2 2022

FINGRID

TRANSMISSION SYSTEM OPERATOR'S MAGAZINE
THEME: SELF-SUFFICIENT IN EMISSION-FREE ELECTRICITY / *fingridlehti.fi*

Clearing increases electricity safety and transmission reliability

Finland's energy system does not need electricity from Russia

Electricity shortages can be prevented by consuming less electricity

IN 2022, A TOTAL OF

5,500

hectares of land will be cleared

APPROXIMATELY

7,000

landowners were notified of the clearing by letter

Clearing increases safety

Managing the vegetation near transmission lines ensures electricity safety and transmission reliability. Regular clearing also helps to maintain vital open habitats for certain animal and plant species.

Clearing and tree-felling ensure that trees do not encroach on transmission lines or fall onto them, which could cause electricity distribution disturbances or personal injury. Electricity safety takes precedence over transmission reliability in the grounds of people's houses, in particular.

On average, clearing takes place every five to eight years, although more frequent clearing may be required in built-up areas, for example. Most clearing work is performed by people working with clearing saws.

The transmission line area is divided between the transmission line right-of-way and the border zone. In principle, there should be no trees in the right-of-way. The border zones are the areas on both sides of the right-of-way, and vegetation is allowed to grow in these zones until it reaches redemption height. For example, at the near edge of the border zone, trees may be up to ten metres tall.

All in all, there are approximately 34,000 hectares of transmission line rights-of-way that must be kept clear.

You can submit feedback on vegetation management using Fingrid's map feedback system at **fingrid.fi/palaute_raivauksista.** This site also provides information about forthcoming clearing and chipping sites. ◆

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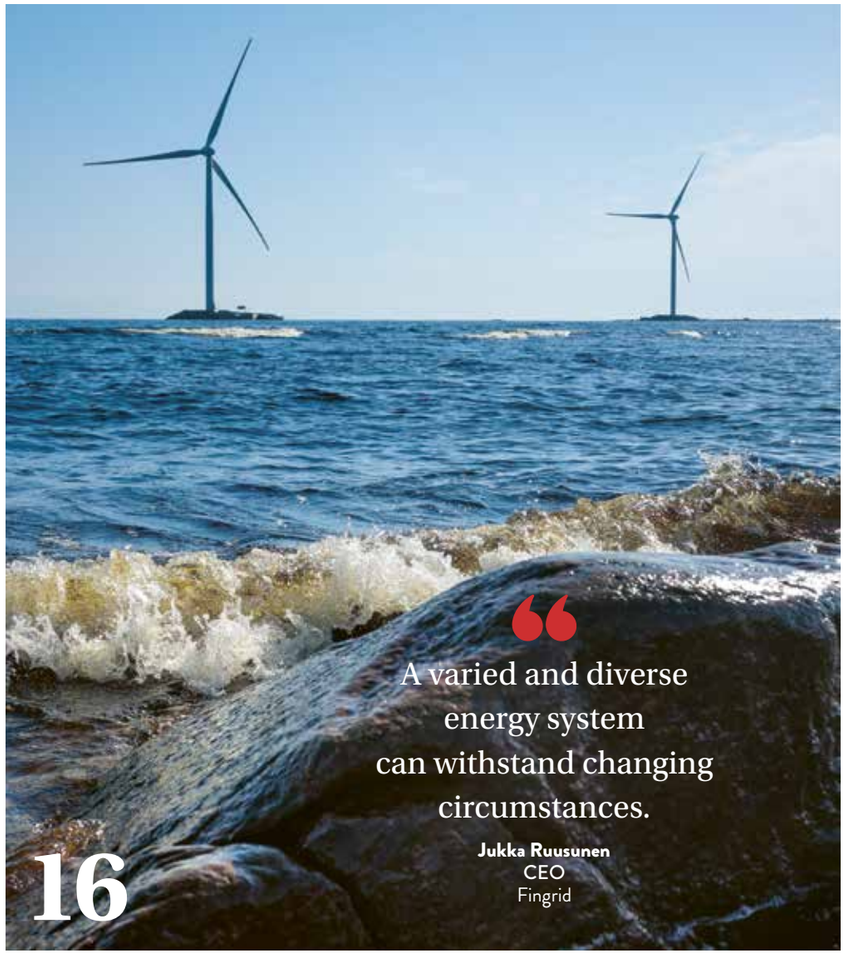

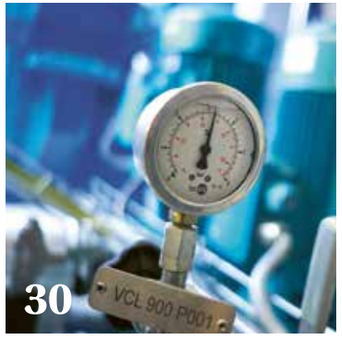

REGULAR SECTIONS

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Changes and opportunities

IT WAS quite a start to the year. I watched events unfold as I learned the ropes in my new position as the Senior Vice President in charge of main grid operations: wind power production surpassed the 3,000 megawatt threshold for the first time, Olkiluoto 3 was synchronised with the main grid for the first time, the value of purchased reserves set a new monthly record in May, and electricity transmissions from Russia stopped.

The system security of Finland's main grid has been first-class for a long time, and spring was no exception to this, despite all the twists and turns along the way.

During the summer, the extraordinary circumstances precipitated by Russia's war of aggression led to unprecedented interest in the adequacy of electricity. Substantial uncertainties surround the adequacy of electricity in the coming winter, and the situation is highly susceptible to changes that could raise the likelihood of an electricity shortage.

It is of paramount importance for every electricity consumer and producer to be prepared for power outages of up to two hours due to electricity shortages. It is vital that the full production and cross-border transmission capacity is available reliably for the electricity market to use in order to avoid an electricity shortage.

As electricity shortage consumers – whether small or large – we can help to avoid an electricity shortage by saving energy and, especially, by using electricity outside of peak consumption hours.

There are certain to be further changes that challenge system security in the coming years. As we look ahead to the coming winter, we should also remember to consider the need to expedite the energy revolution as far as possible.

We should continue to work in close cooperation and seek solutions in the common interest even after the winter so that the transition to a clean electricity system can take place with a high level of system security and cost efficiency.

Tuomas Rauhala
Senior Vice President,
Power System Operation
Fingrid

FINGRID

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Will there be enough electricity?

The coming winter and the possibility of an electricity shortage have been hot topics in Europe since Russia launched its war of aggression on Ukraine. We can all contribute to preventing an electricity shortage by reducing our electricity consumption or consuming electricity at a different time of day.

TEXT MARJUT MÄÄTTÄNEN | PHOTO SHUTTERSTOCK

What is an electricity shortage? How long could the power cuts last? Is there any compensation? How can we avoid an electricity shortage?

These questions – and many others – have been on people's minds recently. An electricity shortage occurs when domestic electricity production and imports are not enough to cover consumption, and it becomes necessary to restrict the use of electricity or even to cut the electricity off in certain regions.

As a last resort, it may be necessary to cut electricity transmission in order to ensure that the electricity remains on in the power system as a whole. If it is not possible to keep consumption and production in balance, the entire power system of Finland is at risk of collapse.

This would cause a blackout, and Finland's entire society would have no electricity for at least a few hours. Planned, short, rolling power cuts are one way of preventing such a situation in extreme cases. Power cuts that only affect specific groups of consumers at one time can ensure that the power system as a whole remains in operation when there is not enough electricity available.

Fingrid has a three-tier procedure that it follows in the event of an electricity shortage, with the tiers corresponding to the severity of the incident. Fingrid also has a predefined model for managing exceptional circumstances. This work is done in cooperation with the local distribution system operators and various authorities.

