FINGRID OYJ MAGAZINE | THEME: RESPONSIBILITY

01
2020

FINGRID

Contents

THE FINGRID MAGAZINE

Did you like what you read? Send your comments on the magazine to the address: Fingrid Oyj, P.O. Box 530, FI-00101 Helsinki. Please write "Fingrid magazine" on the envelope. You can also send feedback via e-mail: viestinta@fingrid.fi.

Now you can also find Fingrid's magazine online at fingridlehti.fi/en/

Fingrid Oyj's magazine
23. volume
1/2020

EDITORIAL STAFF
Telephone: +358 30 395 5267
Fax: +358 30 395 5196
Postal address: P.O. Box 530, FI-00101 Helsinki
Street address: Läkkisepäntie 21, FI-00620 Helsinki
Editor-in-chief: Marjaana Kivioja, marjaana.kivioja@fingrid.fi
Managing editor: Marjut Määttänen, marjut.maattanen@fingrid.fi
Editorial board: Mikko Heikkilä, Jonne Jäppinen, Marjaana Kivioja, Marjut Määttänen, Risto Ryynänen, Jarno Sederlund and Tiina Seppänen
Layout: and content production
Otavamedia OMA

Publisher:
Fingrid Oyj, www.fingrid.fi
Change of address:
elina.nivaoja@fingrid.fi
Orders and cancellations:
www.fingrid.fi/en/order

Printed by: Newprint Oy
ISSN-L: 1455-7517
ISSN: 1455-7517 (Print)
ISSN: 2242-5977 (Online)

FINGRID

PHOTO | MATTI IMMONEN

Corporate responsibility is reflected in Fingrid's duties

Responsible business was one of the most talked-about topics of the last decade. I believe that will continue in this decade. At the beginning of the year, Sitra published its Megatrends 2020 report, identifying the rush for ecological rebuilding as the key factor influencing the future. The next ten years will be instrumental in determining how the ecological sustainability crisis – climate change, loss of biodiversity, overconsumption of resources and waste problems – can be addressed.

Sustainable business also requires other areas of corporate responsibility to be taken into consideration; companies must invest in responsible operations towards their employees, procurement chains, guidelines and management. Corporate responsibility must be genuinely visible and influence the way companies operate.

In the energy world, corporate responsibility is most often associated with combating climate change and the methods for generating energy. We received some good news in Finland at the start of January when Finnish Energy published its statistics on the methods used to generate electricity in 2019: coal is down to only seven per cent. Great news as society continues to use more electricity!

Public debate frequently overlooks the need to transfer clean electricity to consumers without compromising the reliability of supply. Fingrid plays a significant role in this duty. In my opinion, Fingrid's biggest corporate responsibility pledge for this decade is crystallised in our basic mission: Fingrid is tasked with ensuring that our society has reliable electricity under all circumstances and promoting a power system based on electricity generated without emitting carbon dioxide. Fingrid's business model and strategic actions are structured so as to deliver on these duties. This task must also be handled cost-efficiently. The pricing of transmission on the main grid must remain reasonable for electricity consumers and Finnish industry.

We are fully expected to deliver on these duties. New electricity generation is to be connected to the main grid and, if the capacity is insufficient, more must be built. Perhaps this was easier in the past – at least the output capacity of new electricity generators and the necessary transmission capacity were easier to forecast. The increase in renewable electricity generation, particularly wind power, is enormous, and this poses a challenge for Fingrid to build the necessary amount of capacity to the desired timetable. We only need to look to Germany and Norway for examples of countries that have not been able to connect all of their renewable output to the power grid.

The growth in renewable energy generation in Finland and its neighbouring countries influences the construction of capacity, as well as the way in which we ensure the reliability of the power supply and balance the power system. To this end, Fingrid must also modernise electricity markets – not just in Finland, but also on a Nordic and European level: we need new mechanisms to provide us with flexibility in the event of a lack of electricity generation or a lack of demand for electricity. We are modernising with the aim of ensuring the uninterrupted supply of electricity on the main grid in the future.

Every one of us at Fingrid is constantly working to deliver on our corporate responsibility pledge.

Marina Louhija
General Counsel
Fingrid

Responsibility is a way of working correctly

The orderly conduct of duties, security of supply, a sustainable operating culture, offering a transmission platform for clean energy generation: this is Fingrid's responsibility.

TEXT | VESA VAINIO, FINGRID
PHOTO | ISTOCK

Fingrid plays a role that touches the everyday lives of everyone in Finland. Consumers may not be aware of this role. It is our duty to support the value choices that consumers make by enabling clean electricity – wind power, hydro power, nuclear power – to be connected to the main grid. However, consumers expect an uninterrupted supply of electricity, whatever the weather, and – for example – buyers of wind power do not always think about how the electricity supply can be assured if the wind is not blowing. This is Fingrid's work.

"It is completely understandable for consumers to be unaware of Fingrid's role because they do not deal with us directly. In that sense, we are large and unknown among the general public," says **Marina Louhija**, Fingrid's General Counsel, who is responsible for corporate responsibility affairs.

RELIABLE ELECTRICITY, FUNCTIONAL PROCESSES

The security of energy supply is instrumental for Fingrid's customers. Industrial production processes demand uninterrupted electricity transmission, which means that electricity must be supplied without even the slightest outage. Power cuts can easily disrupt processes and, in the worst-case scenario, give rise to substantial financial losses.

In the future, electricity will also be needed to help combat climate change. The intention is to eliminate carbon dioxide emissions from electricity generation and use clean energy to reduce the emissions from other sectors (heating, transport, industrial processes).

"Finnish society is dependent on electricity, and it is our mission to ensure the availability of electricity. We provide a transmission grid that combines clean electricity generation with electricity consumers, enabling clean energy to reach the market. If the transmission grid did not have enough capacity, electricity generation would need to be restricted. This is often overlooked in public discourse," Louhija points out.

Increasing the amount of renewable energy carries many opportunities, but also risks. One example is wind power, which is expanding rapidly in Finland as it is elsewhere in the world. Even when the wind conditions are favourable, the electricity generated by wind turbines would not make it to customers without Fingrid maintaining a constant balance between electricity generation and consumption.

"Balancing electricity generation and consumption is one of our fundamental tasks. We are responsible for keeping the electricity system in balance so that users receive electricity without interruptions."

"In one way or another, corporate responsibility is in everyone's inbox at Fingrid.

Marina Louhija, General Counsel, Fingrid

POWERED BY GOOD MANAGEMENT

When corporate responsibility is discussed, the topic often turns to environmental and social responsibility. Companies also need clear management targets, and Marina Louhija says that good governance lays the foundation for everything else. Corporate responsibility management must be clear. It must be possible to monitor corporate responsibility targets and evaluate the achievement of such targets. Companies also need risk management principles that enable them to control any corporate responsibility risks they have identified.

According to Louhija, responsibility is easy to internalise at Fingrid, as everything that is done in the company has a special societal significance. In one way or another, corporate responsibility is in everyone's inbox. Fingrid plays a part in keeping the wheels turning in Finland, thereby creating value for society.

"When you think about it, we have a huge number of everyday duties that concern corporate responsibility. This means that our operating culture needs to be in good shape. This is what we are focusing on now and will continue to focus on in the future." •

Green financing

In the last few years, mitigating climate change has become one of the key corporate responsibility themes. At the same time, green bonds have become a financing trend. Fingrid issued Finland's first green corporate bond in 2017.

When an investor buys a green bond, the bond capital is allocated to environmentally friendly investments. The bond issuer commits to executing projects with positive environmental effects and precisely defined criteria. **Jussi Pohjanpalo**, Fingrid's Group Treasurer, considers green bonds a good way of financing investments with funding specifically allocated to green investments.

"The investment must meet certain criteria – it must be expected to have a net positive impact on the environment. Examples of such investments at Fingrid may include building a substation to connect an electricity producer's wind power plant. Green investments may also include modernising old transmission lines to improve energy efficiency by reducing transmission losses."

Fingrid's investment programme covers a rolling 10-year period, and the projects facilitated by green financing are carefully screened. In the 2017 screening process, green projects accounted for approximately 15 per cent of the entire programme. This year's project screening process is still underway, but the proportion of green projects is expected to rise with the increased level of wind power investment.

"As an investor, Fingrid aims to use green financing, as it supports the company's goal of enabling the transition to a clean power system. Green financing is also compatible with our responsible operating methods, which include environmental impact assessments of projects, corporate responsibility audits of suppliers and service providers, and requiring suppliers to commit to the company's corporate responsibility rules.

There is plenty of green money on offer in Finland and around the world. The energy sector is in a state of transition, and investors are interested in facilitating new forms of renewable energy and climate investments. Green bonds can help issuers to enhance their standards of corporate responsibility in environmental matters and sustainable development financing, and expand the investor base.

"The number of investors in Fingrid also increased when green bond was issued, as they provided the company with new debt investors with a specific focus on green financing." •

A large carbon handprint benefits the climate

■ In 2019, Fingrid connected 132 megawatts of wind power production to its network. New connection agreements have been signed for approximately 2,000 megawatts, an amount which is expected to be realised in the coming years.

Satu Vuorikoski, Corporate Responsibility Development Manager, highlights the substantial positive climate effects of connecting wind power to the grid. In order to enable Finland to reach its climate targets, Fingrid must ensure that renewable energy producers are connected to the main grid and that the energy is transmitted onwards for customers and society to use. The climate benefits arising from Fingrid's work are much larger than the carbon dioxide emissions arising from the construction and operation of the main grid.

"When the full amount of wind power production included in the connection agreements comes to fruition, we will indirectly avoid approximately 1.1 million tonnes of carbon dioxide equivalent of emissions in the coming years. This is our carbon handprint for positive climate development."

The reduction in emissions corresponds to the annual carbon footprints of approximately 110,000 Finns, as every person leaves an annual carbon footprint of 10 tonnes of carbon dioxide equivalent. •

"Connecting renewable energy production to the main grid is Fingrid's mission, and it is also a part of our carbon handprint.

Satu Vuorikoski, Corporate Responsibility Development Manager, Fingrid

Auditing accelerates responsibility

■ Many of Fingrid's investment projects are executed on the engineering, procurement and construction (EPC) principle with around 15 main partners, with the contracts also including procurement of materials. Fingrid procures some of the materials, such as transformers and conductors, itself directly. Precise quality criteria area always defined for partners and deliveries.

"From 2016 to 2019, we conducted 40 audits around the world. We aim to have audited 90 per cent of our goods suppliers by 2025," says **Timo Kiiveri**, Senior Vice President, Asset Management, at Fingrid.

The audits reveal the partner's commitment to the common goal. The areas under examination include competences, management, occupational safety, processes, environmental matters and quality management. Fingrid's audits are conducted by a global partner.

In Kiiveri's assessment, the various parties understand the importance of auditing. Auditing reinforces corporate responsibility and supports the process of developing matters and getting everything in good order.

"For example, when an Indian company sees that they meet our criteria, they gain access to a larger market. For us, a responsible operating method is a small but genuine way of making the world a better place."

According to Kiiveri, Finnish companies do not need to shy away from demanding that global companies operate responsibly. Similarly, when Fingrid is able to demonstrate that it has a comprehensive, audited network of partners, it inspires trust, both in Finland and internationally. •

"For us, a responsible operating method is a small but genuine way of making the world a better place.

Timo Kiiveri, SVP, Asset Management, Fingrid

The environment is grateful for careful oil tracking

■ Placing a containment basin beneath the substation transformer ensures that oil cannot escape into the natural environment in the event of a leak. However, containment basins are uncovered areas, so rain may cause the basins to fill up with water. The water that accumulates in the basis is regularly drained.

If oil flows into the basin, the normal way to ensure that it is removed is to build a conventional oil sump connected to the basin. However, this is not always possible. Old substations often do not have enough space, and in Northern Finland, the matter is further complicated by the fact that the frost is deeper than in other parts of the country. A new technique for safeguarding the environment has been introduced on sites like these.

"A fixed device uses sensors to track the height of the water, and when it surpasses a set threshold, the device automatically begins draining the water. The device examines the purity of the water optically, and if it detects oil in the water, it returns it to the containment basin," says **Maija Nurmi**, Fingrid's Environmental Specialist.

