

System Operation

METHODS AND LESSONS LEARNT FROM
PILOT TESTS



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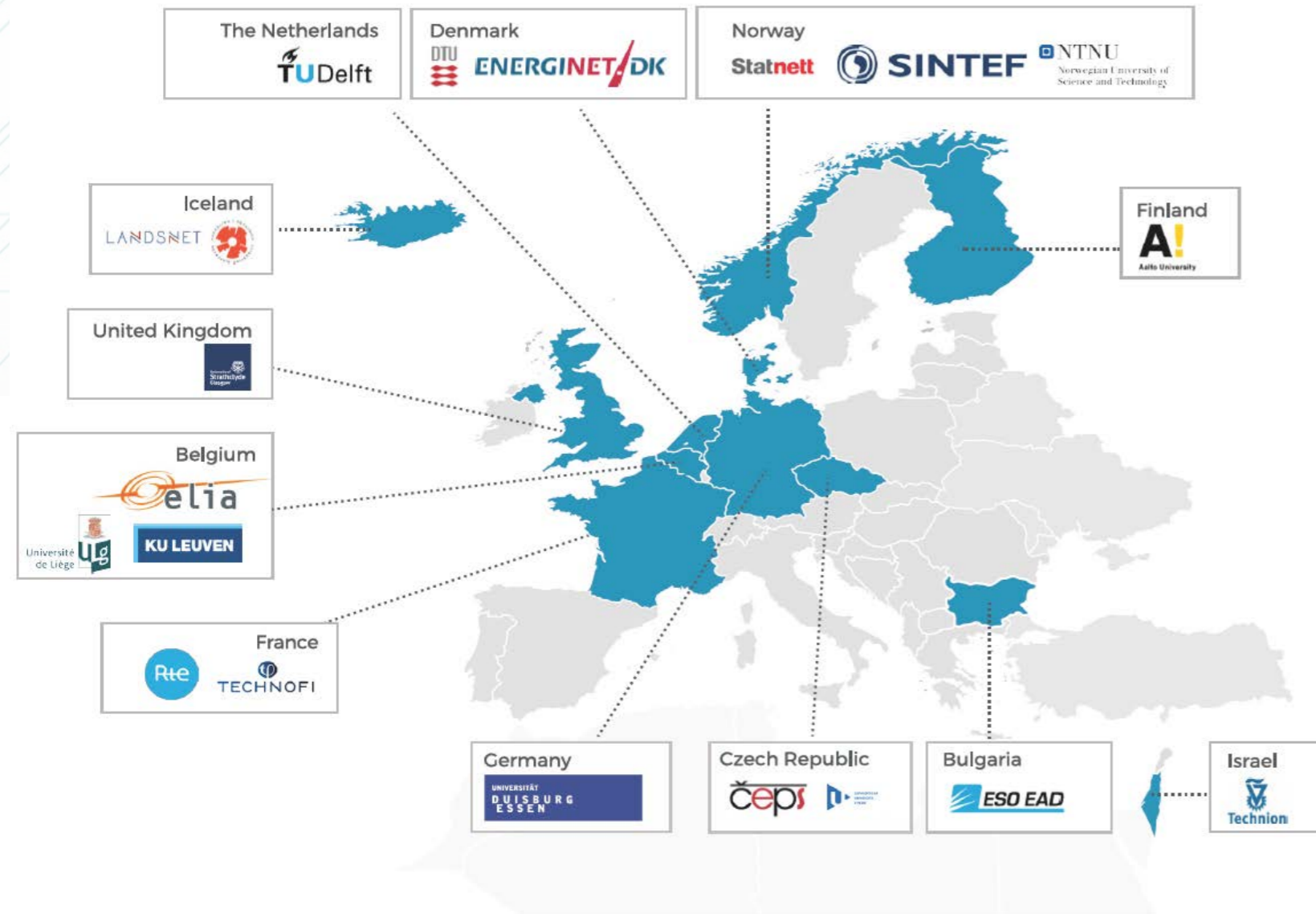
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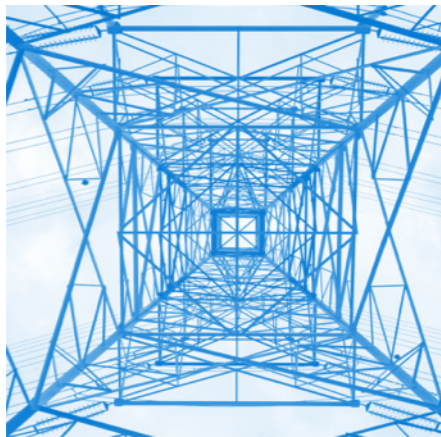
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2 public deliverables
3 internal deliverables