We have published information about electricity shortages on our website, along with a list of frequently asked questions and details on the roles of each party. ◆

www.fingrid.fi/sahkopula

The adequacy of electricity will also be discussed at the autumn Fingrid Current event to be held on 15 November.

PROFILE

At the forefront of the energy industry

Jukka Metsälä has no difficulty motivating himself in his new job. The goal is a cleaner future.

TEXT MINNA SAANO | PHOTO FINGRID

At the start of May, I began working as Fingrid's CFO. I had previously worked for Gasum and PWC. You could say I am a returnee, as I worked for Fingrid just over 11 years ago as business controller and business development manager.

My responsibilities include strategic and business development in addition to finance and treasury. I manage this wide range of duties together with the company's senior managers, various experts, and my finance and business development team.

I am fascinated by people and change – the things we can do together. This company offers motivation and a lot of expertise, and I truly believe that we will quickly accomplish new things. A good value base, sustainable business and creating a cleaner future are among the interesting aspects of my new job.

Fingrid will play a key role in the energy revolution – that was immediately apparent to me. Decisions need to be made every day; changes need to be visible; we need to head in the right direction and ensure that the energy market functions well today and in the future.

Fingrid's strategy is based on the needs of its customers and several stakeholders. When we work together, we need to retain our focus on the right things that really matter and get things done.

In my opinion, Finland offers plentiful opportunities in the energy sector. After all, it is the promised land of wind power." ◆

WHO?
Jukka Metsälä

WORK
CFO

FAMILY
Spouse, two children and one dog

FREE TIME
Children's hobbies, jogging, visiting the holiday cottage, and boating

The power system needs more reserves

The power system's reserves protect the balance between electricity consumption and production.

Previously, reserve power was mainly generated by power plants, but nowadays, it is increasingly provided by large factories and battery installations.

The use of reserves and the need for new types of reserves are increasing substantially due to the energy revolution, Nordic balance management requirements, and the commissioning of the Olkiluoto 3 nuclear power plant. At the same time, the cost of obtaining reserves is increasing.

Other factors exerting upward pressure on the price of reserves include the discontinuation of reserve trading with Russia and higher prices in the electricity market.

Fingrid procures reserves in a way that is as market-based as possible from several different sources in Finland and its adjacent neighbours, which contributes to ensuring the adequacy and cost level of reserves.

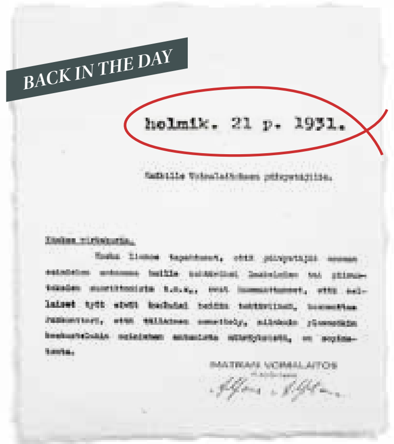
We are developing new Nordic marketplaces alongside our national reserve markets. At the moment, we are studying the possibility of making longer-term reserve agreements, for example.

The growing need for reserves in the power system is also an opportunity for operators in the sector to build new businesses. A good way to kick off the planning process is to visit Fingrid's website, which provides plenty of information on topics such as the acquired reserves and actual prices. ◆

Fingrid was the

19th-largest

payer of corporation tax (2021)



In 1931, employees at Imatra power plant were reminded of the importance of discipline at work:

"**THIS** is about discipline at work. Because it has come to light that the on-call staff, when assigned some calculations, drawings or similar tasks by the plant manager, pointed out that such work was not in their job descriptions. Head Office would like to point out that this practice, along with other discussions of the tasks assigned by the manager, is inappropriate."

PRACTICAL QUESTION

Why have the balance service fees rised?

The balance service fee charged to Fingrid's balance responsible parties has been rising. What is the balance service fee and why is it going up? We asked Jani Piipponen, Manager of Balance Services at Fingrid.

TEXT VESA VILLE MATTILA | PHOTO FINGRID

1 What is the balance service fee?
Fingrid purchases reserves on the reserve market in order to keep electricity production and consumption in balance and maintain the frequency and system security of the power system.

Fingrid covers the cost of some of these reserve purchases by charging main grid tariffs. And part is covered with the balance service fees that Fingrid charges to balance responsible parties, for whom reserves represent the largest cost to cover. These balance service fees cover the costs of purchasing frequency containment reserves, which are used to counterbalance the normal fluctuations in production and consumption, as well as automatic frequency restoration reserves.

2 Why have balance service fees risen?
The main reason is that it has become more expensive to purchase reserves – even more rapidly than anticipated in recent times.

Trading in Russian reserves has been halted, and uncertainty prevails in the electricity market. In addition, the introduction of the pan-Nordic market for automatic frequency restoration reserves has been postponed. All of this has resulted in higher prices for electricity and reserves.

Trading in Russian reserves has been halted, and uncertainty prevails in the electricity market.

3 What does the future hold for balance service fees?
In the coming years, we predict that the need to purchase reserves will continue to rise due to the energy transition and changes in the Nordic balance management. Demand for fast frequency reserves and frequency restoration reserves will increase, which will also affect costs. Fingrid welcomes new suppliers to the reserve market.

Fingrid welcomes new suppliers to the reserve market.

4 How often does Fingrid review its balance service fees?
Balance service fees are valid until further notice. Balance service fees and balance service costs are constantly monitored and the fees are updated to cover the costs of the operation.

5 How is Fingrid developing reserve markets?
We removed the 35-megawatt limit applying to purchases of automatic restoration reserves from Estonia in June. We are developing Nordic and European marketplaces, and we intend to facilitate aggregation, redesign the electricity capacity market from weekly to hourly purchases, and explore the opportunities for longer-term reserve agreements. ◆

HYDROGEN IS TRANSFORMING THE ENERGY SECTOR

Finland's first industrial-scale production plant for green hydrogen and synthetic methane is under construction in Harjavalta. It is being built by P2X Solutions.

TEXT MATTI VÄLIMÄKI / PHOTOS SUSANNA KEKKONEN

Herkko Plit, CEO of P2X Solutions, says that the 20-megawatt Harjavalta plant will be used to produce hydrogen via electrolysis, which uses electricity to break up water molecules into their constituent elements.

"We will use wind energy for this process and possibly also solar power."

The hydrogen will be sold for industrial use all over Finland, and it will also be used to make synthetic fuels at a synthetic methane production facility. The site will also host a hydrogen filling station for heavy-duty vehicles. The Finnish Information Centre for the Automobile Sector expects the number of vans and lorries running on hydrogen to begin rising sharply in the 2030s.

"Electrolysis also produces oxygen and heat, which will be used by companies in the large industrial park in Harjavalta."

WHO?
Herkko Plit

WORK
CEO of P2X Solutions

MISSION
"We aim to build up to 1,000 megawatts of electrolysis capacity in Finland over the next ten years."

“Hydrogen can be used as a balancing power for renewable forms of energy,” says Herkko Plit.

Construction work will begin in the autumn, and the plant is due to be completed in summer 2024. However, the company’s plans do not end in Harjavalta:

“We aim to build up to 1,000 megawatts of electrolysis capacity in Finland over the next ten years.”

HYDROGEN HAS MANY ADVANTAGES

In Plit’s opinion, hydrogen is at the centre of the green transition. Hydrogen is essential for us to have any chance of reaching our emission targets globally.

“When hydrogen burns, the only emission is clean water vapour. The Harjavalta plant alone will reduce Finland’s CO_2 emissions by about 40,000 tonnes per year.”

One other key feature is that hydrogen allows electricity to be stored, either as hydrogen or by using it to produce synthetic fuels.

