1. September 2021

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VP Vysus Group – Promaps Technology

Vysus Group

Ingenuity. Imagination. Insight.

Significant footprint and legacy

80+ years

Heritage

650+

Employees worldwide

1930 – Lloyd's Register Energy

2005
- Capstone
- ODS

2008
- Human Engineering
- Celerity3
- ModuSpec

2010
- Scandpower

2012
- West Engineering

2013
- Senergy

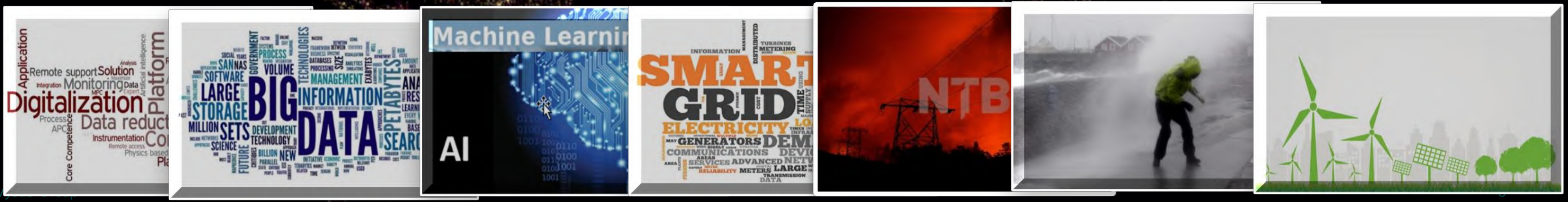
2020 – Vysus Group

2021
- Promaps Technology

The energy system is changing

Challenging the security of power supply

- **Source: ACER – Agency for the Cooperation of Energy Regulators (EU)**
  - *Document: Methodology for coordinating operational security analysis in accordance with Article 75 of Commission Regulation (EU) 2017/1485.*
  - ….. All TSOs shall publish, with the support of ENTSO-E, a report on the progress achieved in Europe on the **operational probabilistic coordinated security assessment and risk management.** The first report shall be published in 2021….
  - ….. development of the **methodology on common probabilistic risk assessment**……
  - ….. By 31 December 2027, all TSOs shall jointly develop the methodology on **common probabilistic risk assessment** taking full account of the requirements……



NTB

Transformation

Destabilizing factors

Challaging the security of power supply

This challenge the Utilities main task

«To provide customers with a stable and secure energy supply

*(**security of supply**)*

combined with

a most efficient operation and development of the electricity grid in the company's licensing area »

Large blackouts in recent years

2021

- Pakistan, 200 million
- Jordan - 10 million for three hours

2020

- Indonesia - 6.8 million
- Mubai, India - millions for hours
- Oklahoma and northern Texas, > 400,000 for multiple days

2019

- Argentina, Paraguay and Uruguay blackout - 48 million
- New York city – 73 000
- UK Blackout – 500 000

Probabilistic risk analyses in near real-time

Calculation principle

- Build an electrical model over the power system 1:1
  - Create a digital twin
  - Import data from SCADA, PSS/e, CIM, Netbas and other static sources
- Build detailed branch library based on the primary and secondary equipment for each voltage level
- Include all available data form the components
- Combine advanced reliability analysis with flow calculations
- Calculate the reliability for each component, each branch, each stations and the system as whole
- Calculation the probabilistic risk level for the whole system