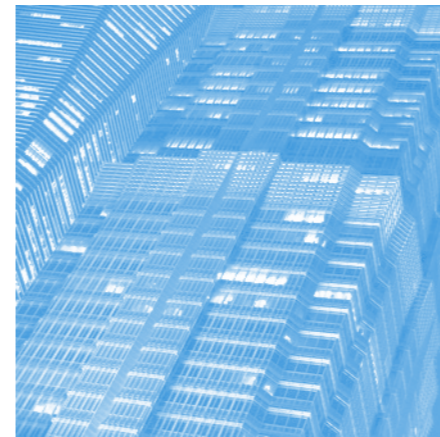
OUTLINE



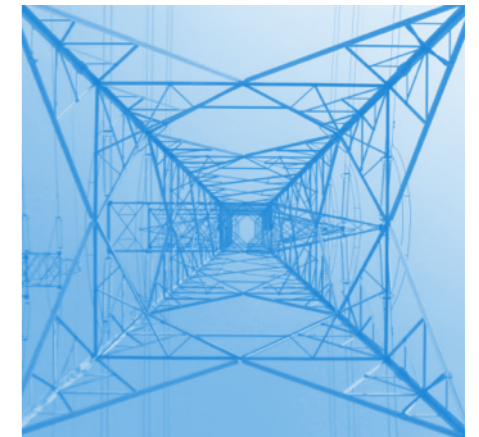
Today's challenges
in system operation



GARPUR method
applied to RT and
Short-term
operations



Lessons learnt
from Pilot tests

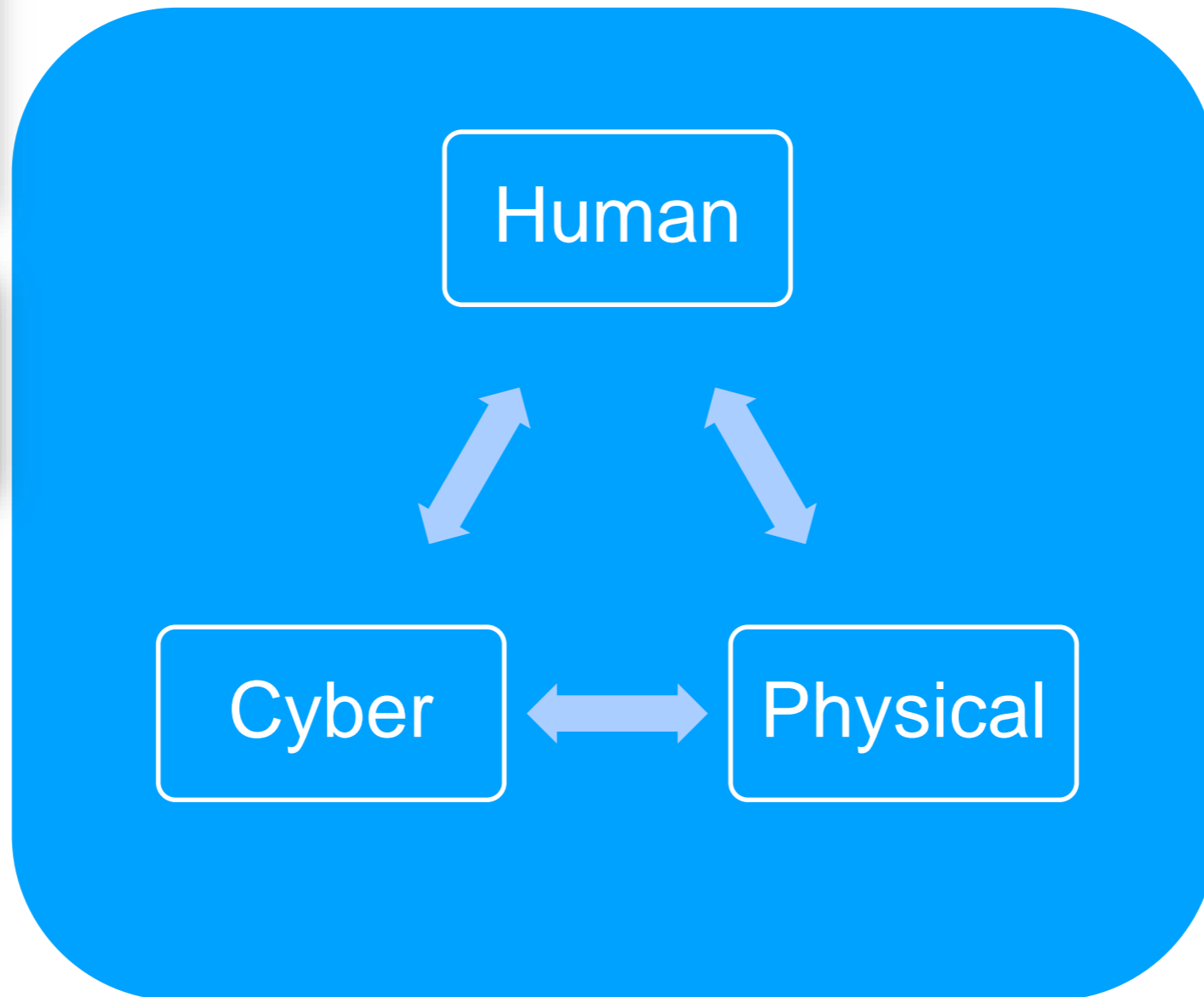


How can TSO's
move forward in
system operation?



Today's challenges in system operation

Complex system in a complex environment

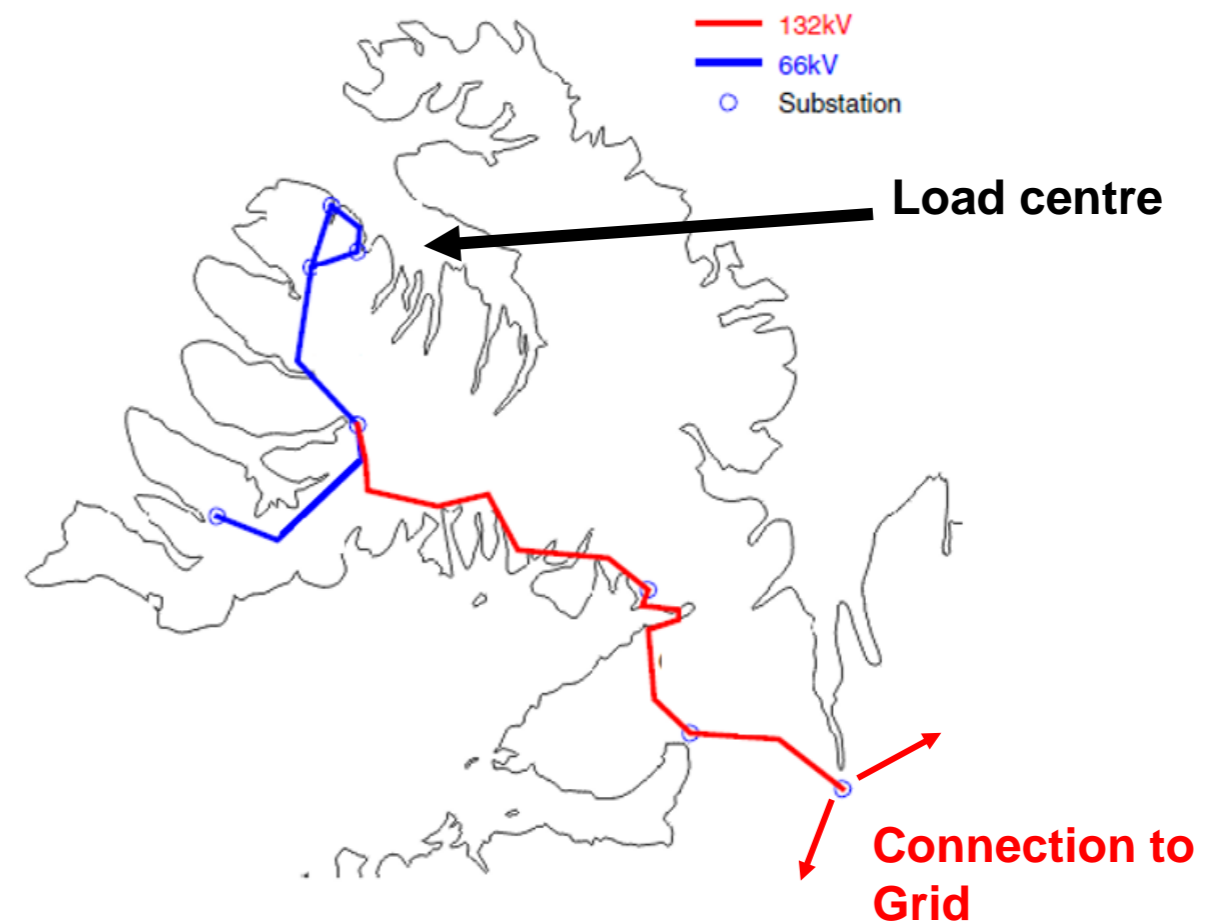




Does N-1 bias us to solving reliability issues with new infrastructure?

EXAMPLE: radial connection (not N-1 secure)

- Installed microgrid system to improve reliability (still not N-1 secure)
- Need new ways to quantify/justify such investments





GARPUR method applied to RT and Short-term operations





GARPUR proposes novel methods for **risk assessment:**

In real-time, taking into account:

- ✓ Current system status, including variable load and generation
- ✓ System response to contingencies
- ✓ Weather conditions and other factors impacting component failure rates.

In the coming hours/days, take into account the following variables:

- ✓ Weather conditions
- ✓ Failure rates of components
- ✓ Load and RES forecasting errors

GARPUR proposes novel methods for **risk control:**

Defining a 'proxy' of real-time operation:

- ✓ A fast estimate of RT risk
- ✓ Used to quickly assess and compare different preventive and corrective control actions
- ✓ Suggest actions to minimize risk to the control room operator.

