System Development

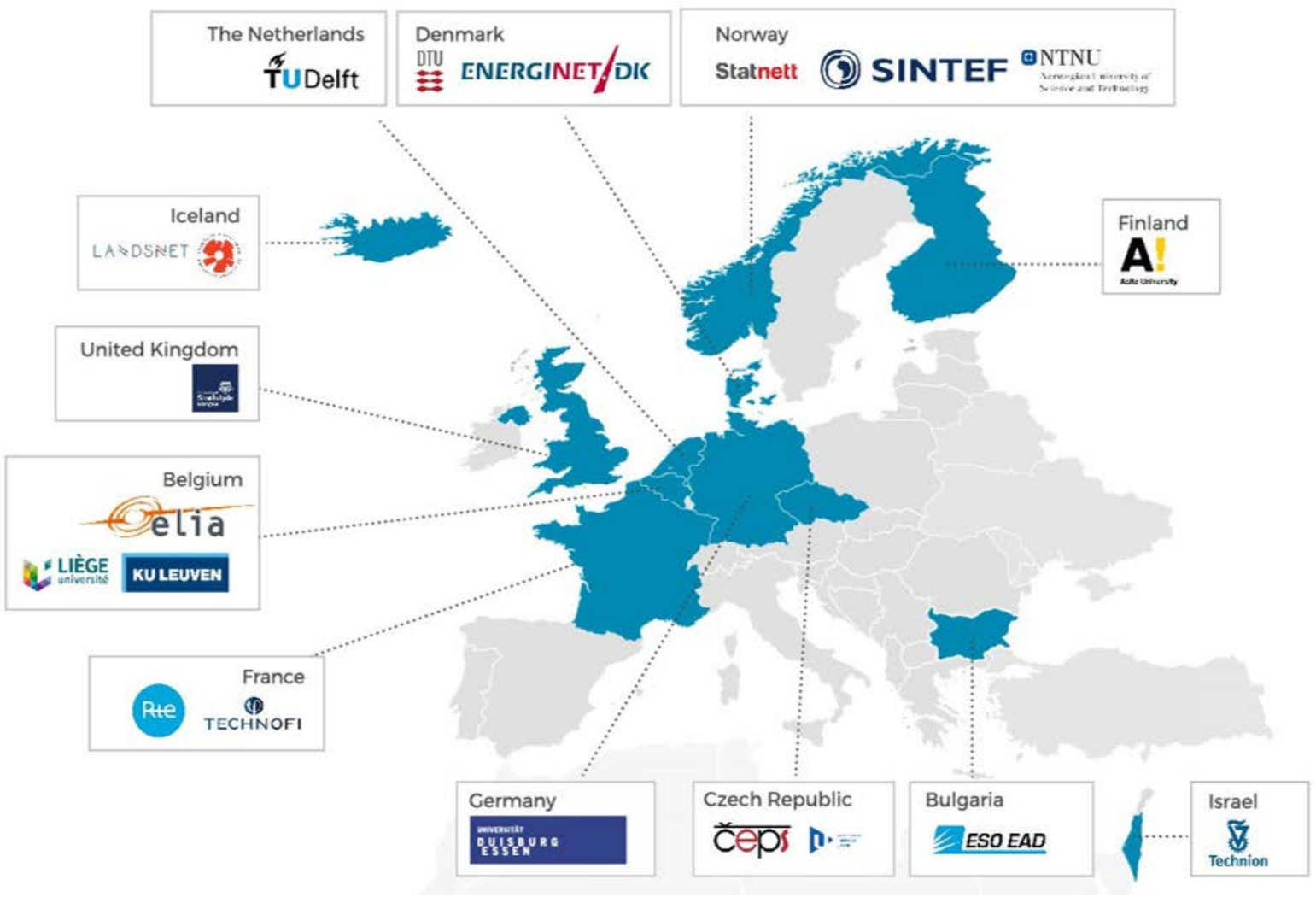
Methods and lessons learnt from pilot tests

