1 2025

FINGRID

TRANSMISSION SYSTEM OPERATOR'S MAGAZINE / RENEWING THE ENERGY SYSTEM / *fingridlehti.fi*

Clean electricity and a strong grid will power municipal vitality for decades to come

Making history

The Helsinki underground cable connection is the first of its kind, and at different stages of construction it has posed many challenges to solve. Despite these, the cable project has kept to its timetable.

The new underground cable connection to the main grid is the first 400 kilovolt cable in history to be made this long in Helsinki. When completed, it will run for 12 kilometres from the Länsisalmi substation in Vantaa to the new Vanhakaupunki substation in the Viikinranta Energy Block in Helsinki. The cable connection is created in collaboration between the City of Helsinki, Helen Sähköverkko and Fingrid.

"There are many different sites and challenges along the route, which have been solved in collaboration with the City of Helsinki, the authorities, stakeholders and various experts, among others. Discussions have been and are still actively taking place, for example, regarding archaeological areas and nature objects along the cable route. It has also taken over a year to get landscape work permits in the Helsinki area," says Project Director **Risto Ryynänen** from Fingrid.

For example, in the Kivikko cultural history area, an archaeologist reviewed and mapped the location of bunkers and cannons from World War I which the cable passes under.

Nature values are considered particularly important in the planning of the route, and various experts, for example Helsinki Nature Conservation Association, have been consulted on the matter.

"We have prepared nature reports and made ground surveys, especially in the areas of the Kivikko forest, Hallainvuori and the fields of Viikki."

When building an underground cable in an area of dense infrastructure, it is necessary to pass through many traffic thoroughfares by horizontal drilling under them.

"This has not been done to this extent before," Ryynänen points out.

In this project, the largest horizontal drillings are under the Porvoo motorway, Vantaa tram, Maratontie, Ring I and the light rail line on Viikintie. In addition, a rock borehole about 360 metres long passes under the cultural history area in Kivikko. There are horizontal drillings in eight locations.

"A number of temporary routes are also being made to the installation sites as the work progresses, so that, for example, people can safely travel around the area for recreational purposes," Ryynänen explains.

The project has progressed according to schedule despite a variety of challenges. The construction of the cable route is nearing the end, and the substation contracts are already topping out. Installation of the cables will begin during the spring and summer of 2025. ◆

STRATEGIC DIMENSIONS OF THE CABLE:

SURFACE AREA OF THE COPPER CONDUCTOR
2,500 mm²

WEIGHT
35 kg/m

DIAMETER
140 mm

PROJECT PLANNING BEGAN IN 2020, AND CONSTRUCTION WORK BEGAN IN 2024. THE CABLE WILL BE OPERATIONAL IN
2026

TRANSMISSION POWER OF THE CABLE CONNECTION ABOUT
1,000 MW

THE CABLE CONNECTION MEASURES ABOUT
12 kilometres

THE COST OF THE INVESTMENT IN THE ENTIRE PROJECT IS OVER
EUR 100 million

"The 400 kilovolt underground cable connection to the inner city of Helsinki is a historic project," say Fingrid Project Managers Joonas Hurtta (left), Jussi Rantanen (right), Jarmo Henttinen (right back) and Project Director Risto Ryynänen.

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THE ENERGY SYSTEM

REGULAR SECTIONS

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The clean transition is about collaboration

THE POWER system is undergoing a big change that affects everyone and often affects us in many different roles—as household consumers, electricity producers, planning and permitting authorities and, for example, as funders of investments.

The current questions relate to climate change mitigation, emissions reduction, electricity production and consumption, transport and heating electrification, land use, nature values, competitiveness and vitality of the regions.

The production of clean electricity and investments based on its utilisation have been identified as important in the construction of Finnish economic growth and well-being at the local and national level.

Electricity production has been rapidly cleaned up thanks to new wind power and additional nuclear power. Last year, the share of zero-emission production in Finland was 95%.

Based on the connection surveys received by Fingrid and the estimates made, Finland's electric future looks bright. The increase in consumption has been minor so far, but last year there was finally a turn towards a slight increase.

Municipalities play a key role in enabling the energy transition and the necessary investments, as they are responsible for town planning and the necessary permits. Electricity production and industrial investments are important sources of tax income and also employment for municipalities. They also bring rent, salaries and other income to the municipalities.

Municipalities play a crucial role in enabling the energy transition.


Sampo Korhonen

Power production and industrial investments require a connection to the grid and sufficient transmission capacity.

The rapid growth in connection and transfer capacity needs has exceeded previous estimates. The reason is a significant difference in the time horizons of network construction, manufacturing and industrial investments. Network construction takes an average of 7–8 years, while battery energy storage facilities or electric boiler investments only take 1–2 years to complete.

The vicinity of electricity networks is one competitive advantage when looking for locations suitable for production or industrial investments. Often investments require the development of the grid, and due to the long-term nature of network projects, early contact is of paramount importance.