Which can extend GARPUR into longer time frames:

- ✓ Week ahead maintenance planning
- ✓ Year ahead maintenance scheduling
- ✓ Assess impact of new infrastructure



The transition to a probabilistic approach

New methodology = new indicators

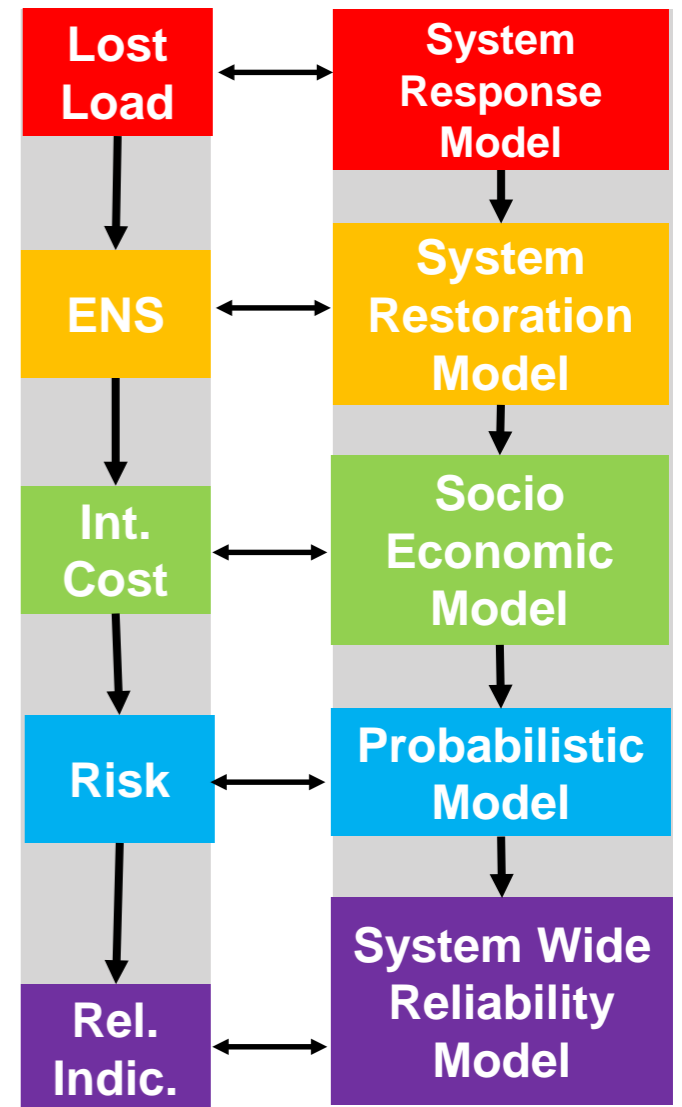
The three main aggregate indicators in the GARPUR method are:

- Assessed Risk
- Residual Risk
- Probability of an acceptable system state



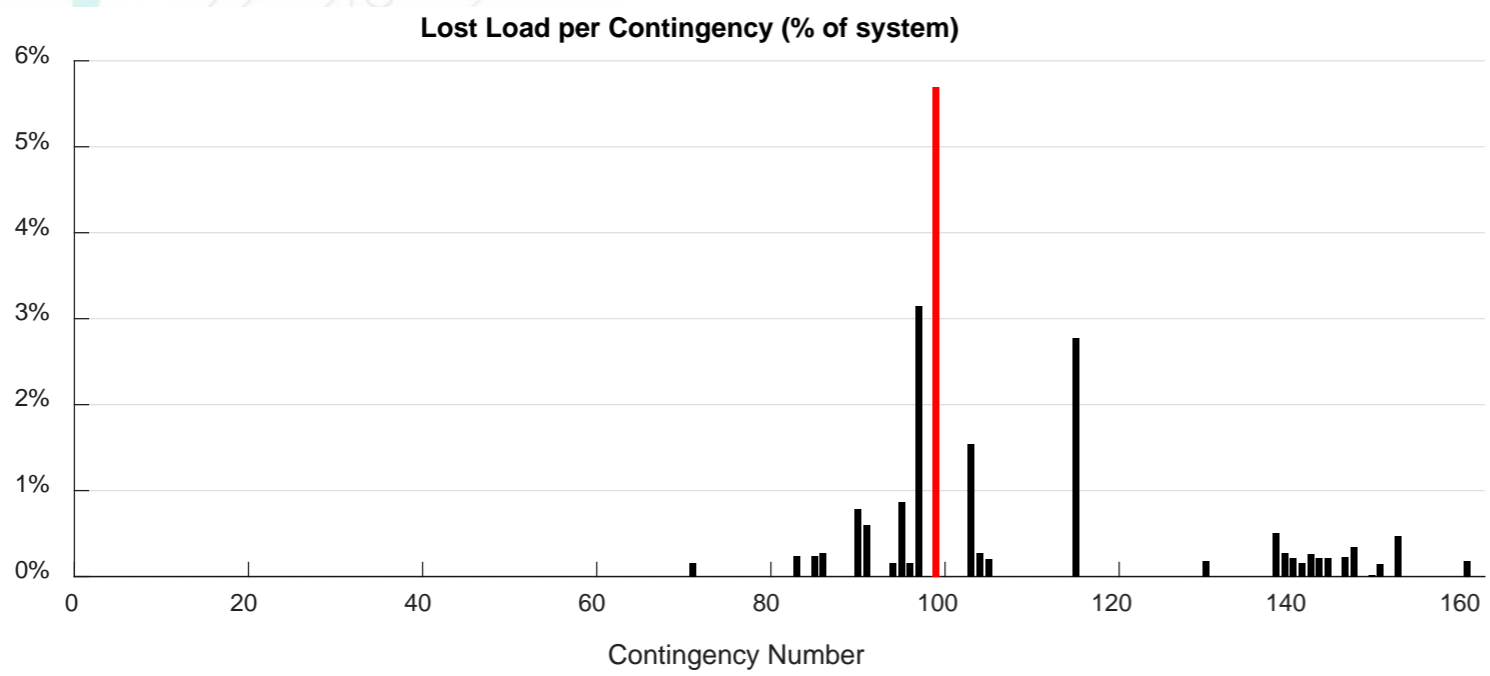
Will the system state be *N-1 secure*?

Is there a *high probability* that the system state will be *acceptable*?