Calculation of the probabilistic risk level in near real time

We use Markov models to represent each individual component in the grid segments:

$$\dot{p}_i = A_i p_i \quad (1)$$

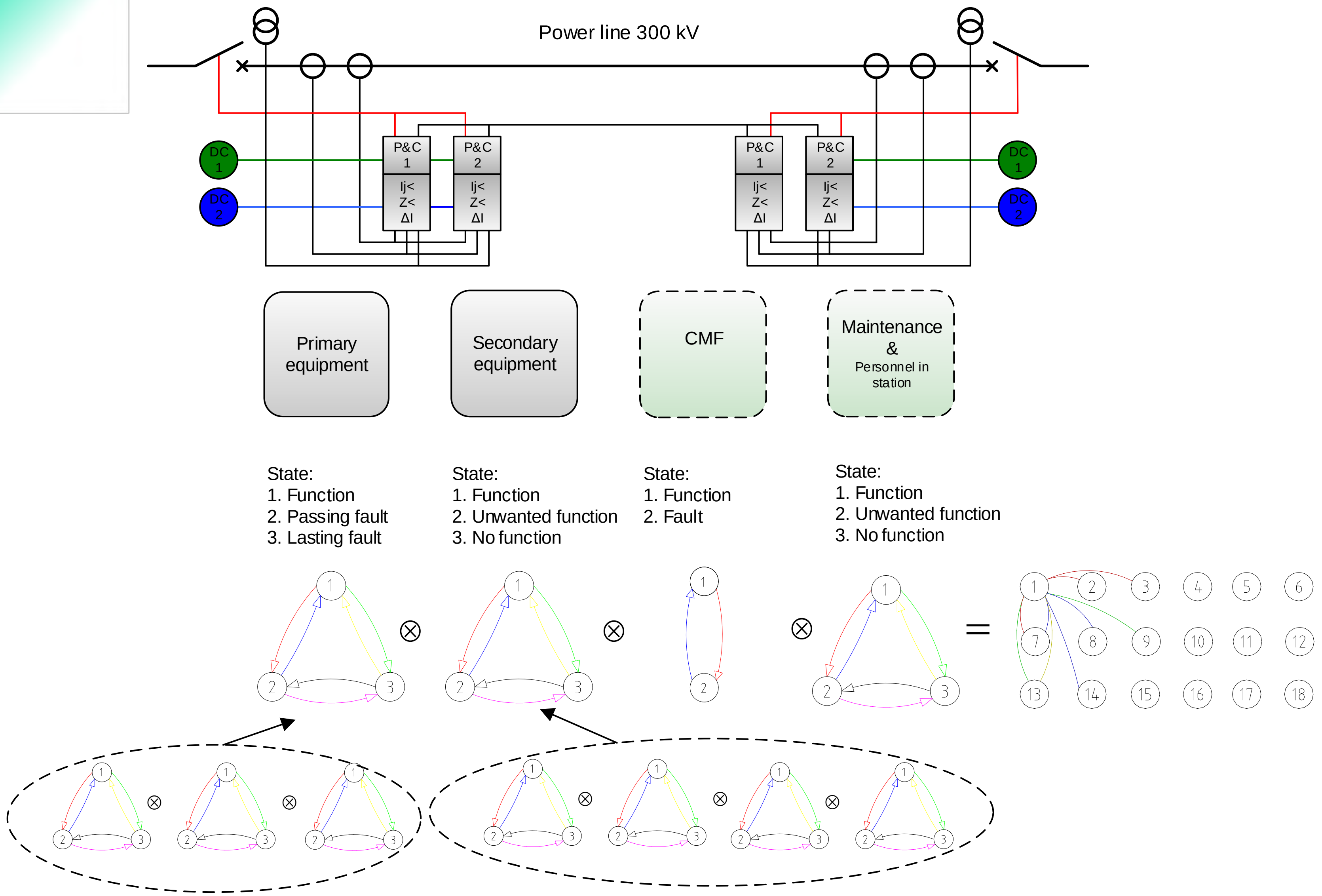
- where A_i is a Markov model containing fault rates and repair rates.

