Impact assessement of flood damage on power grid customers

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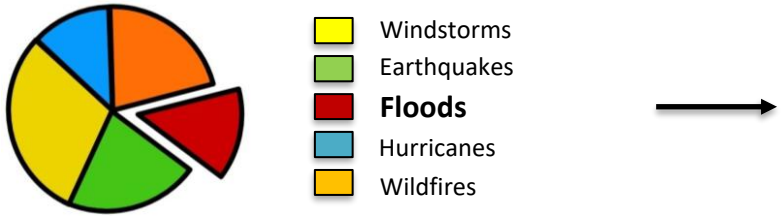
Literature review

Natural hazards are a leading driver of power interruption to end-users around the world.

- Flood events may have a significant impact on power grids functionality in terms of:



Frequency

Magnitude

Power outage duration

- Maintaining the security of power supply under emergency conditions triggered by floods is a challenging task because of the:

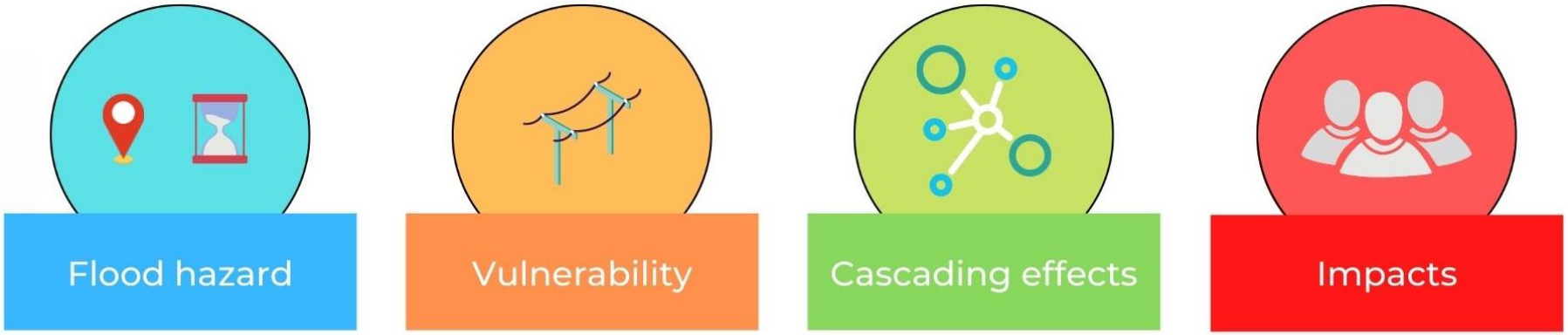
Structural complexity

Dynamic complexity

Research aim and objectives

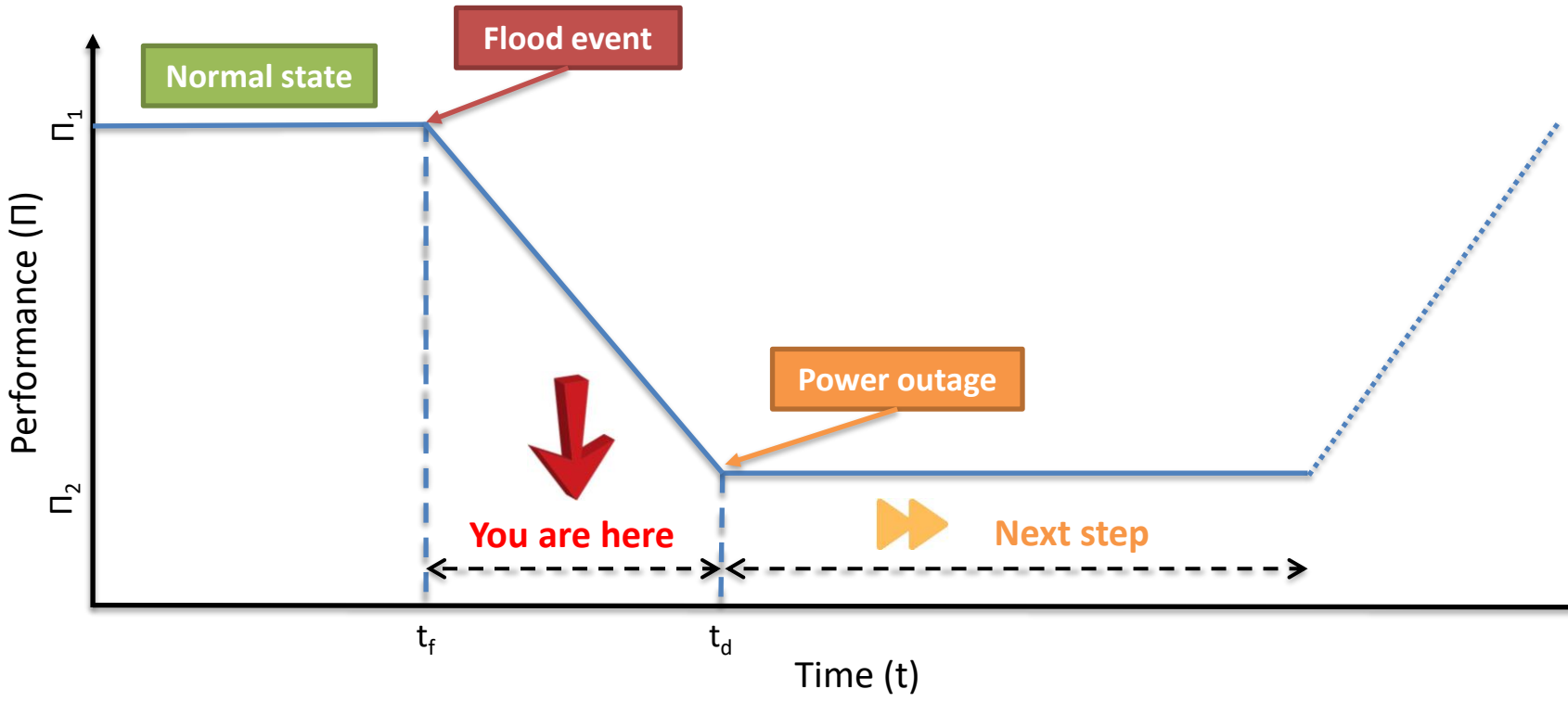
In such a context, we propose a new model for the estimation of direct, indirect, and systemic damage.