Arnaud Vergnol

EXPERT POWER
SYSTEM PLANNING

Elia

BELGIUM



2 public deliverables
2 internal deliverables

WP4 Contributors

Work Package on implementing GARPUR to System Development

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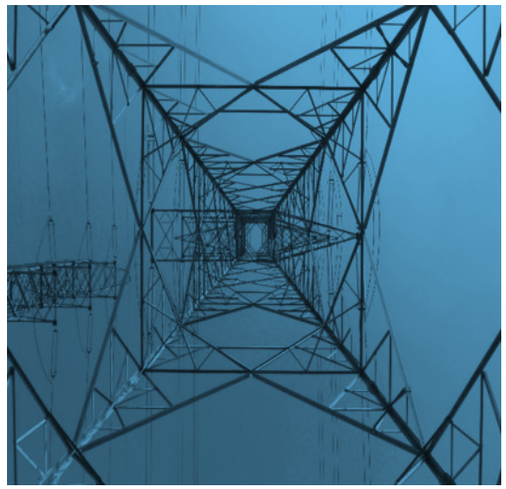
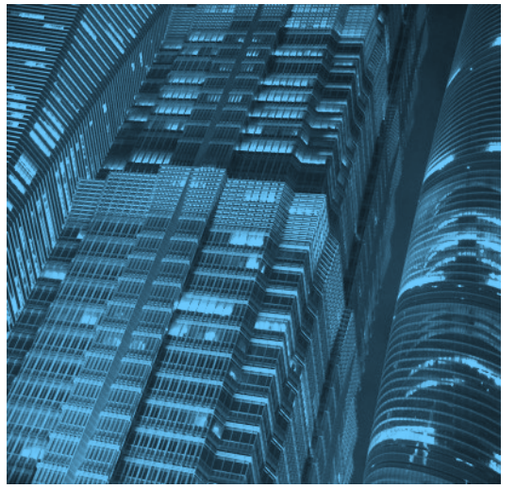
OUTLINE

Main challenges of the system development process

Proposed workflow for system development analysis in the GARPUR framework



Near real-life pilot testing



Lessons learnt and main recommendations

Main challenges of the system development process

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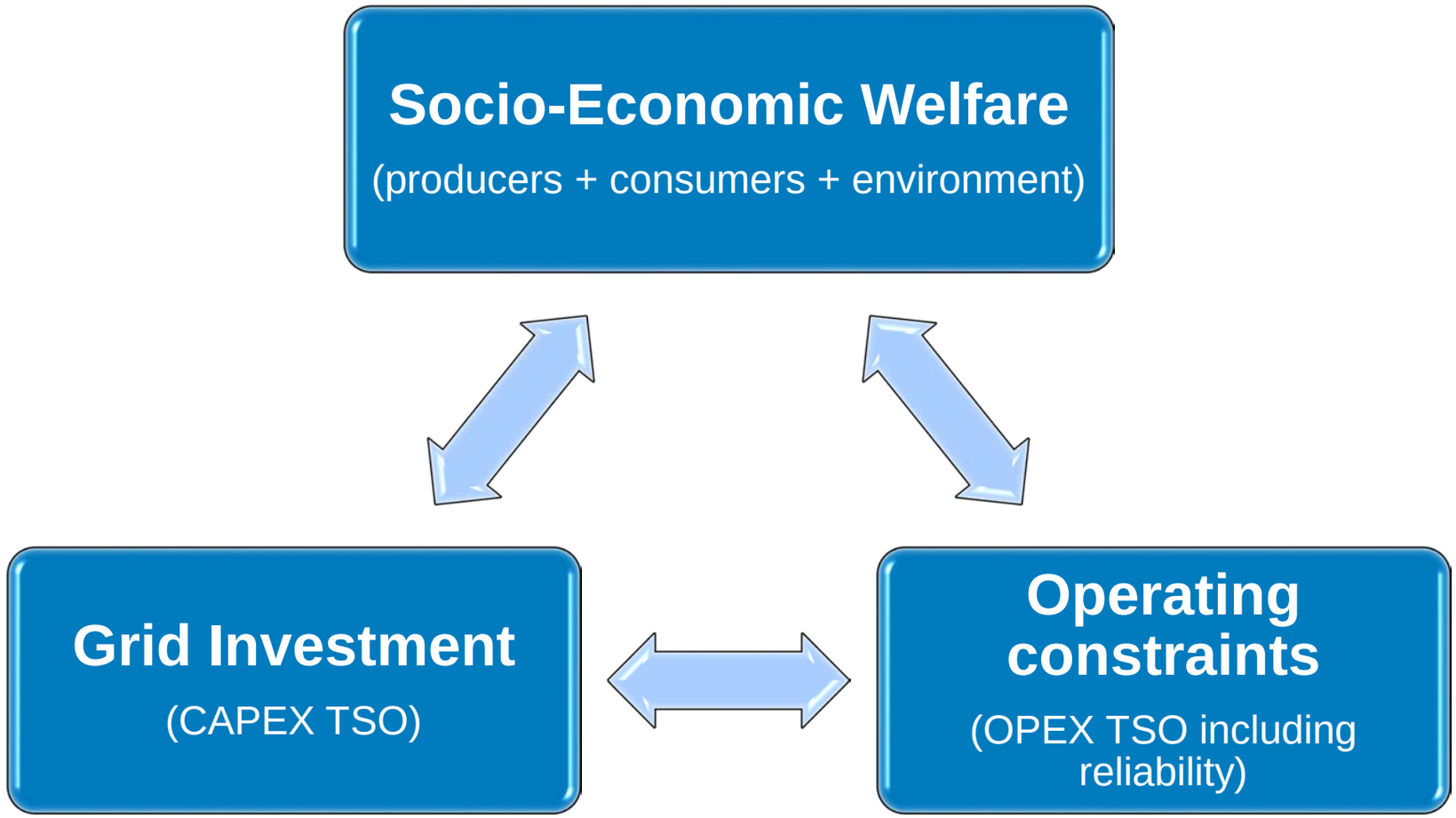
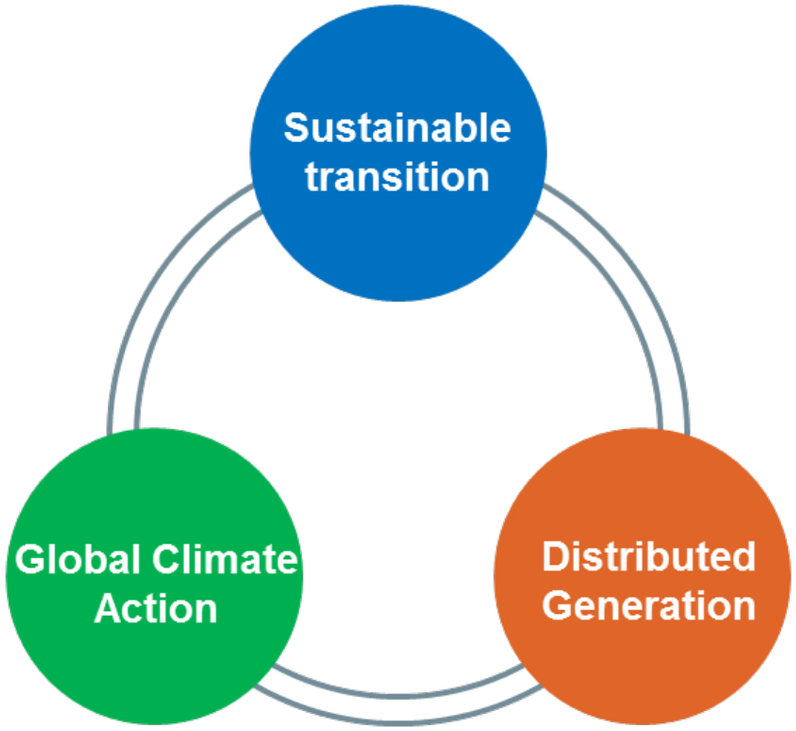
Main challenges of the system development process