At Fingrid, we work for customers and society. Together, we can find the best alternatives for locating projects and enabling investments based on clean energy.

Asta Sihvonen-Punkka
CEO
Fingrid

FINGRID

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TEHTY SUOMESSA MADE IN FINLAND

AUDITED CO_2 NEUTRAL PRODUCT

SHUTTERSTOCK

Large grid energy storage facilities improve the reliability of the main grid.

Location of grid energy storage is very important to the grid

The restriction on connecting grid energy storage systems to the power grid on the west coast south of Vaasa was lifted on 1 February 2025. The restriction could be lifted much sooner than planned thanks to development work with customers.

Grid energy storage systems provide the power system with flexibility, and their location makes a big difference to the grid as it must consider the transmission and connection capacity of the grid.

For example, the Arkkukallio and Kärppiö substations in Isojoki and Teuva in South Ostrobothnia are good examples of excellent connection points for large grid energy storage systems in the main grid because studies have shown that these areas have significant main grid transmission capacity.

Large grid energy storage facilities also improve the reliability of the main grid, as the wind and solar power in the area has a significant effect on stability.

We are preparing the possibility to build new customer connections at the Arkkukallio and Kärppiö substations faster than usual. ◆

fingrid.fi

Transmission line as part of the main grid in Central Ostrobothnia

FINGRID has purchased a section of the transmission line completed last year between Alajärvi and Lestijärvi from Lestijärven sähköverkko Oy. As part of the main grid, the transmission line will be used more efficiently, facilitating the commissioning of new wind and solar power facilities arising in the area.

A new 400-kilovolt main grid transmission line known as the Lowlands Line will pass through the region. Two transmission lines are needed to provide sufficient transmission capacity. The second line will be the connecting line acquired as part of the main grid. We will extend it to the new substation to create a meshed grid.

As part of the meshed main grid, the line will be used as efficiently as possible.

THE episodes of Fingrid's new podcast, "The Pulse of the Main Grid", are available on Spotify in Finnish.

Stay up to date

SUBSCRIBE to Fingrid's newsletter at **fingrid.fi/en/order_publications**

PROFILE

Meetings with landowners

Joonas Vaaramaa, Expert, Forestry Management, travels the length and breadth of Finland when managing the condition of the grid.

TEXT MINNA SAANO / PHOTO HARRI NURMINEN

I work as an expert in forestry management in the Southern Finland region. I am responsible for planning, monitoring and auditing work related to treating the vegetation in the transmission line area and for communicating with contractors and landowners.

My area is the south of the Kristinestad–Tampere–Lahti–Lappenranta line, where there are approximately 5,000 kilometres of transmission lines. In practice, the work requires a lot of travel, and almost half of my working time is spent in the terrain.

Treating vegetation is based on cycle times, i.e. the clearing of the growth at specified intervals. Over the course of 10 years, a huge digital transformation has occurred in my work. When I started in Fingrid, the work was guided with paper maps. Back then, large numbers of maps were sent to contractors. Now there are mobile apps to manage both job instructions and reporting.

WHO?
Joonas Vaaramaa

WORK
Expert, Forestry Management

FAMILY
wife, two daughters, five dogs, three ponies

FREE TIME
hunting, volleyball and heavy metal

Every kilometre we operate in is located on a landowner's land. There have been hundreds of encounters with them over the years. Each has been unique.

It always feels good when meeting goes well. Occasionally, at the end of an inspection, you get invited for coffee. Many things have happened and will certainly continue to happen—it keeps your mind fresh and your work meaningful." ◆

FINGRID

Southern Finland's connectivity improves with reinforcements to the main grid

There will be temporary local restrictions in the connection capacity of the main grid in the Uusimaa, Southwest Finland and Häme regions until 2027. In practice, the restrictions mainly affect quickly deployable grid energy storages and possibly electric boilers and other industrial-scale demand facilities that have not yet agreed upon a connection to the grid.

Electricity consumption in the region has grown even faster than expected while controllable power production in the region has been decommissioned and electricity imports from Russia have ceased. The investments in reinforcing the main grid will be completed gradually and will alleviate the shortage of connection capacity.

Fingrid is implementing the largest investment programme in its history totalling four billion euros, a significant part of which is allocated to enabling the growth of electricity consumption in southern Finland. Fingrid assesses the available connection capacity on a constant basis, and the goal is to ensure maximum number of connections to the grid. In addition, we are improving operational models to speed up the setting of network connections and developing new methods to manage main grid transmissions.

