11.11.2020 Jussi Matilainen

R&D plans and needs – the view from Finland

Research plans and needs for the Nordic transmission system operators

Luleå University of Technology and IEEE Sweden, 11th November 2020, via Teams

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Fingrid in brief

14 300
KILOMETRES OF POWERLINES

TRANSMISSION RELIABILITY ON THE GRID
99,9999 %

BALANCE SHEET TOTAL
€ 2,1 BILLION

EMPLOYEES
380

€ 789 TURNOVER MILLION

TAXES PAID 2019
€ 21 MILJOONAA EUROA

AMONGST THE BEST IN THE WORLD IN EFECTIVENESS OF MAINTENANCE MANAGEMENT AND RELIABILITY OF GRID. SOURCE: ITOMS (INTERNATIONAL TRANSMISSION OPERATIONS & MAINTENANCE STUDY)

GREAT PLACE TO WORK
7 th IN 2020

68,7 TWh
OF ELECTRICITY WAS TRANSMITTED ON FINGRID'S GRID IN 2018, REPRESENTING

76 %
OF THE TOTAL TRANSMISSION VOLUME IN FINLAND

CUSTOMERS' SATISFACTION 2020
38 (NET PROMOTER SCORE)

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Content

- R&D at Fingrid
- Nordic challenges
- Fingrid's challenges and R&D needs

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Why R&D at Fingrid

R&D is required due to the following reasons

- **To shape the clean, market-oriented power system of the future**
- **To secure cost effectively reliable electricity for our customers and society (despite of energy revolution)**
- **To ensure adequate transmission capacity for the electricity markets (despite of energy revolution)**
- **To ensure the expertise in key business areas**

Megatrends increase the need of R&D

- Climate change and energy revolution: electrifying of industry, heating sector and transportation, increasing amount of distributed RES
- Increasing dependency of electricity and higher need for good security of supply
- Digitalization renews methods and processes in the power system and electricity markets

Other trends

- power system more dependent on weather, forecasting becomes difficult
- amount and importance of data is increasing

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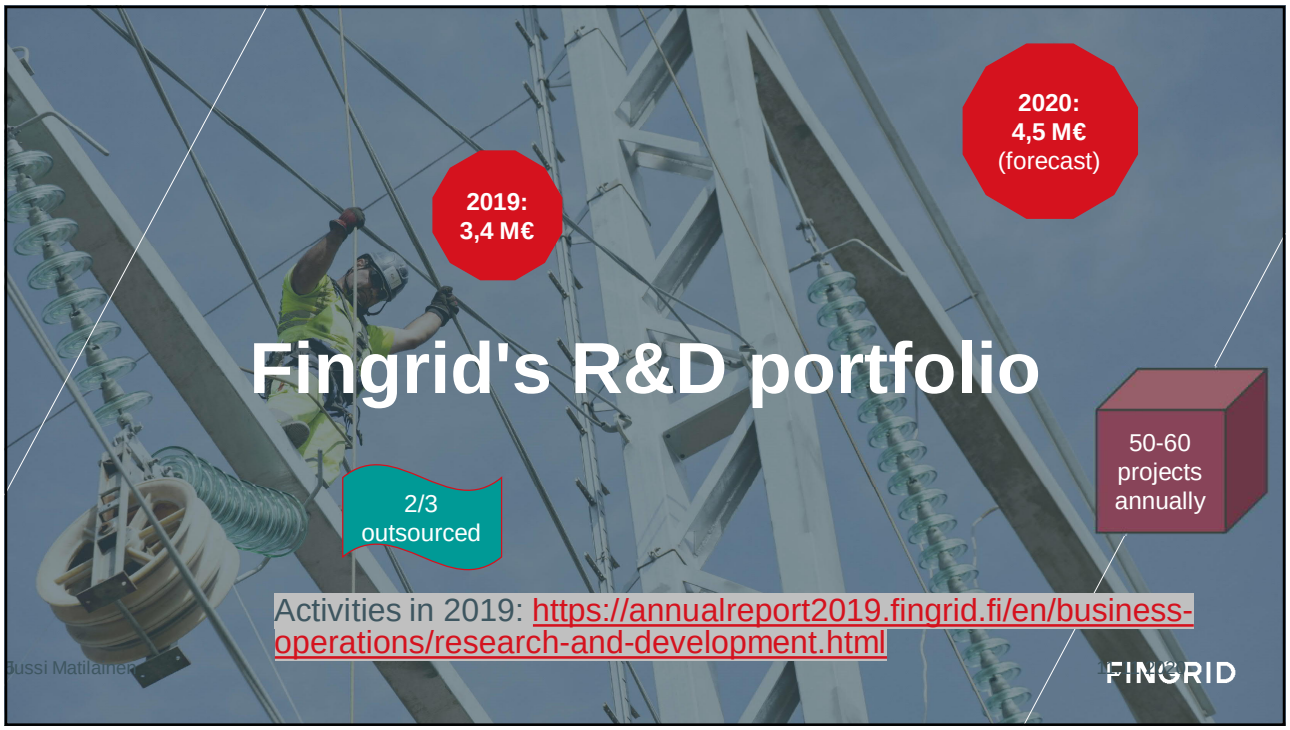