build reliability models of whole grid segments by

- combining all the Markov models of each individual component as Kronecker sums, as follows

$$A = A_1 \oplus A_2 \oplus \ldots \oplus A_n \qquad (2)$$

Best available data



Components

- Type
- Age
- Capacity
- Technical specification
- Location
- State

Load

- Current
- Voltage
- Power
- Frequency
- Temperature
- Pressure
- vibration

Events

- Faults
- Revisions and maintenance

External influence

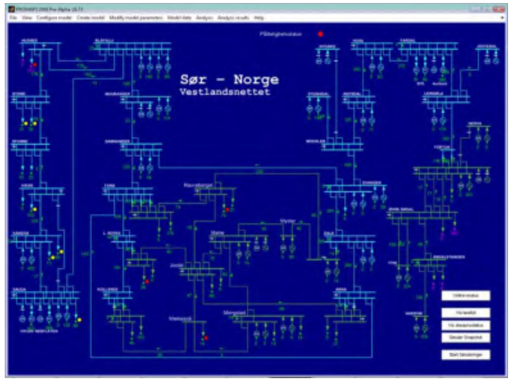
- Weather data
- Geo data
- Vegetation

Reserve stock

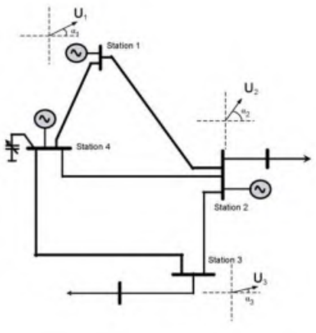
λ

μ

Building a model

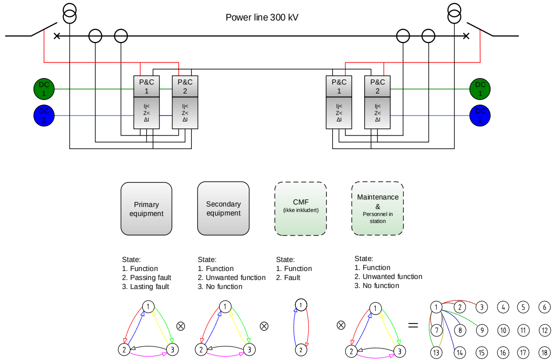


Power system data & configuration

