Antti Harjula

Enabling faster integration of wind power with dynamic line rating

Wind Finland 2023 – 4.10.2023

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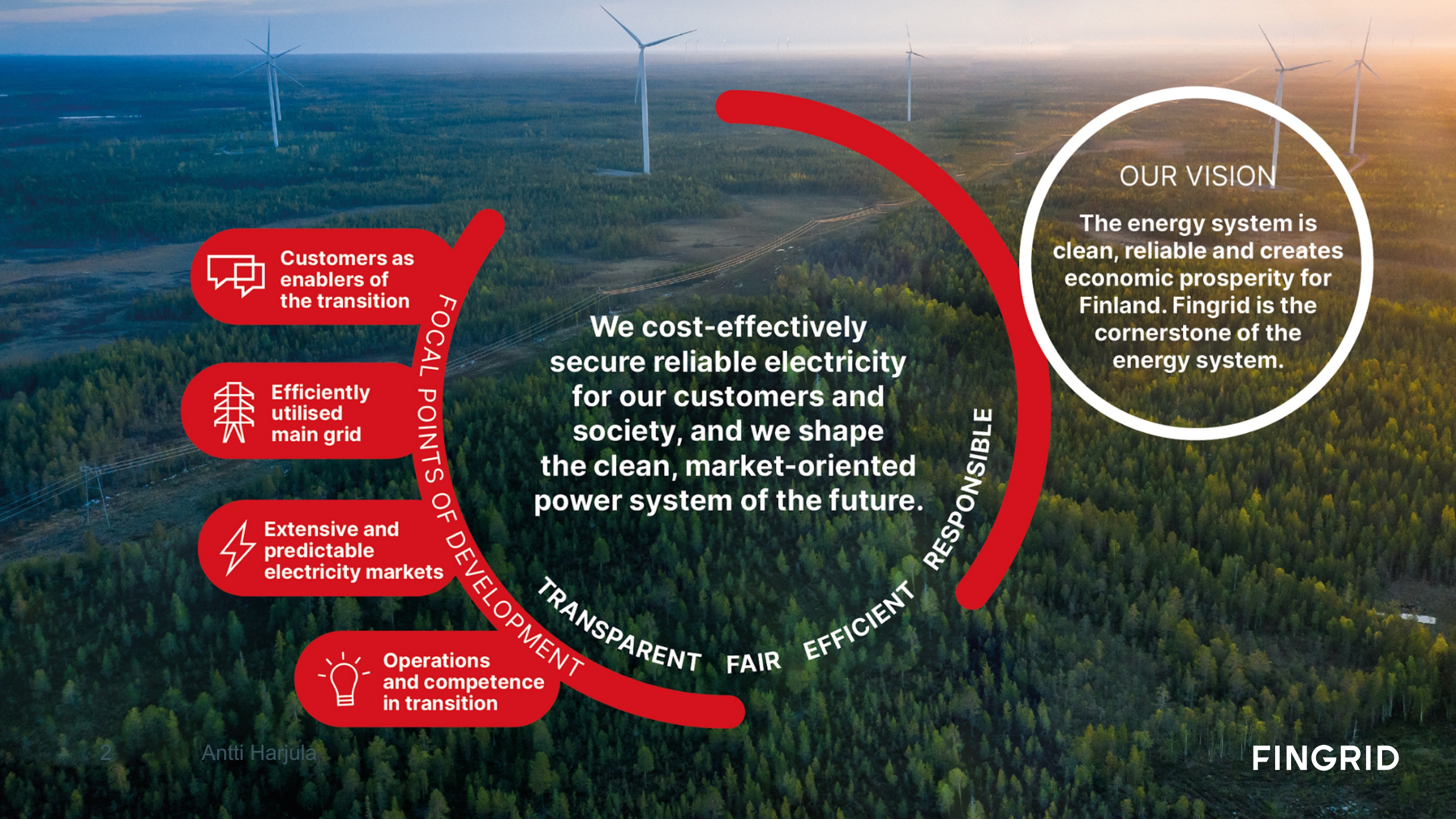
OUR VISION
The energy system is clean, reliable and creates economic prosperity for Finland. Fingrid is the cornerstone of the energy system.
We cost-effectively secure reliable electricity for our customers and society, and we shape the clean, market-oriented power system of the future.
TRANSPARENT FAIR EFFICIENT RESPONSIBLE
FOCAL POINTS OF DEVELOPMENT
Customers as enablers of the transition
Efficiently utilised main grid
Extensive and predictable electricity markets
Operations and competence in transition