Nurmi emphasises that no oily water is discharged into the environment under any circumstances: a tanker is sent to remove the oil remaining in the basin. In the winter, the water freezes and the device goes into hibernation. When the water melts, the device begins draining it.

This tracking system is used in 10 substations, some of which are jointly used by Kemijoki Oy's hydro power plants. The operation of the devices can be monitored in real-time over the internet, which further improves the security of the system. The devices also enable the seals on the containment basins to be checked. •

Kaisa Leikola is the Chief Executive of the Guides and Scouts of Finland. She says that the crucial ideal behind the Scouts' activities is to "love nature and protect the environment".

Climate hope instead of climate anxiety

Scouting is an educational movement that aims to support the development of children and young people, taking their personal characteristics into consideration. Scouting is guided by a value base that is common to all Scouts around the world. These shared values are expressed in the form of Scouting ideals, which include knowing your responsibilities and taking action, as well as loving nature and protecting the environment. These ideals were first put in writing more than 100 years ago, but they are highly relevant in modern-day Finland.

The goal of sustainable development is to ensure that current and future generations have the opportunity to live good lives. The Scouts have committed themselves to reaching the goals set in the UN's Agenda for 2030. The activities that take place at the weekly Scout meetings provide Scouts with the opportunity to learn the skills necessary to act in an ecologically sustainable and just way on behalf of the world.

Urbanisation has taken us further away from direct contact with nature. However, a strong relationship with nature and knowledge of the state of nature are important to anyone wanting to take action to protect the environment. As Finland's largest youth organisation, the Scouts are taking responsibility for helping young people to develop a relationship with nature by offering them the opportunity to do things in forests and on the water. Every year, the Scouts organise more than 12,000 excursions and spend up to 150,000 days camping.

In line with our ideals, we aim to take responsibility for the state of our environment and the preservation of biodiversity. According to the Youth Barometer, 67 per cent of young Finnish people feel uncertainty or insecurity due to man-made climate change. At the Scouts, we believe in taking a positive, solution-oriented approach to combating climate change. Making a small change for the better is always preferable to doing nothing. We promote climate hope rather than climate anxiety.

"As Finland's largest youth association, the Scouts are taking responsibility for fostering the relationship of young people with nature.

Robert Baden-Powell, the founder of the Scout movement, gave the Scouts the following wise encouragement: "Try and leave this world a little better than you found it." This is good advice for all of us – children, adults and companies – who want to act responsibly in modern-day society. •

Aurora pyramids
– the world's northernmost virtual power plant

Tourism company Hullu Poro is introducing a virtual power plant service in Kittilä to enable connections to reserve markets, which balance out electricity generation and consumption. The Aurora Pyramids suites have recently been connected to the service. The solution helps support sustainable development, but the company also benefits financially.

TEXT | MATTI REMES
PHOTOS | HULLU PORO

The Aurora pyramids, the new form of accommodation offered by Hullu Poro, is a cluster of high-quality suites near Levi Fell in Kittilä. The pyramid-shaped glass roofs enable visitors to admire the northern lights and the surrounding fell landscape. In the first half of the year, all 11 pyramids will be connected to the virtual power plant service provided by Vibeco, a subsidiary of Siemens, enabling the hotel to increase or decrease its electricity consumption in order to balance out the power network. As such, Aurora pyramids will become a Fingrid Reserve Unit, and Fingrid will pay the company a fee in return.

The glass roofs of the pyramids are made of electrically heated glass that uses solar energy, which melts any snow and ice on the glass. Guests can admire the scenery all year round. In the winter, selective glass keeps the interior nice and warm while in the summer, it can combine with air conditioning to maintain a pleasant, cool temperature.

Siemens is supplying and installing a micro-network in the area, including technical building services, automation and electrification. In the spring and summer, a 132 kilowatt-peak (kWp) solar energy system and a 1.3-megawatt battery storage will be connected to the network to enable electricity to be generated and stored locally.

'When smart buildings and micro-networks are able to balance out the power network, there will be less need for coal-fired power plants as reserve power.

A PIONEER IN SUSTAINABLE TOURISM

The solution provided for Aurora pyramids is reportedly the northern-most virtual power plant and micro-network. **Päivikki Palosaari**, the entrepreneur and CEO behind Hullu Poro Oy, is excited about the sustainable development solution.

"It's great to be a trailblazer on a project like this which promotes sustainable development: this is an area where everyone should play their part. The energy-efficient solution will also provide the company with financial savings over the long term," Palosaari says.

Hullu Poro is settings its sights on sustainable tourism in Lapland in other ways. For example, it was the first company to seek quality and environmental certification.

"We have systematically reduced our emissions by means such as increasing the number of electric cars we use. Customers often ask us how we handle our environmental affairs. For example, visitors from Central Europe are interested in this."

VIRTUAL POWER PLANT PROVIDED AS A SERVICE

The virtual power plant is delivered as a service: Siemens is liable for the investments required, and it charges a monthly service fee. The contract between Siemens and Hullu Poro will run for the next ten years.

"The service concept means that customers do not need to commit any capital to investments. Instead, they can spend the money on developing their core business," says **Anssi Laaksonen**, Head Of Sales and Operations at Siemens.

He says that one of the benefits of the smart micro-network is that it can operate independently in isolation if necessary, as it has its own electricity generators and storage facilities.

"This ensures that the Pyramids will have enough electricity, even if there is a problem that prevents electricity from being transferred from the distribution network."

ONE OF FINLAND'S LARGEST SOLAR PANEL FIELDS

The solar panel field, which will be built near the micro-network in the spring, will be one of the largest in Finland. The annual solar energy output has been calculated at 114 megawatt-hours. In Northern Finland, solar energy is as readily available as in the south.

"In fact, solar power systems generate the same total amount of energy in the north as they do in Southern Finland. No energy is generated in the winter, but in the summer, the panels output power all day long," Laaksonen states. •

"The smart micro-network generates and stores electricity, and it can also operate as an independent unit in isolation.

Anssi Laaksonen, Head Of Sales and Operations at Siemens

Sector integration will help to manage the power balance

Sector integration means bringing the various energy sectors together to enable them to balance out each other's peaks in consumption and generation. Electricity, heat, gas and transport will be interconnected to provide mutual support to each other. But what does this mean for the power system and the transmission grid?

TEXTS | PÄIVI BRINK
ILLUSTRATION | FINGRID

The impact of sector integration on the development of the power system and on the transmission grid is one of the key questions facing Fingrid in the near future. There is still no certainty about the impacts, but we are studying them together with the energy sector as a whole. Sector integration will proceed in any case, but its impact on the operating environment is still an unknown quantity. We need to make preparations and study the challenges and opportunities it will bring," says **Jussi Matilainen**, Fingrid's R & D Manager.

Renewable energy sources provide energy in varying amounts, but the power system must maintain a constant power balance.

"Finland aims to become carbon neutral by 2035, and sector integration supports this goal. Giving on fossil fuels will give rise to substantial growth in electricity consumption. Electricity can be used to manufacture gas, heat or fuel for transportation. In Finland, the most interesting change will be the consolidation of the heating and electricity systems into a better, more energy-efficient whole."

It is not yet known how much and how quickly consumption will grow, which parts of Finland will demand more electricity, and how much consumption will fluctuate. As regards electricity generation, the locations of new wind turbines will affect the way the transmission grid is developed.

FINGRID IS TAKING RESPONSIBLY FOR THE FUTURE OF THE TRANSMISSION GRID

Sector integration will help Fingrid and the industry as a whole to realise a clean electricity system cost-efficiently. However, the challenges that sector integration will place on the transmission grid must also be addressed.

"Fingrid is ultimately responsible for keeping the power system in balance, so the control centre must be able to forecast consumption and generation. The electricity network must also have enough transmission capacity. It is also our job to develop the electricity market and the related flexible market," Matilainen says.

Fingrid cannot make preparations for sector integration alone. European transmission system operators are working together to develop the power system. In Finland, the Smart Grid Working Group has been discussing the future of the electricity network. In addition, the Ministry of Economic Affairs and Employment is managing a study in which every industry is examining what it can do to become carbon neutral. Sector integration could be a cost-efficient means of doing this.

While parties in the industry work to gain an overview of how they can reach the targets for 2035, Fingrid must prepare itself for the challenges and opportunities that sector integration will pose for the planning of the transmission grid, development of flexible markets and operation of the power system.

"Work has already begun, but there is still a need for new research and development projects," Matilainen says.

RESEARCH PROJECTS LOOK TO THE FUTURE

Researchers around the world are considering the future of sector integration.

"Universities are studying areas such as demand-side management, battery storage, improving transmission links and controllable power plants. In Finland, the spread of heat pumps and electric vehicles will support sector integration: they provide excellent support for demand-side management. As development proceeds, the heating system will be able to offer more flexibility and control. At LUT University, we are researching fields such as charging solutions for electric cars and the related business models. Smart charging systems can support the power system rather than putting a strain on it," says **Samuli Honkapuro**, Associate professor in Energy Markets at LUT University.

Research is currently underway to examine the possibilities of making synthetic fuels using electricity and the carbon, captured for example from factory chimneys.

"Our research is focusing heavily on new opportunities for electricity: using electricity to isolate hydrogen, which can be used as a fuel or even a nutrient. Projects like these can only be feasible with low cost electricity."

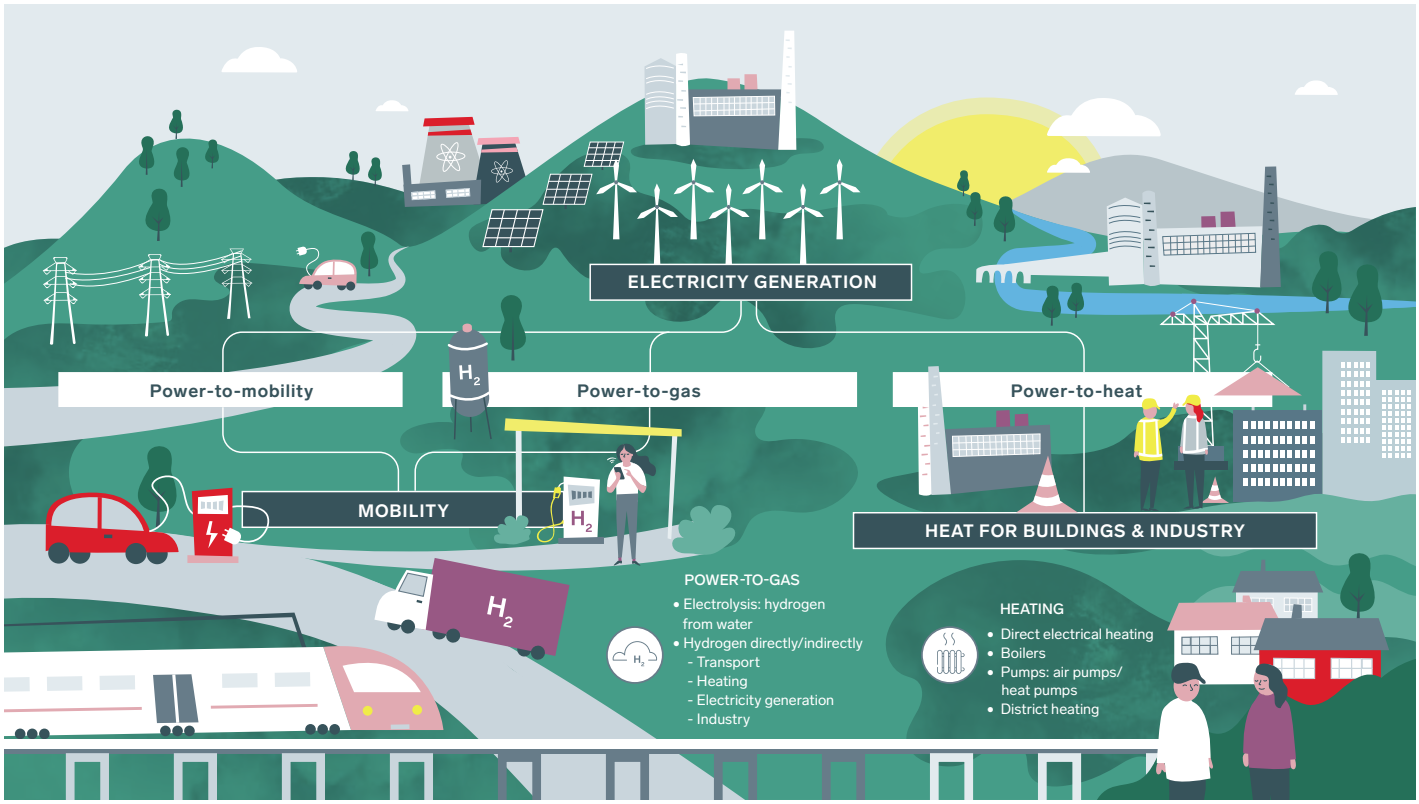
Finland is a pioneer in developing electricity markets.