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Nordic challenges

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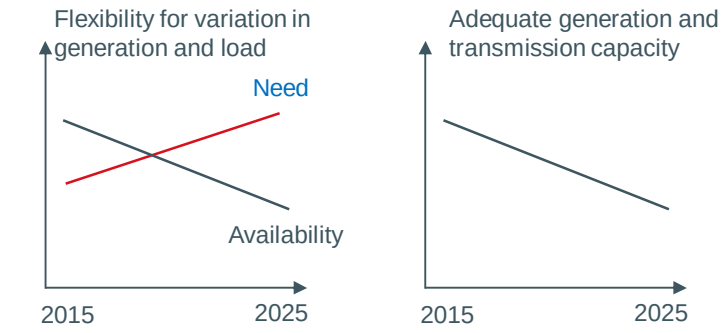

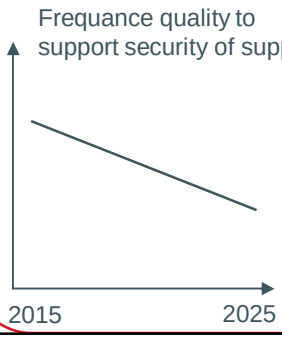

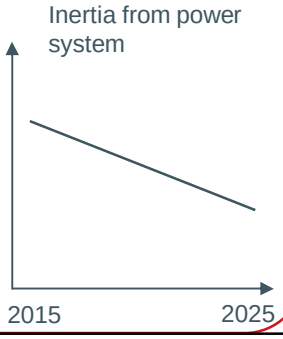

Nordic challenges

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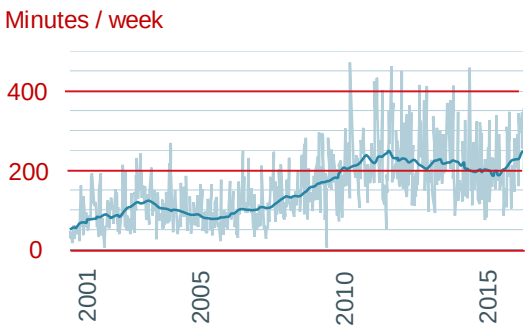
Frequance quality to support security of supply

Reasons for the decreased frequency quality, among others

- More generation which power is difficult to forecast
- Large changes in HVDC flows

Number of minutes where frequency is below 49,9 Hz or over 50,1 Hz



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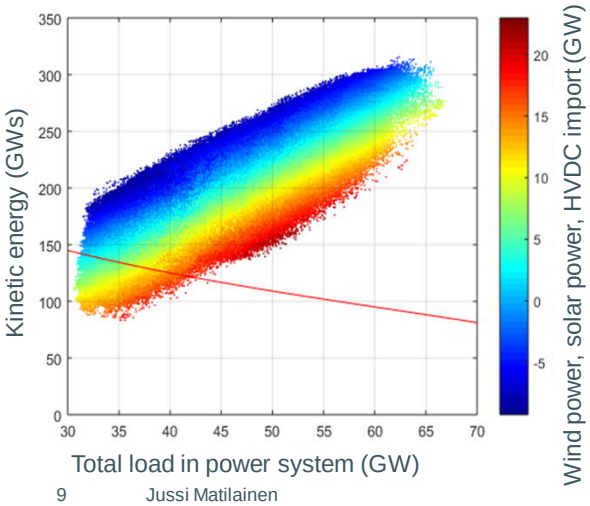
Estimation of kinetic energy in 2025



