REALISEGRID

Transmission planning: present challenges and possible new methodologies

Ana Roxana Ciupuliga	TU Delft	a.r.ciupuliga@tudelft.nl

WP3 Final Workshop

31-03-2011 Rome

WP3.1 Improved system reliability and technical planning criteria

- D3.1.1 Review of existing methods for transmission planning, including grid connection rules for large wind plants, *JRC & TU Delft*

  Authors: G. Fulli, A.R. Ciupuliga, A. L'Abbate, M. Gibescu

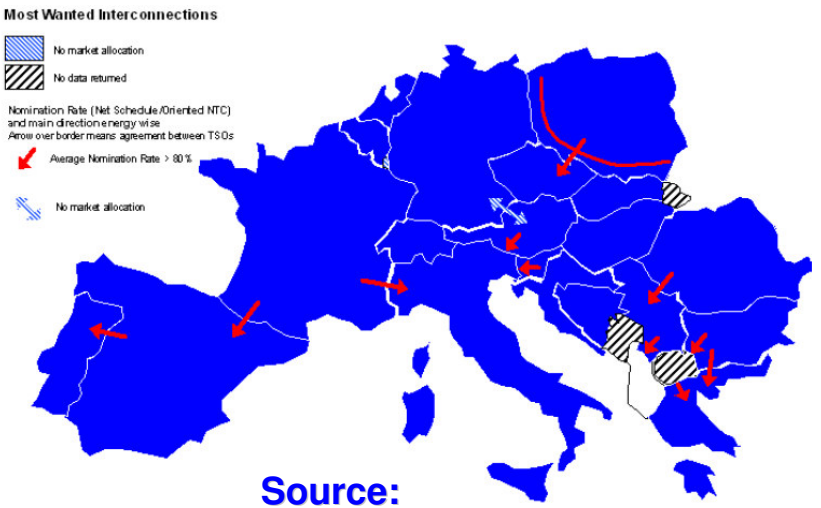
- D3.1.2 Report on extension and harmonization of transmission planning criteria, *TU Delft*

  Authors: A.R. Ciupuliga, M. Gibescu

- Special thanks to Terna, TenneT, APG and RTE for all their valuable input and feedback.

Recent trends on power grids

- Vertically integrated utilities replaced by unbundled companies; competition in electricity markets
- Liberalization process leading to increasing & shifting inter-area exchanges and congestion
- Increasing onshore (and offshore) wind deployment
- Security of supply and environmental concerns



Source: ENTSO

Network planning objectives & tasks

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

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 pervading the power system, 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

Comparison of planning practices in some EU27 countries (2009)

Country / Area	Time horizon for adequacy and planning studies	Deterministic (D) and probabilistic (P) network planning criteria			Consideration of market issues in network planning	
		D	D with P items	P	Low	High
NORDEL	5-10 years	■	■		■	
France	7 - 15 years	■	■		■	
Great Britain	7 years	■			■	
Ireland	5-10 years (15-20 years time frame for a limited set of studies)	■	■		■	
Italy	5-10 years	■	■		■	
Spain	10 years	■	■		■	
The Netherlands	7 years (21 years in the strategic Vision2030 document)	■			■	