“Hydrogen can be used as a balancing power for renewable forms of energy. For example, if a lot of wind power is available at a low price, it makes sense to use this energy to make hydrogen. When electricity prices are high, the stocks of hydrogen or methane can be converted back into electricity.”

Hydrogen will also allow us to improve our energy self-sufficiency. Given the prevailing geo-political situation,

The European Commission’s hydrogen strategy estimates that almost one-quarter of the world’s energy supply will already be produced using green hydrogen by 2050.

Western Europe has stepped up its efforts to free itself from dependence on Russian fossil fuels more quickly.

“Hydrogen can even be used to manufacture proteins – in other words, food,” Plit notes.

WILL FINLAND BECOME A PIONEER IN THE HYDROGEN ECONOMY?

Plit says that Finland has a wealth of opportunities to develop a hydrogen economy.

“Compared with other European countries, Finland can offer highly competitive onshore wind power, and more wind power

is being built all the time. Our country also has lots of clean water, which is required for electrolysis, not to mention the strong technical expertise and know-how of Finnish professionals.”

The European Commission’s hydrogen strategy estimates that almost one-quarter of the world’s energy supply will already be produced using green hydrogen by 2050, and annual sales will reach EUR 630 billion. According to a report by Goldman Sachs, a bank, demand for electricity will double over the same period, and electrolysis will become the largest consumer of electricity.

Plit thinks that the hydrogen economy could be the next Nokia for Finland. However, until functioning markets arise, the state will need to subsidise investments, and the infrastructure required cannot be built in a day.

“It took about 12 years for wind power to become commercially viable and 8 years for solar power. The time scale for hydrogen could, perhaps, be from four to six years.”

Neste is also working on hydrogen-related plans and there also other companies active in the Vantaa, Vaasa and Turku regions with such ideas. ◆

It would be efficient to develop electricity and hydrogen infrastructure at the same time

Fingrid and the Finnish gas transmission grid Gasgrid have drawn up a joint interim evaluation report entitled *Energy transmission networks as enablers of a hydrogen economy and a clean energy system.*

According to the report, Finland is well placed to become a pioneer in the hydrogen economy. The country enjoys a confluence of factors, such as good wind conditions and the possibility of building tall, cost-effective wind turbines.

The companies interviewed for the report expressed the hope that Finland’s electricity and hydrogen infrastructure would be developed in tandem to yield an optimal solution.

The construction of a hydrogen transmission infrastructure would enable the electrolysers that produce hydrogen to be located close to electricity production hubs, reducing the need for electricity transmission. Hydrogen could be produced efficiently in the north, where wind power is abundant, and transmitted to the south in a hydrogen pipeline.

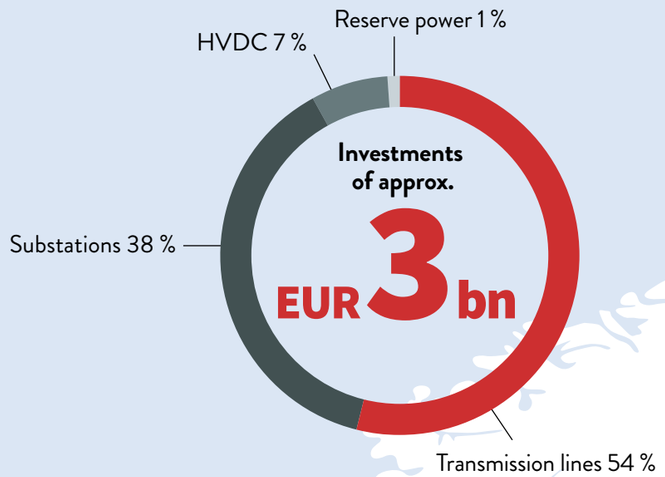
Hydrogen transmission links from Finland to other European countries would enable hydrogen exports, the development of larger hydrogen markets, and market integration. It would also allow the hydrogen storage facilities in Central Europe to be used for seasonal hydrogen storage.

The project will complete its final report at the end of 2022, and a joint stakeholder event will be held in connection with the publication.

MORE CAPACITY FOR THE MAIN GRID

Over the next ten years, Fingrid will invest a record EUR 3 billion in the main grid. This money will be used for the following purposes.

COMPILED BY JUHANI TONTERI, LAURI LAHTINEN AND KEIJO VÄLIMAA / INFOGRAPHIC BY LAURA YLIKAHRI



New investments
78 %

Replacement investments
22 %

Volumes of materials used in transmission line projects

130,000 tonnes of steel

60,000 tonnes of aluminium

220,000 tonnes of concrete

The execution of transmission line projects will require

7 million hours of work

5,250 km of new transmission lines

- 3,200 km of 400 kV transmission lines
- 2,000 km of 110 kV transmission lines
- 50 km of HVDC cable

44 % alongside existing lines

36 % in existing rights-of-way

20 % in new rights-of-way

11,200 new towers

- 4,500 new 400 kV towers
- 5,000 new 400+110 kV towers
- 1,700 new 110 kV towers

300 km of insulator chains

29,000 km of 400 kV lines
= 25 times the length of Finland

12,500 km of 110 kV lines
= 11 times the length of Finland

Approx. **180** substation projects

45 new substations

30 substation expansions

21 substation modernisations

12 comprehensive refurbishments

2 substation demolitions

approx. 70 smaller projects

A VARIED AND VERSATILE ENERGY SYSTEM CAN WITHSTAND CHANGES

TEXT SAMI LAAKSO / PHOTOS FINGRID

The energy sector has traditionally been seen as a very slow-moving one in which changes occur only gradually. However, the pace of life around the world has become faster, and changes can happen quickly.

“Next year, Finland may produce as much electrical energy as it consumes.”

This year, the range of means available to produce the electricity consumed in Finland has changed significantly, as imports of electricity from Russia have been discontinued. At most, it was possible to import nearly 1,500 megawatts, but the change was not a problem, because Finland has maintained a strong and diversified domestic electricity production mix.

In addition, a combined 3,700 megawatts of capacity in the import connections from Sweden and Estonia provide alternatives.

“Our energy system does not need electricity from Russia. A varied and diverse energy system can withstand changing circumstances. However, with the coming winter in mind, it is very important that Olkiluoto 3 is commissioned on time,” says **Jukka Ruusunen**, Fingrid’s CEO.

Although Finland will get by without importing electricity from Russia, the change in Russia’s status in the international energy trade is impacting the electricity markets in Finland.

“The occasionally dramatic price rises in Finland are because of Russia. When the price of gas rises significantly, electricity produced using gas in Central Europe becomes more expensive, and this price signal is transmitted on the common electricity market as far as Finland. When we have more domestic production, the price of electricity produced by burning fossil fuels elsewhere will have less of an impact on us,” Ruusunen says, describing the causal link.

ELECTRICITY BECOMES A COMPETITIVE FACTOR

Electricity production in Finland has increased substantially, and more is on the way.

“Next year, Finland may produce as much electrical energy as it consumes,” Ruusunen says.

However, he emphasises that Finland would not constantly be producing the electricity that is consumed in Finland. Instead, electricity is exported and imported via the cross-border connections depending on the circumstances.

The Olkiluoto 3 nuclear power plant is a major addition to Finland’s capacity. The plant is currently expected to begin outputting a steady 1,600 megawatts of base power in December. Alone, it will account for about 15 per cent of the electricity consumed in the country. Even before this milestone, Olkiluoto 3 will feed electricity into the grid during trial operation at varying levels of power.

The second enormous change in scale is the combined effect of the wind turbines being built around the country.