- Production and consumption are based on market simulations
- Colour of dots shows the amount of wind and solar power generation as well as HVDC import
- Hydrological years 1962–2012 included
- Red line shows the estimated amount of required kinetic energy
- **Time of inadequate kinetic energy is about 8% of total time**

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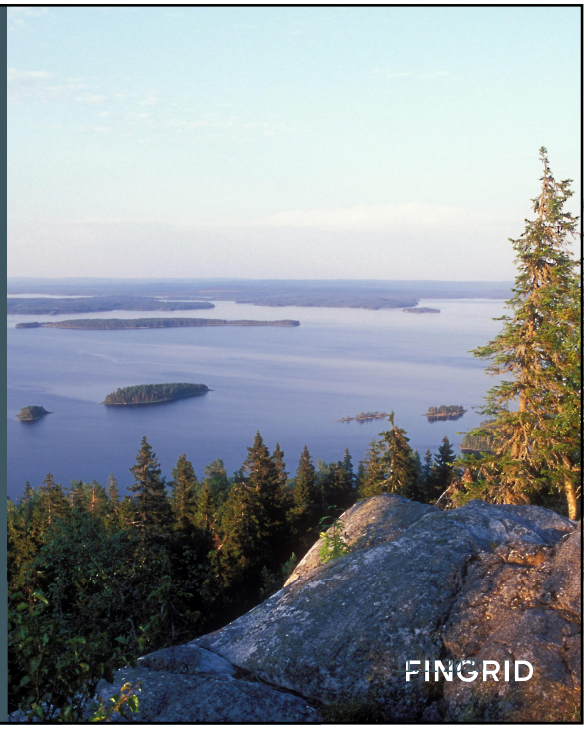
Fingrid's challenges and R&D needs



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Fingrid's strategic focus areas

1-2 year	3-5 year	5+ year
Data and architecture		
Preparing power system for renewable energy sources Flexibility solutions		Power system as a part of the energy ecosystem
Management of power system operation		
Digitalization for more efficient grid development and asset management		
Business processes and renewable corporate culture		

Development *Research*

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Preparing power system for renewable energy sources

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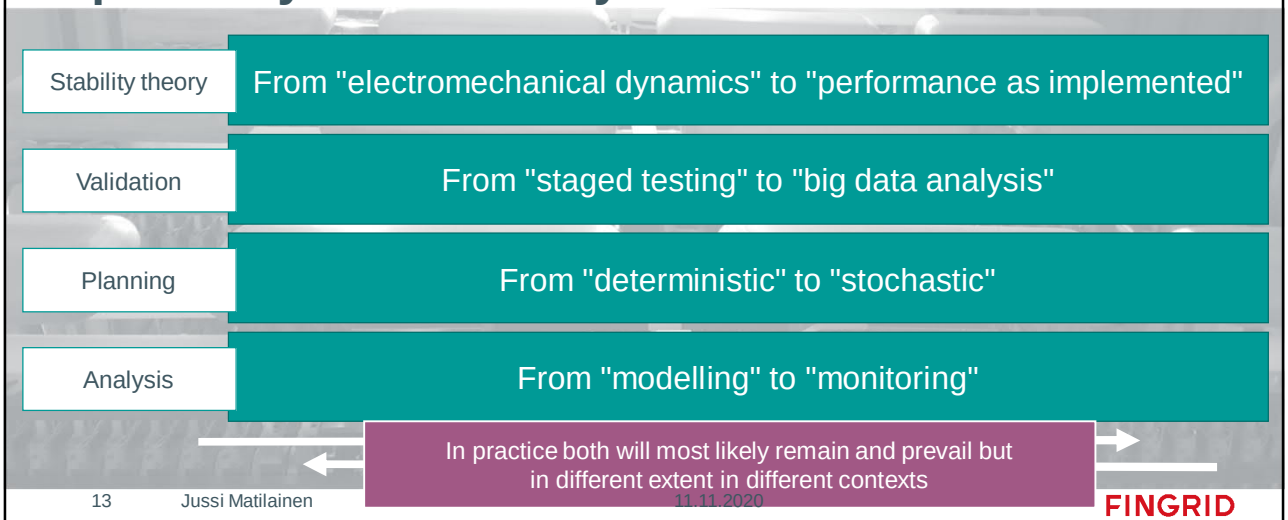
Possible changes in prevailing paradigms of power system stability