Transmission planning in Spain

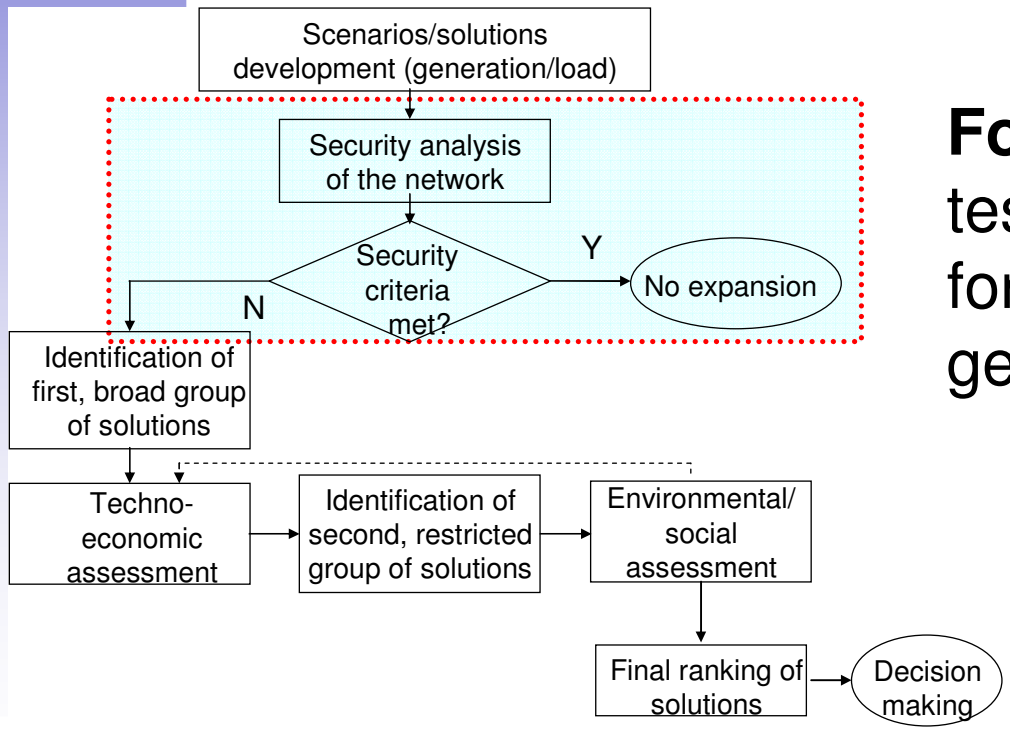
- Transmission expansion planning criteria
  - minimizing investment and operations network cost
  - achieving a secure and efficient static & dynamic network
  - complying with environmental, administrative, and social requirements
- Transmission planning with 10-year horizon
- 4-step expansion planning methodology
  - Multiple scenario generation covering the whole planning horizon and detailed analysis of these scenarios
  - Information structuring and index calculation
  - Identification of competitive and necessary network reinforcements
  - Decision making

Emerging needs for grid planning

- 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** among 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

Transmission planning framework

"A probabilistic **approach** combining chronological market simulations and static security analysis to deal with uncertainties."



Focus in D3.1.2:
test the system's robustness for various future scenarios of generation/load development

