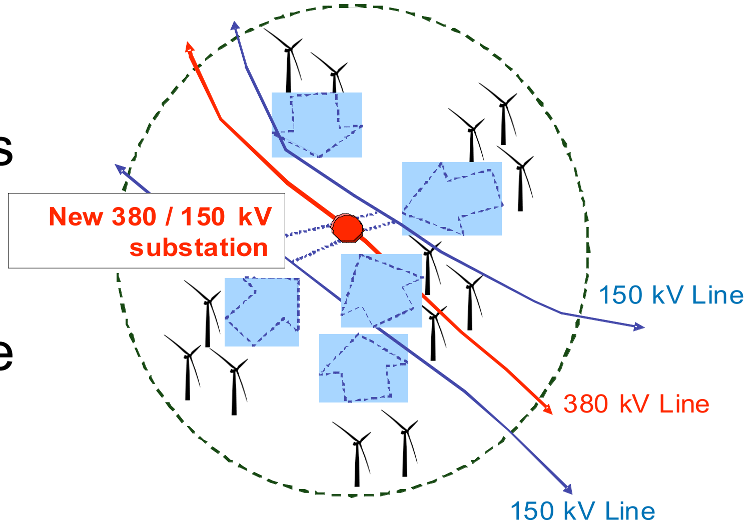
- Vertically integrated utilities replaced by unbundled companies competing in power markets
- Liberalisation process leading to increasing & shifting inter-area exchanges and congestion
- Escalating onshore (and offshore) wind deployment
- Security of supply and environmental concerns



Source: ENTSO

Wind connection and grid planning

- Network **planning** and generation **connection** are two separate yet **intrinsically interlinked** processes
  - Power production (rather than demand) tends to exert the greatest influence in terms of new transmission requirements
  - Wind electricity has not simply to be connected to the closest busbar of the grid but has to be effectively integrated into the system through targeted network development and optimization actions



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Network planning objectives & tasks

- Network planning before/after liberalisation:
  - Before: the integrated utilities minimised generation and transmission costs, subject to technical constraints
  - After: Transmission System Operators (TSOs) minimise transmission costs and pursue maximum social welfare, while meeting technical constraints
- Basic tasks of TSO planners (iterative process):
  - forecast power and energy flows on the network
  - check the system compliance against a set of criteria
  - devise a set of solutions to overcome the criticalities
  - select the solutions with better cost/benefit performances

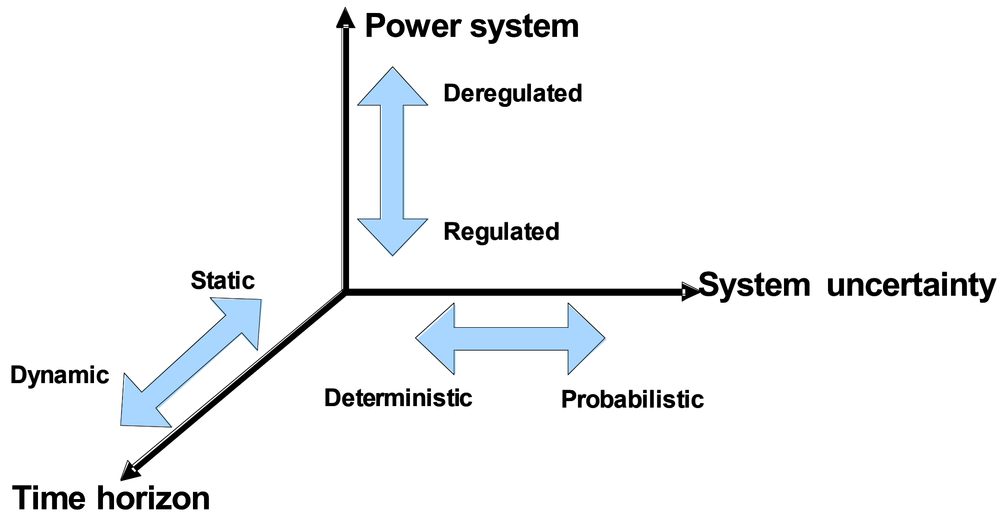
Existing planning practices

- Existing planning methods commonly make use of **worst-case scenario(s)** approach
  - power flow analysis is performed for a small number of cases selected by experienced network planners
- Despite **stochastic** elements are pervading the power systems, probabilistic approaches are not yet fully employed
  - in some cases, they mainly aim to complement **deterministic** analyses, upon which the planning decisions are primarily made