- The key objective of this model is to be an operational tool able to:



System resilience

Evaluating the resilience of power grids to flood events, someone would wonder:

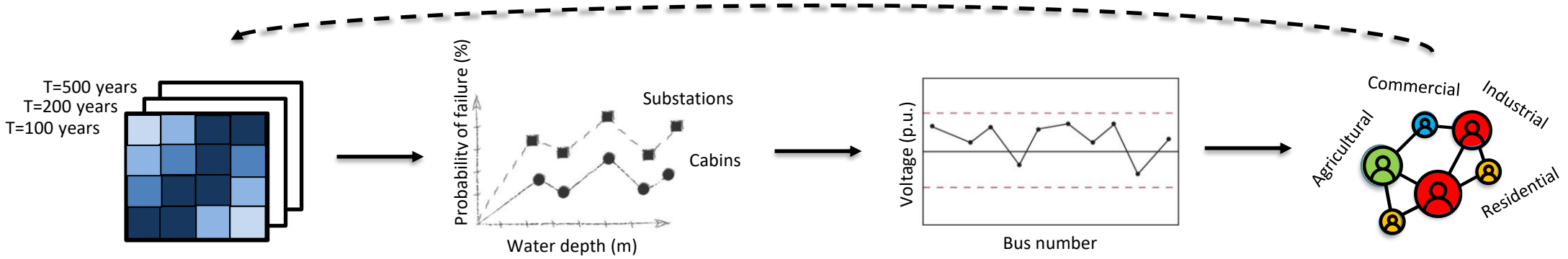


Where are we now?

Workflow

To achieve this goal, the model combines:

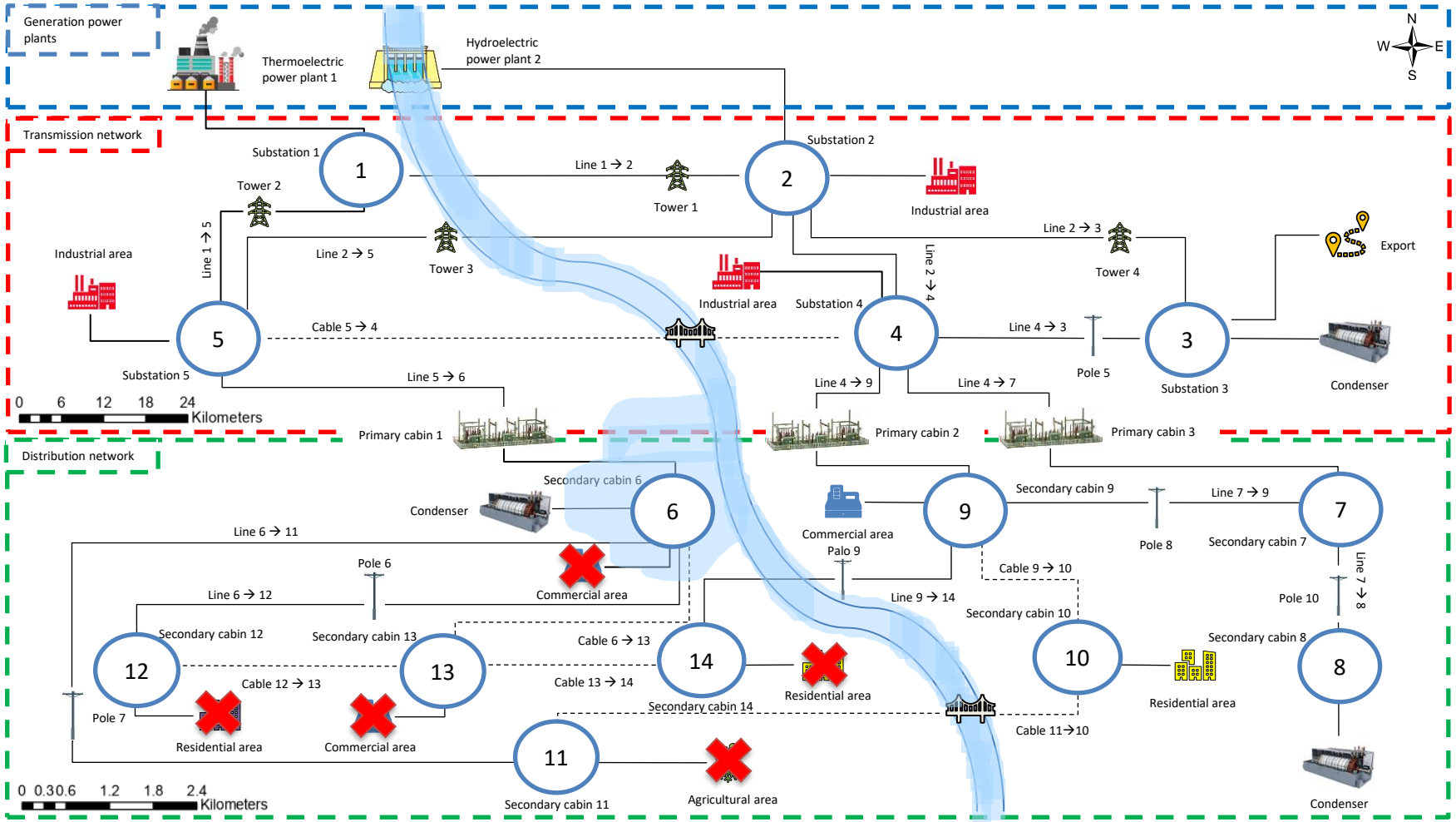
i. deterministic flood hazard scenarios developed by the HEC-RAS 2D modeling
ii. fragility curves of power grid components for different voltage levels
iii. a spatially distributed power flow model referring to the IEEE 14 bus system benchmark
iv. a social model describing the various users connected to the power grid

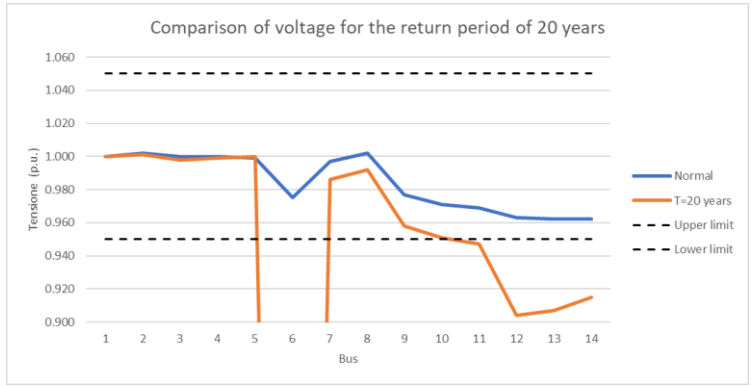


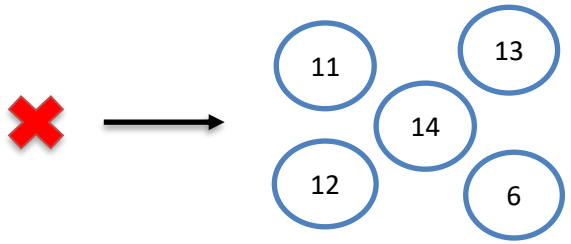
Flood hazard maps *Fragility curves* *Load flow analysis* *Impact modeling*