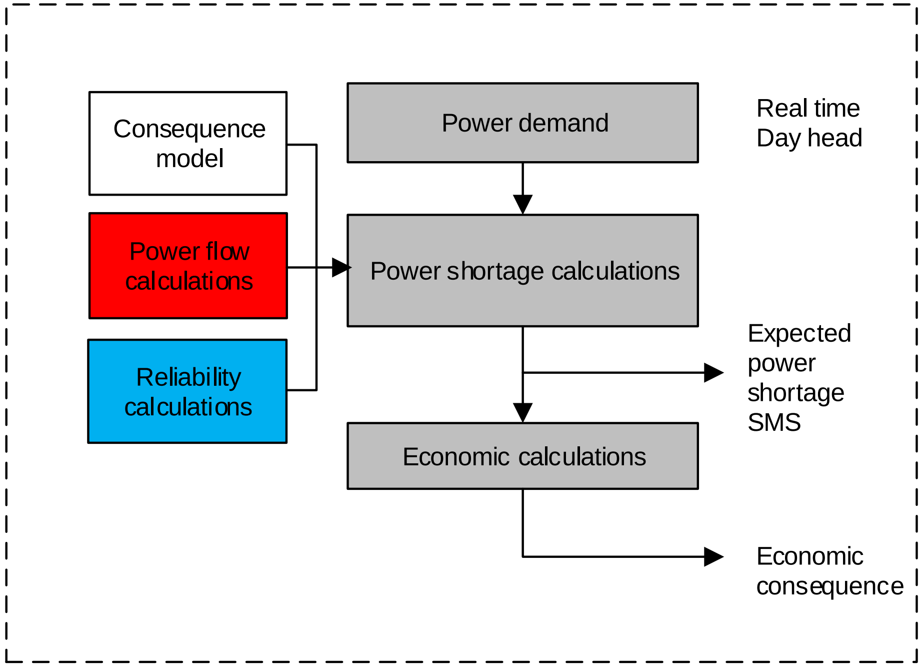


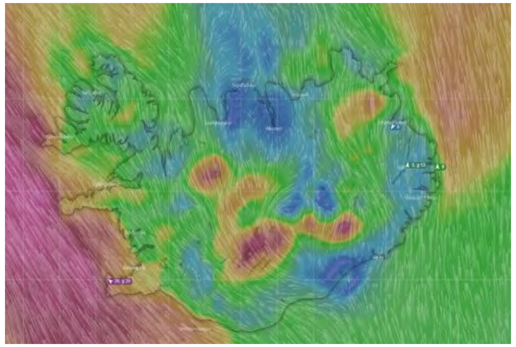
Rule based system response
-System response data from external sources

System respons data



Reliability data & Branch model libary





Weather data

Promaps Realtime – data driven system operation

Real-time probabilistic risk analysis of power systems

Result

Consistent risk management

Product development

Current state: Promaps Realtime – data driven system operation

Risk	:	Expected not delivered energy EENS [MWh/h)
Security of supply	:	System minutes, SMS or in 99,9xyz %

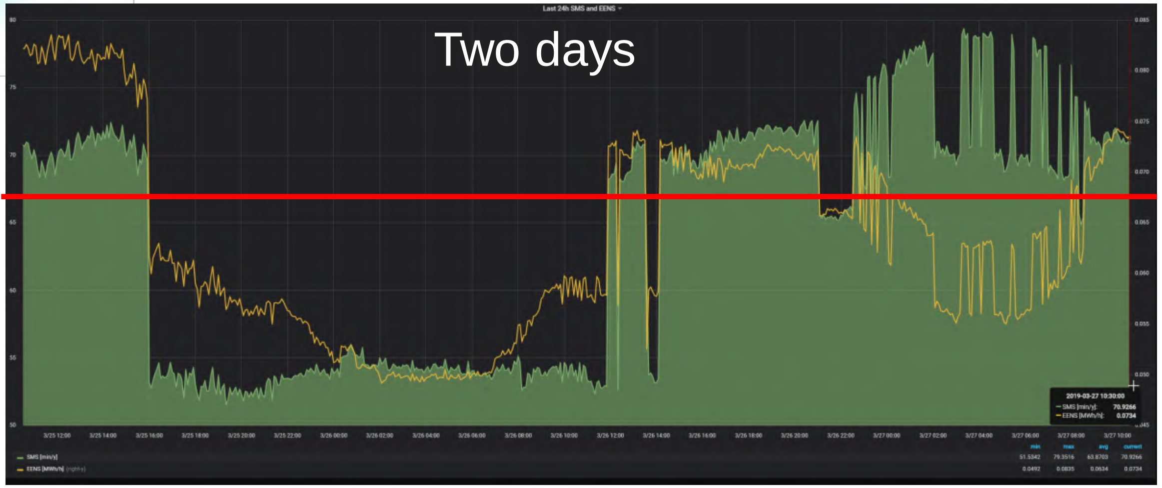
All combinations of fault in the system are ranked in each calculation