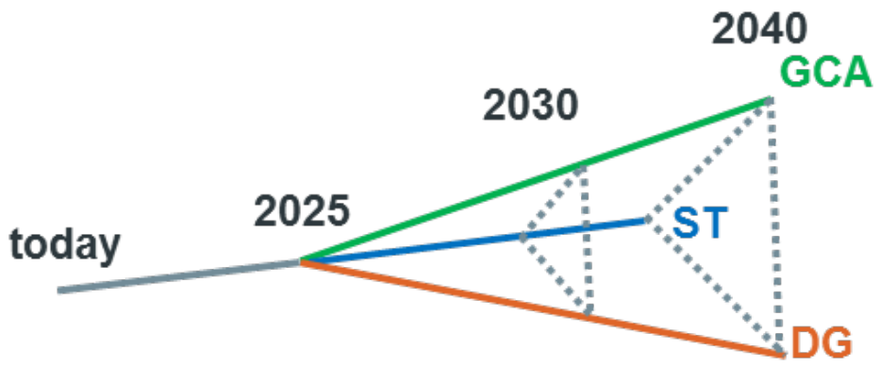
- The core of system development is development of an adequate transmission system in taking into account economic efficiency



Main challenges of the system development process

- System development looks very far ahead in time ➔ very large range of uncertainties
  - Macro-scenarios group the uncertainties about fuel prices, technology prices & maturity, load evolution, generation mix & location...





i.e.: Macro-scenario TYNDP 2018

Proposed workflow for system development analysis in the GARPUR framework

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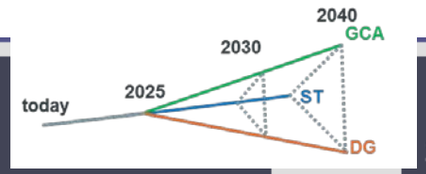
Proposed workflow for system development analysis in the GARPUR framework



Step 1: Selection of a target year for system development studies.

Step 2: Considering deterministic macro-scenarios (inline with ENTSO-e vision and regional variants)

Step 3: Construct operational yearly scenarios "Monte Carlo Years"

Step 4: Identify market clearing for unconstrained grid capacity and a set of grid transfer capacities

Step 5: Perform zonal to nodal conversion of market results

Step 6: **Complexity reduction stage.** Clustering approach to group similar operating states into credible operating state to be further analyzed

Step 7: Identify critical operating states and provide insights of system weakness

- SCOPF to estimate welfare impacts
- Proxy of outage planning
- Operational acceptability criteria

Step 8: Analyze critical operating states and proposal of mitigation measure by system planner.