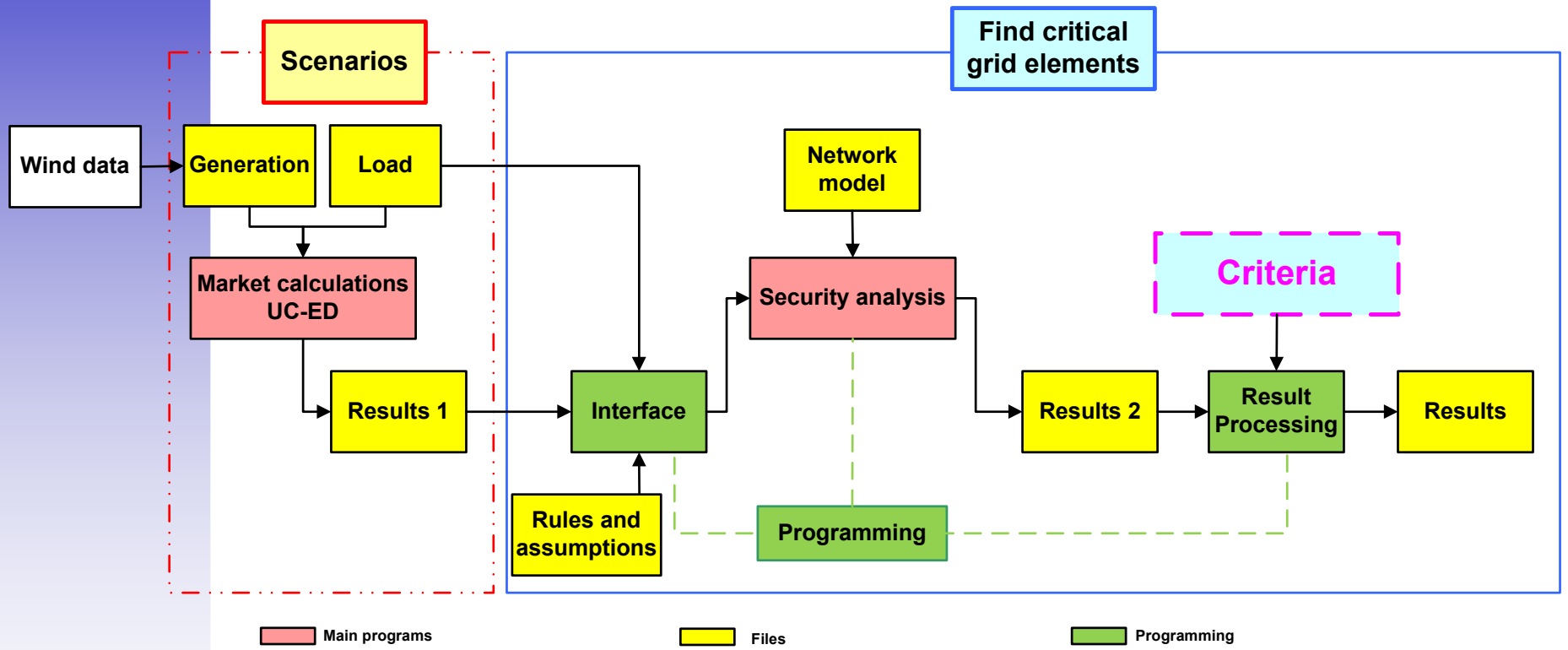
Advantages

- our method considers both ***chronological*** and ***correlation*** aspects within