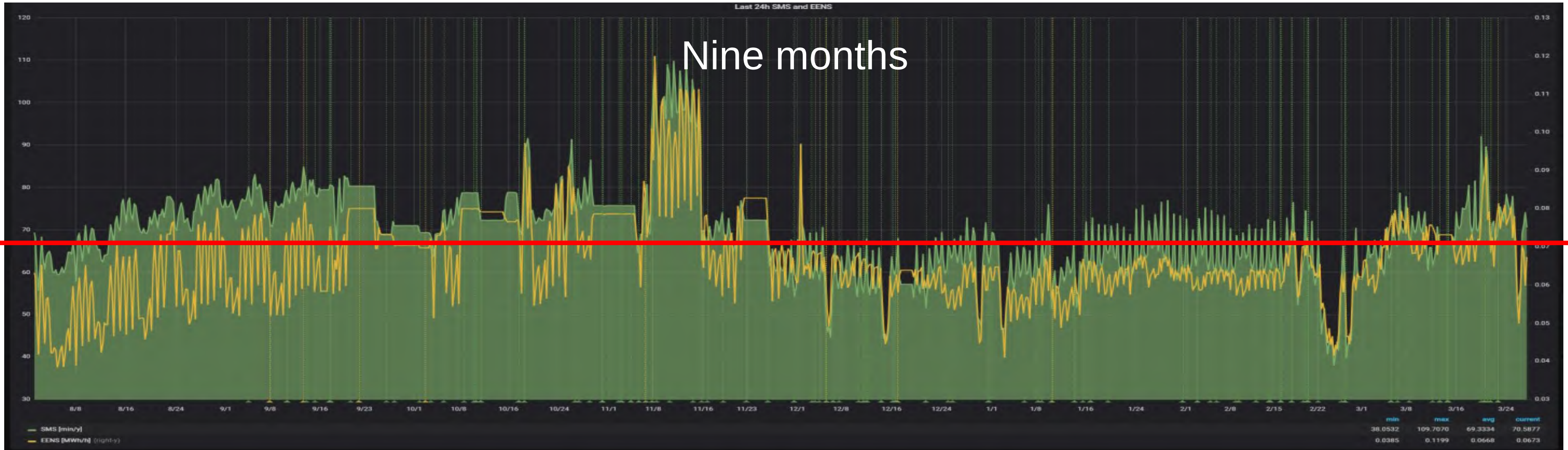
Contingency list

Contingency	EENS [MWh/h]	Probability	Consequences
66RIMAKOT-VESTMANN1	0.01177	0.1464%	13.51 MW
132MJOLKA-GEIRADAL1	0.00256	0.0662%	18.92 MW
66HVOLSV-RIMAKOT1	0.00240	0.0214%	16.68 MW
132HAMRA-OLDUGATA1	0.00198	0.0156%	12.73 MW
66VARMAHLI-SAUDARKR1	0.00186	0.0448%	5.84 MW
66VATNSHAM-VEGAMOT1	0.00156	0.0188%	8.43 MW
66STUDLAR-FÁSKRÚDSFJ1	0.00105	0.0278%	17.50 MW
66THR-LINDAB1	0.00102	0.0449%	7.12 MW
132GLERASKO-HRUTATUN1	0.00096	0.0184%	20.88 MW