Iterative process on target years

Iterative process on market capacities

Iterative process on grid reinforcement alternatives

Near real-life pilot testing

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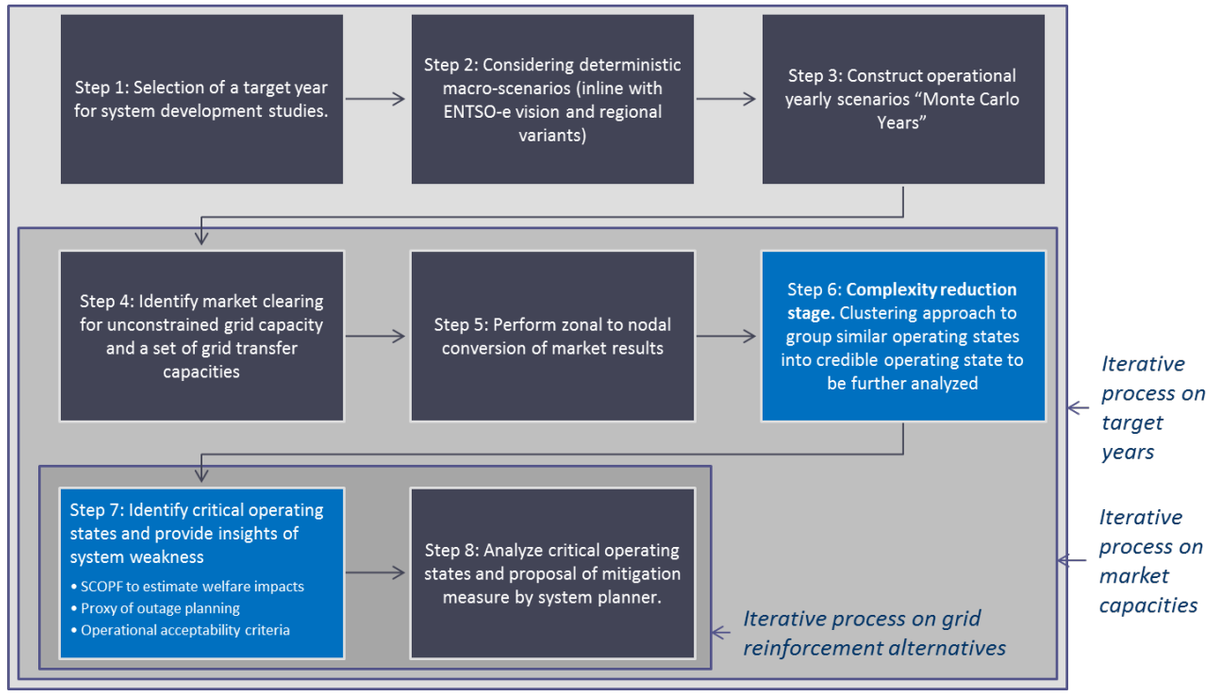
Near real-life pilot testing

Pilot test objectives:

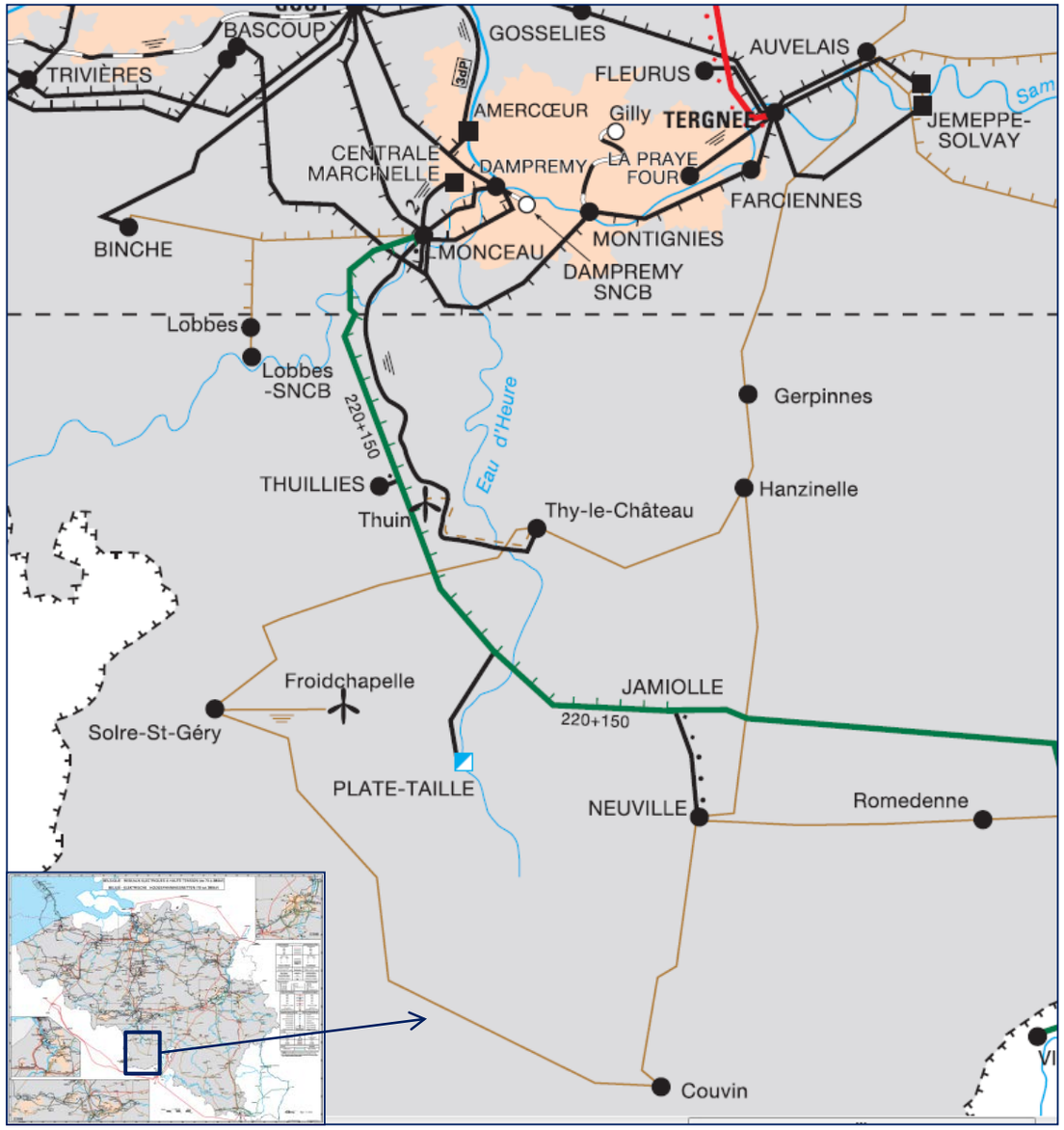
- To validate the concept proposed by GARPUR for the screening of operating states in a near-real life environment
- To compare its performance with more conventional approaches implemented in the same environment
- Recommendations for improvement of the new approach



Near real-life pilot testing

Belgian regional transmission grid:

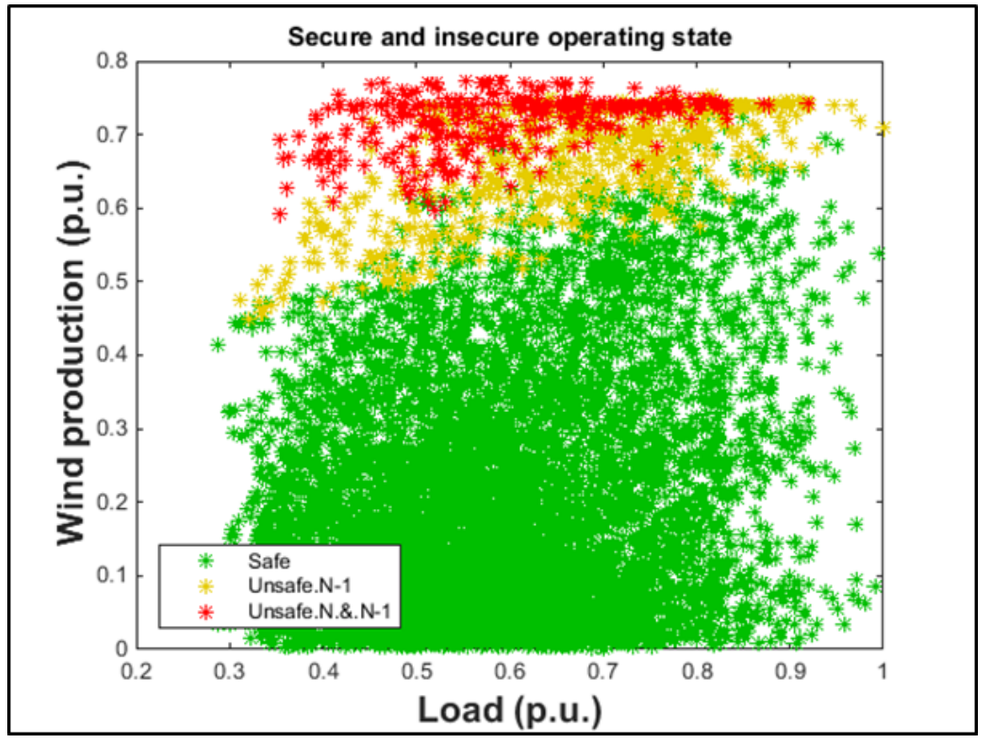
- Rural 150 - 70 kV grid
- Main needs in LT:
  - End of Life: [2025 – 2030]
  - Wind integration
  - Maintainability assessment