the market simulations

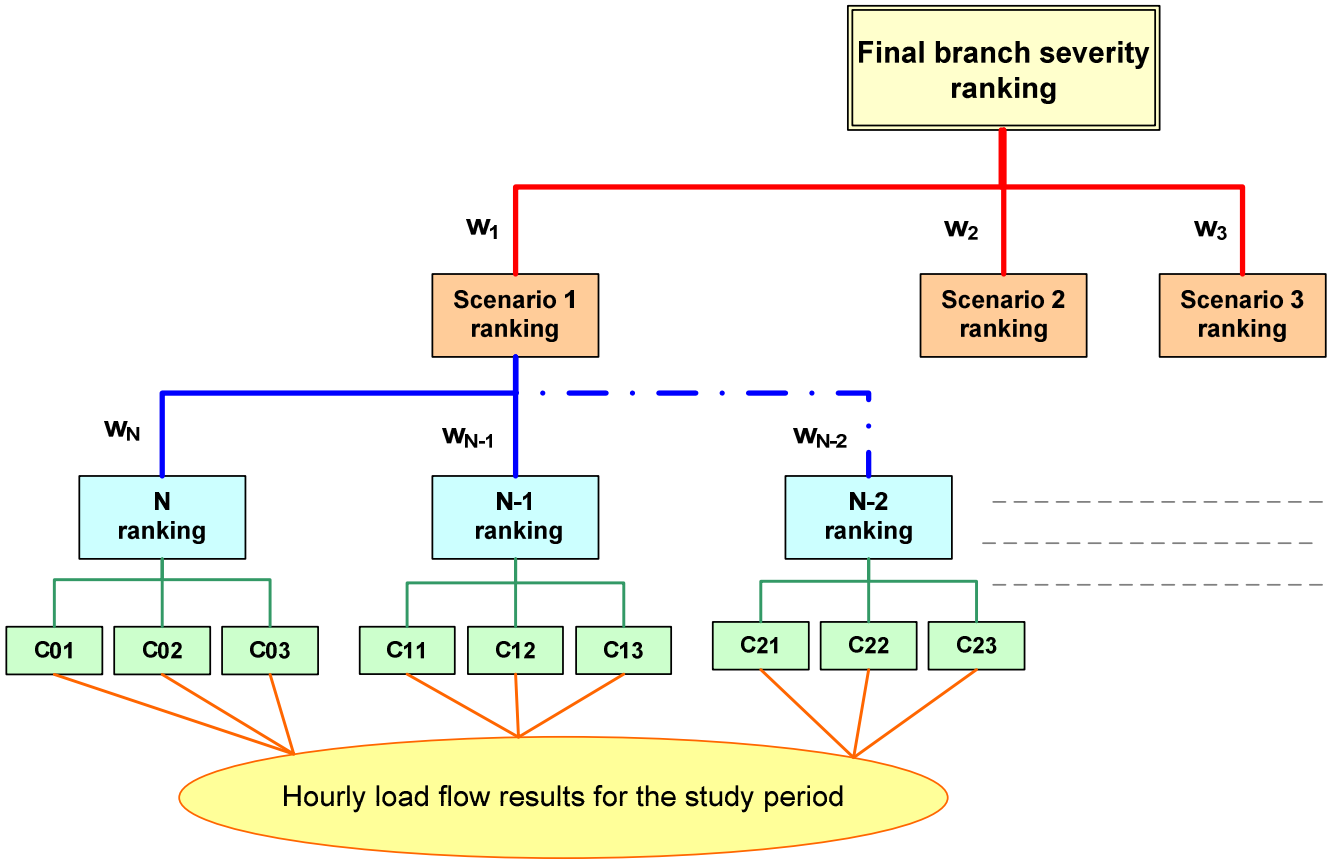
- followed by a security analysis, performed for all the simulated hours.