"Fingrid is doing outstanding work. They are able to put their limited resources to good use, and demand-side management is considered an important resource for the market," Honkapuro says. •

"In Finland, the most interesting change will be the consolidation of the heating and electricity systems into a better, more energy-efficient whole.

Jussi Matilainen, R & D Manager, Fingrid

What is sector integration?



The various energy sectors – primarily electricity, heat, gas and transport – are being interconnected to create a smart energy system where energy can be stored and transferred in the form that is most techno-economically suitable for the need in point. Sector integration will provide the energy system with the flexibility it needs to balance out peaks in generation and consumption.

Renewable energy generation cannot flexibly adapt to consumption, so the demand must adapt to the supply. In Finland, the consolidation of the electricity and heat sectors will contribute most to demand-side management. When electricity is expensive, large heat storage facilities can be used as an energy source. When electricity is cheap, the heat storage facility can be warmed up using electricity. Sector integration can enable energy to be stored for a longer period, at a lower cost and in larger amounts than with battery-based electricity storage.

Another new concept is the virtual power plant. An example of this is when consumers make agreements with electricity suppliers to enable the consumers' heating systems to be used for demand-side management. In aggregate, the heating devices constitute a virtual power plant that can be regulated as required. •

Fingrid sets code specifications for grid energy storage

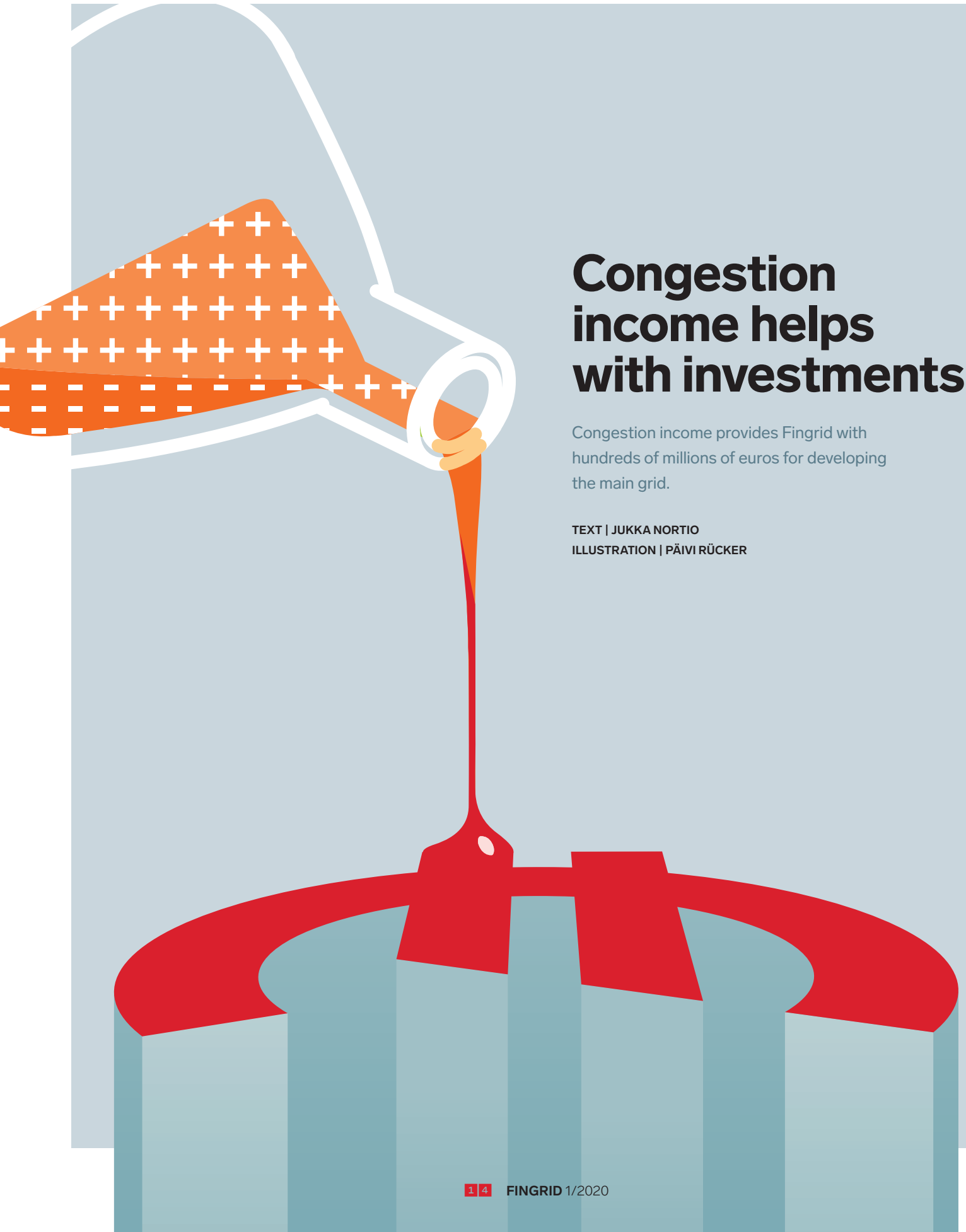
There were no previous grid core specifications for grid energy storage, and it has become necessary to specify some requirements as storage technology has developed and the number of grid energy storage facilities has increased.

"Last autumn, we specified the technical grid code specifications for converter connected grid energy storage facilities connected to the power system of Finland, and we submitted our proposal to the Energy Authority for commenting. We anticipate that the Energy Authority confirms the specifications in spring 2020," says **Antti Kuusela**, Expert at Fingrid.

"The code specifications are set according to the size of the facility from class A to class D. Almost all of the grid energy storage currently in use in Finland belongs to class A, meaning that the capacity is less than one megawatt. Grid energy storage is typically used to deliver a frequency-controlled reserve."

Fingrid ensures that the main grid operates reliably.

"It is in everyone's interests to have coherent requirements and a functioning system," Kuusela summarises. •



Congestion income helps with investments

Congestion income provides Fingrid with hundreds of millions of euros for developing the main grid.

TEXT | JUKKA NORTIO
ILLUSTRATION | PÄIVI RÜCKER

Congestion income arises in electricity markets when the transmission capacity between bidding areas is not enough to balance out the differences between supply and demand in the market areas. The market areas become separate price areas in which electricity buyers in one area pay a different price than the amount received by the electricity seller in the other area.

The price difference accrues on the power exchange in the form of congestion income, which the power exchange settles 50/50 between both transmission system operators on either side of the price areas. Agreements have been made between Finland and the Nordic countries and between Finland and Estonia to share the congestion income between the countries evenly.

WEATHER FLUCTUATIONS AND POWER PLANT SHUTDOWNS

Congestions are typically caused by the weather conditions. When Sweden and Norway are having a rainy year, there is an overcapacity in electricity generation and the price of electricity is low. At the same time, the conditions in Finland may be normal, and the price of electricity will be normal.

If the transmission capacity between Sweden and Finland is not enough to offset the imbalance between supply and demand, the price difference will give rise to congestion income for the transmission system operators in Sweden and Finland. Congestions may also arise if it is necessary to shut down a nuclear power plant or a transmission link between the market areas develops a fault.

TARIFFS DOWN OR INCOME FOR DEVELOPMENT

Congestion income is governed by EU law, which states that it may be used for the maintenance and development of the electricity transmission grid and for reimbursing electricity consumers for the market failure caused by the congestion; in other words, for reducing tariffs.

Network maintenance and development are necessary in order to reduce the number of market failures due to congestions, thereby evening out the price of electricity between market areas in the long run.

In an ideal situation, the transmission system operators in different market areas would operate on the same principle. In such a case, the transmission capacity would be improved on both sides of the border. This would be an effective way of eliminating congestions.

"It is important for us to have clear rules about how congestion income is used. The logic is that the congestions will be addressed. In practice, the transmission system operators receive money in order to rectify the market failures by investing in network development," says **Jussi Jyrinsalo**, Senior Vice President, Grid Services and Planning, at Fingrid.

FINGRID INVESTS IN THE NETWORK

When Fingrid is planning to use congestion income for investments, it must first seek the Energy Authority's approval.

At present, Fingrid is making major investments in several projects, which include building the Forest Line, a transmission line linking the north and south of Finland, and increasing the transmission capacity towards Sweden in the Tornio river valley.

"Congestion income is excess income for transmission system operators, and it describes a deficit in the markets. For this reason, congestion income should be used to minimise this deficiency," says **Jarno Lamponen**, Leading Specialist at the Energy Authority.

In Sweden, not all of the congestion income is spent on investments to eliminate the congestions they originated from. Instead, some of it is used for other projects. Jyrinsalo from Fingrid would like the congestion income to be used symmetrically on both sides of the border.

"Spending the congestion income on strengthening the network is one aspect of Fingrid's corporate responsibility.

Jussi Jyrinsalo, Senior Vice President, Customers and Grid Services and Planning, Fingrid

HUNDREDS OF MILLIONS IN 20 YEARS

Fingrid's congestion income has averaged EUR 20–30 million this millennium, with a peak of EUR 90 million. This money has been spent on market-oriented network development: securing the availability of electricity for Finnish people and ensuring that the price of electricity remains reasonable under all conditions.

"Significant sums of money are required to improve and strengthen the network to enable the energy revolution," says Jyrinsalo.

Spending the congestion income on strengthening the network is one aspect of Fingrid's corporate responsibility – it is making investments in reducing market failures.

Fingrid uses market simulation models to forecast its congestion income and estimate how much of its investment expenditure will be covered.

"The congestion income is a natural consequence of the current market model. If there were no congestion income, we would be in the position of having invested too much in the grid," Lamponen says. •

Preparation of network code requirements is well underway

Fingrid's customer organisations are working to implement the requirements of the EU network code on electricity emergency and restoration. The 24-hour operability requirement and automatic under-frequency load shedding system must be implemented by December 2022.

TEXT | OLLI MANNINEN
PHOTOS | ELENIA, UPM ENERGY, SUOMEN ERILLISVERKOT, FINGRID

Customers' awareness of the requirements of the EU network code has increased substantially over the last six months, as the actions required by the network code have been discussed by various working groups," says **Heikki Paananen,** Unit Manager, Operations, at Elenia, who also chaired Fingrid's Operations Committee until the end of 2019.

Pekka Pollari, Hydro Power Manager at UPM Energy, highlights the fact that the guidelines for the network code requirements must be as clear and detailed as possible so that everyone can take the right action at the right time.

"Customers are approaching this issue from very different perspectives. The network code calls for investments, so long-term planning is required. If changes are made in great haste, it may double the eventual investment," Pollari says.

UPM is already able to meet the network code requirements with its current measures.

"The 24-hour operability requirement is a step in the right direction. UPM's control centre in Tampere will coordinate the implementation of network restoration actions and the associated 24-hour requirement with Fingrid and customers," Pollari says.

"The telecoms links are already fault-tolerant, and we are upgrading substations to meet the new requirements.

Heikki Paananen, Unit Manager, Operations, Elenia

SMARTER LOAD SHEDDING SYSTEM INCREASES FLEXIBILITY

Elenia's Heikki Paananen explains how his company has planned and advanced matters on three levels.