Emerging needs for grid planning

- With the increased uncertainty and the many assumptions necessary for the analysis, more combinations of load, (renewable) generation and international exchange shall be captured for a robust planning under a variety of scenarios
  - **probabilistic** analyses should be further developed
- Transmission planning shall change and be even more focused on
  - better **coordination** between national TSOs (promising initiatives are being set up)
  - **revised** and expanded planning **criteria and tools** to design flexible, coordinated and secure transmission networks including innovative technologies

Literature review of planning methods



- Classified by approach
  - deterministic, non-deterministic
- Classified by timeframe horizon
  - static, dynamic, pseudo-dynamic
- Classified by power system structure
  - regulated systems, restructured systems
- Classified by technique
  - classic optimisation, heuristic, meta-heuristic

Need for improved cost-benefit analyses

- A cost-benefit analysis should take into account the improvements in terms of both reliability and market competitiveness, as well as the interests of consumers and other market players
- Unlike what happened in old vertical integrated markets, grid expansions may be controversial as they can advantage:
  - some stakeholder on others, enhancing or reducing producers' possibility to exercise market power
  - a zone on another (especially for cross-border investments) and provide diversified incentives to new generation

New systemic approach

- A valuable cost-benefit analysis should evaluate the advantages of new investments both system-wide and locally, considering the viewpoint of consumers, producers and TSOs (systemic approach)
- New technologies (WAMS, FACTS, HVDC,…) to better exploit the grid are also assessed
- The **new approach** proposed by REALISEGRID, will consider the different benefits (economic, environmental and SmartGrid,...) and weigh them together by carrying out a **multi-criteria analysis**
  - A scoring number is calculated to rank possible reinforcements and select the most promising ones in the society's perspective

Benefits from transmission expansion

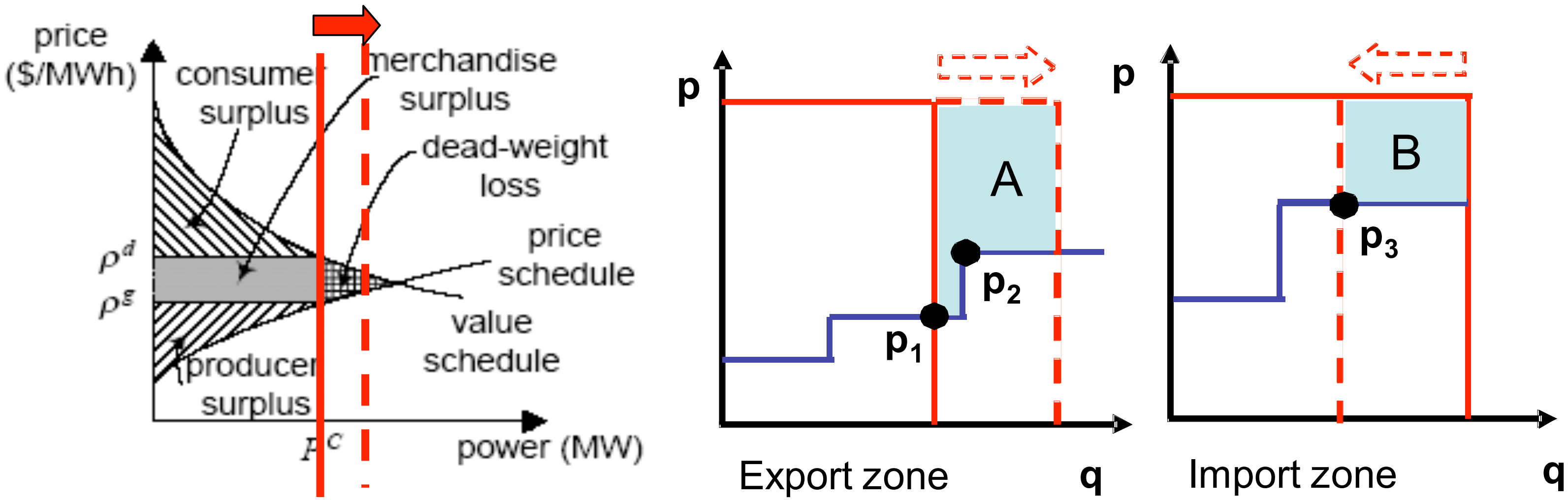
- System reliability, quality and security increase
- System congestions reduction
- Market competitiveness increase
- System losses reduction
- Avoidance/postponement of investments
- More efficient reserve management
- Exploitation of energy mix (also in presence of RES)
- Emission savings (in presence of RES)
- Power flows controllability increase (via FACTS/HVDC)
- External and internal costs reduction (in presence of RES)
- Improved coordination of transmission and distribution grids