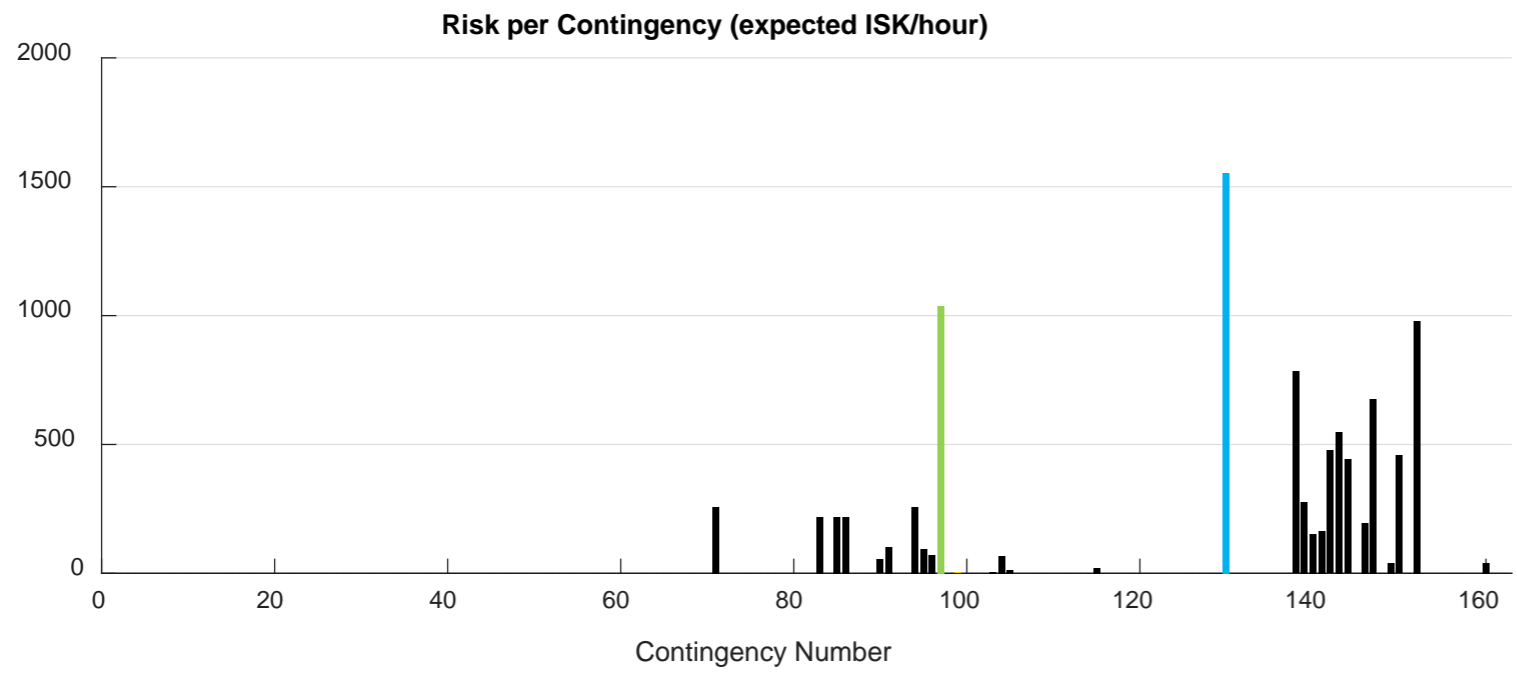




GARPUR METHOD APPLIED TO SYSTEM OPERATION

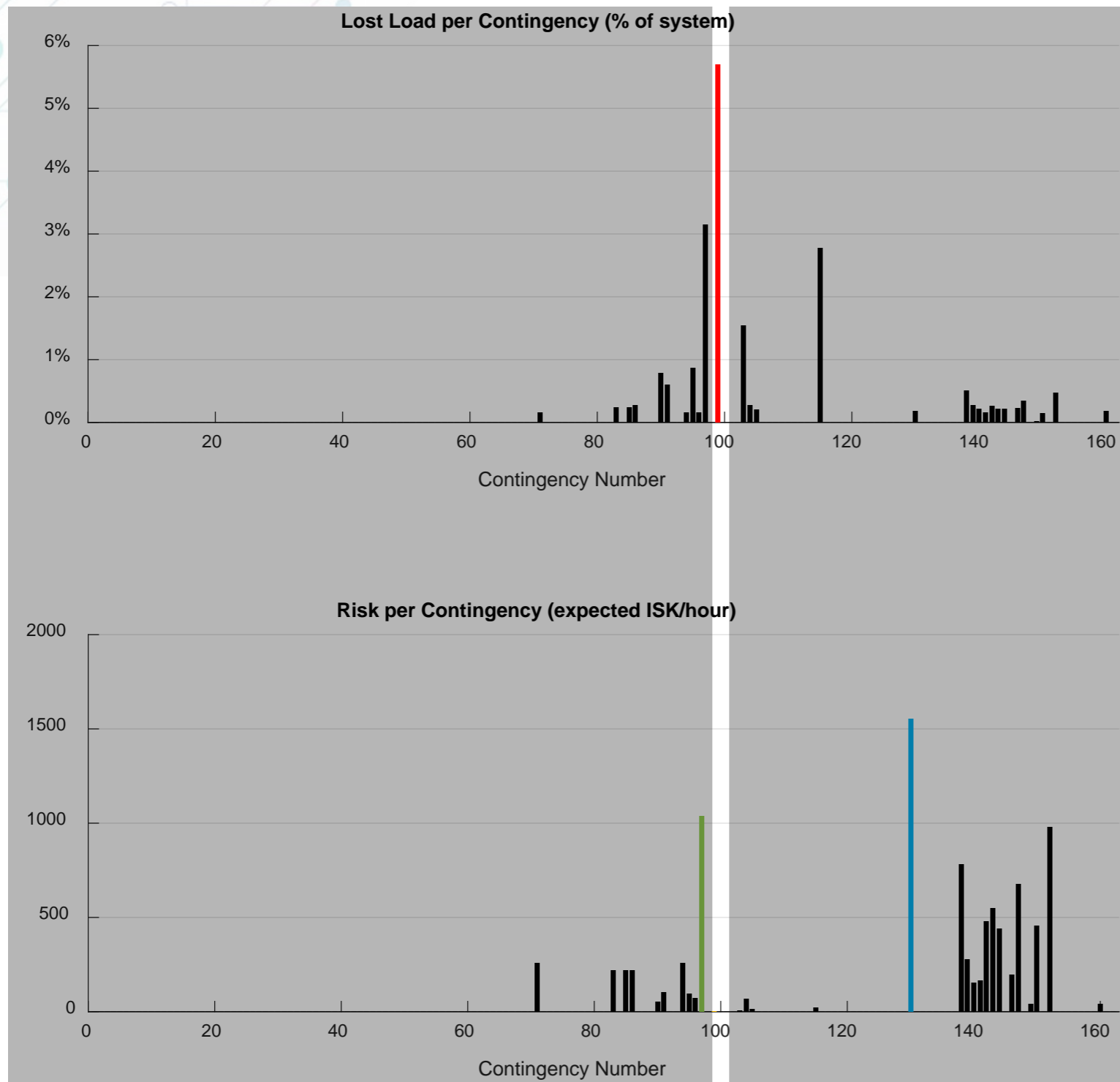


Example output from the Icelandic pilot test





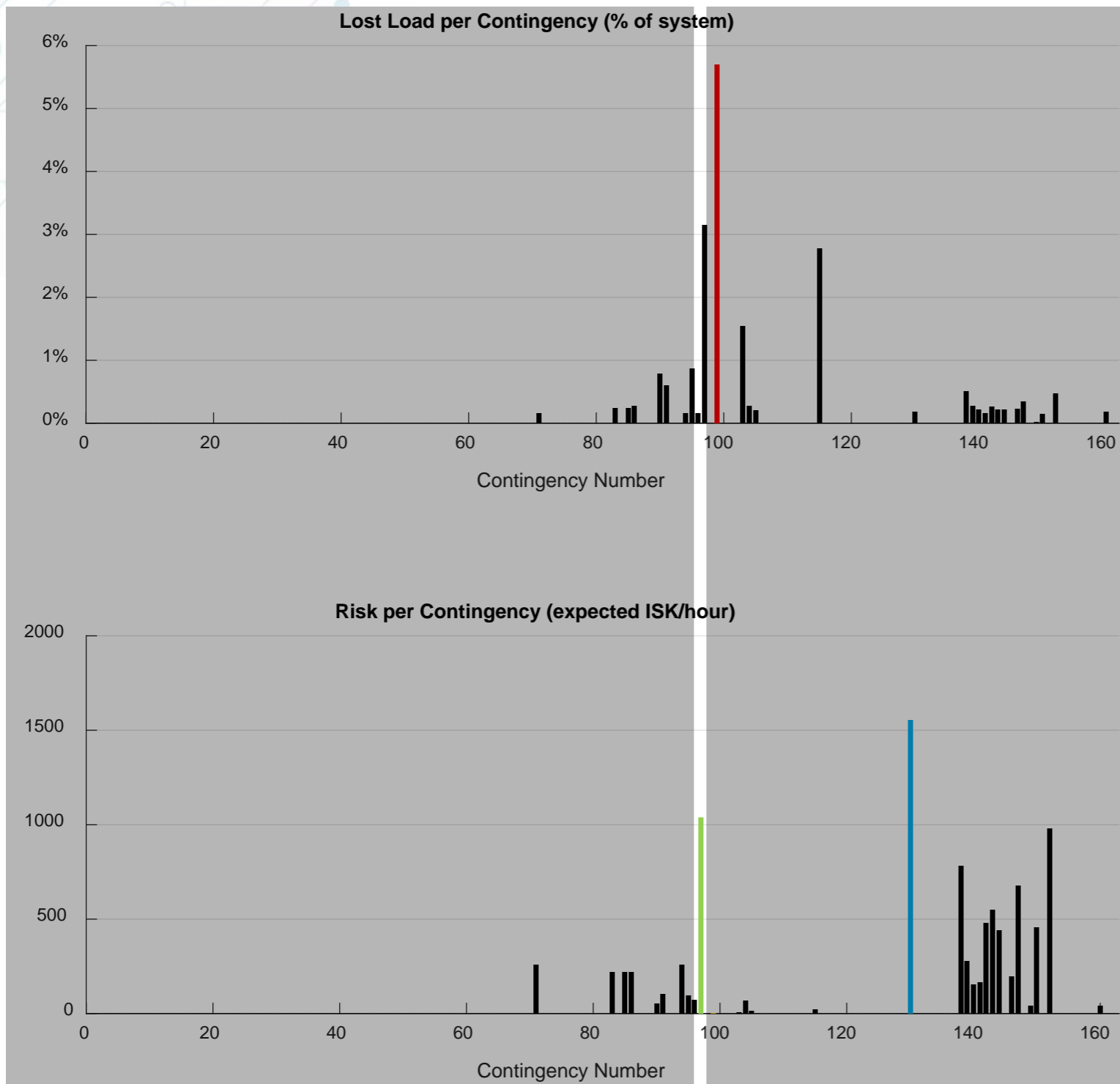
GARPUR METHOD APPLIED TO SYSTEM OPERATION