"We have actively followed Fingrid's guidelines and acted accordingly. We have already ensured that our telecoms have 24-hour fault tolerance for the reserve connection, and the main connection is now being planned. At the same time, we are working on upgrading the substations within the scope of the network code so that they meet the requirements. As regards the load shedding system, we have been cooperating with Fingrid and intend to implement our plans next year," Paananen says.

According to **Jari Siltala**, Fingrid's Control Centre Manager, the new under-frequency load shedding system is better than the current solution at addressing the future challenges of decentralised power generation when under-frequency protection is moved from the main grid onto distribution networks and electricity consumption sites.

"The modernised load shedding system offers a more flexible and sensible approach to disconnecting consumption and generation. The impacts of disturbances can be minimised more effectively. The system also places more responsibility on the distribution network operators," Siltala says.

NETWORK CODE COORDINATES AND HARMONISES PRACTICES

The Network Code for Emergency and Restoration (NC ER) specifies the common requirements and goals for handling emergencies, major disturbances and restorations in the power system. The network code seeks to coordinate and harmonise the operation of the power system in the event of an emergency, major disturbance or restoration between different parties throughout the EU and with third countries.

The NC ER obliges all European transmission system operators to prepare two plans: a system defence plan and a restoration plan. The signifi-

"The high-readiness network is by far the best way to communicate, but at present, it is simply too expensive.

Pekka Pollari, Hydropower Manager, UPM Energy

cant parties and substations needed to implement these plans must also be designated.

"Fingrid is obliged to provide the Energy Authority with a list of the significant parties to whom the network code applies. We are currently developing a smart process for keeping the list up-to-date. This will ensure that in the future, we can immediately incorporate entities such as new wind farms into the system," Siltala says.

"The modernised under-frequency load shedding is flexible and will enable the impacts of disturbances to be minimised more effectively.

Jari Siltala, Control Centre Manager, Fingrid

FOUR OBLIGATIONS FOR OPERATORS CONNECTED TO THE MAIN GRID

The network code obliges the transmission system operator Fingrid to take preparatory measures, as well as the distribution network operators that Fingrid has designated as significant in terms of the system defence and restoration plan. The network code also places obligations on electricity producers and consumers.

Parties who are designated as significant to the restoration plan are required firstly to meet the 24-hour operability requirements related to critical tools and premises, including the control centre.

Secondly, they must ensure the operability of substations designated as significant.

The third duty is to ensure that the operation control system and the other systems essential for its operations continue to function, including data communication.

The fourth obligation is to arrange voice communication with Fingrid in such a way that phone calls can be prioritised in the event of an emergency or major accident. •

Communication must be assured, even if there is no electricity

■ The network code also calls for a 24-hour backup power supply for the phone call, data communication and automation systems used to restore electricity. Fingrid has worked with State Security Networks Group Finland and electricity companies to develop a high-readiness network service entity capable of maintaining the data communication links that are critical for restoring electricity for 24 hours, even if power distribution is interrupted.

The high-readiness network is based on a fixed, high-availability state security network, which is equipped with backup power for more than 24 hours and operates between control centres, connecting the transmission system operator, Fingrid, and other important parties.

The high-readiness network consists of three services: voice traffic between control centres, Krivat situational awareness and cooperation, and the FEN service, which provides a technical overview of the electricity network.

"The pilot phase is drawing to a close, and we will transition into production in February. The voice service is an entirely new service, while Krivat and FEN have been in use for some time now," says **Pekka Tynkkynen**, Account Manager at State Security Networks Group Finland.

"We aim to develop high-readiness services in such a way that they provide the maximum possible benefit also when the power system is operating normally," Tynkkynen says.

Customers who are interested in the service can make an agreement with State Security Networks Group directly.

COSTS OF THE HIGH-AVAILABILITY NETWORK CAUSE CONSTERNATION

Among customers, opinion is split on the benefits of the high-availability network.

"Technically, it is by far the best way to implement communications, but the costs need to come down. At present, it is simply too expensive," says Pekka Pollari from UPM Energy.

At the moment, UPM's communication connections are handled using the Virve network and satellite phones in the event of an emergency.

"We have been using Virve for a long time for communication with the emergency services. In addition, we intend to purchase more satellite phones, although their bandwidth is limited. This would be a satisfactory solution for us," Pollari says.

However, Fingrid's Control Centre Manager Jari Siltala points out that Virve phones are not an adequate solution because they do not meet the 24-hour operability requirement.

Elenia's Operations Manager Heikki Paananen says that Elenia considers the high-readiness network a good solution for situational awareness and communication.

"Elenia will deploy the system, along with a backup voice connection. We think that the high-readiness network service entity should be maintained with the customers' needs and efficiency in mind. This should improve the cost-effectiveness of the system," Paananen says. •

"High-readiness services are being built so that they also benefit the power system when it is operating normally.

Pekka Tynkkynen, Key Account Manager, State Security Networks Group Finland

Houses tell their own energy stories at the Tuusula Housing Fair

Energy is one of the four themes of the 2020 Housing Fair in Tuusula. The municipality of Tuusula and energy companies are heavily involved in turning the fair site into a virtually zero-energy area.

TEXT | PÄIVI LEINONEN
PHOTO | ASUNTOMESSUT

A residential area named Rykmentinpuisto is under construction near the centre of Tuusula. Construction began with the Housing Fair area, and the district will eventually accommodate 15,000 residents. The energy vision for the area is based on locally-generated renewable energy.

The doors to the exhibition houses traditionally show a summary of the building's technical details, such as its energy performance class. In Tuusula, the information will also include the building's carbon footprint and carbon handprint, the latter being an account of the building's positive environmental effects. Every house will also tell its own energy store, including details such as which energy-efficiency solutions are a tangible part of the residents' everyday lives.

"A survey was used to ask the housebuilders about their choices, and their responses were used to create an energy story for each house," says **Katerina Zaitseva**, Project Manager at the municipality of Tuusula.

Many of the housebuilders had opted for renewable forms of energy. Geothermal heat was the most popular of these. There are also a lot of heat pumps and solar panels. The intention is to create a consolidated energy performance certificate for the entire area using the energy performance certificates for the individual buildings.

"We prepared guidelines for housebuilders concerning energy solutions, which are intended as encouragement or recommendations rather than orders or regulations," explains Zaitseva.

BIDIRECTIONAL DISTRICT HEATING NETWORK USING LOCAL ENERGY

Fortum is offering an open bidirectional district heating network for the Rykmentinpuisto area, enabling customers to act as heat producers. Fortum will offer residents solutions such as solar power packages, smart heating control and charging solutions for electric vehicles.

Buildings may sometimes produce more energy than they consume if, for example, they have solar thermal collectors or heat pumps. On the open bidirectional network, residents can sell the surplus heat they generate back to Fortum at market prices. The range of services also includes a cooling system that can direct the condensate heat back into the open network for reuse.

Fortum is also investing in local energy generation. One innovation is Horse Power, which gathers power from the nearby horse stables. The owner of the stables receives a service whereby a wood-based bedding material is delivered to the stables and the manure pit is emptied. The fuel is then used at Fortum's power plant to generate renewable, environmentally friendly local energy.

ACTIVE DAY-TO-DAY LIFE IN A SMART HOME

The other themes at the Tuusula Housing Fair are smart homes, active everyday life and art.

"During the land application phase, the house-builders told us how they would incorporate the themes in their projects," says **Riikka Uusikulku**, Project Manager for the Tuusula Housing Fair.

The overarching principle of the Housing Fair is to showcase new housing solutions.

"Smart home solutions are highly advanced in one house, which is being built for a person who was injured in an accident. One trial project will involve offering an electric car for the shared use of residents in a block of flats for the first year." •

Plenty of heating options

When people build new houses, they can choose from several alternative heating systems. Before selecting one, it is a good idea to think about the appropriate floor area and whether the thermal energy required by the building can be reduced using better insulation and more energy-efficient heat recovery.

When selecting a heating system, it is a good idea to think about environmental friendliness, ease of use and energy costs in the present and the future, as well as the purchasing and operating costs.

The following are suitable for use as primary heating forms:

- District heating
- Natural gas
- Woodchip, firewood and log boilers
- Pellet heating
- Ground-source heat pump
- Air/water heat pump
- Oil heating
- Water-circulation central heating with electric heating
- Direct electric heating

Supplementary heating systems act as reserve heat sources and reduce the need to buy energy in:

- Exhaust air heat pump
- Air heat pump
- Solar heating system
- Fireplace with heat storage

View the comparison of heating types, and read more about the operating costs and environmental impacts: **www. fingridlehti.fi/en/asuntomessut**
Source: Motiva

Developing building automation for control centre buildings

■ Fingrid owns about 100 control centre buildings in various parts of Finland. The buildings themselves resemble ordinary family homes, right down to the technical building services. The buildings are equipped with a bathroom, small kitchen, heating, ventilation and lighting. However, nobody lives in these houses, and inspection visits are made only rarely.

The new control centres use building automation systems to regulate the temperature. In the coming years, automation will undergo further development to enable more effective monitoring.

"We intend to develop the system so that it enables remote monitoring. At present, automation solutions work locally on the sites," says **Jonne Lantto**, Building Automation Specialist at Fingrid.

Due to the number of electrical components, the buildings must not be allowed to get too cold. At warmer times of year, air-source heat pumps can provide cooling if necessary.

The control centre buildings are designed to be energy-efficient. The lack of windows in the buildings ensures that the buildings are airtight and energy-saving. The control centres have electric heating, but the first building heated with geothermal energy is currently on the drawing board. •

The new control centre buildings are beginning to resemble family homes in terms of their technical building services and energy efficiency. The buildings are equipped with toilets, small kitchens, heating, ventilation and lighting. Pictured: the control centre of the Ruotsinkylä substation.

Smart energy for electric vehicles

■ Three different solutions exist for charging electric vehicles: conventional charging, smart charging and bidirectional charging.

"Smart charging is the modern-day solution for households because it takes into consideration the needs of consumers and the environment," says **Ville Väre**, Energy Service Manager at Liikennevirta Oy.

As electricity markets become more flexible and decentralised, the ability to control things increases in importance, as electric vehicles are a means of enabling an increase in renewable energy. Conventional charging refers to the form of charging where electricity is fed into the vehicle without any form of control system.

Smart charging uses a control system that can regulate charging according to various needs. Often, it is sensible to charge vehicles when the price of energy is at its lowest. Another reason is to schedule charging for the hours when the household's energy consumption is low.

Bidirectional charging enables electricity to be fed from the vehicle back into the grid. This enables the vehicle to be used as a battery and a backup energy supply. Car batteries are fairly large, storing plenty of energy to satisfy a temporary need.

"Bidirectional charging works very well with solar power, as the battery is charged when the sun is shining and discharged when electricity is needed." •

Wind turbines are stopped during severe storms when the wind speed exceeds 25–30 metres per second for a sustained period. Such storms are rare in Finland.

Do storms bring wind turbines to a standstill?

TEXT | JUHA-PEKKA HONKANEN
PHOTO | ISTOCK

HOW WEATHER-DEPENDENT IS WIND POWER?

Finland is a great place for generating wind power because wind power generation is highest in the cold winter months when energy consumption is also at its highest. There is a widespread misconception that there is no wind on very cold days, but this is not the case, particularly at the hub heights of modern wind turbines.

Wind turbines are stopped when the wind exceeds the durability and safety requirements for a long period, typically when the wind speed is above 25–30 m/s. In such cases, the blades are placed into a position where they are out of the wind, and the turbines are shut down. Statistically, it is very rare in Finland for the wind to blow at a speed that requires turbines to be stopped.

WHAT ARE THE BEST LOCATIONS FOR GENERATING WIND POWER?

The best wind speeds can be found on the tops of hills or on the coast, but technical development has enabled wind turbines to be built higher, making construction in inland areas more feasible.

HOW IS THE SIZE OF A WIND POWER UNIT DETERMINED?

In general, wind turbines are built as large as possible with the greatest possible efficiency, as this minimises the cost of generating energy. However, it is sometimes necessary to make compromises due to the environmental, permit processes or land ownership.

Wind turbine blades have also grown in length over the last five years, enabling significantly more energy to be obtained from the wind.

WHAT STAGE IS WIND POWER CURRENTLY AT?