→ this method is adequate for security analysis at regional level.

Implementation of the proposed method



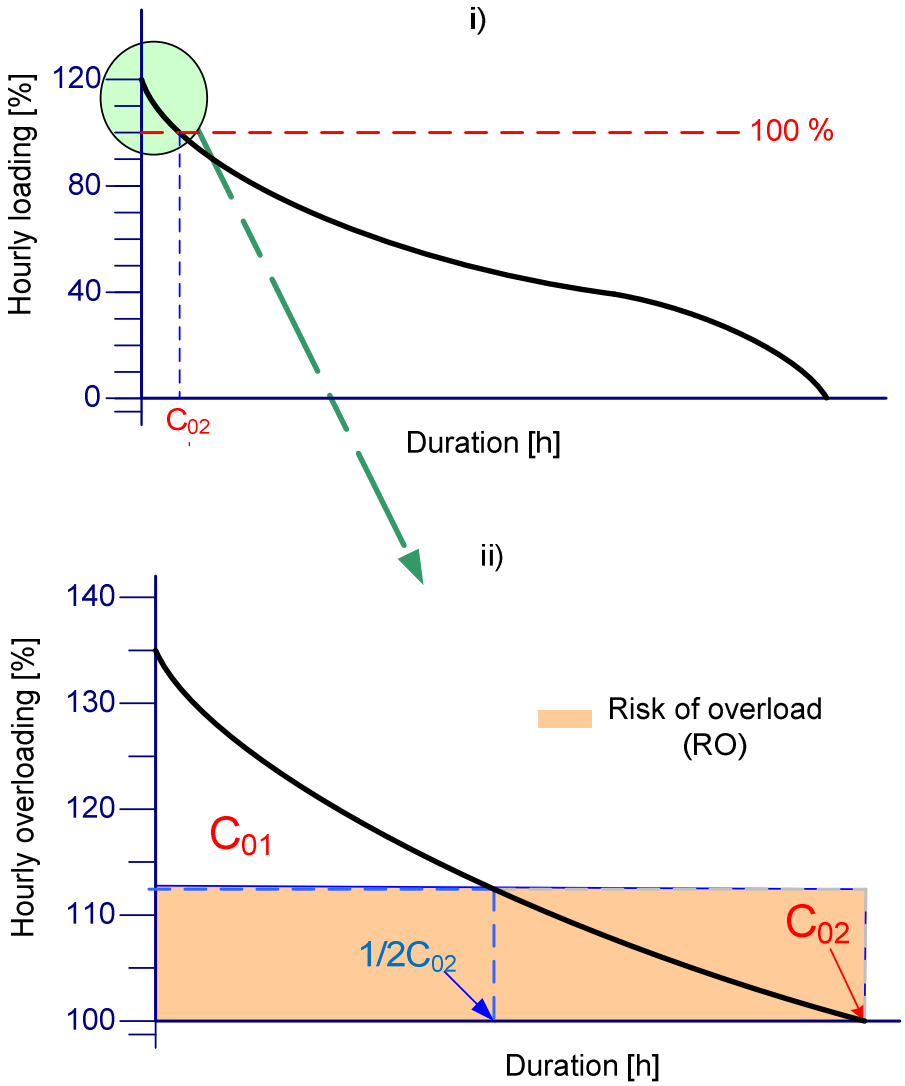
Multi-criteria analysis



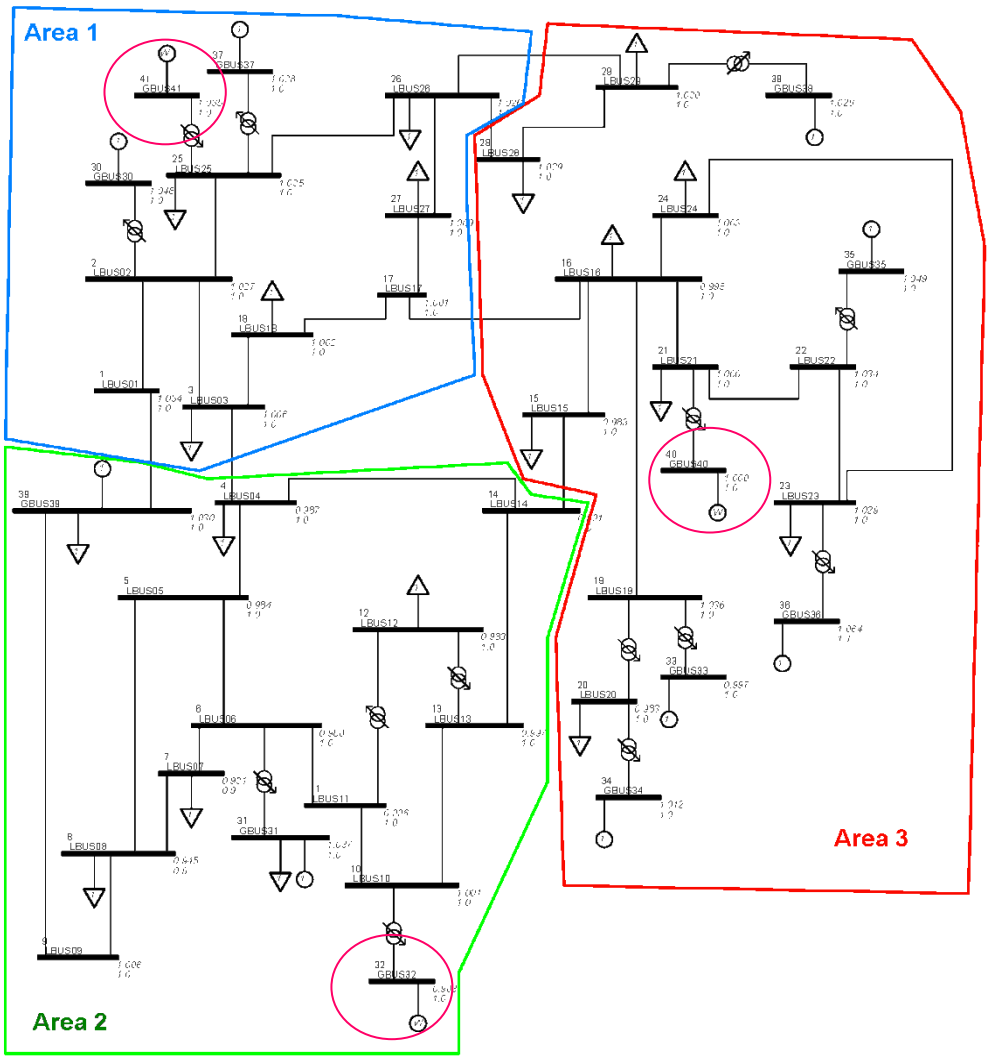
Risk of overload and severity ranking of bottlenecks

- For each of the three situations (N, N-1, N-2) the same procedure will be applied.
- The severity ranking index of a branch for a situation is given by the risk of overload (RO) for that branch.
- The RO is the product between the total overloaded hours and the branch loading median for the overloaded hours minus the overload threshold (=100%).