Large amount of converters at system level

Transition from large rotating machines to large amount of small converters

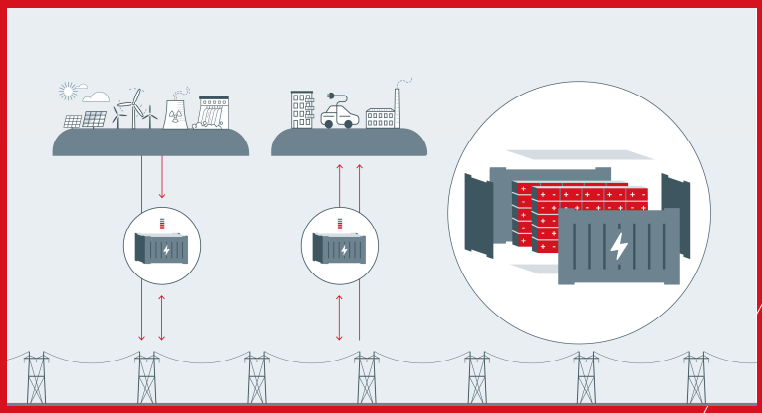
- Increasing amount of equipment with stochastic generation/consumption pattern will result into increasingly large variations in the technical performance characteristics* of the system
- System level measures to estimate, monitor, visualize and manage the impact of the variations on system security are required to support both the planning and operations
- How the impact of the converters shall be managed on system, regional and local levels?

Large scale wind power in the middle of heavily meshed and heavily compensated transmission system

- Management of subsynchronous and over-voltage ride-through issues in very complex network structure

* short circuit capacity, voltage support, reactive power flows, inertia, prevailing stability phenomena etc.

Flexibility solutions



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The transition increases the need for flexibility

(and there is a need to faciliate market-driven mechanisms to release the flexibility potential)

Evolvement of increasing need for flexibility	Flexibility resources to address increasing need	Mechanisms to release flexibility
	Power plants >10 MW	Reserve markets
	Consumption >50 MW	Balacing power markets
early stages of wind integration		Investments to flexible assets (e.g. compensation)
	Power plants >1 MW	Demand side management
	Consumption >1 MW	Nordic Balancing Model
	Aggregated flexibility resources	15 min balancing period
Transformation of energy system (wind and solar integration, descreasing CHP generation, sector integration, electrification of societies)	New energy technologies/resources	New flexible transmission technologies (e.g. dynamic line rating DLR)
	Energy communities	
	Sector integration	Flexibility/locational markets
Climate neutral power system		

Our development domain

Our research domain

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What it takes to release the new flexibility?

Along with the on-going transformation of electrical energy system, the new energy resources have great potential to play a key role in management of transmission capacity at local, regional and national level

Preconditions for releasing the potential
(most of these require still R&D natured effort)

- Availability of adequate power and energy capability to address the network needs
- Access to multilateral markets - releasing the full value of flex
  (possibility to provide services for grid operators, balance responsible parties, 3rd party aggregators)
- Technology solutions to facilitate the provision of flexibility (validation, monitoring etc.)
- Tools for planning and operation of power systems full of flex (e.g. forecasting for different time frames and visualization)

- Sector-integration!
- Aggregation!
- Flexibility markets!
- Co-ordination of planning and operation!
- Data exhange!