Thanks to technological advancements, new wind power capacity is currently being built without public subsidies in an amount that will double the installed capacity in Finland. These investment decisions were made over the last 18 months. Wind power has become the cheapest way of generating electricity in the Nordic countries, which is a clear indication that the energy revolution is well underway.

This interview was conducted with ***Teemu Loikkanen****, who is Regional Manager Finland and the Baltics at OX2 and a member of the Finnish Wind Power Association's Board of Directors.* •

OL3 system protection completes Olkiluoto 3 connection to the grid

One of Fingrid's duties is to connect new, high-capacity power plants to the main grid. The company has made careful preparations for the grid connection of Olkiluoto 3, one of the world's largest power plant units. The final phase of these preparations includes the implementation of OL3 system protection, which will ensure that the power system functions reliably under all circumstances once the power plant is ready.

TEXT | OLLI MANNINEN
PHOTOS | FINGRID, TVO

Fingrid is ensuring adequate conditions for Teollisuuden Voima TVO, the owner of Olkiluoto 3, to commission the power plant unit with the plant supplier in such a way that it operates safely and reliably under all circumstances.

The OL3 system protection designed and implemented by Fingrid and TVO will fix challenges caused by a trip of power plant unit due to different kind of faults.

"The OL3 system protection will ensure the uninterrupted transmission of electricity in the main grid in the event that there is a fault in Olkiluoto 3 and the power supply to the main grid is interrupted or if Olkiluoto 3 is unable to supply power to the main grid because of a fault in the grid," says **Minna Laasonen**, Senior Expert at Fingrid.

A 1,600-MEGAWATT GIANT

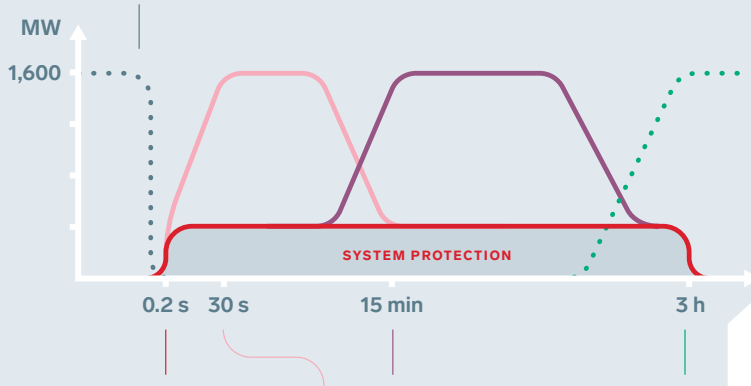
As the reactor at Olkiluoto 3 can produce up to 1,600 megawatts of electricity, a sudden disturbance in such a huge power unit could paralyse Finland's power system. The OL3 system protection will disconnect electricity consumers in such a way that the change in power to the main grid is no more than 1,300 megawatts in the event of a sudden interruption in the power supply from Olkiluoto 3.

"The OL3 system protection will enable an uninterrupted supply of electricity. This is a technical arrangement that decreases electrical comsumption on eight industrial sites within 0.2 seconds if the power supply from Olkiluoto 3 to the main grid is interrupted. In order to ensure a fast and reliable activation time data communications from Olkiluoto to industrial sites are used, Laasonen says.

She has worked as Project Manager on Fingrid's project with TVO to ensure that the commis-

What happens if Olkiluoto 3 is unable to supply electricity to the main grid due to a sudden fault?

Olkiluoto 3 power plant unit produces 1,600 MW electricity. OL3 system protection will react in 0.2 seconds if Olkiluoto 3 is unable to supply electricity to the main grid due to a sudden fault.



- OL3 system protection is activated. Electrical load on eight industrial sites is reduced. The total change in power in Finland is 1,300 MW.

Nordic frequency containment reserve for disturbances is activated.

Fingrid activates production or consumption from the balancing power markets and, if necessary, starts up reserve power plants.

Consumption and production are balanced on the electricity market. Olkiluoto 3 returns to the grid and generates electricity.

sioning of Olkiluoto 3 goes safely and reliably from the perspective of the main grid.

LARGE FACTORIES CUT ELECTRICITY CONSUMPTION IN THE EVENT OF A FAULT

The OL3 system protection, which calls for a reduction in electrical loading of approximately 350 megawatts, involves Kemira Chemicals Oy from Äetsä, Metsä Board Corporation's factories in Joutseno and Kaskinen, Stora Enso Oyj's factories in Anjalankoski and Imatra, and UPM Paper Ena Oy's factories in Jämsänkoski, Kaipola and Rauma.

"In terms of the Specifications for the Operational Performance of Power Generating Facility, Olkiluoto 3 is no different from any other power plant, but its enormous output sets it apart. For this reason, OL3 system protection was required to reinforce the reliability of the power grid," Laasonen says. •

FACT BOX

- Olkiluoto 3 will increase Finland's self-sufficiency in energy, provide more power on cold winter days and increase the inertia in the Nordic power system.
- With a power output of 1,600 megawatts, Olkiluoto 3 is the largest power plant unit in Finland and the Nordic countries.
- By international comparison, Olkiluoto 3 is the world's third-largest power plant unit after Taishan 1 and Taishan 2 (1,660 MW) in China.
- Olkiluoto 3 will generate an average of 15 per cent of the electricity consumed in Finland.
- Altogether, the three Olkiluoto power plants will generate one-third of Finland's electricity.
- Olkiluoto 3 will be connected to the main grid in November 2020, and regular electricity generation will begin in March 2021.

A unique substation

Olkiluoto 3 will be connected to the main grid via Fingrid's modernised Olkiluoto substation, which consists of three separate switchgear stations and control buildings. When Olkiluoto 3 is complete, the three nuclear power plants in Olkiluoto will generate one-third of the electricity consumed in Finland.

The substation entity consists of a new 400-kilovolt switchgear station with double circuit breakers built for Olkiluoto 3, two switchgear stations to serve the Olkiluoto 1 and 2 nuclear power plants, and separate control buildings.

Although the power plants are connected to the same station, they can be electrically isolated from each other using switching devices. This makes it possible to ensure that an individual fault could never cause more than one power plant unit to be disconnected from the network. Each switchgear station connects to the main grid via two lines, which increases the reliability of a substation at a critical junction in the main grid and enables maintenance work to take place without interruptions.

"Thanks to the new duplex structure, the Olkiluoto power plants can be isolated from each other more reliably. The switchgear station solution enables an almost unlimited number of different connections to investigate disturbances or interruptions," says **Hannu Heikkinen**, Project Manager at Fingrid.

Each switchgear station has two main bus bars. Thanks to the bus bar protection built into the switching stations, a faulty bus bar can be easily disconnected from the network without losing the functionality of the entire station.

"Designing and building dozens of alternative connections was a complex technical process, which required an enormous amount of testing, but we got there in the end," says Heikkinen. •

New lightweight connection stations improve the quality of electricity

Fingrid, Outokummun Energia and PKS Sähkönsiirto are together realising a solution for reducing the number of outages caused to customers on long main grid lines by more than half.

TEXT | VESA VAINIO
PHOTO | MIKKO NIKKINEN

The transmission reliability rate of Finland's main grid is almost 100 per cent, but there are some variations depending on the connection method. The system security is at its weakest when customers are connected to long transmission lines on the main grid by branch lines. These customers can suffer outages if any faults or maintenance outages occur on the trunk line and the lines connecting to it.

Fingrid has mapped the main grid transmission lines with the highest numbers of outages for electricity consumers. For example, there are long sections of line of this type in North Karelia, where customers also have long connecting lines.

"We invited customers and contractors to join us in thinking up a cost-effective solution for reducing the inconvenience caused by outages. The solution identified during these discussions was to build connection stations. We will now set about building them together," says **Antero Reilander**, Customer Manager at Fingrid.

EXPECTED OUTCOME: HIGH-QUALITY ELECTRICITY

Outokummun Energia's electricity network provides power to a large number of industrial companies, particularly in the metal industry. CEO **Juha Sotikov** says that customers' requirements include high-quality electricity.

His example is Fingrid's 110-kilovolt line between Kontiolahti and Alapitkä, which runs for more than 140 kilometres on the main grid. This stretch of line has suffered a number of disturbances. Conversely, their own 15-kilometre branch line rarely develops any faults.

"Typically, lines running through the Eastern Finnish terrain have been sensitive to faults, and lightning has been a particular cause of disturbances. There have been more brief reclosure outages than on our own medium-voltage network."

Jukka Ahonen, Network Development Manager from PKS Sähkönsiirto, has observed problems on the same stretch of line, as they also affect PKS Sähkönsiirto's customers. It is important that development work is underway to reduce the number of disturbances.

"High-quality electricity for our customers is an important success factor for us. It is good that Fingrid has taken the initiative to improve system security." Ahonen says.

LONG TRANSMISSION LINE INTO TWO SHORTER SECTIONS

Sotikov and Ahonen are happy that the problem is being addressed as a joint effort. Outokummun Energia has four substations, and they are supplied with electricity from two directions. Two of the substations are connected to the Kontiolahti–Alapitkä line and two are connected to the Kontiolahti–Varkaus line.

PKS Sähkönsiirto is the larger of the two network companies, and it has a total of 35 substations. Seven of these are connected to the two aforementioned main grid lines. According to Ahonen, the substations serve a catchment area covering approximately 17,000 customers, all of whom are affected by disturbances on the transmission lines.

Fingrid, PKS Sähkönsiirto and Outokummun Energia have agreed that Fingrid will construct a connection station on both stretches of main grid line. The connection stations should be built in 2022. Sotikov expects the new stations to improve the quality of electricity and the security of energy supply substantially.

"A connection station located in the right place divides a long transmission line into two shorter sections. An individual disturbance in the main grid cannot then affect the customers connected to the line branch station. In the event of large-scale disruption, it is possible to use the other point of connection to the main grid as a secondary power supply."

Reilander says that connection stations are a lighter-weight alternative to main grid substations.

"Connection stations are reliable but are minimalist switching stations with no room for expansion. Connection stations cost about half as much as normal substations."

FEWER DISTURBANCES, MORE CONNECTION POINTS

All three parties will pay some of the costs of the two connection stations. Ahonen says that they were unsure whether to get involved. They agreed after considering the broader benefits, as well as the opportunity to tackle the impacts of disturbances.

"In the future, we will be able to use our own electricity network more intelligently. We can increase the power capacity and the system security of the network by having substations in the right places."

Sotikov agrees with Ahohen that the investment will be good for the basic infrastructure over the long term.

"This is an important project for everyone involved, and we all have the same goal in our sights."

Reilander emphasises the fact that planned maintenance outages can affect customers as well as disturbances. The connection stations will also reduce the area of impacts of these. And the role of renewable energy generation should not be forgotten.

"It is possible to connect new electricity generation plants to the stations; in the future, for instance wind turbines."

ACTION ON SEVERAL FRONTS

The disturbances on Fingrid's main grid in 2019 caused connection points to be without electricity for 4.3 minutes on average. There were 227 disturbances, causing customers an average of 0.18 outages lasting more than 30 seconds per connection point.

These figures do not include rapid reclosures – Reilander says that Fingrid is also focusing on addressing the impacts of these. Although Finland's main grid has one of the highest levels of system security in Europe, there is still room for improvement.