1 2 3 4 5

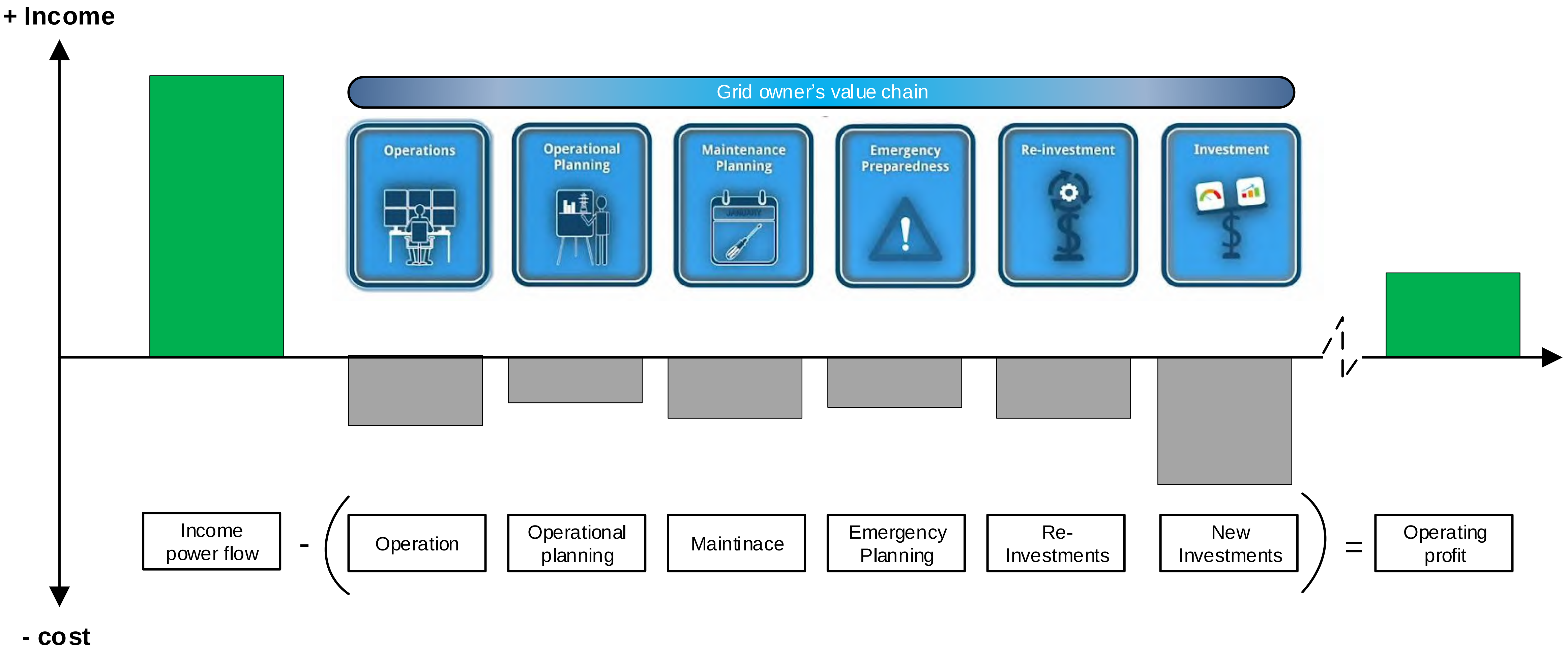
Security of supply is dynamic