Lost Load Contingency with most lost load has a probability so low that the risk is nearly insignificant

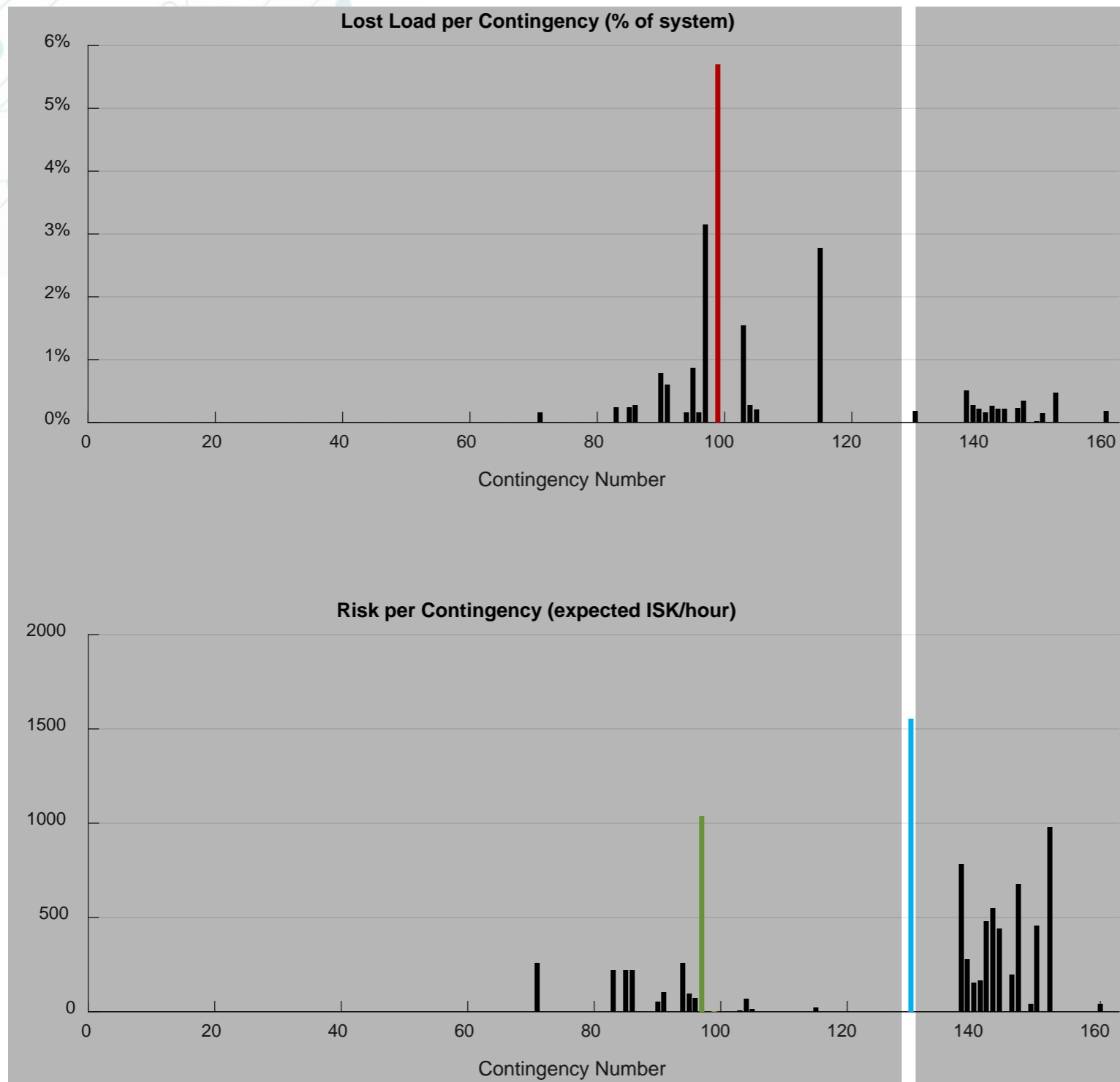


GARPUR METHOD APPLIED TO SYSTEM OPERATION



Lost Load Contingency with most lost load has a probability so low that the risk is nearly insignificant

Cost The socio-economic impact of the green contingency is higher than others, but not most probable



Lost Load Contingency with most lost load has a probability so low that the risk is nearly insignificant

Cost The socio-economic impact of the green contingency is higher than others, but not most probable

Risk Highest risk contingency is not noticeable in terms of lost load, but is far more likely to occur than others

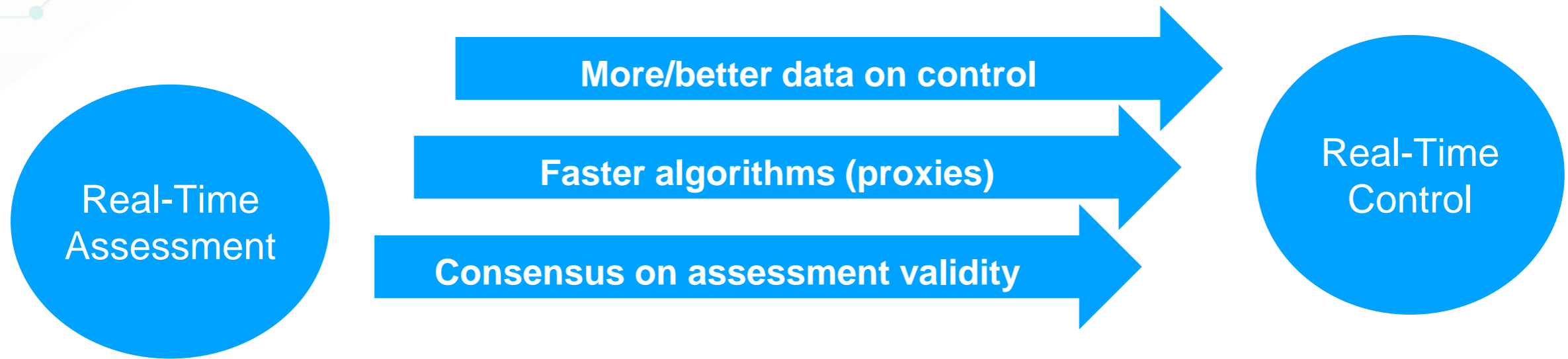


How do we move forward from real-time assessment?