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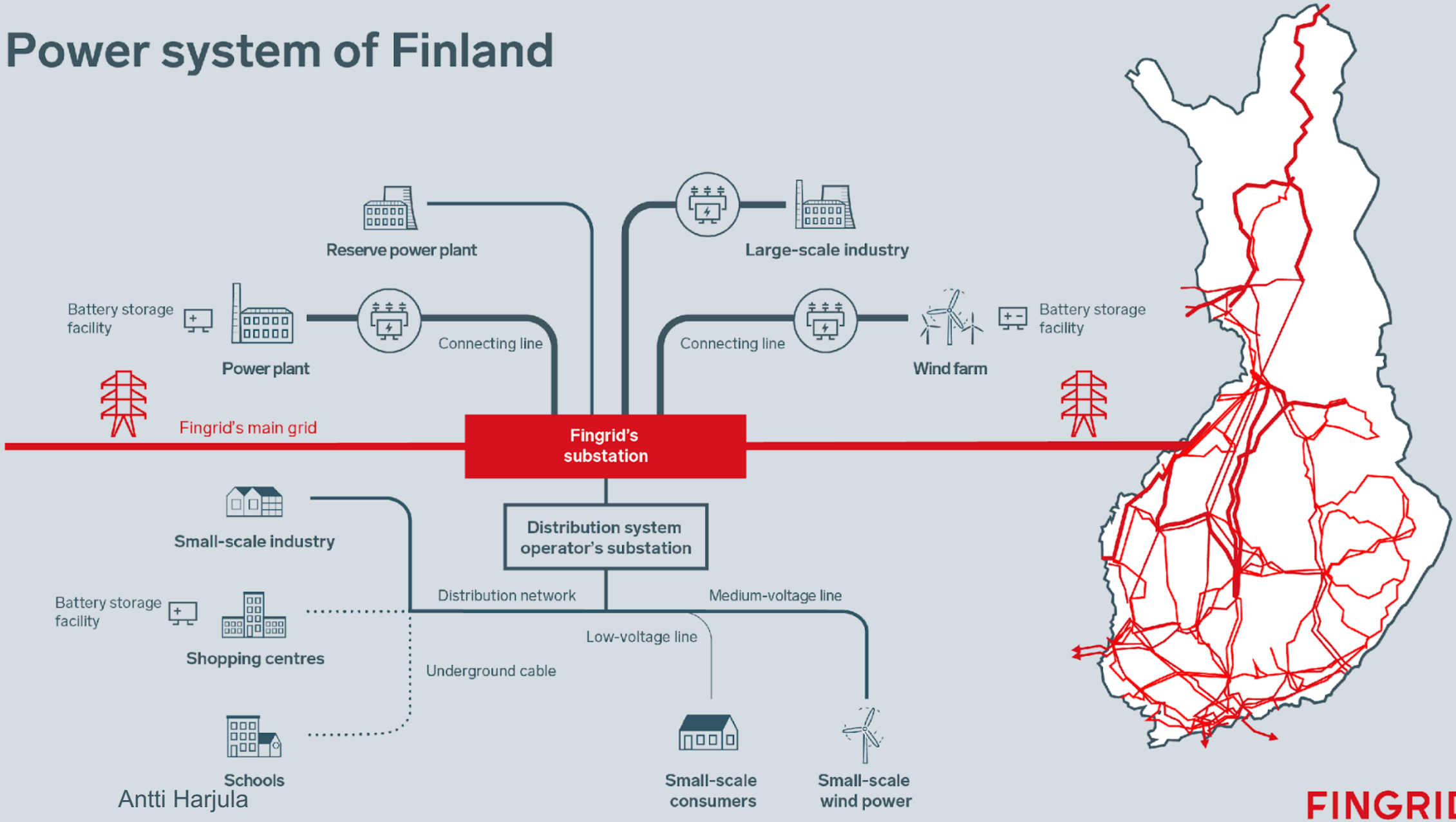
Power system of Finland