According to the Finnish Wind Power Association, a record 1,900 megawatts of new wind power will be completed this year. If this comes to pass, Finland will have more than 5,000 megawatts of wind power by the end of the year. The Olkiluoto 3 nuclear power plant will bring Finland’s total nuclear power capacity to 4,400 megawatts.

Comparing the nominal output of wind power plants to the nuclear power production capacity can be misleading. Nuclear power produces electricity at a constant and steady rate, while the output of wind turbines varies significantly depending on the weather conditions.

Wind power has already reached a peak output of almost 3,200 megawatts. Last year, nearly 12 per cent of all the electricity consumed in Finland was generated from the wind.

Wind power construction is making giant leaps forward. By the end of 2025, the installed capacity is expected to reach 10,000 megawatts. Some have said that as much as 20,000 megawatts of wind power capacity may be installed by the end of the decade. Then, wind farms could generate an astonishing 65-70 terawatt-hours of electricity every year, equivalent to nearly all the electricity produced last year. This will require a significant increase in electricity consumption, and Finland offers the right conditions for the abundant supply of clean and affordable electricity.

“We still need additional electricity generating capacity to make up for the dips in production when the wind does not blow. New forms of energy storage will also be important,” says Ruusunen.

RELIABLE, GREEN AND CHEAP

The change will require investments to be made by electricity producers and also Fingrid, which is investing a record three billion euros in the main grid over the next ten years.

View the state of the power system in real time

The information page entitled “State of the power system” provides a real-time overview of electricity production, consumption and transmission in Finland. It is also possible to track the market price of electricity, as quoted on the power exchange hourly.

The page also shows how much electricity is being generated by units such as water, nuclear and wind power plants at any given moment, as well as how much electricity is transmitted between Finland and its neighbouring countries and the direction of flow.

fingrid.fi/sahkojarjestelmantila

In the first six months of this year alone, Fingrid has worked on 63 substation projects and numerous transmission line projects that will boost the electricity transmission capacity.

International transmission connections are also being built. The Aurora Line, due for completion in 2025, will increase the electricity transmission capacity from Sweden to Finland by 800 megawatts. Fingrid is now working on plans for Aurora Line 2, which will be the fourth AC connection to Sweden, as well as the third interconnector to Estonia.

Jukka Ruusunen also emphasises the importance of electricity consumers as drivers of development.

“In the future, we will ask where more electricity is needed. Indeed, significant investments at the consumption end would be beneficial. Industrial projects dictate the rules of this game, and hydrogen production will start to have a major effect before the end of the decade.”

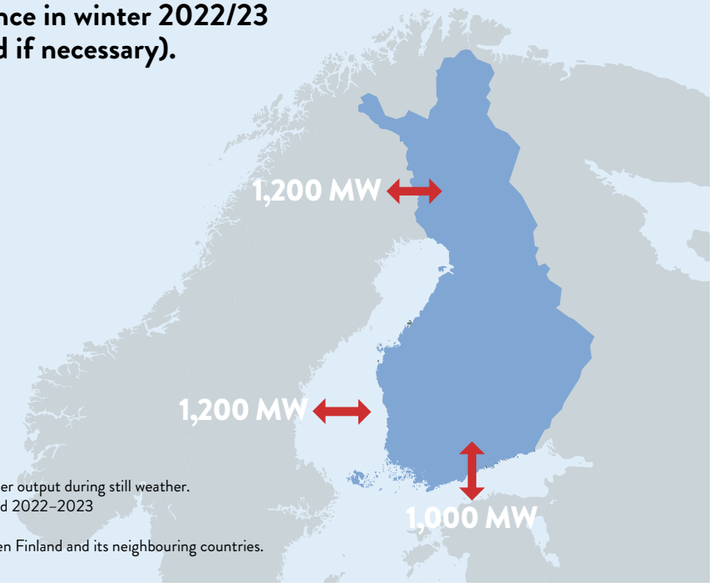
The scale of the impact will be huge: while the rapid progression of electrification in road traffic will lead to less than 5 terawatt-hours of annual consumption by 2035, hydrogen projects and the electrification of industry may increase consumption by tens of terawatt-hours.

According to Ruusunen, inexpensive onshore wind power is a major competitive advantage for

Preliminary estimate of the power balance in winter 2022/23 on a very cold winter day (to be updated if necessary).

Finland, cold winter day once in every ten years

Domestic production capacity*	12,300 MW
Peak load reserve**	600 MW
Estimated peak consumption***	15,100 MW
Domestic power balance, net	-2,200 MW
Import capacity from EU countries	3,400 MW
• From Sweden	2,400 MW
• From Estonia	1,000 MW
Import capacity from Russia	
• Out of use since May 2022	0 MW
In addition, Fingrid's reserves	*1,300 MW*



* Includes the Olkiluoto 3 nuclear power plant and the estimated wind power output during still weather.
** Energy Authority's proposal for the power reserve capacity for the period 2022–2023
*** Preliminary estimate to be updated before the winter season
The arrows in the picture show the electricity transmission capacity between Finland and its neighbouring countries.

Finland. The clean, renewable energy generated in this way will offer a wealth of opportunities for industrial investments.

"Industry needs electricity that is competitively priced, reliable and green. This will lay the foundation for a new wave of industrialisation."

EYES ON THE BALL WITH THE WHOLE GAME IN MIND

While Fingrid ensures there is enough electricity to cater for current consumption peaks, it is important to look ahead, well into the next decade. One milestone will be 2035, the year by which the Finnish government aims for the country to become carbon neutral.

"If we are to reach the carbon-neutrality target, electricity consumption will need to increase dramatically to almost double the current figure."

It is also important to look farther ahead because it can take as long as decades for energy investments to come to fruition. For example, the Finnish parliament made a decision in principle on the construction of the new Olkiluoto nuclear power plant 20 years before the plant generated any electricity.

"Back then, the future looked very different. Projections for the growth in electricity consumption were based largely on the assumption that Finland would have much more heavy industry, which consumes a lot of energy," Jukka Ruusunen says.

The idea was to create a robust power system based on centralised production.

"In those days, carbon dioxide emissions and climate change were not the hot topics they are today. Renewable energy was seen as a marginal phenomenon." ◆

Users are developing applications using open data

The open data offered by Fingrid enables new services and applications to be developed for the energy sector. Kemijoki Oy, Finland's most significant producer of hydro and balancing power, makes use of Fingrid's open data.

The company says that it uses Fingrid's data to supplement the data it collects from its own power plants. Kemijoki consolidates the data to prepare analyses and forecasts, and it also uses the data in an application based on artificial intelligence. The data is essential for keeping production and consumption in balance at all times in the electricity market.

data.fingrid.fi

TEXT SAMI LAAKSO / PHOTO RISTO UUSITALO

Will there be enough electricity next winter?

PEOPLE PROBABLY remember the unusually sharp peaks in the electricity price last winter. When the war in Ukraine put an end to electricity imports from Russia in May, there was some concern about whether there would be enough electricity next winter. Imports of pipeline gas and wood fuel from Russia have also stopped.

If we have a cold winter, people may be wondering whether the lights will stay on and society will continue to function normally.

"The outlook for next winter is less positive since the discontinuation of trading in electricity and natural gas with Russia. There may be some momentary difficulties in the availability of electricity if temperatures are very low and any power plants or cross-border connections are out of action. In terms of the adequacy of electricity, the critical factors would be, for example, delays to Olkiluoto 3, multiple breakdowns or extensive fuel shortages," says **Jussi Närhi**, Specialist at Fingrid.

Even at times of peak consumption, approximately 10 per cent of the electricity consumed in Finland was imported from Russia. The maximum import capacity from Russia was less than 1,500 megawatts, so the extra capacity provided by Olkiluoto 3 more than makes up for that.