How to gauge the reliability benefits

1. Criteria-based approach:
   - EENS (Expected Energy Not Supplied)
   - LOLP (Loss Of Load Probability)
   - LOLE (Loss Of Load Expectation)
   - SAIDI (System Average Interruption Duration Index)
   - CAIDI (Customer Average Interruption Duration Index)
   - SAIFI (System Average Interruption Frequency Index)
2. Value-based approach:
   - VOLL (Value Of Lost Load)
   - IEAR (Interruption Energy Assessment Rate)
   - WTP (Willingness To Pay)
   - ECOST (Expected Customer Outage CoST)

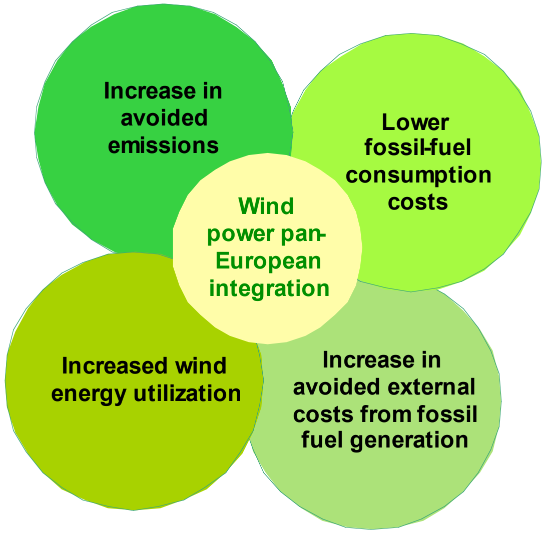
Market related benefits

- Increased market competitiveness leading to market price reduction ('**strategic effect**') and network congestions reduction allowing the unlock of more efficient power generation ('**substitution effect**') can be measured by the Social Welfare (SW)



Other benefits

- Sustainability benefits (in presence of variable RES)
  - Better exploitation of RES (wind) in the generation mix
  - Emissions savings (CO_2, NO_x, SO_2)
  - Reduction of conventional generation external costs
  - Internal (fossil-fuel) costs reduction



- SmartGrids development benefits
  - Improved interaction of transmission and distribution grids

New methodology and tool

- REALISEGRID is developing a systemic approach to transmission planning, to quantify the benefits of grid expansion in a liberalised environment
- REALISEGRID is developing a new tool able to calculate the economic benefits resulting from a transmission system enhancement for the different players and for the society as a whole
- The new simulation tool, among others, has to:
  - be suitable for power system and market studies
  - carry out reliability studies (probabilistic criteria)
  - incorporate emission amount and cost calculations

Conclusions

- Transmission planning will have to adapt to new situations and uncertainties (mostly represented by market opening and renewable integration)
  - Transmission planning criteria should be expanded to **consider probabilistic** approaches
  - **Improved cost-benefit** analyses need to systematically and quantitatively assess grid expansion advantages
- REALISEGRID is developing a **new systemic approach** and tool for transmission planning, to better evaluate the benefits of grid expansion
  - This will be tested on the projects belonging to the Trans-European Network priority axis "EL.2. Borders of Italy with France, Austria, Slovenia and Switzerland"

Thanks for your attention

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