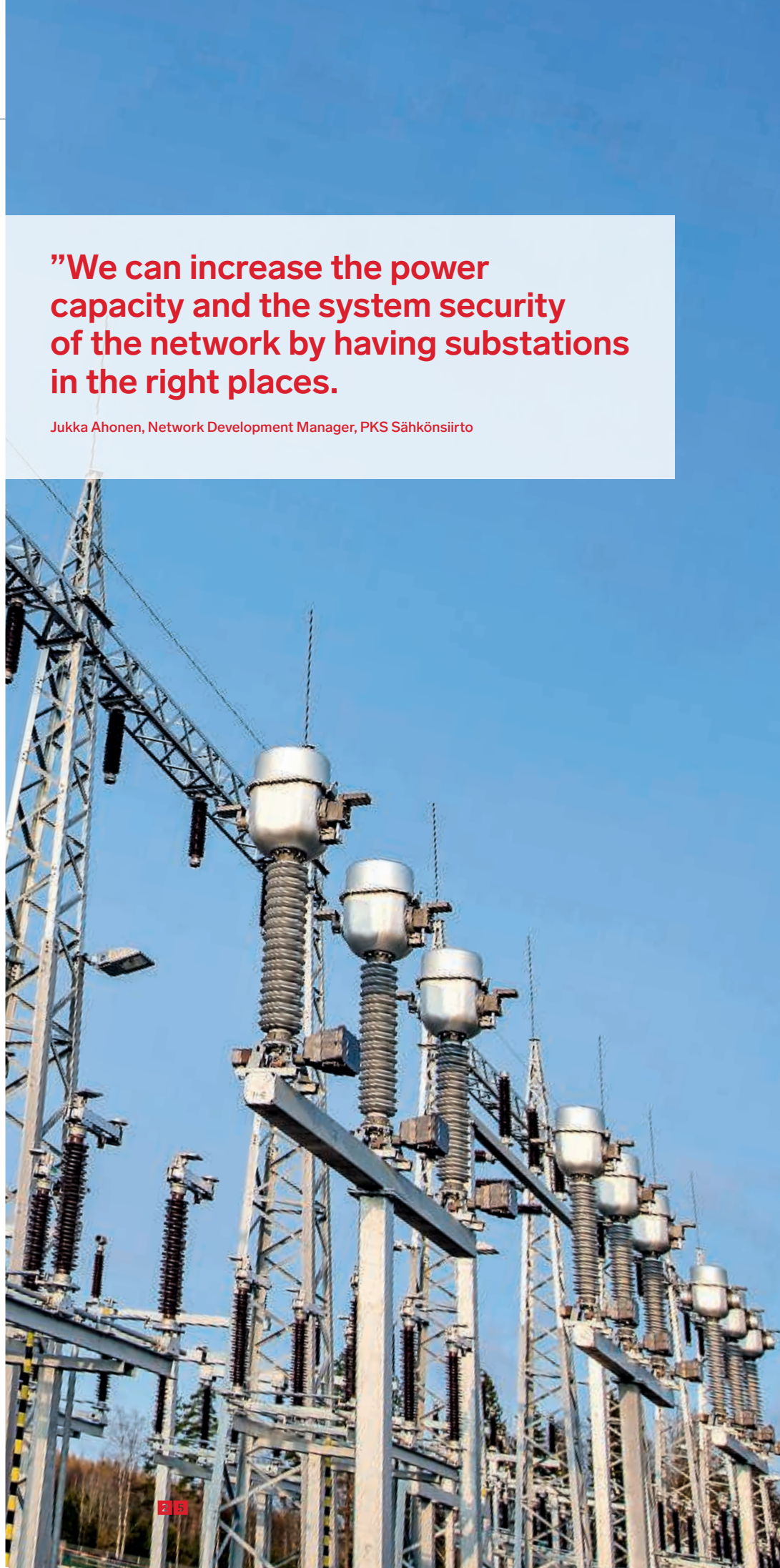
"Faults in the electricity network cause harmful voltage dips for critical industry. We aim to mitigate voltage dips by improving relay protection."

One area for development is in improving fault location on transmission lines. The aim is to find the locations of faults to the nearest tower. This involves forecasting certain faults, such as ice loads on lightning conductors.

"We are equipping the transmission lines on the main grid with a system for locating travelling wave faults. Following the pilot phase, we will also offer the system to our customers." •

"We can increase the power capacity and the system security of the network by having substations in the right places.

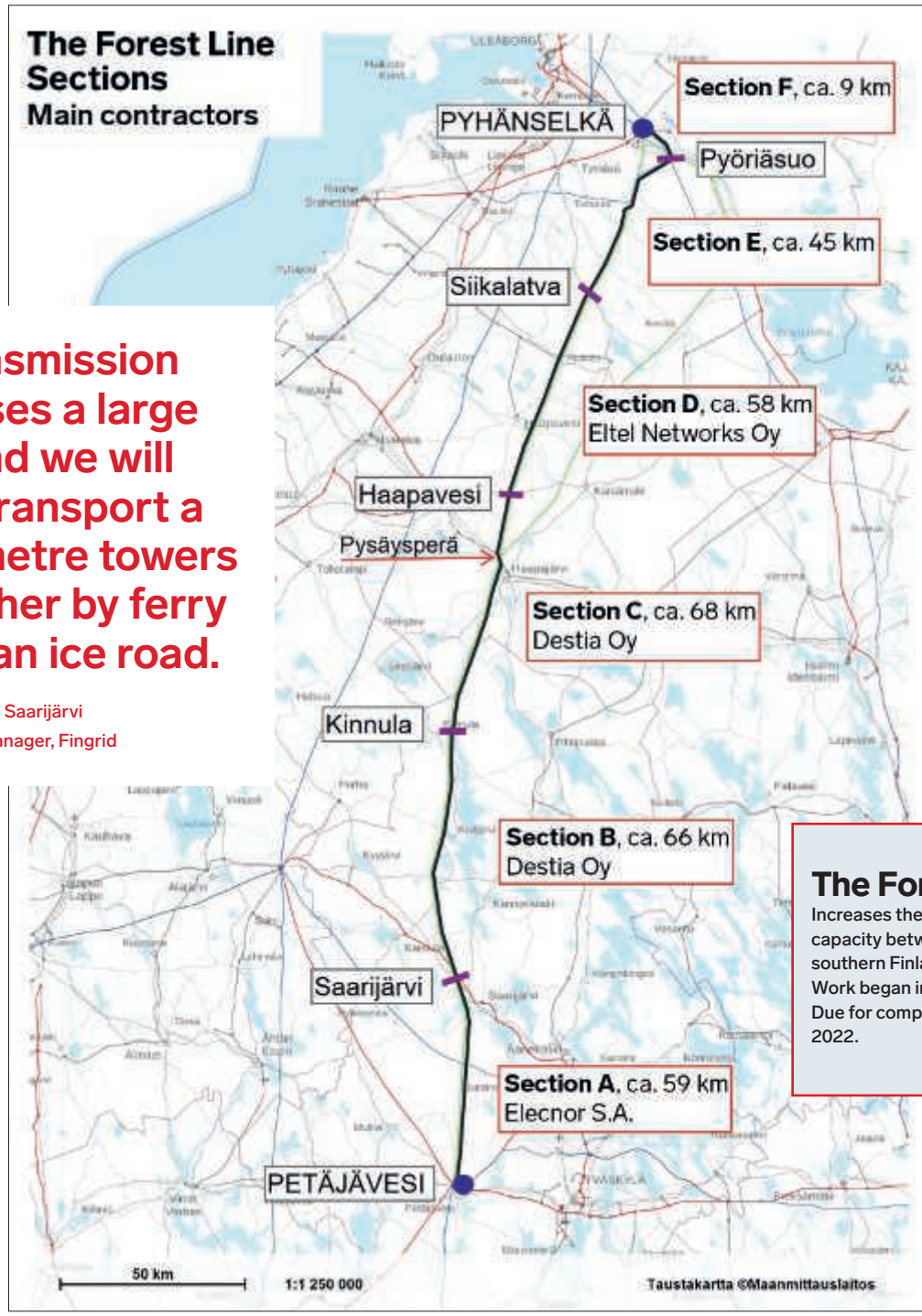
Jukka Ahonen, Network Development Manager, PKS Sähkönsiirto



Through forests and over marshes

– the Forest Line addresses the needs of ecological electricity generation

TEXT AND PHOTOS | JUHA-PEKKA HONKANEN



”The transmission line crosses a large island, and we will need to transport a few 40-metre towers there, either by ferry or along an ice road.

Section A, Petäjävesi - Saarijärvi
Antti Linna, Project Manager, Fingrid

The Forest Line

Increases the transmission capacity between northern and southern Finland by about 700 MW. Work began in autumn 2019. Due for completion in September 2022.

The Forest Line, which will be completed in 2022, is a transmission line connection between Petäjävesi in Central Finland and Muhos in North Ostrobothnia. The 400-kilovolt transmission line will trace most of its 305-kilometre course through forests, but the route also passes through marshlands, islands and numerous sites of natural significance. The tree-clearing work, which began in autumn 2019, is a major job, requiring the removal of 60,000 cubic metres of material.

The Forest Line is necessitated by the change in the origin of the majority of the electricity consumed by Finnish people: in Southern Finland, the amount of condensing power obtained from coal is decreasing. At the same time, a large amount of wind power capacity has been built in Northern and Western Finland. **Maarit Uusitalo**, Fingrid's Manager, Power System Planning, expects both trends to continue. When the new cross-border connection to Sweden over the Tornionjoki River is completed 2025, the Forest Line will be in even higher demand.

"Electricity generation capacity is increasing in the north and decreasing in the south, so there would be a congestion in the transmission capacity if we were not building the Forest Line," says Uusitalo.

This could lead to a situation in which Finnish people pay different prices for wholesale electricity depending on which part of the country they live in. Uusitalo says that Sweden was divided into four bidding areas precisely because of internal congestions in the power grid.

The Forest Line will also support the utilisation of wind power throughout the country.

"The network vision guiding the construction of the main grid follows the realisation of wind power projects. The next project for approval will be the Lake Line, and the Forest Line will be extended to the south, based on the places where major wind power projects are realised next."

"The depth of the Muhos rift valley is not known precisely, and construction will take place on piling in these areas.

Sections E and F, Siikalatva - Pyhänselkä
Ritva Laine, Project Manager, Fingrid

"This section is a true Forest Line: there are very few settlements, and it has been necessary to clear a lot of trees.

Sections B, C and D, Saarijärvi - Siikalatva
Hannu Kuikka, Project Manager, Fingrid

Responsibility becomes reality on worksites

Antti Linna, Hannu Kuikka and Ritva Laine, Project Managers at Fingrid, carry an important responsibility on worksites like the Forest Line. We asked them about the special characteristics of each segment of the line in terms of the environment and settlements and how corporate responsibility is reflected in their everyday work.

■ Construction Manager **Keijo Välimaa** says that the principle of working in harmony with the surrounding communities and nature begins during the planning phase. Projects are adapted around people's living environments and business requirements. Environmental impact assessment (EIA) is a statutory and significant part of building a power grid.

"During the construction phase, contractors have detailed site cards that guide them in planning work on-site so as to avoid endangering conservation areas."

PETÄJÄVESI–SAARIJÄRVI 59 KILOMETRES ANTTI LINNA, PROJECT MANAGER

"The section of the line between Petäjävesi and Saarijärvi crosses a large island, on which two or three towers will be built. Getting the towers onto the island will be a headache as their total length is 40 metres. They will be transported either by ferry or on an ice road."

In addition, a live transmission line travels alongside this section. This must be kept in mind at all times because, in some places, the 40-metre towers would make contact with the adjacent transmission line if they were to fall during erection.

"For me, corporate responsibility means working in accordance with jointly agreed rules. The contractor on this stretch of the line is from Spain, and Finland is an unfamiliar country for them. I can play a part in helping the contractor to do a good job by making sure that everyone on the worksite follows the jointly agreed rules."

SAARIJÄRVI–SIIKALATVA 192 KILOMETRES HANNU KUIKKA, PROJECT MANAGER

"This section is a true Forest Line, as it has been necessary to clear a lot of trees. The line crosses a few bodies of water and also a railway. One striking feature is that there are very few settlements near the line."

During the environmental impact assessment, it became apparent that the Forest Line crosses a marsh classified as a Natura conservation area. One alternative would have been to go around the area, but an old power line corridor already crosses the marsh, so that will be used instead of building a new route.

In its final segment, the Forest Line passes over the branch line to Haapavesi power plant. The branch line shall be temporarily de-energized to allow the construction work of the new line take place on-site, and a backup supply connection must be used. The first plans for this were made before the contract was initiated.

SIIKALATVA–PYHÄNSELKÄ 54 KILOMETRES RITVA LAINE, PROJECT MANAGER

"Section E contains a lot of marshland. In marshy terrain, the transitions are long, and in some places, work cannot be started until after the long frost cycles have ended. The mild early winter has given rise to some challenges."

The depth of the Muhos rift valley is not known precisely, but the fault-line in the bedrock is at a depth of about one kilometre. Construction will take place on piling in these areas.