The wind power production capacity will also increase significantly this year, and when it is windy, Finland will generate more electricity than it consumes. When the wind dies down, Finland can fall back on its 2,400 megawatts of import capacity from Sweden and 1,000 megawatts from Estonia.

"We will have more domestic electricity production capacity than last winter thanks to the new Olkiluoto 3 nuclear power plant and more wind power. During the winter, it is very important that domestic production is available and the cross-border connections operate reliably."

Närhi says that Fingrid has prepared calculations that illustrate Finland's power balance under highly challenging conditions, exemplified by a cold winter's day with little wind. The calculations are based on a very cold winter, which statistically occurs once every ten years.

The calculations envisage a consumption peak of 15,100 megawatts, while last winter's peak was just over 14,000 megawatts. Domestic production is estimated to provide 12,300 megawatts, and a total of 3,400 megawatts of import capacity will be available.

"This calculation reflects perhaps the worst possible scenario: consumption is very high, and the calculation only accounts for 300 megawatts of wind power production, even though the total capacity is expected to be around 5,000 megawatts next winter," Närhi explains.

"Under such challenging conditions, it comes down to fine margins. If there is not enough production available on market terms, we can activate reserves to ensure the adequacy of electricity."

In addition to this calculation, Fingrid assesses the adequacy of electricity using hourly models.

"These also take into consideration the availability of electricity imports from Sweden and Estonia more effectively. We will monitor the situation and update our calculations as winter approaches," Närhi says. ◆

TOWARDS EMISSION-FREE ELECTRICITY AND HEATING

Varma's energy-renovated rental homes make everyday life quite environmentally friendly.

TEXT TUIJA HOLTTINEN / PHOTOS EEVA ANUNDI

Varma, a pension insurance company, owns about 60 residential properties in various parts of Finland, with a total of approximately 4,000 rental homes. New residential properties are built every year.

At the end of last year, Varma began carrying out its third bundle of energy renovations covering multiple residential properties.

"Sustainability is a decisive theme in everything we do, and it is also a major part of our strategy," says **Sarianna Sipola**, Portfolio Manager, Residential Real Estate at Varma.

Sustainability goals guide all Varma's investments, whether they are in equities or real estate.

"We are committed to ensuring that 25 per cent of our investments are in climate allocations by 2025. This means that they must form a climate-friendly package of investments."

At the end of last year, tangible climate action continued in the pension company's residential real estate investments when it embarked on major energy renovations in nine of the residential properties it owns. The aim is for all of the buildings to use emission-free electricity by 2025 and also emission-free heating by 2030.

These are ambitious targets, but Sarianna Sipola considers them realistic:

"We have already done a lot of work and made some visible leaps forward. On our residential investments, we started in the places with the greatest potential."

Varma, a pension insurance company, aims to use only emission-free heat on its properties by 2030 and emission-free electricity by 2025. The carbon footprint of Varma's properties decreased by 57 per cent from 2015 to 2021.

SWIFT PROGRESS FROM THE INITIAL ASSESSMENT ONWARDS

Varma began planning major energy renovations in 2019. The first step was to assess the entire residential portfolio, reviewing every property.

The situation evolves as technologies, the environment, materials and solutions change, so a one-off assessment is not enough. That is why Varma is already beginning a new round of assessments.

In practice, the most significant part of an energy renovation is the transition to geothermal energy.

"This can make it possible for the entire property's heat production to be free of emissions. However, there are some sites where we continue to use district heating alongside geothermal solutions," Sipola says.

Varma is also installing equipment such as solar panels on the roofs of buildings, making use of various heat pump solutions, deploying more efficient heat recovery, switching to LED lighting, and testing and regulating the settings.

"We always take the circumstances and the property in question into account when we assess the necessary and beneficial actions to take on – every building is unique."

Certain constraints must also be taken into consideration, such as the locality, the characteristics of the plot, the age of the building, and the standard of energy efficiency at the outset.

MILLIONS INVESTED

The ongoing and completed renovations will affect over 1,300 homes.

"I believe every major company is taking sustainability action and renovating its properties, but I do not know of any other organisation doing it on this scale – in effect, the entire residential portfolio – with dozens of properties," Sipola states.

Regular customer satisfaction surveys indicate that tenants are also interested in sustainability issues. When an energy renovation is carried out, it has no practical effect on everyday life in the home, but the consequences can be significant.

"We know that sustainability is important to our residents. That is one reason we wanted to embark on these measures," Sipola states.

Tenants do not incur any costs for an energy renovation, but Varma's investments are running into the millions when adding all renovations of different properties together.

"The investments pay for themselves in lowered maintenance costs." ◆

TEXT PÄIVI BRINK / PHOTO IONSIGN

Timely maintenance of condition management equipment

Fingrid is the first organisation in the world to deploy a digital condition management system developed in collaboration with ionSign. The system helps to identify potential defects long before any problems arise.

Digital condition management helps Fingrid take care of the switchgear in substations. Maintenance measures can be allocated precisely where they are needed. Fingrid has been developing condition management devices as part of a research and development project over approximately five years, and the devices have now been deployed for production use at ten substations. Fingrid aims for extensive adoption of the digital condition management system in the main grid by 2025. The system will provide a constant stream of up-to-date information on the condition of switchgear and current transformers.

No equivalent condition management devices have been developed in any other country. In 2018, Fingrid held an innovation competition with the aim of developing condition management devices, and the winning proposal was submitted by ionSign, a design bureau based in Rauma, Finland.

"ionSign was established in 2007 and currently has eight employees. We design IoT solutions that combine remote management electronics and data transfer. Our devices collect data from the field and transfer it to a cloud service for further processing," says **Mika Kivistö**, ionSign's CEO.

"The devices we have developed in collaboration with Fingrid perform functions such as registering acoustic emissions – in other words, abnormal sounds – and measuring the current profiles used by devices, temperature rises, and leakage currents, which can reveal insulation failures," Kivistö continues.

CONDITION MANAGEMENT DEVICES SUPPORT RISK MANAGEMENT

The devices have only been used for a short time so far, but they have already produced tangible benefits.

"Fingrid's specialists can refine and analyse the collected data and use it to target maintenance measures to the devices that really need them. Maintenance based on data and key indicators is a cost-effective and timely use of resources," says **Mika Vartiainen**, Specialist at Fingrid.

In the future, Fingrid aims to train artificial intelligence to interpret the data based on machine learning models and automatically suggest what maintenance is required.

"Enhancing the efficiency of condition management is a challenge that every transmission system operator faces. There is an international market for condition management devices," states Mika Kivistö, ionSign's CEO.

"By anticipating faults, we can prevent disturbances in the main grid and hazardous situations at substations. For example, damaged insulation could cause a device to explode, and no comparable means were previously available for identifying such damage. Ultimately, this is a matter of risk management," Vartiainen summarises, speaking of the system's benefits.

At the moment, ionSign is developing condition management devices specifically for Fingrid's needs, but transmission system operators in other countries could also benefit from them in the future. ◆

Openly silent?

PUBLISHING INFORMATION is a form of communication, and as **Osmo A. Wiio** said in his first law of communication: "Communication usually fails, except by chance."

When I began working as an information security specialist, there was a data breach, which I wrote an article about for our intranet. It only took about an hour before a journalist from a local newspaper called our IT Director with a juicy headline in mind: "Massive data breach on campus".

My article was not open enough – it left some things to the imagination. In the end, the case was not newsworthy, but I learned to communicate more openly and understand that the internal communication channels in large organisations are, for all practical purposes, public.

It is better to be thoughtfully open than passively silent.

LET US consider the importance of open information for an organisation's operations.