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Management of power system operation

Control room challenges

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What is changing ?

- electrification
- role of electricity is increasing
- distributed resources
- grid congestions may occure more frequent bottlenecs in the transmission network flexible increasing need for balancing
- situation awareness is more difficult to maintain
- the role of operator is changing ➔ **less time to react for changes**
- more data available and more data needed ➔ **the role of data quality becomes more critical**

What is needed to be able to react in the control centre?

- automatic control to save operators time for analyses
- new tools and methods for forecasting
  - production / consumption
  - inertia
  - local tranmission needs in the network
  - weather
  - flexibility recourses, availability and location
- results of system analyses (e.g. contigency, dynamic stability) should be presented in an understandable way
  - current situation and forecasts
- need for data transfer between it-systems: real-time and 24/7
- network models must be updated more often and easily

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Digitalisation for more efficient asset management

Improving asset management efficiency in substations by IoT

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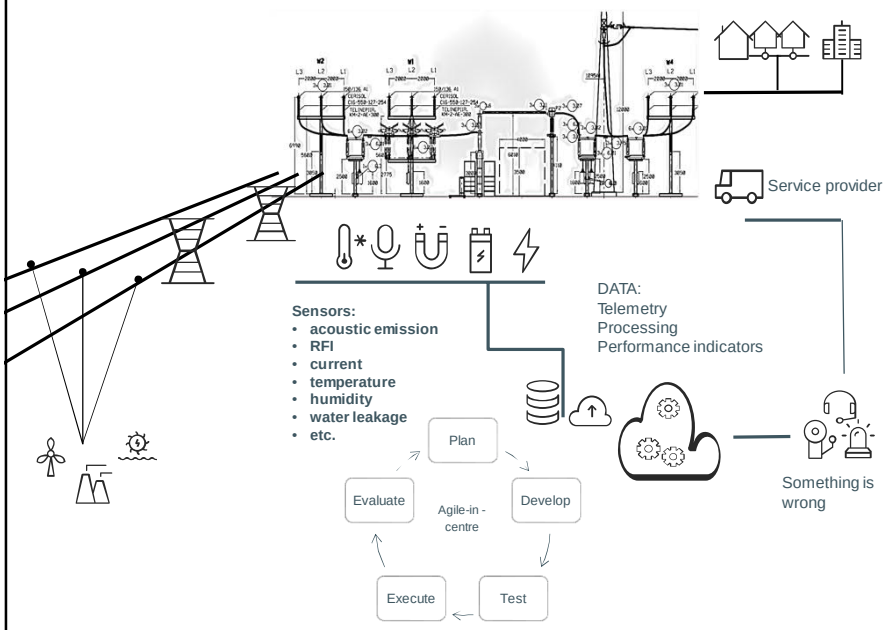
IoT – The Logic



Why ?

1. Improve know-how on assets condition
   Securing grid quality
2. Minimise outages of assets condition checks
   Improving grid availability
3. Allocate service action on need basis to correct assets
   Improving cost effectiviness

What does it mean?

1. Time based measurements will be replaced by sensor monitoring
2. New models for service contracts
3. Need for training and orientation / change management project.

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IoT in substations - challenges

- Asset management is already IoT-based in four substations (IoT-based monitoring of buildings in all substations) in Finland
- Cooperation with other TSOs who are also using the same concept and common database
- Benefit: the more substations and devices to be monitored, the more data ➔ better forecasts

Challenges

- to develop modular and scalable architecture
- to have an interface between different monitoring systems (e.g. in different countries) where seamless data transfer (despite of possible different formats) and cybersecurity can be ensured
- to ensure that AI-based data analysis can manage the situations where the methods of measurements slighly varies (or how to ensure one common measurement method per device type for the entire Europe)?