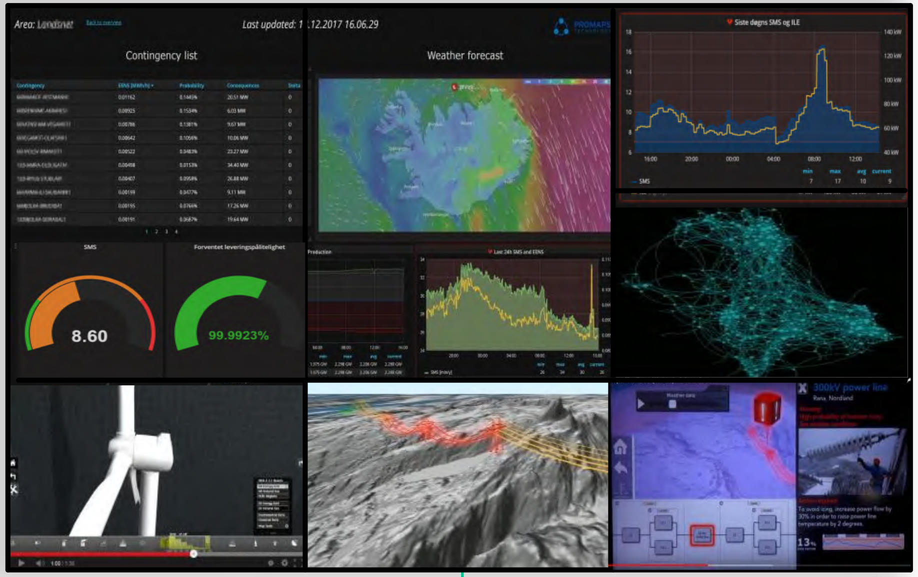


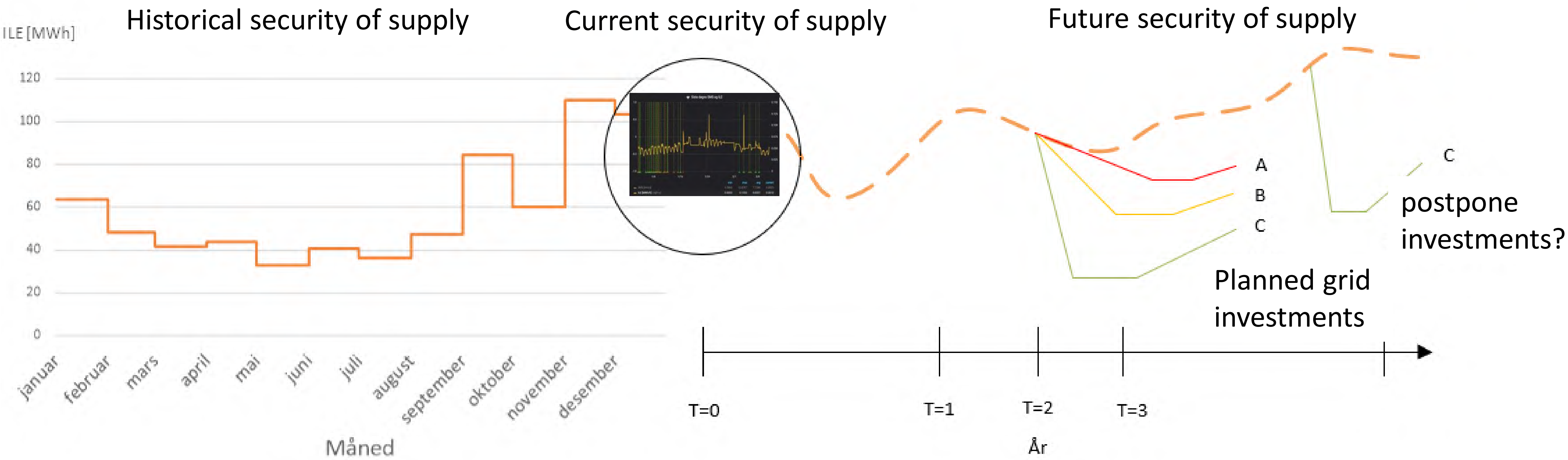


What is the correct risk level?