One good example related to safety is the provision of up-to-date information to consumers about expected repair times in the event of a power cut or a planned power outage. Both provide users and, depending on the transmission grid where the outage occurs, other actors with information relevant to their safety or feeling of safety and give the organisation an opportunity to concentrate on handling the outage effectively.

One bad example related to continuity is allowing all types of photography in the automation control room. In production environments based on recipes, the most important information to protect – the recipe – can be copied from a photograph of an automation screen. If a visitor takes a photo on their mobile phone and shares it on social media, it could enable low-cost production in foreign countries and jeopardise businesses and jobs.

BEFORE INFORMATION is shared, it should be assessed in terms of the advantages and disadvantages, for example, in the following way. By default, information should be confidential, and it should always be a conscious decision to reclassify information as public or secret.

Open: The organisation benefits from sharing the information.

Internal: The organisation does not benefit if the information spreads outside the organisation.

Confidential: The dissemination of the information causes harm to the organisation, its customers, suppliers or employees.

Secret: The dissemination of the information causes severe harm to the organisation, its customers, suppliers or employees.

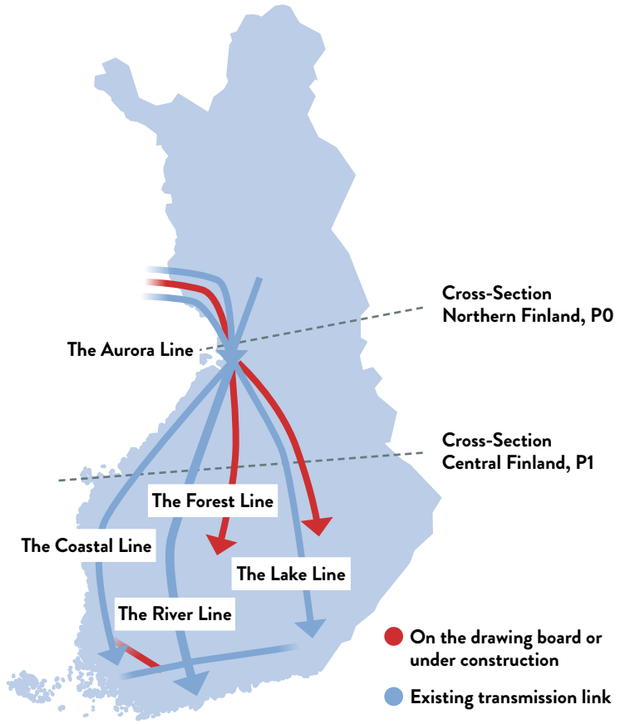
Open publication of information is a conscious step in the management of business continuity and security. The information vacuum always seeks to be filled, irrespective of the organisation, so it is better to be thoughtfully open than passively silent. ◆

Jari Seppälä
is an information security specialist in automation who has safeguarded critical infrastructure for the security of supply in cooperation with parties in the energy sector since 1999.

ELECTRICITY TRANSMISSION IS MONITORED AT FINLAND'S CROSS-SECTIONS

Finland's internal transmission grid has two cross-sections, which Fingrid uses to monitor electricity transmission. In the future, several times as much electricity will need to be transmitted over the cross-sections.

TEXT VESA VILLE MATTILA / PHOTOS FINGRID



P1 and P0 boundaries defined on electrotechnical terms, and a specific transmission capacity exists across the boundaries. To avoid jeopardising system security, this transmission capacity cannot be surpassed.

The energy revolution and the electrification of society are proceeding at pace.

While demand for electricity in the south of Finland grows, new wind power projects are shifting the focus of electricity production to the north of Finland. The electricity produced in the north of the country needs to be transmitted efficiently to consumption centres in the south.

Fingrid aims to ensure that Finland retains its uniform price area in the electricity wholesale market. This will require robust transmission connections between the north and the south.

CROSS-SECTIONS IN CENTRAL AND NORTHERN FINLAND

Finland's internal transmission lines are split by two boundaries specified according to electrotechnical parameters. These are known as the cross-sections, where there are several metering points that enable Fingrid to monitor the transmission of electricity.

The southernmost of the cross-sections is known as Cross-Section Central Finland or Cross-Section P1, and it runs along the axis from Kokkola to Iisalmi. Four-fifths of Finland's electricity consumption takes place to the south of this boundary. Cross-Section Northern Finland, also known as Cross-Section P0, runs along the line of the Iijoki river to the north of Oulu.

“It is also possible that increases in wind power production in Ostrobothnia and the Bay of Bothnia will necessitate new cross-sections.”

“In the future, the locations of the cross-sections may change slightly, depending on factors such as the volumes of electricity production and consumption and the development of the grid,” says **Janne Seppänen**, Senior Expert at Fingrid.

“It is also possible that increases in wind power production in Ostrobothnia and the Bay of Bothnia will necessitate new cross-sections.”

CLIMATE GOALS REQUIRE A STRONG MAIN GRID

In order for Finland to reach its climate goals, industry, heating, and transport will need to be electrified, and the volume of emission-free electricity production must increase substantially. This requires a strong main grid.

“The need to transmit electricity over the cross-sections increases sharply in all the future scenarios we have examined. Over the next ten years, demand for electricity transmission is likely to double or triple,” Seppänen points out.

The locations of electricity production and consumption facilities within Finland are the main factor influencing the rate of increase in the need for transmission.

As wind power production becomes more common, momentary peaks in transmission will become more frequent. The scenarios indicate that the highest demand for electricity transmission will only take place for about 100 hours per year. This represents approximately one per cent of all transmission situations.

FINGRID IS ALSO BUILDING TRANSMISSION LINES

At present, four 400-kilovolt transmission lines go through Cross-Section Central Finland, and three go through Cross-Section Northern Finland. Over the next ten years, Fingrid will invest a record EUR 3 billion in the main grid.

The plans include the construction of four new transmission lines over Cross-Section Central Finland. The Forest Line from Petäjävesi to Oulu will be completed this year. Plans are currently being made for Lake Line 2 and Forest Line 2, which will follow the paths of previous transmission lines, as well as a transmission line from North Ostrobothnia to Southern Finland.

Fingrid is building two new transmission lines over Cross-Section Northern Finland, one of which is part of the Aurora Line, which will cross into Sweden.

SERIES AND SHUNT COMPENSATION TO COVER PEAKS

Building new transmission lines is not the only way of catering for the largest transmission peaks: from the economic and land-use perspectives, more efficient means exist.

Every transmission line that goes over the Central Finland and Northern Finland cross-sections now has series compensation. In addition, shunt compensation is currently being installed to boost the electricity transmission capacity over Cross-Section Central Finland. This project will also have a positive effect on Cross-Section Northern Finland, and the first phase is due for completion in 2023.

“This is a quick, cost-efficient and environmentally-friendly way of enabling hundreds of megawatts of additional capacity without building new transmission lines,” Seppänen says.

Furthermore, Fingrid is studying the use of Dynamic Line Rating (DLR) technology to measure the current-carrying capacity of transmission lines in real time, as well as flexibility in production and consumption.

The transmission capacity over Cross-Section Central Finland is currently limited by factors such as the drop in voltage at substations south of the cross-section following a dimensioning fault. ◆

The future of the electricity market

In the coming decades, it may be necessary to use means such as long-term countertrade resource agreements, location-based grid fees, or grid fees that incentivise joint investment in electricity production and consumption in order to ensure the efficient operation of the Finnish power system.

In the future, we may also need to consider splitting Finland into two or more price areas.

“This matter will be discussed with customers and stakeholders long before we begin preparing any significant changes,” says **Janne Seppänen**, Senior Expert at Fingrid.