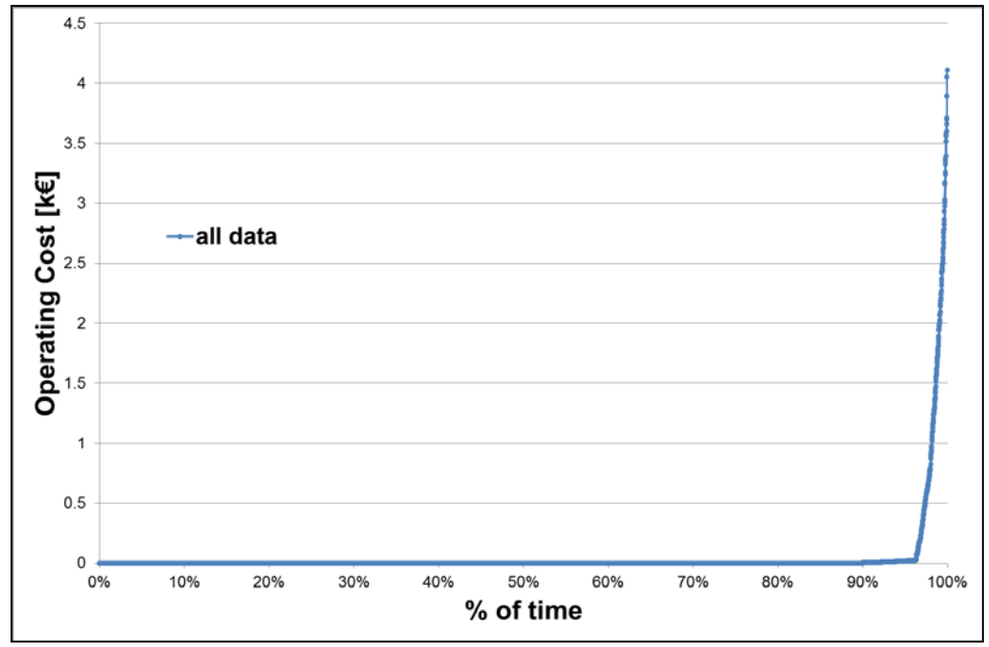


Near real-life pilot testing

Results on full year data set (1 point = 1 hour)

- 14% of the operating cases were insecure (N and N-1)
- Only 4% of the operating cases are a significant operating cost (OPEX) if taking into account the failure rate (Insecure in N)
- Global operating cost is 414 k€/yr