Results

1. T = 20 years



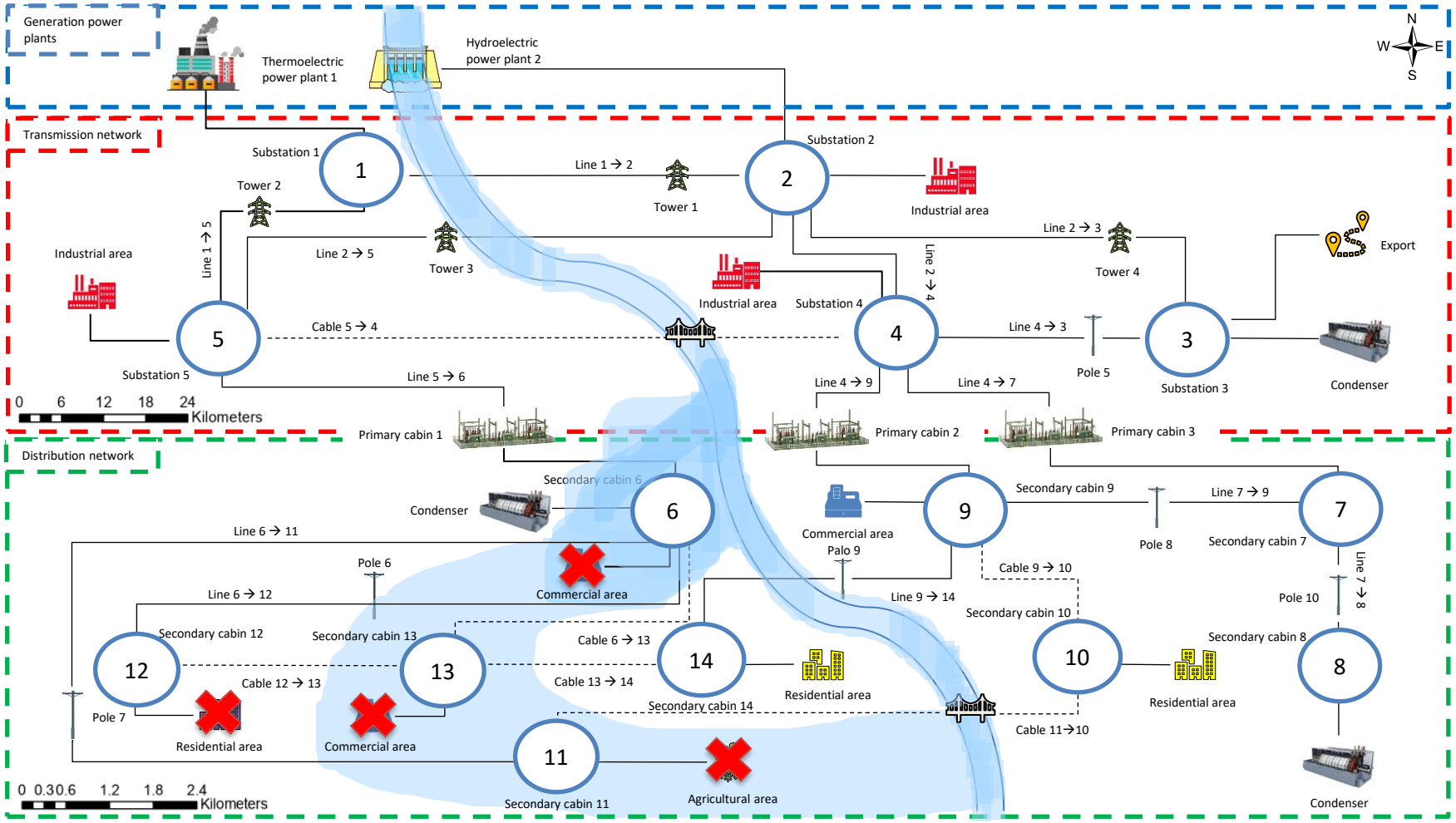


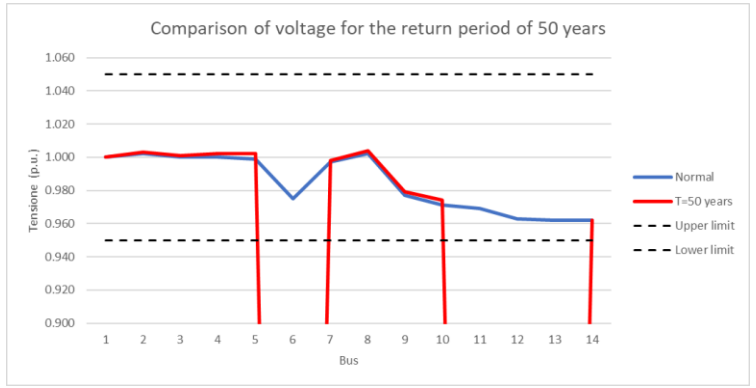


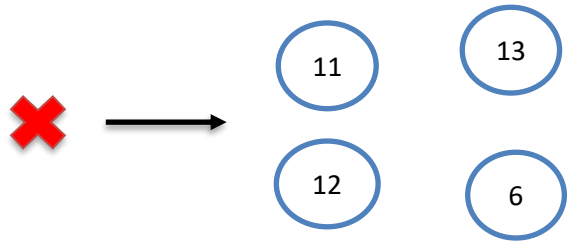
Failure of only the west part of distribution network