Risk of overload and severity ranking of bottlenecks

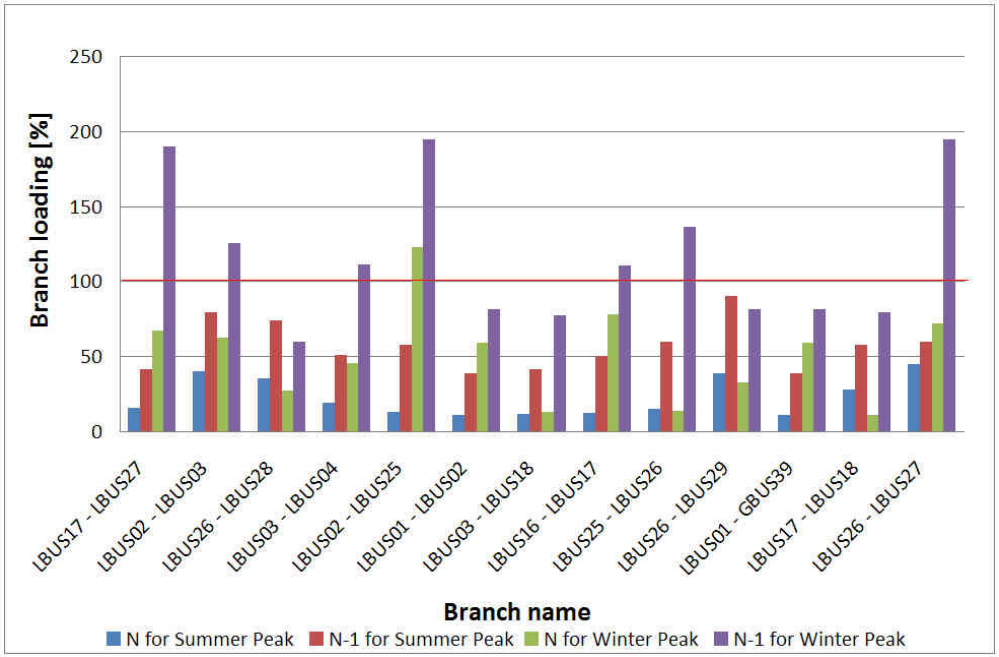


Test model: the New England system

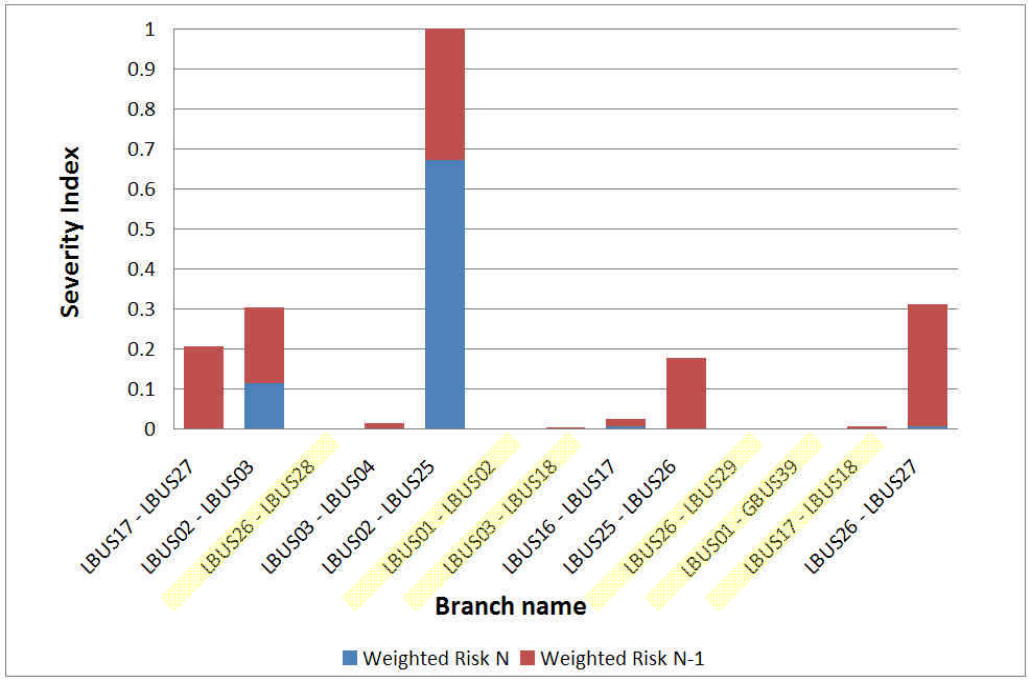


- A testing of the method on an extended version of the New England system.
- Assumption: all branch rated capacities = 900 MVA.

Detailed security analysis Area 1: comparison with the snapshot method



The weights are 0.67 for the N case and 0.33 for the N-1 case.



Harmonisation of transmission expansion practices

- For making the proposed method work effectively the following steps are considered of high importance and are further recommended:
  - Regional coordination: same scenarios and market simulations for the whole region
  - Better cooperation between TSOs regarding data exchange that is crucial for an increase in the quality of results
  - Reduced network and contingency list at regional level; more detail at national level
  - Agreement on the weights for the security criteria bottleneck ranking
  - Seasonal values of rated capacity and harmonized overload thresholds are needed

Conclusions and recommendations

- Transmission planning will have to adapt to new situations and uncertainties
  - **consider probabilistic approaches**
  - **improve security analysis**
  - **improve cost-benefit analyses**
- In WP3.1 a statistical method for bottleneck ranking to be used in transmission expansion planning was developed.
- The method uses a round-the-year approach with wind power time series based on real data, and is adequate for interconnected power systems that have a high penetration of wind power.

Conclusions and recommendations

- Market simulations + detailed load flow calculations for getting a complete picture of congestion in the grid.
- The chronological aspect in market simulations and the (auto) correlation properties of load and wind-speed time series are considered.
- Criteria for prioritizing bottlenecks were developed together with a ranking method according to a risk-based severity index.
- The method was tested and it gives more accurate results than the snapshot method.

Thank you for your attention!