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The power system is in a state of transformation

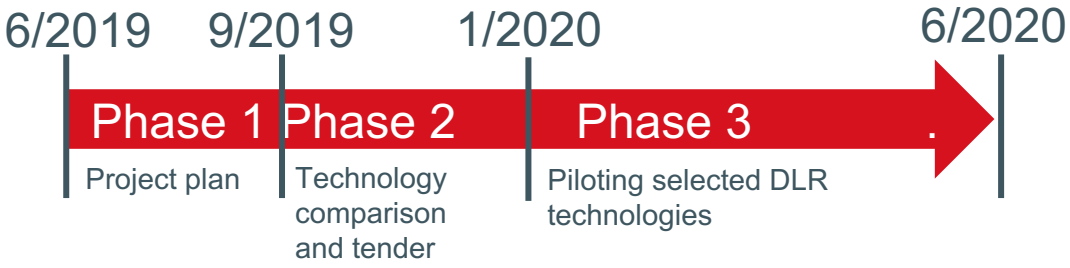
- Finland aims to become carbon neutral by 2035
- Weather-dependent renewable production
  - Balancing

- Technological revolution in generation and consumption

 Flexibility in consumption, production *and transmission* will be required, as well as grid energy storage facilities.

DLR pilot project

- 2½ year R&D project
- Aim to find out potential and risks of using dynamic line rating in the Finnish transmission system
- Based on initial technology comparison testing DLR systems on Isokangas-Pyhänselkä 400 kV line
  - Motivation for selection of the line was to enable faster connection of wind power on the north side before realizati



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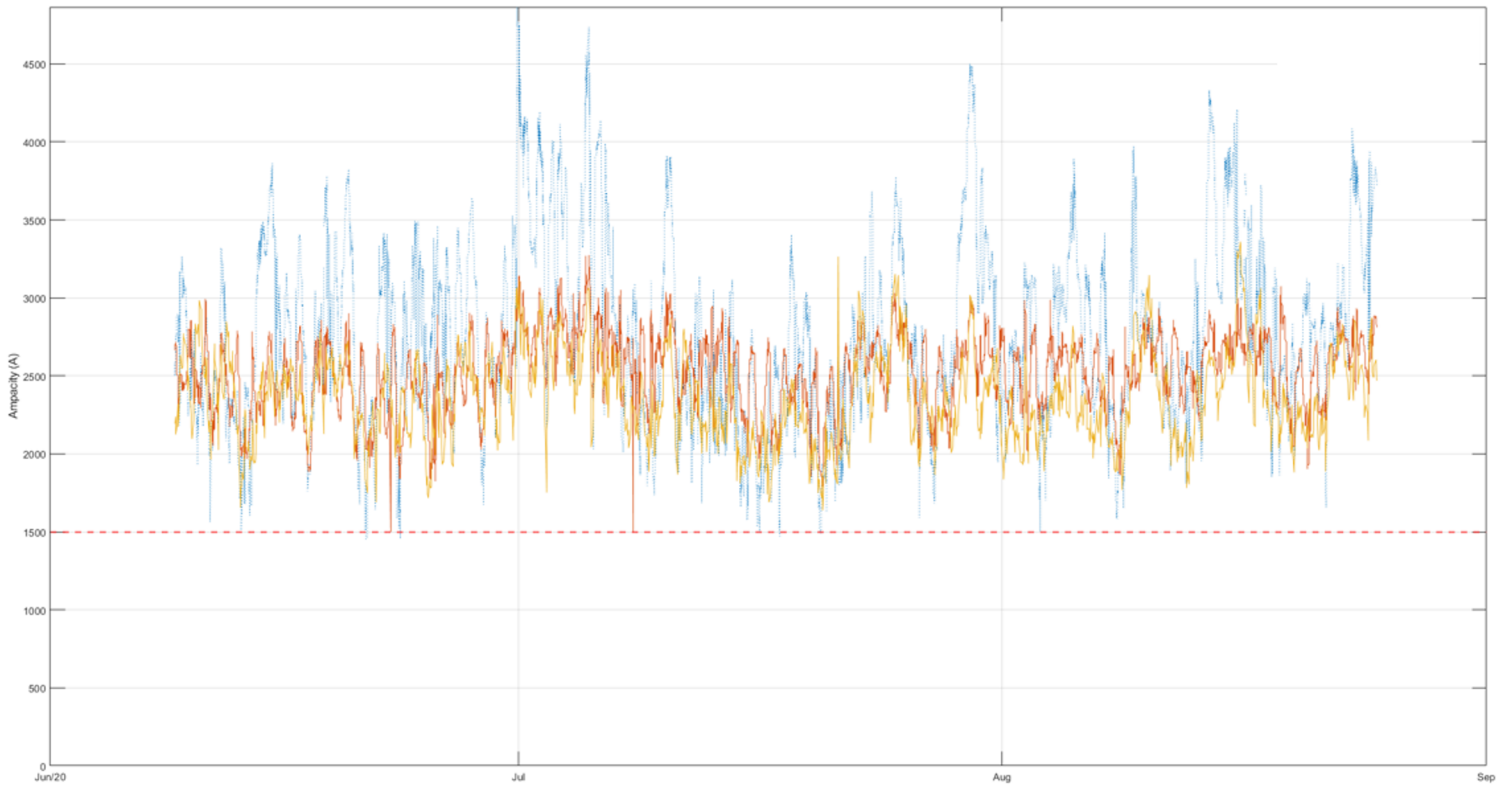
DLR technologies and findings