Real-Time
Assessment

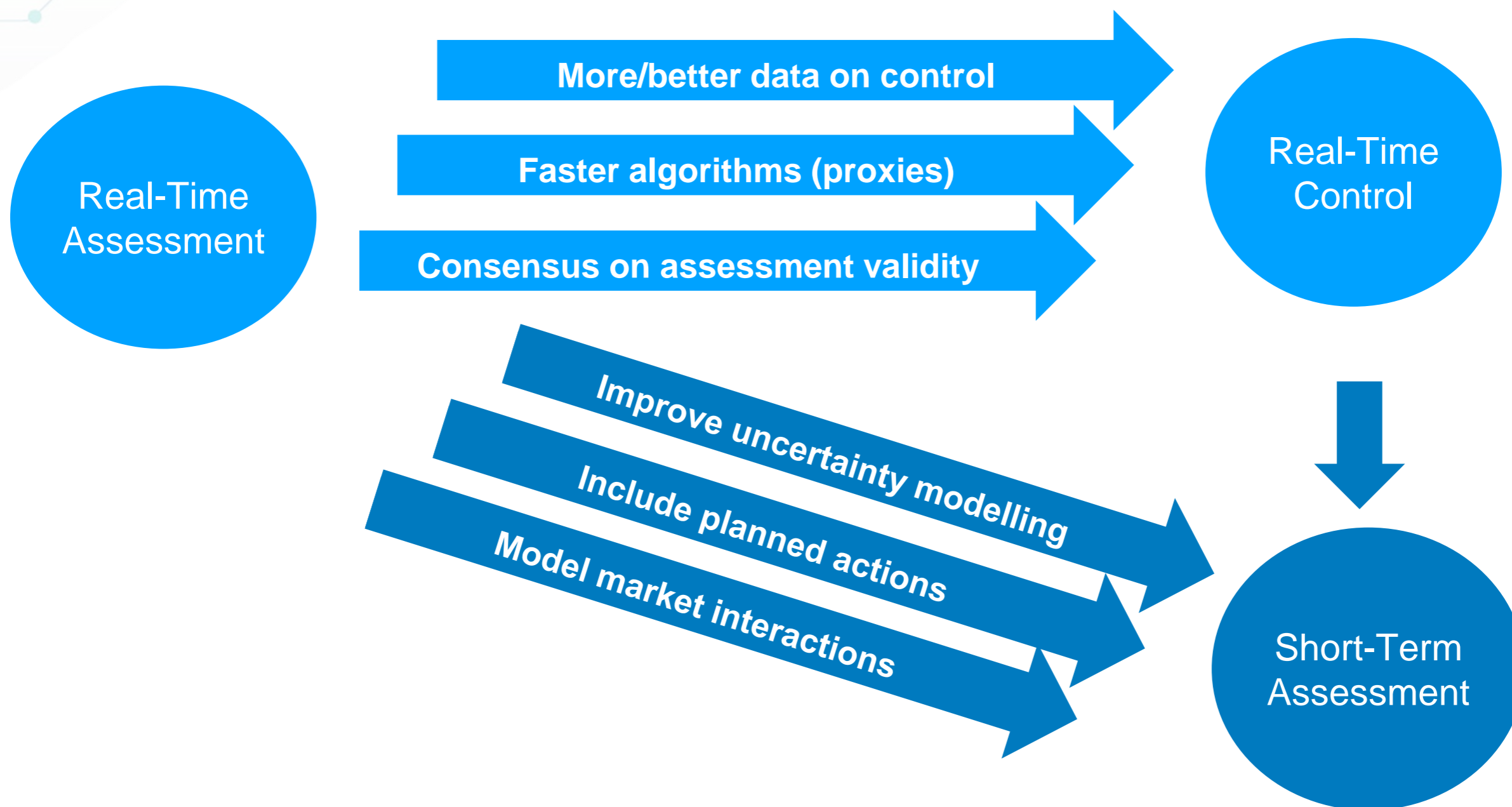


How do we move forward from real-time assessment?





How do we move forward from real-time assessment?





Lessons learnt from Pilot tests



The Icelandic System



■ Pilot test objectives

- Is the computation fast enough?
- Does the output make sense?
- How sensitive are the outputs?