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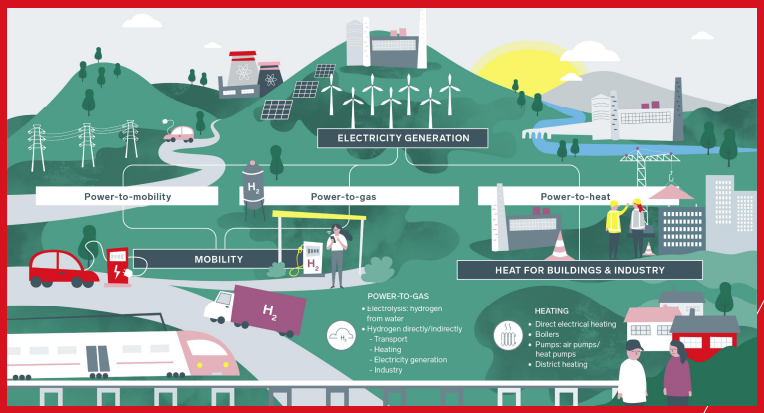
Power system as a part of the energy ecosystem



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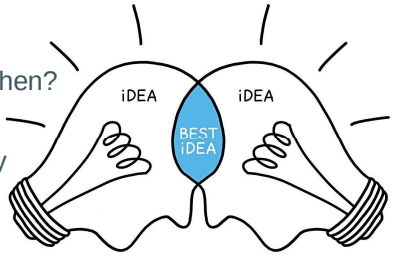
Relevant questions

- Electrification – how much electricity is needed, where and when? How it varies over time?
- What will be the future flexibility potential (including all energy sectors)?
- Solutions for long term energy storages?
- How to create markets for multisectoral needs?
- What data (real time / market-based) is needed to ensure the forecastability of energy use (consumption, production, storage)?
- Concept of data exchange between the sectors?
- Electric vehicles: How is a charging power changing over time in future? How to enable access to EV battery and charging data in order to have system level view of flex potential?



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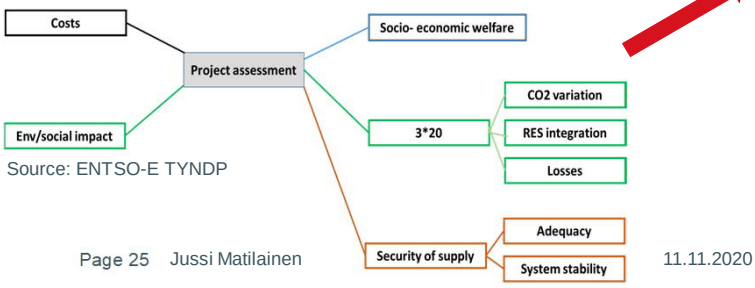
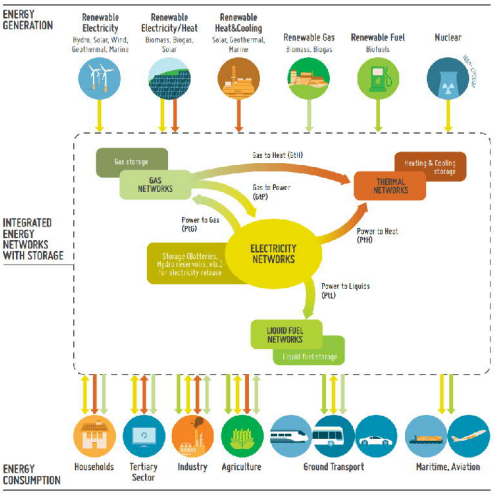
From transmission grid planning to energy system planning

- Modelling of different sectors; level of details, national, regional or European wide?
- Data quality and availability?
- Combining different sectos into one (simulation) model?
- Total optimisation, criteria?