Local conditions will be taken into consideration, including a place where Muhos residents like to swim, so efforts will be made to minimise the disruption to people enjoying the waters. At the start of the procurement chain, the operations of factories are audited systematically. The points scored when factories are re-audited demonstrate that fruitful measures have been taken to improve activities. •

Jäätyvä teaches the value of determined forecasting

In the event of a severe disturbance in electricity distribution, the authorities, municipalities and electricity companies need to work seamlessly together. An extensive, prolonged disturbance in the power network could quickly paralyse society for a long period.

TEXT | ANNELI FRANTTI
PHOTOS | HUOLTOVARMUUSKESKUS, TURKU ENERGIA, FINGRID

What operating models are required, and how can operating capacity be maintained while faults are rectified? How can people communicate when no electronic communication tools are available? In 2019, five Jäätyvä exercises put communications to the test in various parts of Finland. The electricity was not actually disconnected, but some important lessons were learned about preparedness and fault tolerance.

Electricity distribution could be disrupted by things such as abnormal weather, terrorism, cyber-attacks, negligence, ignorance or accidents. The sixth Jäätyvä exercise will take place in Greater Helsinki in 2021.

We requested:

1 What was the most important lesson your organisation learned from the Jäätyvä exercise?

2 What will you be working on in 2020 as a result of the Jäätyvä exercise?

Katja Ahola, Head Of Communications, National Emergency Supply Agency

1 The series of Jäätyvä exercises became a story about the development of communications. During the most recent exercise, joint communication was practised more intensively than ever before. The numerous communications professionals involved in the exercise have given good feedback.

It was fascinating to observe the creative new communication solutions that arose in the exercise scenario. Furthermore, professionals from several different fields were given a feeling for the importance of communications in the event of disturbances.

2 In the future, the National Emergency Supply Agency should put more pressure on the communicators involved in the exercise from the perspective of media and social media games. Backup communication tools should be tested more effectively during exercises and in real life.

We are also responsible for developing the functionality of the game platform used for the exercise. We are currently in talks with Yle, the Finnish national broadcaster, about how we could incorporate cooperation with the media more deeply in various exercises on disruption scenarios.

Anne-Mari Repola-Mäkinen, Communications Manager, Turku Energia

1 1. The most important lesson for Turku Energia was the journey to the exercise itself. We began planning well in advance, and we updated our emergency guidelines, crisis communications plan and responsibilities for leadership in the event of a crisis.

The exercise highlighted the importance of collaboration with various stakeholders and the authorities in the event of such a serious disturbance, and this collaboration cannot be initiated in the midst of a crisis. That is why we planned communication during the exercise with the City of Turku, the authorities and other communicators from the organisations involved in the exercise. Good communications ensure that information can be obtained as quickly as possible, and the same content is provided to everyone.

In the event of a disturbance, the media is an ideal partner for distributing information. However, there must be a clear plan for working with the media, as well as a proactive approach to ensure that our message is delivered. We need to know which personnel in our organisation will issue statements and ensure that they have the latest information at their disposal.

It would have been good if the exercise had put us under even more pressure, as such an enormous disturbance would give rise to constant pressure on people in communications. We also needed to think about resourcing and, naturally, keeping our personnel informed in the event when no electronic communication tools are available.

2 Jäätyvä showed that we had taken the correct measures before the exercise. The most important things for us to work on in 2020 are bringing into use the operating models that were tested during the Jäätyvä exercise and maintaining our employees' readiness for crises. We will pay particular attention to improving the activities of our situation room in the event of a crisis and making use of role cards.

Reima Päivinen, Senior Vice President, Power System Operations, Fingrid

1 Fingrid was involved in all five Jäätyvä exercises, and it also participated in designing them as part of the Power and District Heating Pool.

Several employees were able to participate, thereby enhancing and broadening their expertise. The exercises have improved our readiness and introduced new routines for using various tools. In particular, the use of the Krivat system and Virve, which are required for communication between organisations, has improved substantially.

2 No major changes are on the horizon. We will review the lessons we learned during the exercises and make the necessary changes in our operations. Managing crises, building situational awareness and communication roles and job descriptions will be updated to ensure that we can use the simplest possible operating models. A disturbance could occur at any moment, so the operating instructions need to be deeply ingrained in our employees' memories and not just filed away in a folder of instructions. •

SF6
An excellent dielectric gas in controlled environments

TEXT | VESA VAINIO
PHOTO | ISTOCK

Sulphur hexafluoride gas (SF6) has been the primary insulating medium in high-voltage electrical switchgear and controlgear for 40 years. Fingrid prevents the potent greenhouse gas from escaping into the atmosphere by constantly monitoring the equipment where it is used.

Fingrid's transmission grid consists of more than 100 substations with air-insulated substations, circuit breakers and gas-insulated switchgear. Although advancements have been made in electrotechnical equipment in recent decades, one thing remains constant: sulphur hexafluoride gas (better known by its chemical formula, SF6), which functions as a dielectric medium and arc quenching medium in circuit breakers.

Specialist **Juhani Tammi** explains that SF6 became the dominant circuit-breaking technology in the early 1980s, having enabled the first high-voltage gas-insulated switchgear (GIS) to be developed back in the 1960s. According to Tammi, there are several important factors behind SF6's dominance.

"SF6 is three times more effective than air as an electrical insulator. Switchgear insulated with SF6 takes up less space, is less prone to faults and requires less maintenance than corresponding components in outdoor switching stations. SF6 is an effective and permanent dielectric gas that also extinguishes arcs in circuit-breakers."

In the gaseous state, sulphur hexafluoride is invisible, odourless, non-combustible and non-toxic. It is also heavier than air, so it displaces oxygen.

SAFELY INSIDE EQUIPMENT

As the climate change debate intensifies, SF6 has risen up the agenda. Fingrid's Environmental Specialist, **Jenni-Julia Saikkonen**, explains why.

"SF6 is approximately 23,500 times more potent as a greenhouse gas than carbon dioxide (CO_2). This is not a problem as long as the gas remains inside the equipment and the amount escaping into the atmosphere is minimised."

The European Union's F-gas Regulation governs the processing of SF6 gas, setting limits for monitoring leaks and qualification requirements for gas handling. Tammi emphasises that Fingrid constantly controls and monitors its use of SF6.

"All of our GIS is within the scope of online monitoring, as are 60 per cent of our outdoor circuit breakers. We monitor possible leaks and take immediate action if any are found."

GIS typically contains hundreds or thousands of kilograms of SF6 gas. The quantity is much lower in circuit-breakers in outdoor switching stations at 5–30 kg per circuit breaker. In total, Fingrid has 46,000 kg of SF6 gas in various pieces of equipment.

In total, Fingrid uses 46,000 kg of SF6 gas in various pieces of equipment. In 2018, Fingrid's SF6 emissions amounted to approximately 21 kilograms.

EMISSIONS HAVE REMAINED LOW

The quantity of SF6 in use has risen constantly, as Fingrid has modernised old sections of the network and built new parts to enable the energy transition. The integration of wind power is currently strongly on the agenda. As regards emissions, Saikkonen is able to present lower figures.

"Equipment containing SF6 continuously experiences very minor leakages of 0.1–0.2 per cent per year."

In 2018, Fingrid's SF6 emissions were 494 tonnes of carbon dioxide equivalent (CO_2eq). In absolute quantities, this amounted to approximately 21 kg of gas. Fingrid reports to Finnish Energy on its use of SF6 gas.

SF6 does not constitute a major part of Fingrid's carbon footprint. The greatest impact is made by transmission losses, which gave rise to emissions of 200,400 CO_2eq in 2018.

A EUROPE-WIDE SOLUTION

In the European Union, emissions of SF6 gas are equivalent to 6.73 million tonnes of carbon dioxide, which is about 0.15 per cent of total emissions. GIS is manufactured by three large companies in Europe, which, according to Tammi, are alive to the situation.

"The manufacturers have taken the initiative to develop new insulating technology. Growing pressure from the industry and the EU has served to accelerate this development."

Fingrid is following developments closely, analysing the alternatives and preparing to pilot new solutions, beginning with the 110-kilovolt network. All of the manufacturers have already launched solutions based on alternative dielectric gases for voltages up to 110 kilovolts. However, none of the new solutions are ready for large-scale adoption because they do not yet meet all of the technical requirements and they lack maturity.

In any case, the transition to a new dielectric technology will take a long time. The estimated service life of switchgear is 40–50 years, and as the dielectric gas in the equipment cannot be changed, it will be decades before new technologies begin to gain traction on the network. •

Sulphur hexafluoride

Chemical formula	SF6
Molar mass	146,1 g/mol
Form	Odourless, non-toxic, non-combustible gas
Density	6 kg/m^3, 1 900 kg/m^3 (liquid)
Melting point	–51 °C
Boiling point	–64 °C
Use	Refrigeration and insulation in the electrical industry
Applications	Switching stations for electricity transmission and distribution network equipment
Environmental impact	A permanent compound, which remains in the atmosphere for the long term. A potent greenhouse gas.

TEXT | MARJUT MÄÄTTÄNEN PHOTOS | FINGRID, ISTOCK

Main grid transmission lines to be photographed from the air in the summer

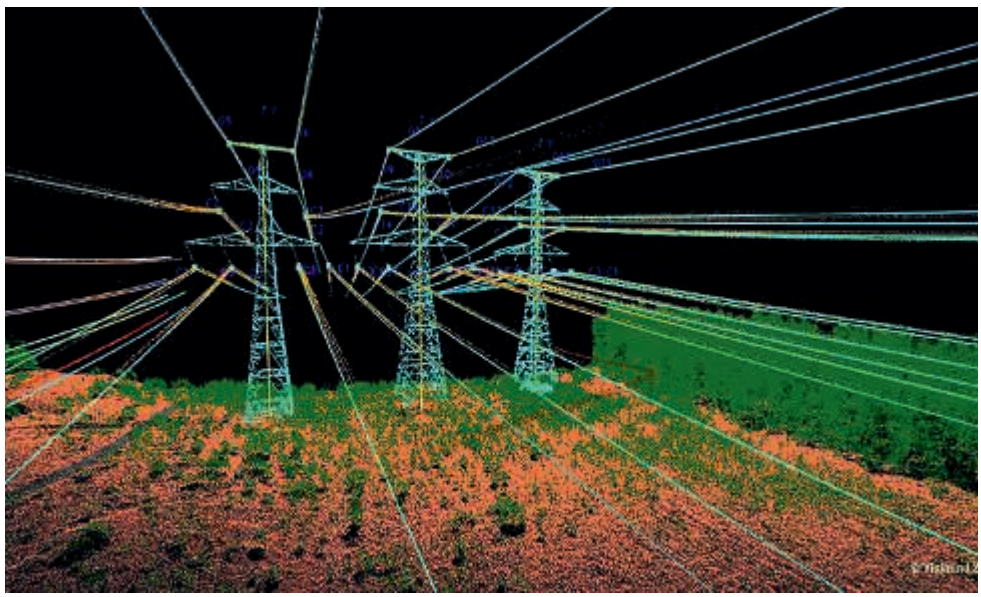
This summer, Fingrid will photograph transmission lines from the air. The company intends to photograph approximately 12,000 km of transmission lines – an unprecedented amount. The remainder of the transmission lines (just over 2,000 km) have already been photographed.

The network documentation is being updated with aerial photographs, which will enable an assessment of the network's condition and the work that needs to be planned. When new lines are planned alongside old ones, the material enables a decision to be made at an early stage on the feasibility of designing new lines in the specific location.

In addition, the aerial photographs will be used to analyse the vegetation and assess whether action needs to be taken if trees in the border zones have grown too tall. When Fingrid's asset information is up-to-date, it is able to make better decisions without necessitating field visits.

The aerial photography material will include accurate vertical images, known as orthophotos, laser scanning material, which can be used for a range of analyses, and detailed inspection images of structures.

The photographs will be taken from helicopters between May and September. We will release more detailed information about the timetable in the spring and summer. Check Fingrid's website for more details. •



Fingrid is taking aerial photos of its transmission lines to ensure that its documentation is up to date. The laser scanning images can be used to perform various types of structural analysis.