Pilot Test Grid Model


Buses: 85

Branches: 107

Generators: 71

Loads: 65

220kV 

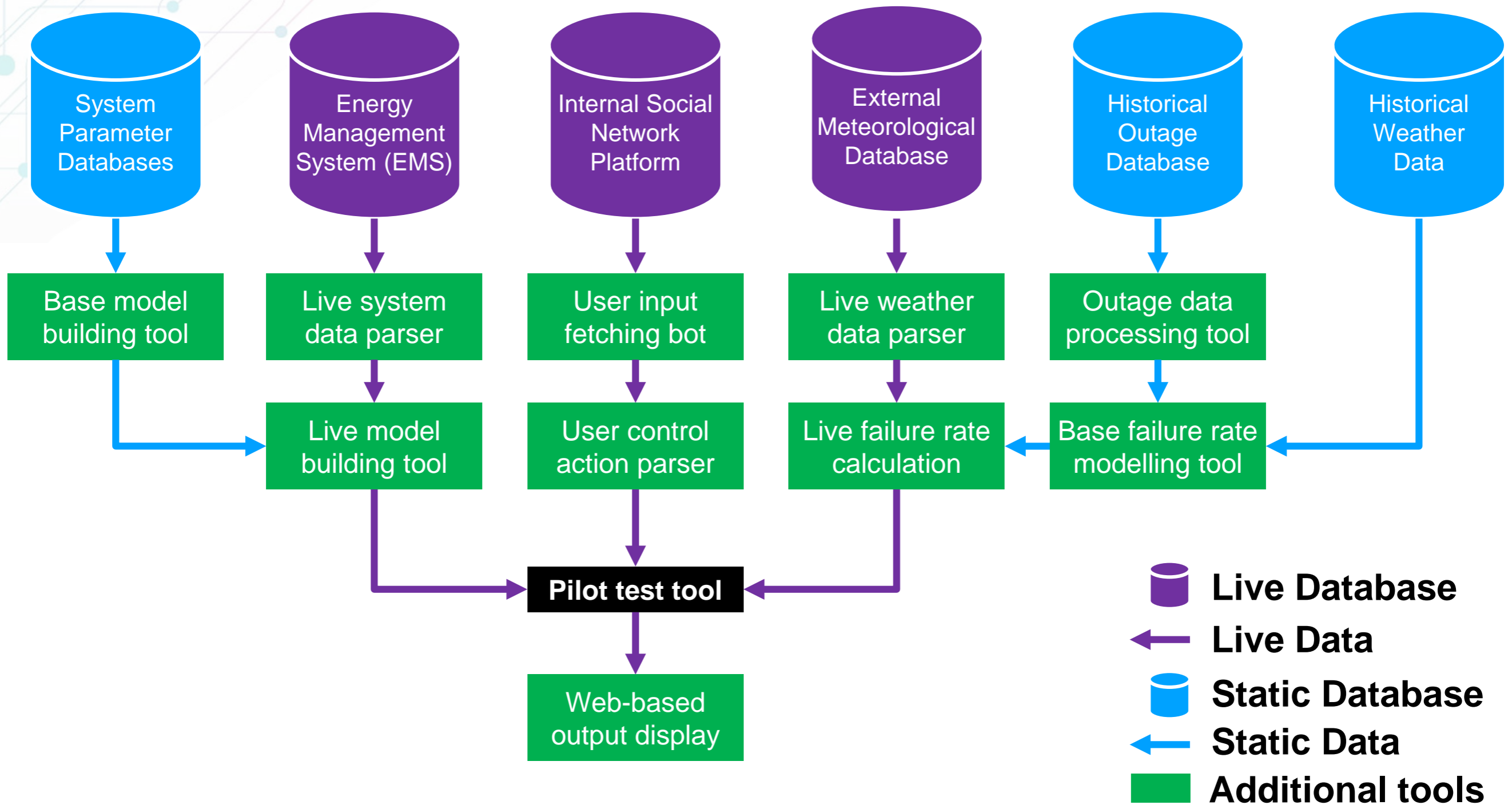
132kV 

66kV 

33kV 



LESSONS LEARNT FROM PILOT TESTS





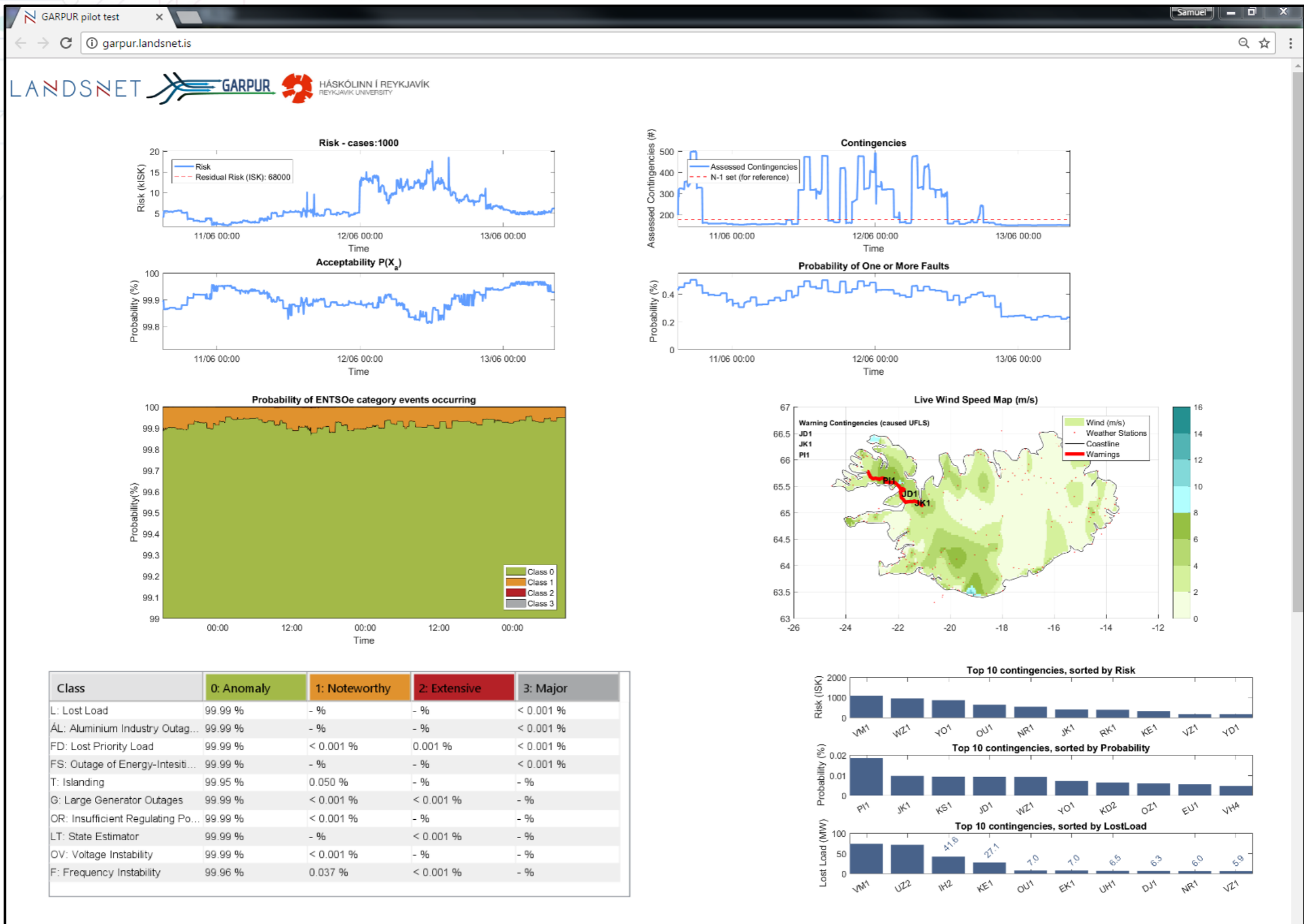
LESSONS LEARNT FROM PILOT TESTS

- **Processor** 2.2+ GHz 10 cores
- **Memmmory** 32 GB
- **Hard Drive** 512 GB SSD
- **Network**
- **Reasonable desktop PC**