Results

2. T = 50 years



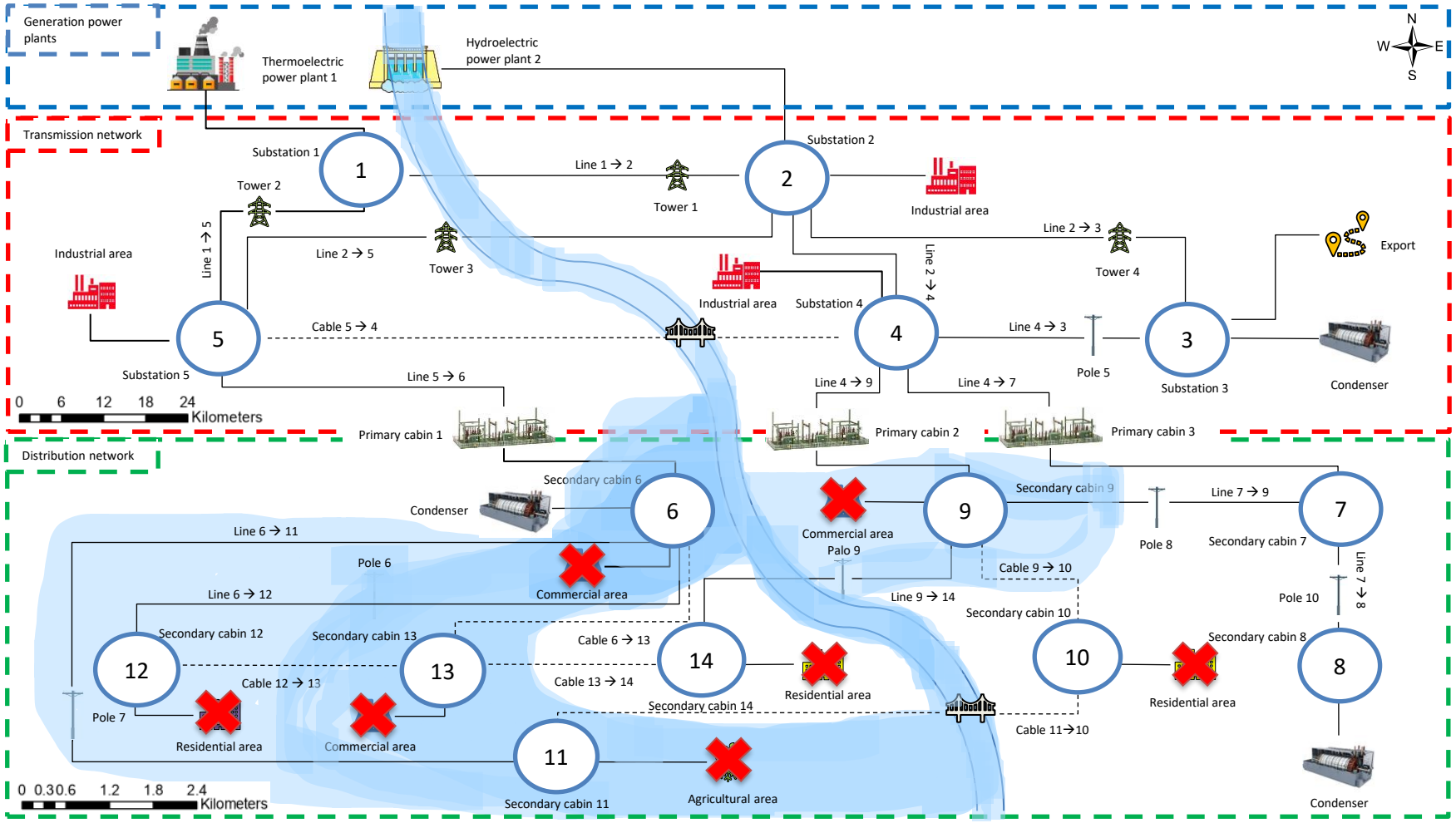


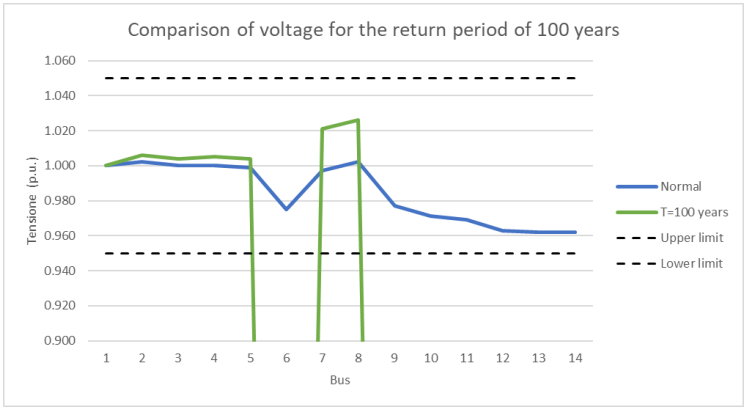


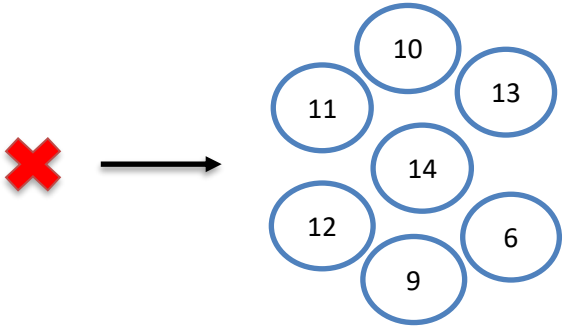
More cabins have been flooded but less cabins have been failed