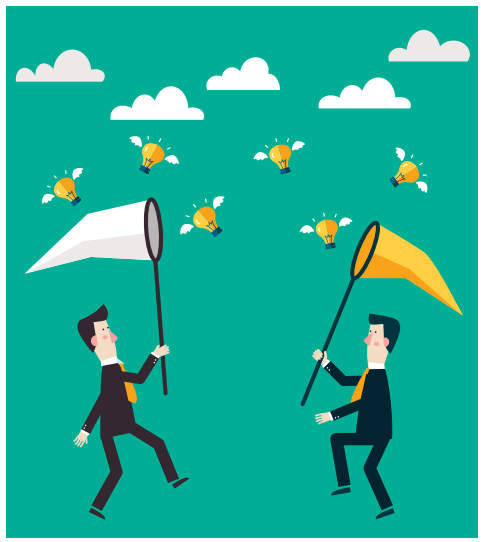
Competition between power exchanges begins

Competition between power exchanges will begin in Finland and the rest of the Nordic countries this spring. The authorised power exchanges will be allowed to operate on the Finnish Day-Ahead Market.

Competition will provide market operators with more options for acquiring trading services. This change is a step in the direction of deeper integration in European power markets. Power exchanges can already compete on intraday markets.

For more on this topic, visit Fingrid's website and follow Fingrid on social media!

www.fingrid.fi
Twitter: @fingrid_oyj



LUT University is developing a small nuclear power plant for district heating

LUT University is researching an entirely new solution to address the problem of carbon dioxide emissions due to heating. The university is developing a small nuclear power plant that will provide district heating. The minimum output of the district heat reactor must be 20–30 megawatts, and a few such units could satisfy the district heating needs of a medium-sized town.

PHOTO | TEEMU LEINONEN

Juhani Hyvärinen is Professor of Modelling in Nuclear Engineering at LUT University.

The small nuclear power plant is safe thanks to its size, location and design, which is based around the laws of nature. The reactor will generate district heat only, and it can be built to operate at low pressure and low temperatures. Heating reactors can be designed with higher safety margins than large power plant reactors.

The district heating reactor can be thought of like a kettle working on nuclear power. The reactor is cooled in the normal way, using water circulated by a pump. In the event of a problem – if the pumps stop – the reactor shuts down, and cooling is provided by gravity. When the water heated by the reactor boils, the steam rises and makes contact with the cold wall surfaces, where it cools and flows back down as water. The temperature of the small reactor's core is easier to control than that of a large nuclear power plant.

The small modular reactor is simple in structure and cost-efficient. The power plant's components and technical manufacturing expertise are already available in Finland.

As its name implies, the small nuclear power plant is small in size and easy to build partially below ground – it could even be placed in the middle of a residential district. The power plant does not need to be surrounded by an enormous exclusion zone, nor does it need to be manned. The small district heating reactor contains 100–200 times less radioactive material than a large reactor for generating electricity. According to LUT's estimates, the greatest risk posed to the people near the reactor is that the nuclear reactor stops and the heating goes off.

"The reactor is designed with scalability in mind so that, if necessary, the reactor can also be made in a larger version with an output of around 100 megawatts of thermal power. Such reactors would be suitable for large cities like Helsinki, which is just starting up the Helsinki Energy Challenge in an effort to eliminate carbon dioxide emissions from its heating," says **Juhani Hyvärinen**, Professor of Modelling in Nuclear Engineering at LUT.

The idea has been tested in theory, and now we are in negotiations with financiers. The design of the main components and structures has also begun. The current legislation enables the first version of the reactor – for research use – to be built, and it is expected to be completed within five or six years. However, the mass production of small reactors would require the reform of nuclear energy legislation. •

Fresh information on the electric and magnetic fields of transmission lines

Fingrid has published a brochure on the electric and magnetic fields of transmission lines.

Electric and magnetic fields occur everywhere, and the legislation on public exposure was reformed at the end of 2018. The transmission lines on the main grid satisfy the boundary conditions, and there is currently no evidence of health risks due to the magnetic fields of transmission lines.

"However, we are aware that people living in the vicinity of transmission lines may feel that transmission lines carry potential health risks. For this reason, we have published this brochure to draw attention to the views of independent experts on questions related to the magnetic fields of transmission lines," says **Jussi Jyrinsalo**, SVP, Grid Services and Planning, at Fingrid.

www.fingrid.fi/ymparistoesitteet

Key figures for 2019

In 2019, Finland's electricity consumption decreased by approximately 1.5 per cent year-on-year. A total of 86.1 (87.4) terawatt-hours of electricity was consumed. A total of 68.7 (68.6) terawatt-hours of electricity was transferred on Fingrid's network, which corresponds to 79.9 (78.4) of the total amount of electricity transferred in Finland (consumption and meshed transfer).

Fingrid's transmission reliability rate was 99.9998 (99.9999) per cent. Fingrid paid EUR 35 (50) million in taxes. •

Grid quiz winner, 3/2019:

Petteri Helisten, Oulu. Congratulations!
The winner has received the prize by post.
As of this issue, the grid quiz will be replaced by a new series of articles about "Professional in the spotlight".

TEXT | RISTO UUSITALO, ANNELI FRANTTI PHOTO | RISTO UUSITALO

Drawing the Forest Line

Risto Uusitalo, who supervises the work on the Forest Line transmission line worksite, spends his days meeting contractors and conducting site inspections in the field. Many of his colleagues are also familiar with Risto's dog, Ilona, who sometimes accompanies him on-site. This is the first in a new series of articles about "Professional in the spotlight".

Is anything special happening with the Forest Line at the moment?

Work has now begun on the final two stretches of the Forest Line – known as sections E and F. As a supervisor, I am involved in contractor's kick-off meetings, where we review the work phases before going out into the field. We also ensure that matters related to safety, the environment and contractor obligations are handled as we want them to be. In the field, I conduct site inspections to ensure that this theory is put into practice.

The kick-off meetings have just been held, and the contractors have started making agreements on the use of worksite roads and landowner issues. Work on the foundations for the guyed towers is well underway, and it will soon commence for the free-standing towers once the ice roads are strong enough to bear the weight of the cement mixers. The mild winter is making it difficult to prepare ice roads across marshland. Logging is going well along the transmission line corridors, and it will continue on the winter sites.

The contractors and I have met with landowners at redemption kick-off meetings. Participating in these meetings helps to streamline the project's progress.

What did you do before your current job?

After I completed my military service, I began working at Strömberg's large transformer factory in Vaasa while also travelling for work. I graduated as an electrical power technician in 1986. After that, I moved to Muhos and worked in an operational position at a hydro power company called Oulujoki Oy. Inspired by company changes, I joined IVO Voimansiirto in 1994, before the name-change to Fingrid in 1997. I worked as the group leader for the Northern Finland regional centre and then as operations planner. For a long time now, I have been able to concentrate almost entirely on transmission line work.

It feels as if I am now finishing my final project, as we are building the Forest Line and then RAC3 – the third cross-border connection with Sweden.

What is good about your work or the energy sector in general?

Everything is in such a state of flux that no two days are alike. There is so much involved in building transmission lines, from the foundations all the way to the lighting conductors at the top of each tower.

We are constantly surrounded by change in the energy sector. At the moment, it is great to be involved in developing the network that will form the basis for using renewable energy. In just a short time, I have noticed the shift away from large coal-fired power stations as more wind power is connected to the network.

The work itself is changing thanks to new tools. Global warming will also give rise to challenges and things that need to be developed in the field.

Would you like to say anything about your family and hobbies?

My wife and I are originally from Vihanti. In our busiest years, our household also included two boys and one girl, all of whom are now working or studying.

My favourite hobby is spending time outside with Ilona, my dog, which also helps to keep me fit. I also do a little photography. If I ever find the time, I also plan to fix up a 1980s classic car.

What do people not know about you?

People may not know that I own an ice swimming simulator. I built it using a milk-cooler that I purchased from a dairy. Cold-water swimming accelerates muscle recovery and eases pains in the joint – I strongly recommend it!

I also have a maiden name: Kontinaho. When I got married, I took my wife's surname, Uusitalo (which means 'New House' in Finnish). I have always liked new things, so the change of name felt like a natural option because my mother's maiden name was Vanhatalo ('Old House' in Finnish). •

Fingrid initiates discussion on topics related to its industry. In this series, we participate in the discussion by highlighting electric novelties and current phenomena. You can suggest a topic for this page via e-mail: viestinta@fingrid.fi

Hello! This is your fridge speaking

Our work experience trainee found out about smart fridges.

TEXT | KASPER SEDERLUND
PHOTO | SAMI HEISKANEN

What is a smart fridge?
Smart fridges are higher-technology versions of conventional fridges. They are connected to the internet and represent one example of the Internet of Things (IoT).

Who makes smart fridges?
Smart fridges are made by many manufacturers of domestic appliances and electronics, including Samsung, LG, Hoover, Bosch and Siemens. LG made the first smart fridge back in 2000, and the price tag was EUR 20,000. At present, Samsung's fridges offer the most functionality.

Have fun with your fridge!
The example smart fridge is a Samsung Family Hub model with a "camera inside" function, which shows what is in the fridge. This makes it easy to check whether you have run out of cola when you are in the supermarket.

The 21.5-inch full HD screen built into the fridge door serves as a kitchen entertainment hub. You can use it to watch your favourite shows, listen to music or search for recipe suggestions based on what is in your fridge. Family Hub offers 36 different apps, such as Uber and Spotify, which can be controlled on the screen.

The Fridge Manager function adjusts the fridge temperature and keeps products fresh. If the smart fridge develops a fault, it is able to tell you what is wrong.

Monitor your energy bill
The Hoover smart fridge is an example of energy consumption control. The fridge temperature can be adjusted using a smartphone app. You can also control the fridge's energy consumption and monitor it using the app. The artificial intelligence built into the Hoover smart fridge attempts to use the data it collects to boost its efficiency and reduce its energy consumption.

Should I buy it?
Smart fridges range in price from EUR 1,000 to EUR 5,000 depending on the model and the size. New technology is raising prices, and there is plenty of functionality. You may not even use some of the functions, so it is worth considering what you really need. Is it an advantage or a disadvantage if your fridge door opens automatically?

Smart fridges may help busy people. I can hardly wait to see what other new surprises IoT will bring. •

Kasper Sederlund tests the smart refrigerator's interior camera functionality at a store in Tammisto.

SAMSUNG FAMILY HUB 2.0 FRIDGE-FREEZER

- *21.5" Full HD screen and Tizen operating system. You can listen to the radio, shop online, browse your photos and take notes.*
- *WiFi connection*
- *Interior cameras: three cameras, which can send images to a smartphone.*
- *Refrigerator volume: 351 litres, freezer: 199 litres.*
- *Adaptable: part of the appliance can be used either as a refrigerator or a freezer as required.*
- *Energy consumption: 460 kWh per year*
- *Energy class: A+*
- *Dimensions: 182 x 91 x 61 cm, weight: 159 kg.*

How much electricity is being consumed right now? How much electricity is being generated, and which fuels are being used to generate it?
How much will electricity cost in the next few hours? What are the estimated CO2 emissions?
For answers to these and many other questions about the power system, visit the State of the Power System website. Fingrid's most popular site can be used on phones, computers and tablets:
www.fingrid.fi/en/electricity-market/power-system/

Now you can also find Fingrid's magazine online at fingridlehti.fi/en/

FINGRID

Läkkisepäntie 21, FI-00620 Helsinki • P.O. Box 530, FI-00101 Helsinki
Phone number for all offices: +358 30 395 5000
• fingrid.fi • fingridlehti.fi/en

@fingrid_oyj • Fingrid Oyj • @fingridfi • @Fingridoyj

Hämeenlinna
Valvomotie 11
FI-13110 Hämeenlinna

Oulu
Lentokatu 2
FI-90460 Oulunsalo

Petäjävesi
Sähkötie 24
FI-41900 Petäjävesi

Rovaniemi
Teknotie 14
FI-96930 Rovaniemi

Vaasa
Runsorintie 1
FI-65380 Vaasa

Varkaus
Wredenkatu 2
P.O. Box 1
FI-78201 Varkaus