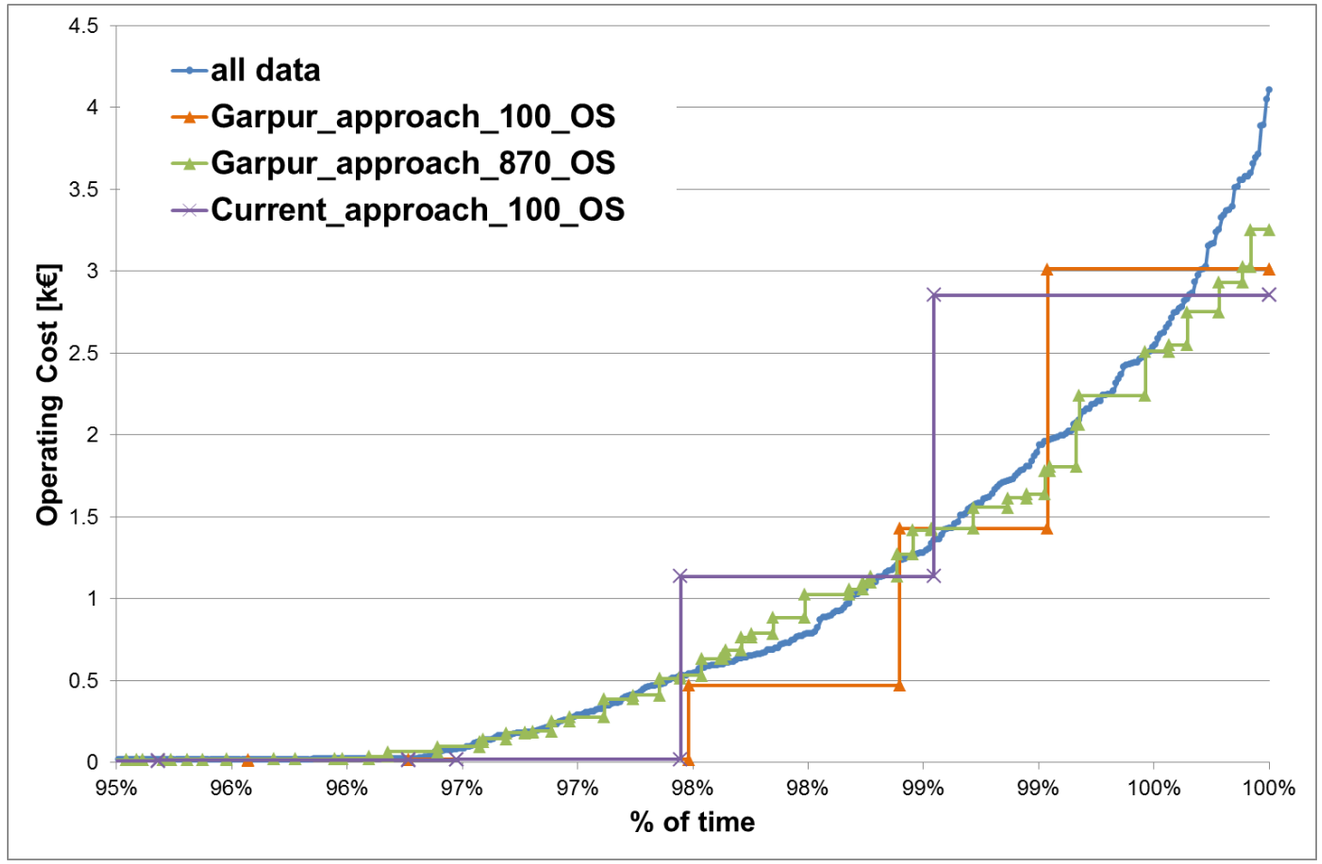




Near real-life pilot testing

- All assessed clustering methodologies failed to capture the high impact / low probability operating state.

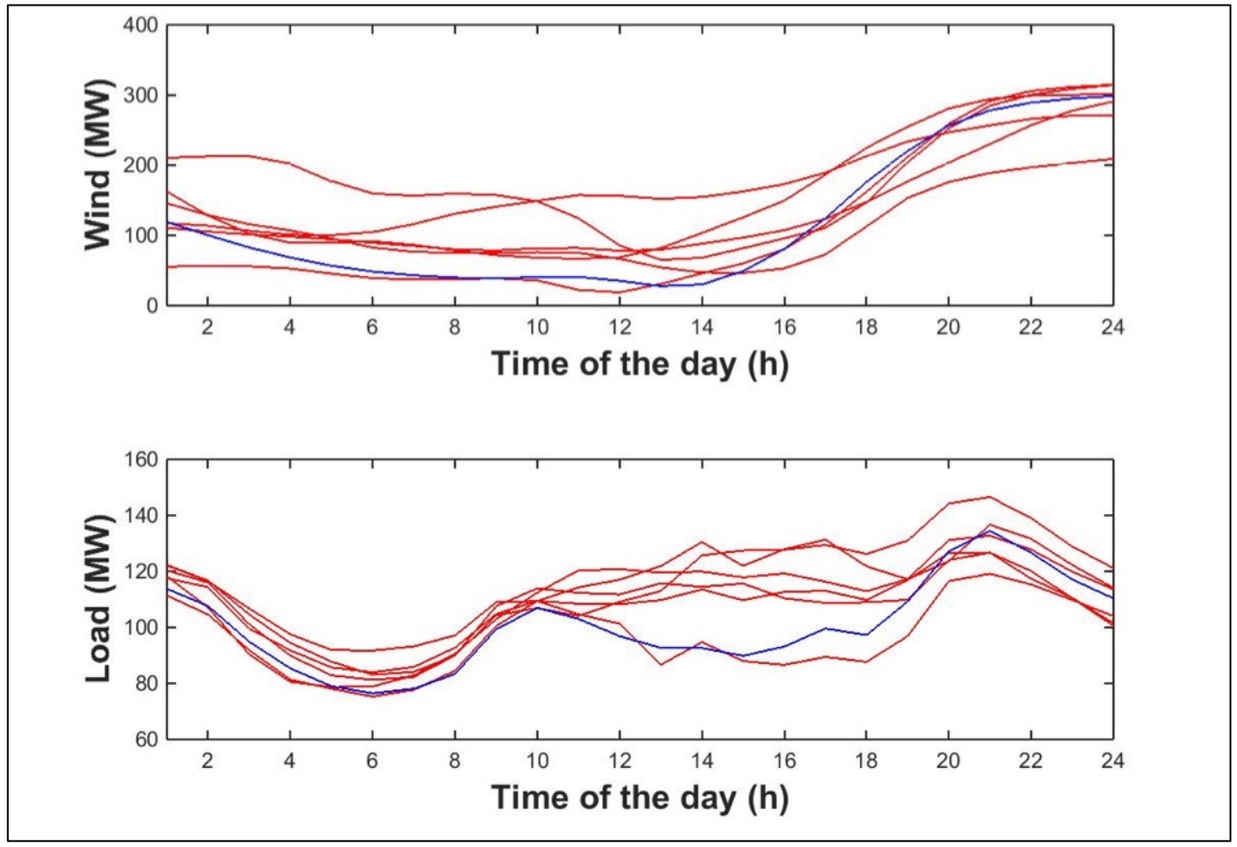
- Computation time to cluster all data to 100 representative Operating States (OS)
  - Current method : 15 minutes (Solver Tool in Excel)
  - K-means : 1 minute (Matlab)
  - (3.4 GHz – 8 cores – 16 GB)