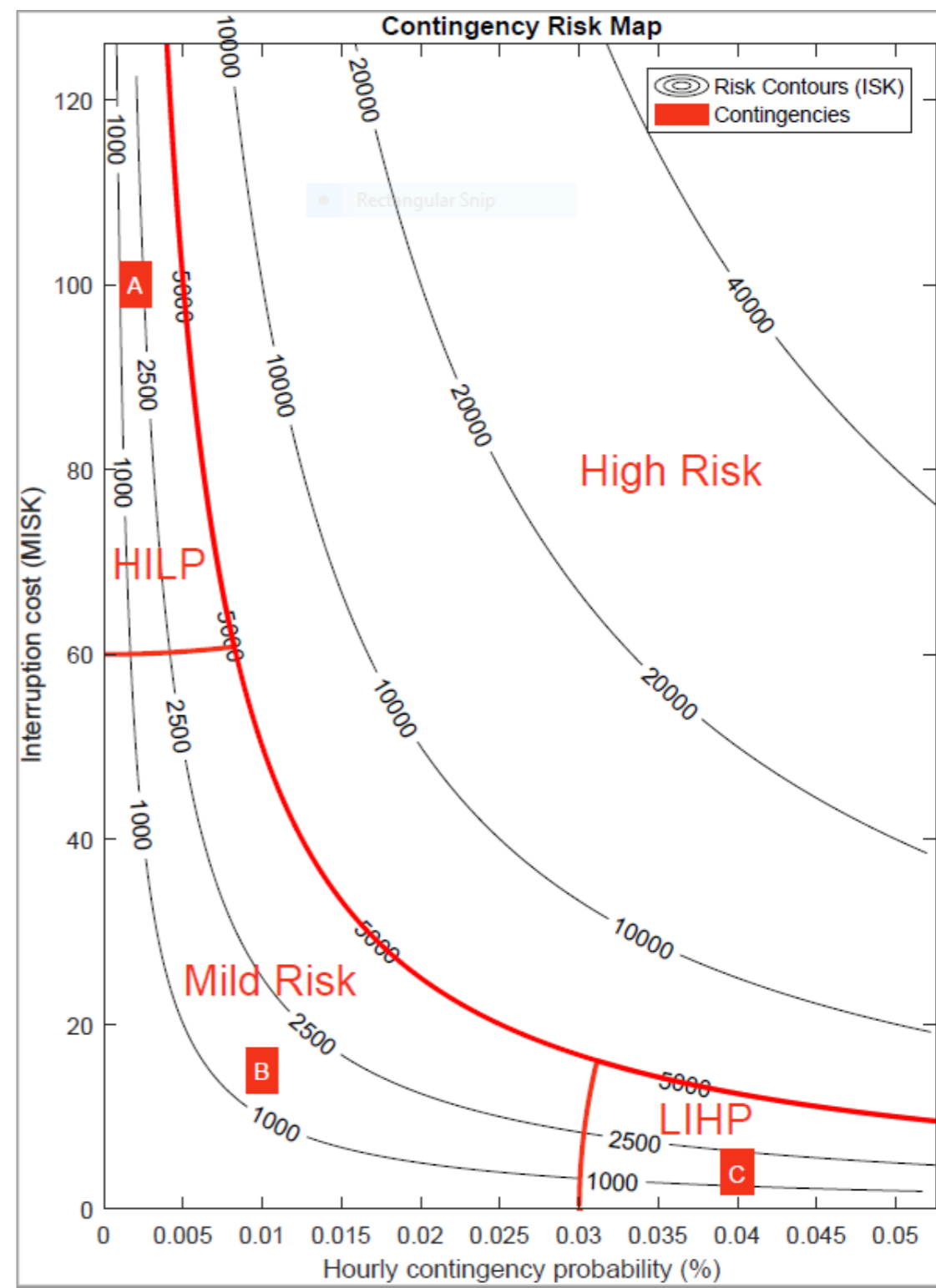
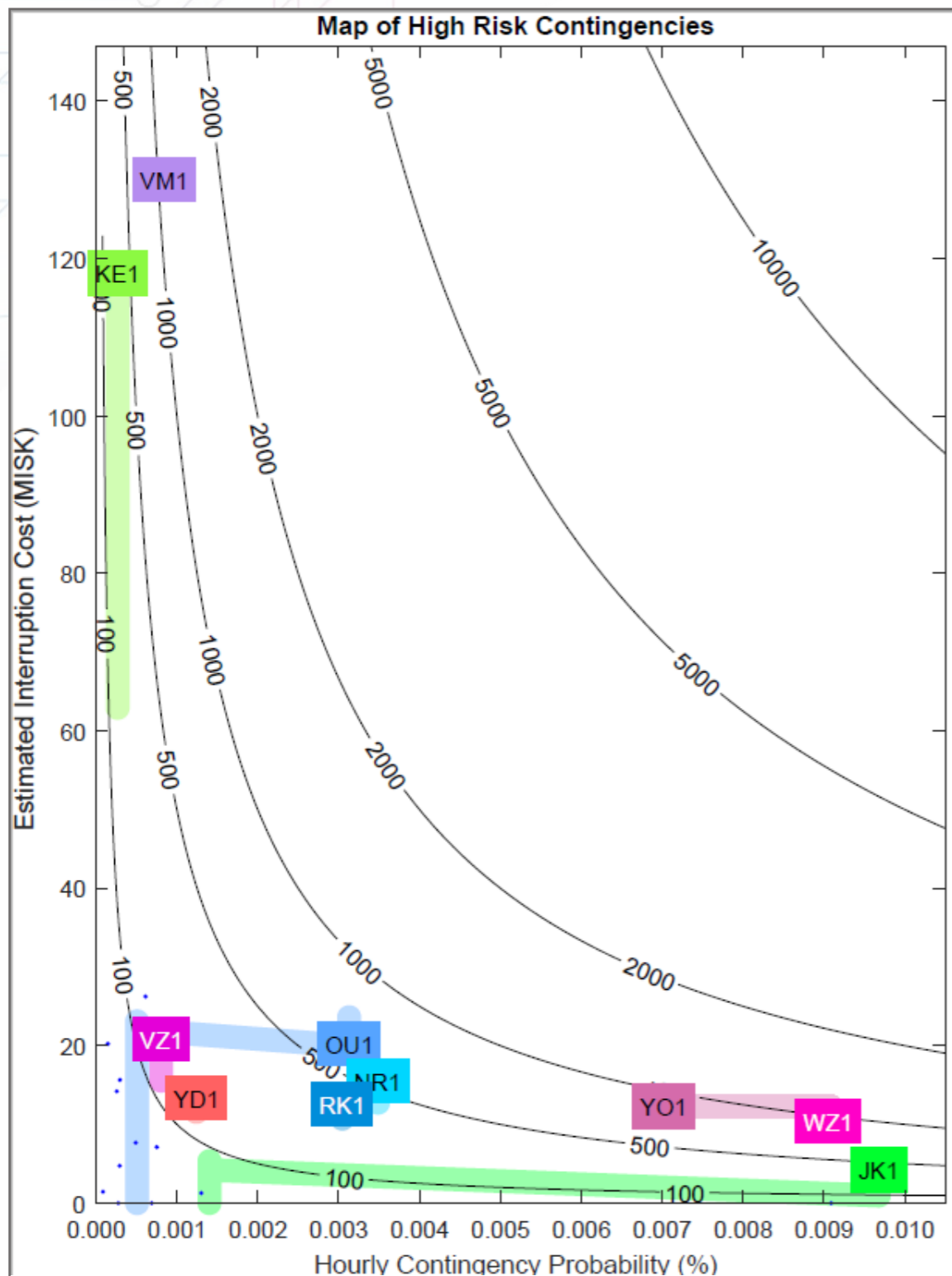


LESSONS LEARNT FROM PILOT TESTS





LESSONS LEARNT FROM PILOT TESTS





How can TSOs move forward in system operation?





BENEFITS AND IMPACT OF THE RESULT

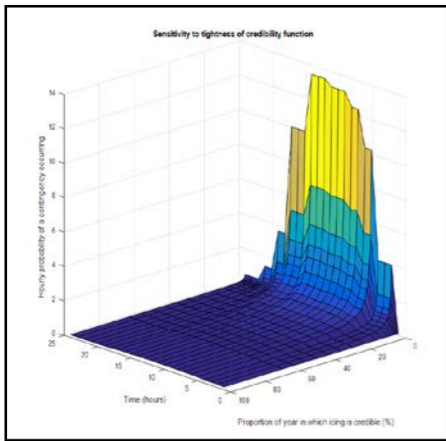
- The new method gives:
 - A quantitative answer instead of a YES/NO answer to the reliability question
 - A higher resolution to risk assessment, resulting in improved risk management
- Quantifying risk in socio-economic terms, rather than technical terms, allows:
 - for easier communication to non-technical stakeholders
 - for direct cost-benefit analyses in risk management.

The result of the risk assessment is greatly dependent on the:

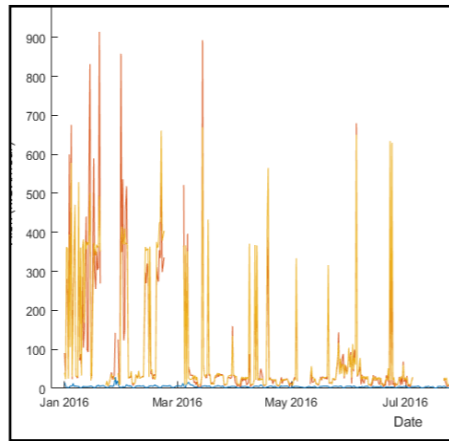
- consequences of contingencies (system response model, and system state)
- varying uncertainty in the system (RES/weather-dependent failure rates)
- economic evaluation of service outages for different consumers



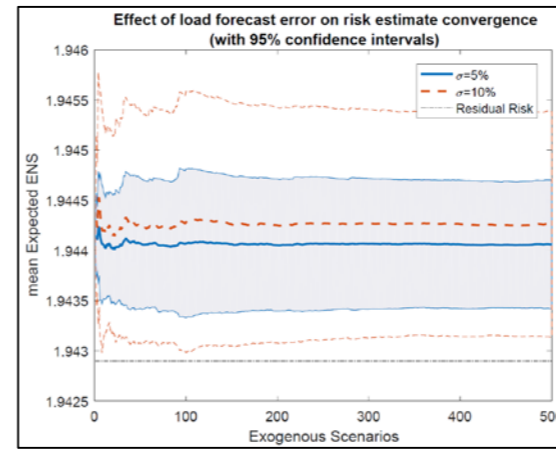
How are we moving forward?



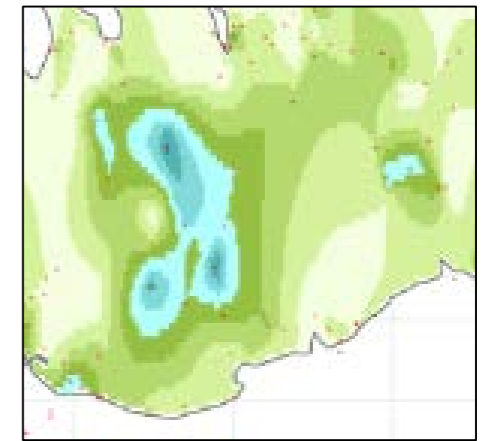
Continued development of the pilot test



Day-ahead reliability assessment



Probabilistic state forecasting



Online threat assessment and data collection

THANK YOU FOR YOUR ATTENTION!

<http://www.garpur-project.eu/>