Transmission lines in Finland

There are four 400-kilovolt transmission lines between Southern and Northern Finland:

- The Coastal Line from Turku to Keminmaa
- The River Line from Helsinki to Oulu (2 x 400 kV)
- The Lake Line from Lappeenranta to Oulu
- The Forest Line from Petäjävesi to Oulu (currently under construction and is due to be completed in 2022)

Plans are currently being prepared for Lake Line 2 and Forest Line 2, which will follow the paths of previous transmission lines. Fingrid also intends to build a fourth transmission line from Jylkkä to Toivila via Alajärvi.

Two new transmission lines are under preparation over Cross-Section Northern Finland.

The new Aurora Line connection, which is being built by Fingrid and the Swedish transmission system operator Svenska kraftnät, will be completed in 2025. It runs from the latitude of Oulu via Ylitornio to Sweden. Fingrid is also planning a new transmission line from Petäjäskoski to Nuojuankangas.

In order for the Baltic states to join the Continental Europe Synchronous Area, they must prepare their frequency management system and strengthen their networks.

TEXT KATARIINA KRABBE / PHOTOS ELERING

THE BALTIC STATES
READY TO CONNECT TO THE SYNCHRONOUS GRID OF CONTINENTAL EUROPE

The Baltic Countries are preparing to synchronize their electricity system with Continental Europe at the beginning of 2026. If Russia decides to disconnect them before this time, they can be connected to the Continental European grid within a few hours, in case of emergency.

Estonia, Latvia, and Lithuania belong to European Union. However, their electricity grid is still connected with the Russian synchronous area.

Connecting to the Continental European synchronous area is in preparation: the Agreement on the conditions for interconnection with Continental European synchronous area was signed in May 2020, and if the project is finished according to the plan, from the first of January 2026 the Baltic states will be part of the synchronous grid of Continental Europe.

"The decision was made thinking first and foremost of Baltic energy security. Our electricity system is dependent on Russia, who we couldn't completely trust. Now we know, now Russia has attacked Ukraine, that our decision was right, although perhaps it should have been made earlier", says **Märt Allika**, Head of Energy System Control Centre of Estonian transmission system operator Elering.

There is a lot of work to be done before the Baltic countries are ready to be synchronized with Continental Europe.

Märt Allika

"We need to build our infrastructure and upgrade our control systems and control and planning procedures. We must strengthen our grid and, most importantly, get our frequency control system ready."

Also, the Polish electricity grid needs to be reinforced, since the connection will be made via the transmission lines between Lithuania and Poland. Furthermore, the new Harmony link must be built in order to make commercial electricity trade between the Baltic states and Poland possible.

"The project is advancing according to the original schedule, but since it is tight, we can't hurry it."

This is a huge, once-in-a-lifetime project for everyone involved.

"This is a very challenging but also interesting project because there have been and will be a lot of surprises on the way, and taking new perspectives is necessary. We just need to learn and understand more of what happens in our grid."

Everything needs to be coordinated between all three Baltic states, and with the Polish.

The two cables between Finland and Estonia enable a transmission capacity of 1,000 megawatts.

“We don’t know if Russia will decide to disconnect us today, tomorrow, after three months or any other time. That’s why we need a back-up plan.”

“Cooperation has been good and timely. None of us can finish the project alone, but we all must meet the requirements in order to be able to connect to the Continental European system as planned.”

THE BACK-UP PLAN

The commercial import of electricity from Russia to Baltic states ceased completely last May, as it did to Finland. Russia decided to stop exporting due to sanctions affecting payment transactions. Russia still provides Baltic states with frequency support. This means that Russia still provides electricity to the Baltic grid if the frequency falls.

There is a risk, however, that Russia could disconnect Estonia and other Baltic states from the Russian electricity grid.

“We don’t know if Russia will decide to disconnect us today, tomorrow, after three months or any other time. That’s why we need a back-up plan. We have the technical capability to be synchronized with Continental Europe and we also have an agreement in place that enables us to be synchronized with Continental Europe without meeting all the requirements that are mentioned in our project agreement, if we end up being disconnected by Russia”, Märt Allika says.

If this happens, the Baltic region will be connected to the Continental European synchronous area as quickly as possible. In case of emergency, it can be done by bypassing the HVDC link between Lithuania and Poland.

“If necessary, we can join the Continental European synchronous area within a few hours.”

After that, there would be frequency support from Poland to the Baltic area using the connection between Lithuania and Poland.

SUPPORT FROM THE NORDIC GRID

The intermediate stage, when the Baltic states would be disconnected from the Russian grid but not yet connected to the Continental European one, would be critical. The Baltic states would then form a temporary island operation, which could cause frequency fluctuation.

However, there is support available from the Nordic synchronous grid via HVDC links – from Finland to Estonia and from Sweden to Lithuania.

“Through the sea cables we can offer fast frequency support to Estonia, and we will give as much support as we can”, confirms Planning Manager **Timo Kaukonen** from Fingrid.

The technical capacities of HVDC links between Finland and Estonia enable adjusting the links.

“We are ready to support the Baltic power system with fast services and reserves that activate within a fraction of a second, when needed.”

There are two sea cable connections between Finland and Estonia, which together enable a thousand megawatts of electricity transfer capacity for commercial transmissions, frequency stability, and other system services. ◆

Sand batteries to help in energy storage

The sand battery developed by Polar Night Energy is an efficient way of storing energy and further reducing the emissions from district heating. The first commercial-scale solution has been built as part of Vatajankoski Oy’s district heating network.

TEXT ARI RYTSY / PHOTO POLAR NIGHT ENERGY

While they were still studying, **Markku Ylönen** and **Tommi Eronen** discussed ways of enabling cleaner energy for housing uses. At that point, solar power was in pole position, but it seemed impossible to exploit it on a large scale without any way of storing the energy.

Water was initially considered as a medium for energy storage, but a solid substance – especially fine sand – offered better properties and suitable thermal parameters for the purpose at hand.

Now, a seven-metre steel cylinder has been built outside a district heating plant in Kankaanpää, Finland. The cylinder contains sand that can be heated to approximately 500°C using inexpensive wind power.

The heat stored in the sand is then conducted onwards to Vatajankoski Oy’s district heating network. It is reportedly the world’s first sand battery built for commercial use, and it is also involved in Fingrid’s balancing power market.

Ylönen says that the sand battery can help to further reduce the emissions associated with district heating and transform it into an energy source that does not rely on combustion. Storage can also help to make better use of energy from sources such as the waste heat discharged by data centres.

“In this regard, the technology and supply chain are already in good shape – all we need now is investment. There are international markets for sand batteries because even hot countries need to store heat,” Markku Ylönen, Polar Night Energy´s CTO, estimates.

He confirms the construction projects for new sand batteries. The heat storage project for the school on the island of Kökar has already been publicised. The project received EU funding and will use wind power and solar energy. So far, Polar Night Energy has worked on projects on the scale of around 10 megawatt-hours, but Ylönen says that the battery solution is scalable all the way up to 1,000 megawatt-hours. ◆

sand can be heated to approximately **500°C**

The heat stored in the sand is then conducted onwards to Vatajankoski Oy’s district heating network

SAFEGUARDING **biodiversity**

Fingrid trains its contractors to identify harmful invasive alien species, limit the spread of such species, and combat them correctly.

TEXT SUSANNA CYGNEL
PHOTOS SHUTTERSTOCK

The garden lupine's flowers are pruned before the seeds end up in the ground.

Controlling invasive plant species classified as harmful is an important step in safeguarding biodiversity. On its substation properties, Fingrid acts in the capacity of landowner, so it is responsible for eradicating harmful invasive plant species.