Results

3. T = 100 years



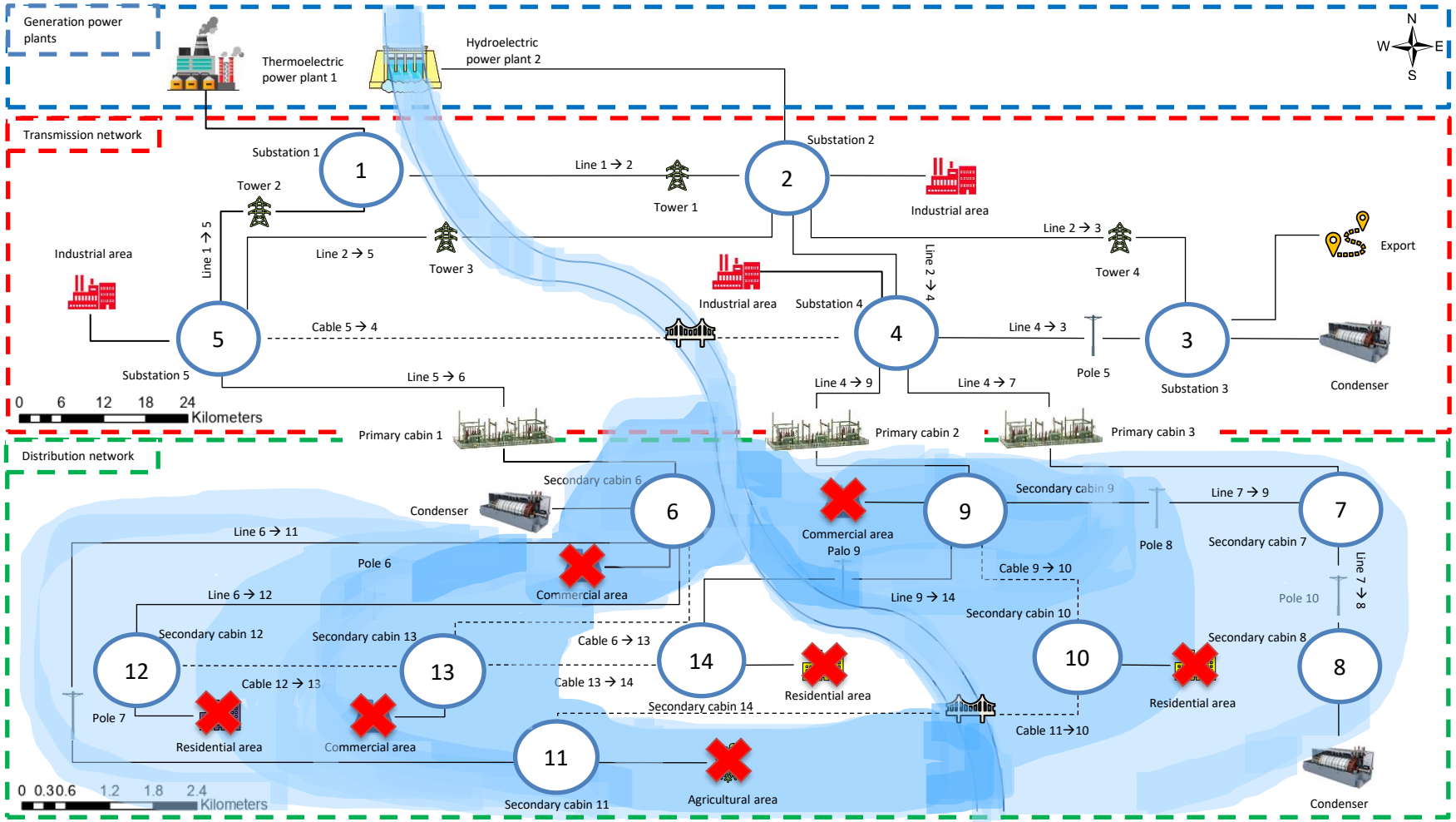


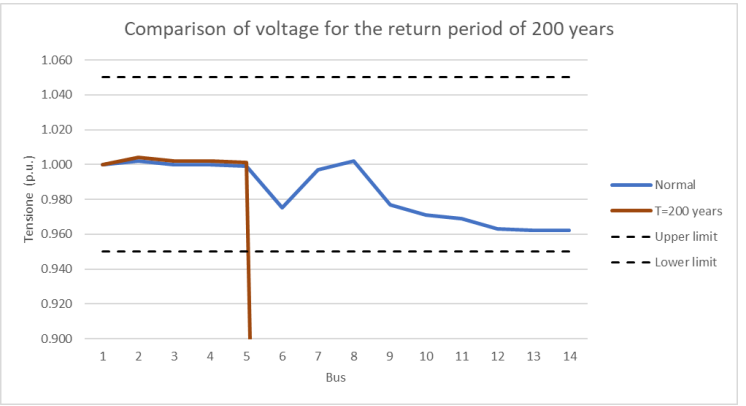


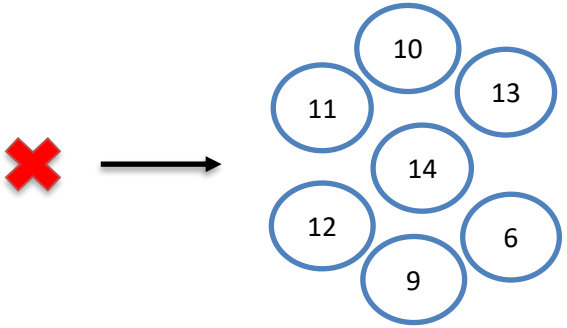
Failure of the whole distribution network