- Weather based DLR gives good approximations on 400 kV lines and with adequate safety margin can be used
- Variations between technologies seem to be towards conservative from “real” values
- Using the full potential of DLR requires (quite a lot of) measurement devices, but majority of benefits can be achieved with weather per span approximation

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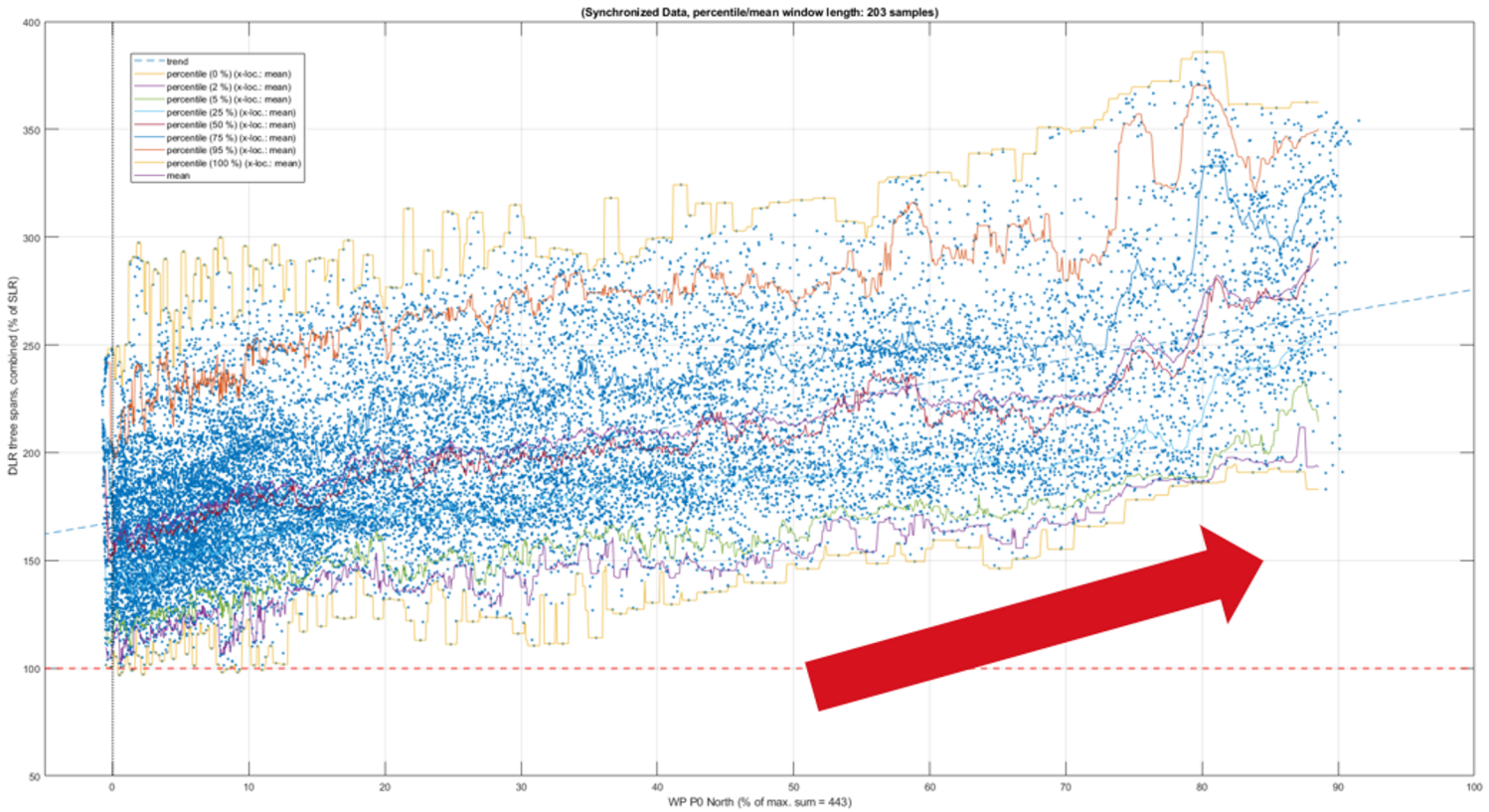
Wind power generation and DLR