"We can combat the spread of seeds by means such as avoiding unnecessary passing through areas with invasive plant species. If necessary, preventive measures may also be taken on Fingrid's substation properties," says **Nina Nordblad**, Environmental Specialist at Fingrid.

At Fingrid's substations, the main focus is to identify the most common harmful invasive plant species occurring in Finland, such as hogweed, Indian balsam, garden lupines, Japanese rose, Japanese knotweed and giant knotweed.

Different plant species are controlled in different ways. If the species spreads from seeds, like the garden lupine, the flowers are pruned before the seeds end up in the ground. Japanese rose also spreads from seeds, as well as root suckers, so it can also be disposed of by digging it up. Indian balsam is destroyed by mowing it down, but hogweed should never be treated in this way.

"Hogweed sap can cause the skin to burn in the sunlight, representing an occupational safety risk. Hogweed is removed by digging it up, covering it, or removing the flowers," advises **Miia Korhonen** from Luontoturva, an organisation specialising in the control of invasive plant species.

"It is very important to remove all fertile parts of plants and place them in sacks in mixed waste or take them to the dedicated disposal points at waste disposal centres, so they do not end up spreading in other natural habitats," she adds.

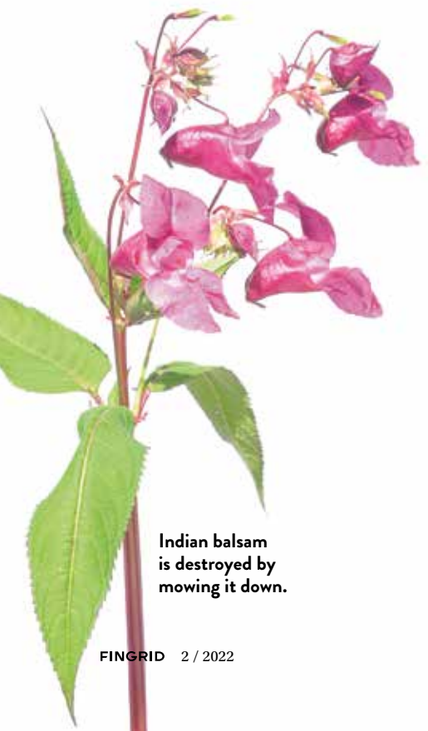
Japanese rose spreads from seeds, as well as root suckers, so it can also be disposed of by digging it up.

Korhonen and Nordblad have trained the contractors working at substations to identify and control harmful invasive plant species, as identifying these is of paramount importance.

This summer training was put into practice.

"The training included instructions on how the various plant species spread and the ways of limiting such spread. During the past summer, surveys of invasive plant species on substation properties were started to obtain more information of possible occurrences," Nordblad says. ◆

Further information: **vieraslajit.fi**



Indian balsam is destroyed by mowing it down.

TEXT MINNA SAANO / PHOTO SHUTTERSTOCK

A country with two electricity frequency areas

The choices made in Japan 130 years ago are still affecting the country's electricity system.

Japan's utility frequency is split into two areas: a 60-hertz area in the west and a 50-hertz area in the east.

The history of the two areas stretches back to the 1890s when Tokyo purchased electrical installations from Germany and Osaka bought them from the United States. Germany has a 50-hertz power system, while the United States operates at 60 hertz.

"I have not been able to uncover any detailed information about these decisions. The equipment was purchased at about the same time, when Tokyo took over from Kyoto as the capital city in 1868, and I think this may have been a factor. Perhaps the old capital region wanted to make decisions based on its own needs, which may have been different from those of the new capital city," says **Marcin Pohjanpalo**, an Expert at Fingrid.

The capacity of the frequency converters required to transmit electrical energy between the two frequency areas has been a major problem for the Japanese power system. Historically, the capacity across the boundary between the 50 Hz and 60 Hz areas has been fairly low, but now efforts have been made to increase it.

"Last year, the capacity was raised from 1,200 megawatts to 2,100 megawatts. There are plans to increase this further – to 3,000 megawatts – by the end of the decade."

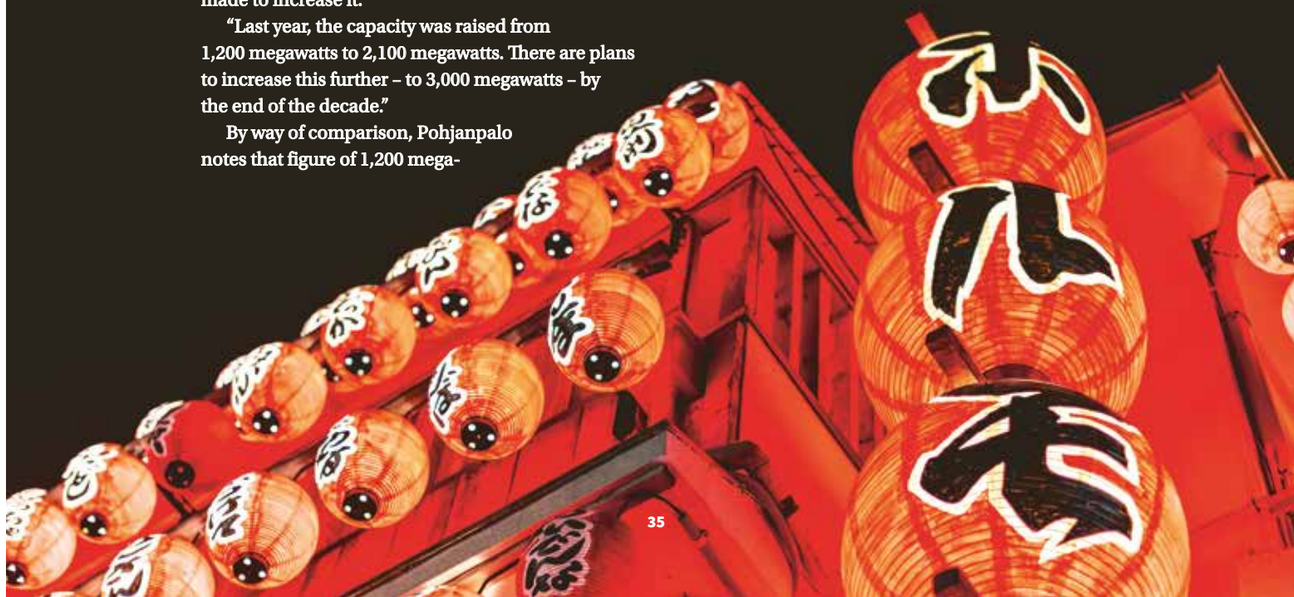
By way of comparison, Pohjanpalo notes that figure of 1,200 megawatts is equal to the HVDC capacity between Finland and Sweden, but the peak consumption in Japan is 159 gigawatts, compared with a combined peak of just 43 gigawatts in Finland and Sweden.

The low electricity transmission capacity gives rise to price differences between the different areas of Japan.

"Japan has ten transmission system operators, and the electricity price depends on which transmission system operator's area you happen to live in. The statistics show that in 2017, there was a price difference of about 20 per cent for small-scale consumers between the most expensive area – Tokyo – and the least expensive – Osaka."

For end-consumers, the only appreciable difference between the various frequency areas in the Japanese power system is the difference in the electricity price.

"If an installation is extremely sensitive, it may require either a 50 Hz or 60 Hz connection, but consumer electronics work in both frequency areas without any issues. You can use the same phone charger in Tokyo and Osaka." ◆



Fingrid Current

1:00 pm–4:30 pm on Tuesday
15 November 2022, Helsinki
Theme: Will there be enough electricity?
The event will be held in Finnish.

THE EVENT IS INVITATION-ONLY, but an online broadcast will be made available to everyone. We look forward to welcoming you!

Further details:
www.fingrid.fi/tapahtumat

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