Results

4. T = 200 years



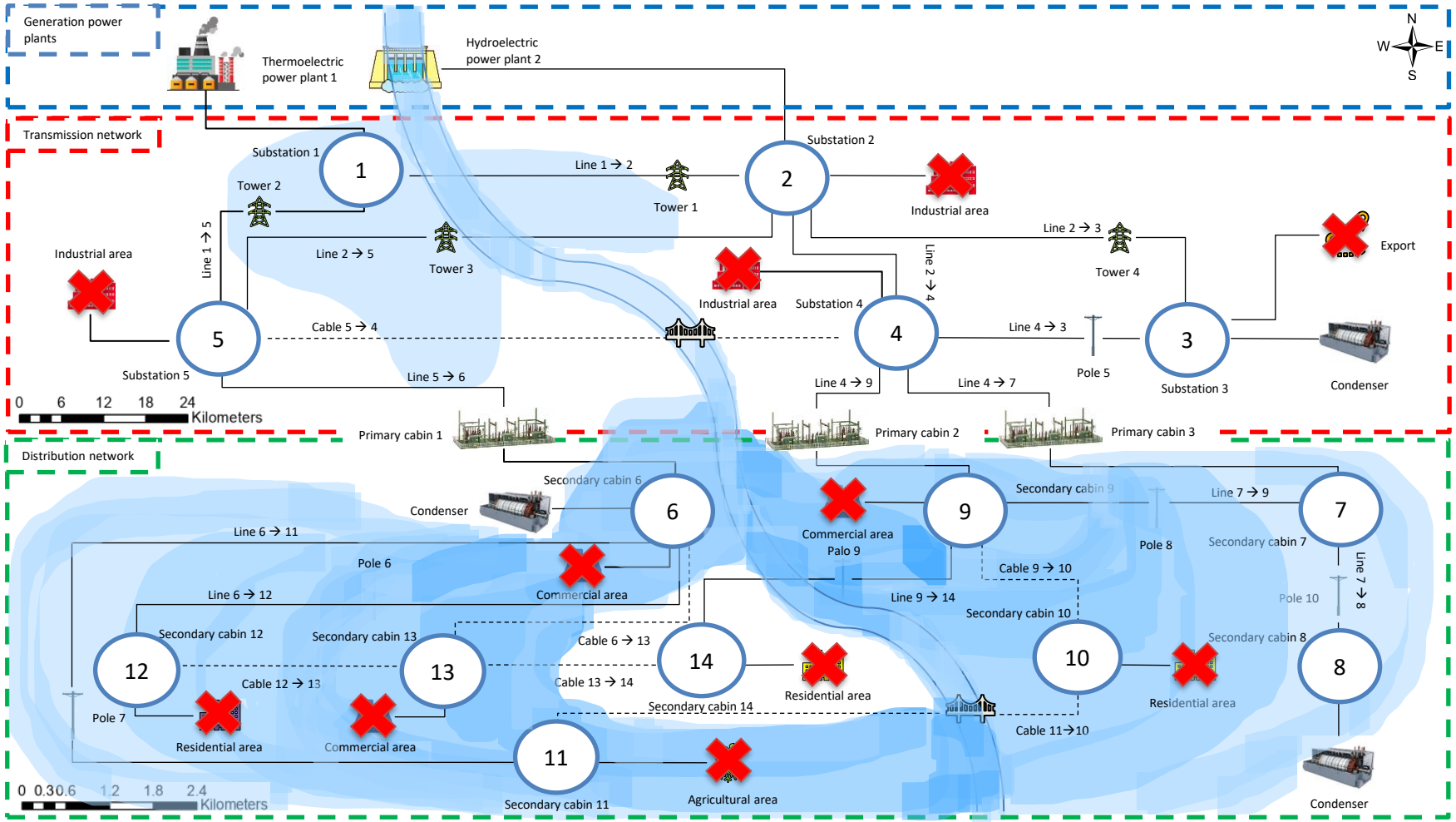


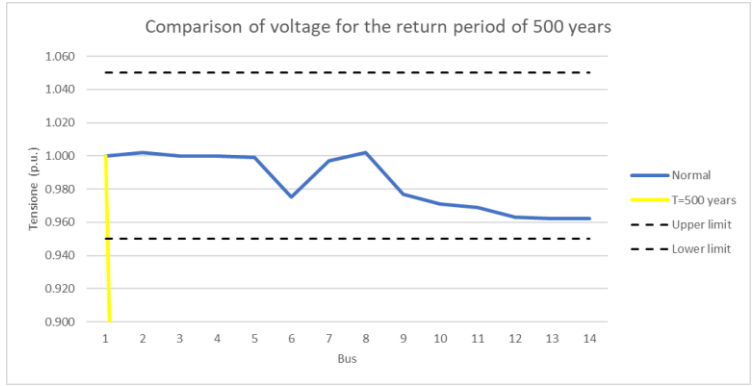


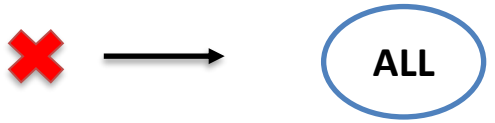
More cabins have been flooded but the same number of cabins failed