Source: ENTSO-E TYNDP



Source: ETIP/SNET Vision 2050

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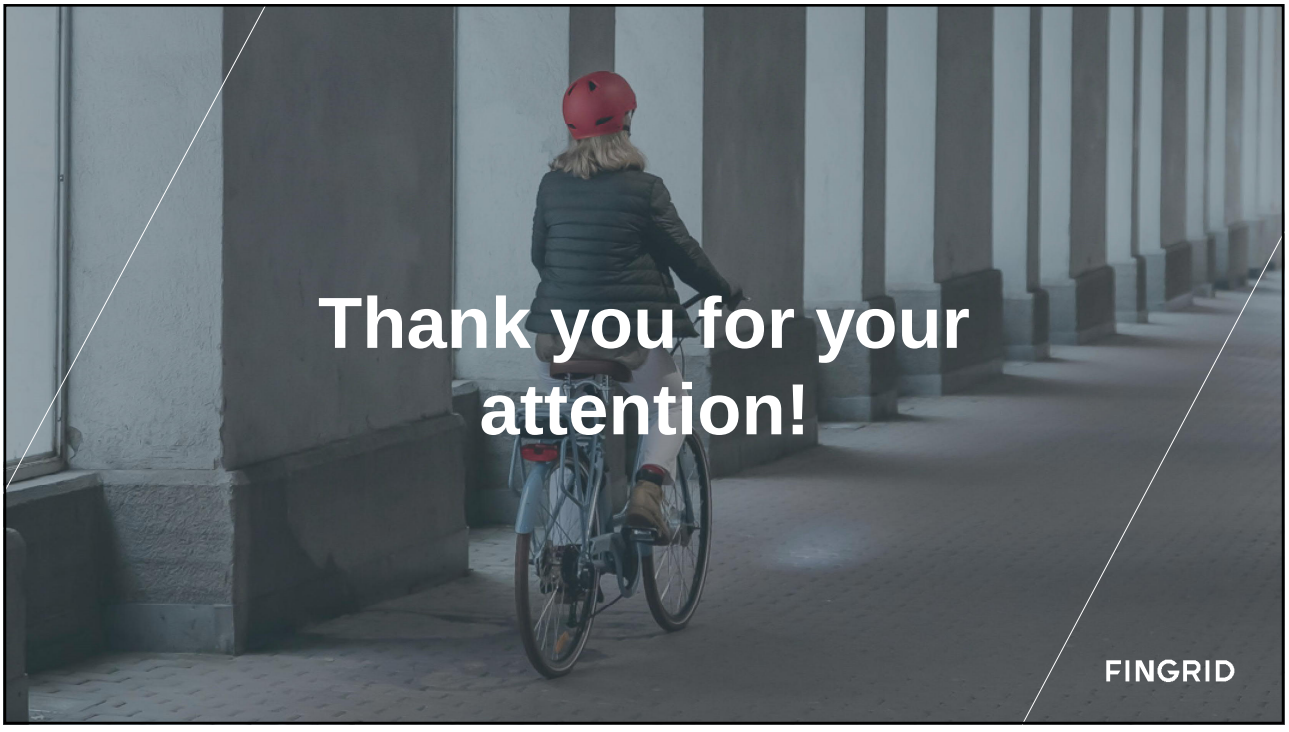