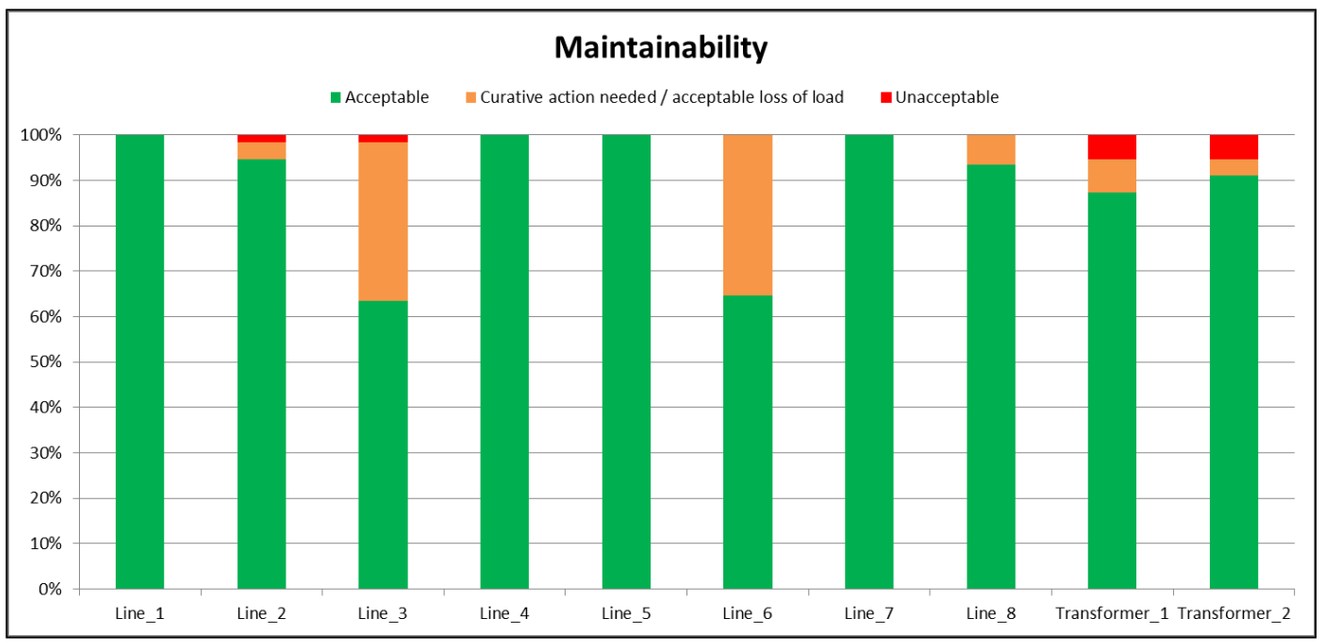


Approach		Operating cost	
		[k€]	Relative Error
Full data set		414	0%
Clustering GARPUR (K-means)	100	377	-8.9%
	870	397	-4.1%
Clustering Current (Solver in Excel)	100	477	15.2%

Near real-life pilot testing

- To evaluate the “maintainability” of the grid:
  - To compute all the N-1-X (the first -1 being a planned outage and the –X being a contingency list) on the typical reference days (result of 24 h time series clustering).





Lessons learnt and main recommendations

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Lessons learnt

- Proposed workflow for system development analysis:
  - The implementation of the reliability criterion and socio-economic assessment
  - To be adapted to different power systems
  - The migration from current TSO practices
- Method/proxies validated on a real test case and in a real-life environment (Tools used within Elia) with main focus on:
  - Complexity reduction stage
  - Impact quantification
  - Assessment of maintainability

Main recommendations

- Recommendation 1 - “Collect and share outage data”
  - Define a framework for collecting context dependent asset outage data.
  - Adopt framework on a larger sampling base to improve data quality

- Recommendation 2 - “Study a wide variety of contexts and clustering”
  - Establish grid development standards to consider the different expected future operating conditions and their evolution to plan the power system
  - Adopt suitable clustering methods to allow a greater but not excessive number of ‘micro-scenarios’ to be assessed

- Recommendation 3 - “Consider and quantify operational impact of events”
  - Improve the SCOPF algorithm to mimic the actions of the operator in short-term / real-time
  - Define at EU level the factors to be considered for adequate evaluation of the societal impact of events on grid users, TSOs and regulators

- Recommendation 4 - “Take into account maintenance scheduling in grid development context”
  - Adopt methods for the analysis and quantification of impact of maintenance and project work

THANK YOU FOR YOUR ATTENTION

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