Results

5. T = 500 years





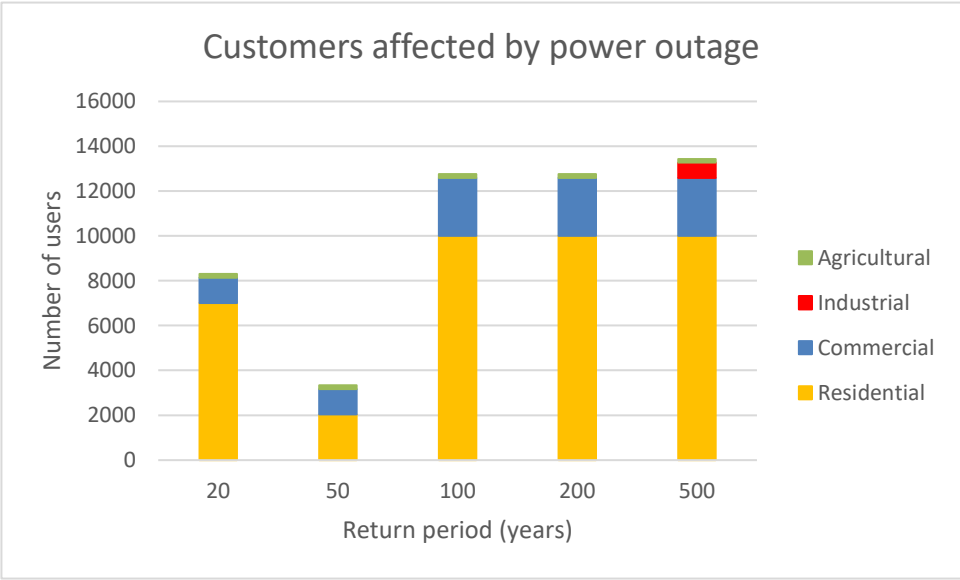


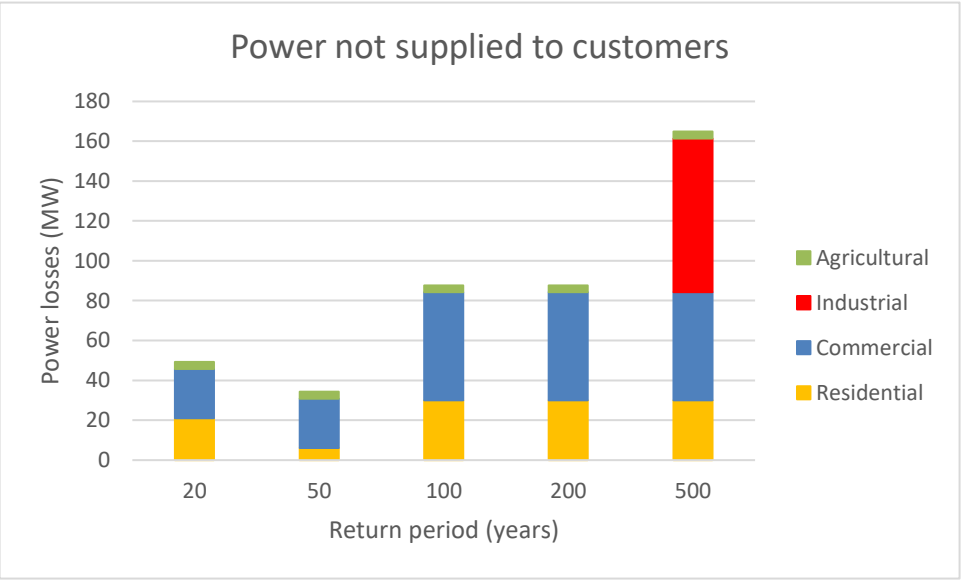
Failure of both the transmission and distribution network

Conclusions

The impact assessment of flood damage on power grid customers evidences:

- the propagation of damage to power-dependent customers far from the flood event
- the need for real-time optimal dispatch strategies in emergency planning
- the criticality of certain substations and cabins for the security of power grid supply

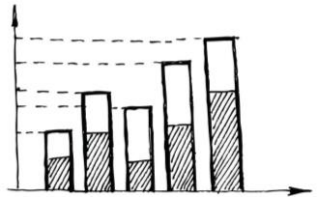




Future recommendations

Next research efforts will be devoted to the:

- adoption of a probabilistic approach, by substituting deterministic hazard scenarios with spatial dependent, probabilistic ones

Deterministic   Probabilistic

- sensitivity analysis of the different modeling phases to identify the components of the model on which the final damage scenario depends mostly