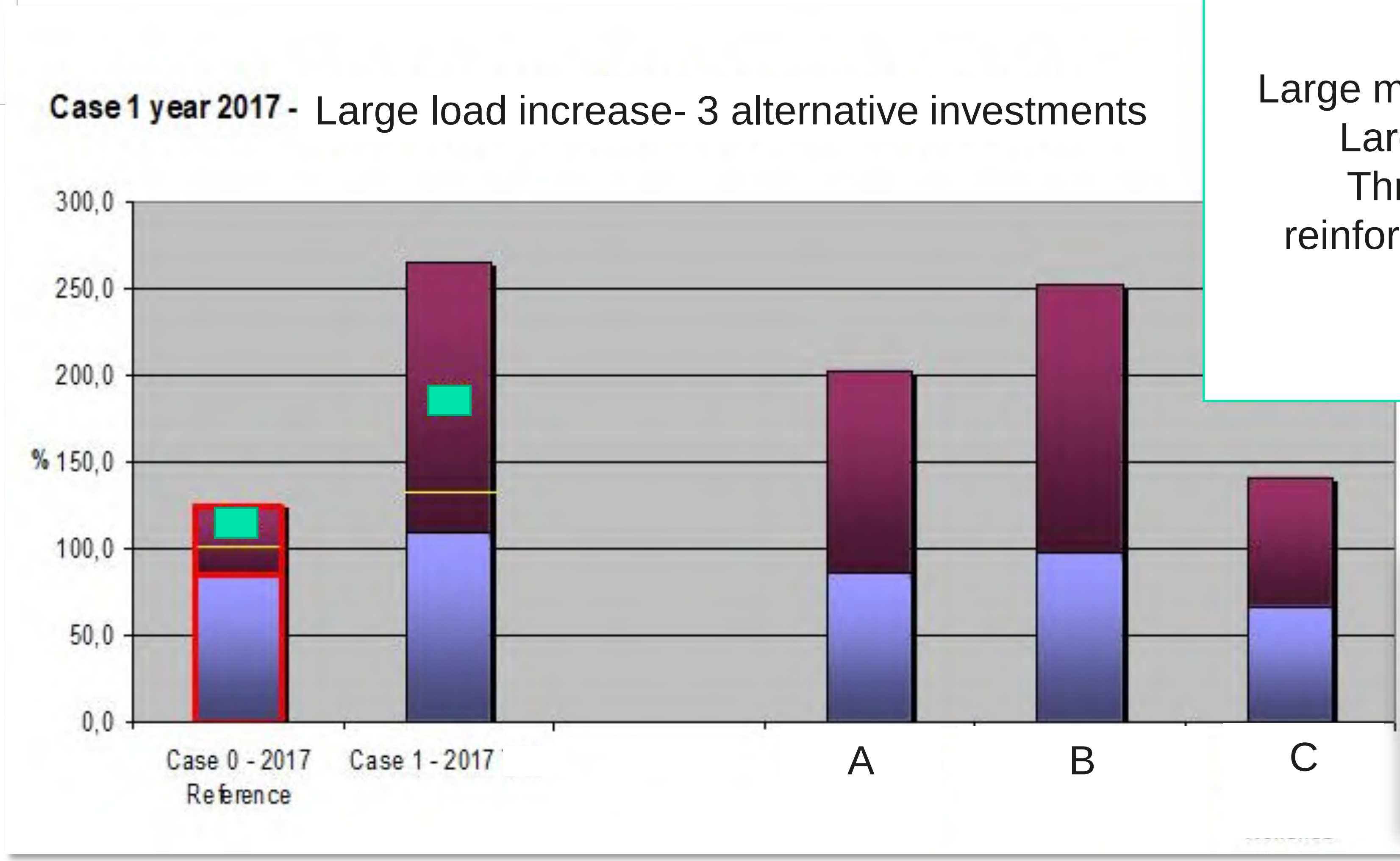
Maintenance is a key to network integrity



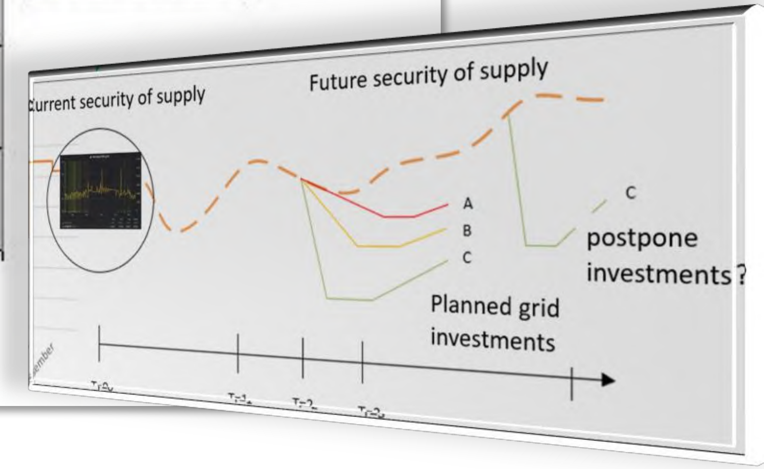

Contingency list
Weather forecast
8.60
99.9923%


Historical security of supply
Current security of supply
Future security of supply
ILE [MWh]
120
100
80
60
40
20
0
januar
februar
mars
april
mai
juni
juli
august
september
oktober
november
desember
Måned
A
B
C
C
postpone investments?
Planned grid investments
T=0
T=1
T=2
T=3
År

Example



Large meshed power system
Large load increase
Three different grid reinforcement alternatives considered



Conclusions

- Power system is rapidly changing towards the digital power system

- Need to understand the inherit property of the power system in real time:
  - The impact of the changes that are coming
  - Introduce new technology and production based on this insight

- Probabilistic real time risk assessment will give vital insight for achieve this

Vysus Group

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