- Strong correlation between wind power generation in large regions and DLR of transmission lines
- A lot of potential to efficiently utilize transmission capacity needed to transmit power generated by wind

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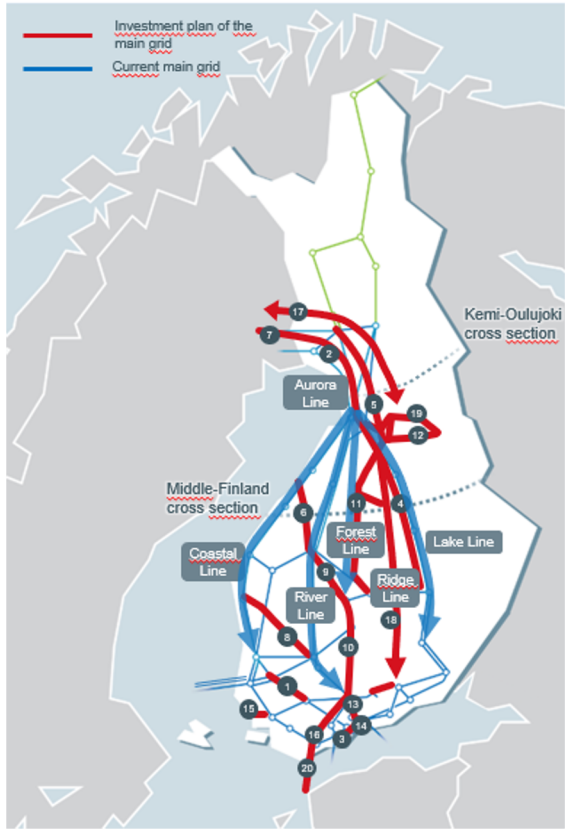
Whoa! Could we just connect 50 % more? – No

Other limitations

- Substation equipment ratings
- Voltage stability
- Angle stability
- Converter driven stability (emerging)

We need more grid and more compensation devices alongside DLR

Main grid investment plan



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DLR use now and next steps

- Based on the pilot project Fingrid took into operational use DLR on four 400 kV lines and currently DLR is monitored on the lines and capacity is also calculated for the northern Kemi-Oulujoki cross-section based on DLR
- Next phase of the DLR implementation is just starting & the **vision** is
  - To have weather estimation and forecast based DLR calculation on all 400 kV lines and possibly measurement based on few critical 110 kV lines
  - To integrate the achieved real-time and forecast DLR values with real-time and forecast grid models to identify critical elements and remedial actions
  - To automate the related calculations

“The pessimist sees difficulty in every opportunity. The optimist sees opportunity in every difficulty.”

– Winston Churchill

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