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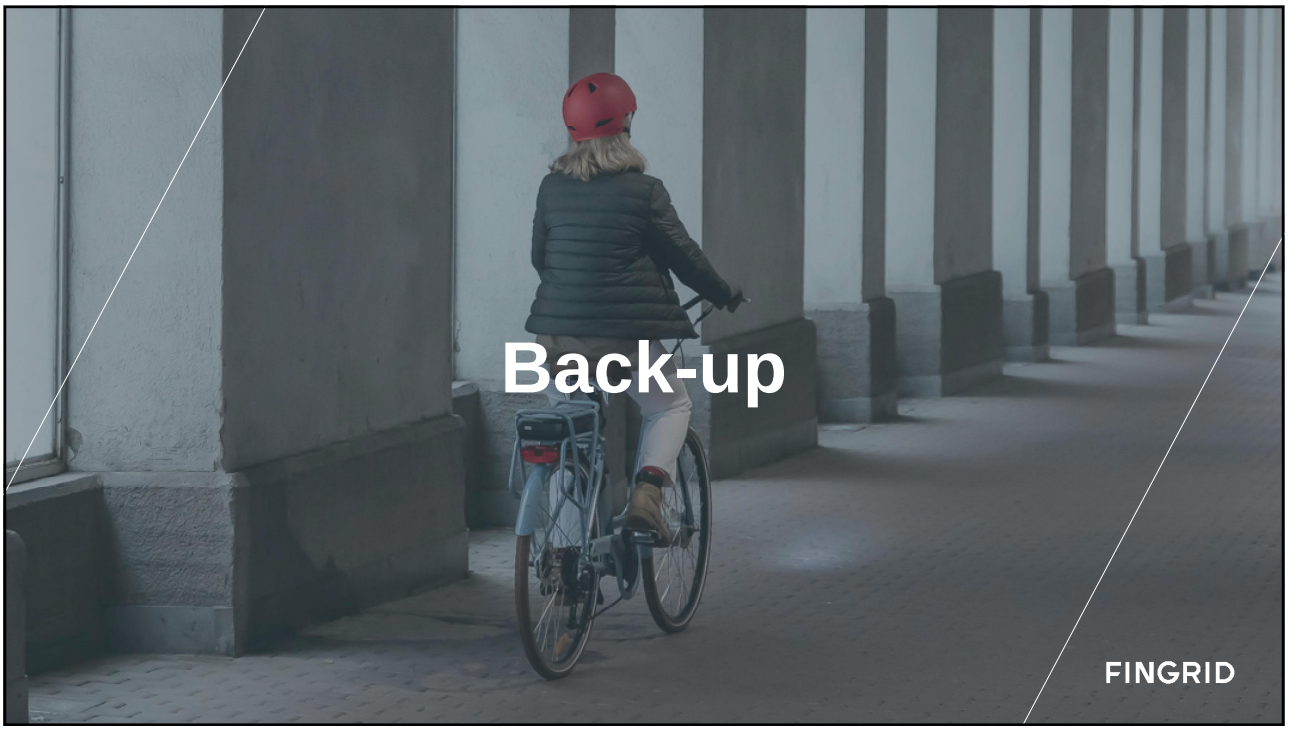

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Artificial intelligence to support business

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HOME / NEWS / FINNISH COMPANY IMPRESSED BY AI TECHNOLOGY OF AVS START-UP FINDEST

Finnish company impressed by AI technology of AVS start-up Findest

OCTOBER 15, 2020Amsterdam Venture Studio's startup Findest scouts technologies by using IGOR^AI. A Finnish electricity grid operator Fingrid Oyj used IGOR^AI to find out how they could increase the transmission capacity or eliminate bottlenecks. In Fingrid magazine the company shared their experience, arguing that "[IGOR^AI] is one of the first applications to really demonstrate how artificial intelligence could help knowledge workers in the future." For the Finish company, the AI system identified 38 technologies. Nine technologies were selected and more information was obtained.

Although the results about the technologies are still under examination, Fingrid Oyj stated that "IGOR identified some truly impressive technologies: there are now several routes that can be taken to address bottlenecks."

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AI pilot to optimise the visual information for power system operator and other information users

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Open innovation to reach the best expertise

Fingrid is looking for new ideas for condition monitoring of transmission grid post insulators and temperature monitoring for grid components

Does your company have a great idea or solution, which you would like to pilot in collaboration with Fingrid? Do you yearn for new business opportunities and world class expertise to help in commercialising your idea? We are announcing a search for partners for companies looking for new condition monitoring business.

Fingrid, in collaboration with Spinverse, announces a partner search for companies, corporations and teams of all sizes looking for partnerships and new business in the field of condition monitoring. Fingrid's cost-effectiveness and network reliability have been ranked among the best in international comparisons. However, activities

Fingrid and Spinverse are now looking for new cost-effective project ideas for assessing and monitoring the condition of post insulators used in the power grid's electric stations, as well as continuously monitoring the temperatures in power grid components.

What kinds of ideas do we seek?

- Ideas must be feasible within 1-5 years. Already commercialized solutions are also welcome.
- The solutions must work in a live grid, since the post insulators are part of a 110-400 kV system and the components the temperature of which is to be measured are a part of a 20kV-400kV system.
- Ideas can be related, **for example**, to measurement technology (eg modern, inexpensive wireless sensors; power, vibration, acceleration, image, sound, temperature, pictures), information processing (eg neural networks, genetic algorithms), visualization of measurement information, drones or laser scanning. We do not rule out any technology.
- The data transfer methods that may be used in the idea need to be based on commercial solutions