Consumption facilities offering flexible capacity and customers engaging in close cooperation with the transmission and distribution system operators can contribute to connecting new demand facilities in southern Finland. Adequate connection capacity can also be ensured by keeping regional adjustable electricity production, especially combined heat and power production, in service over the coming years. ◆

Request for tenders on Olkiluoto 3 grid load limitation sites

THE OL3 grid load limitation is a technical arrangement that enables Teollisuuden Voima's Olkiluoto 3 nuclear power plant unit to produce more than the maximum value of 1,300 megawatts set for the power system. According to the decision made by the Energy Authority in 2024, Fingrid is responsible for the procurement of sites participating in the OL3 grid load limitation and TVO is responsible for the costs of the compensation paid to the sites. The current grid load limitation arrangement will end in June, and Fingrid has arranged a tender for the selection of sites to be connected to the OL3 grid load limitation as of the start of July.

TVO

PRACTICAL QUESTION

Why does it take so long to process crossing statements?

When working near a transmission line, a crossing statement from Fingrid is always required to ensure safety. The project does not need to cross a transmission line; a crossing statement is required when the project is near a transmission line. The processing time for crossing statements is currently four months, says Expert Heidi Oja from Fingrid.

TEXT MARJO TIIRIKKA / PHOTO FINGRID

1 What causes the bottlenecks in receiving crossing statements?
Bottlenecks accumulate from many factors. Fingrid is building and designing more new transmission lines than ever before. Therefore, the statements must also consider ongoing transmission line projects and plans for future transmission lines.

Parts of our network are old: up to 80 years old. Therefore, not all the required documents can be easily found. Finding the right information can be very laborious and time-consuming and may require the knowledge of many people.

We conduct a lot of studies for crossing statements and they are only added to the statement as a guide if they have real significance for the statement. Therefore, a statement can sometimes be very short, even though it has taken several hours—sometimes several days—to investigate.

Bottlenecks are also caused by personnel changes in our team, but we have now received reinforcements.

2 How many crossing statements do you write? What types of statements do projects need?
In recent years, approximately 450 statements have been prepared annually. The number varies monthly, for example, depending on the scope of the site.

Since the processing time is long, it is important to let us know if your plans evolve or you no longer need a statement.

Requests for statements on large projects such as data centres, trams and industrial areas located in the immediate vicinity of a transmission line have accumulated on my desk. Dozens of statements may be needed for such a site, so that information is provided on all the activities that will take place in the area.

New crossing points, such as hydrogen pipelines, will also be introduced near transmission lines. These standards and guidelines are not yet known, so we need to be constantly studying.

3 What is included in the statement and what should the applicant consider?
The statement is always made on the basis of a request and is given on the basis of the information that we have received.

It is especially important to mention all electrically conductive structures so that we can provide guidance.

On the other hand, the plans do not need to be completely finished. If street lighting is planned for a road, for example, a statement can be requested at the beginning of the planning. ◆

Examples of activity that requires a crossing statement:

- Underground cables
- Lighting
- Roads, cycling routes
- Fences
- Cultivating Christmas trees
- Grazing animals that care for the landscape
- Game control area or hunting tower
- Park
- Car park
- Stormwater management structures

TRANSMISSION SYSTEM OPERATOR AT YOUR SERVICE

Fingrid is the transmission system operator for Finnish people. Its mission is to safeguard a reliable energy supply for society and promote a clean, market-based power system.

COMPILED BY MARJUT MÄÄTTÄNEN / INFOGRAPHIC LAURA YLIKAHRI

FINGRID is responsible for electricity transmission in Finland's main grid, the backbone electricity transmission network. An undisrupted power supply now and in the future is our responsibility. Our mission is to ensure that electricity production and consumption are balanced 24/7.

FINGRID owns the main grid. Through it, electricity is distributed throughout Finland to our customers who are large electricity production plants, large industry and regional distribution system operators connected to the main grid. Distribution system operators, on the other hand, transmit electricity onward to households, among other things.

FINGRID plays an active role in the energy transition and mitigating climate change. By developing the main grid, we create a platform for a clean power system. We work closely with customers, technology partners, government officials and policy makers.

What is in the main grid?

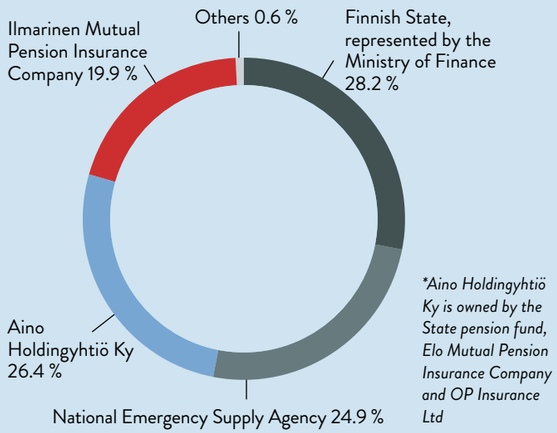
The main grid consists of 400, 220 and 110 kV transmission lines. The total length of transmission lines is over

14,500 km

The transmission reliability rate in 2024 was

99.9995 %

Fingrid's owners are the Finnish State and Finnish pension and insurance companies

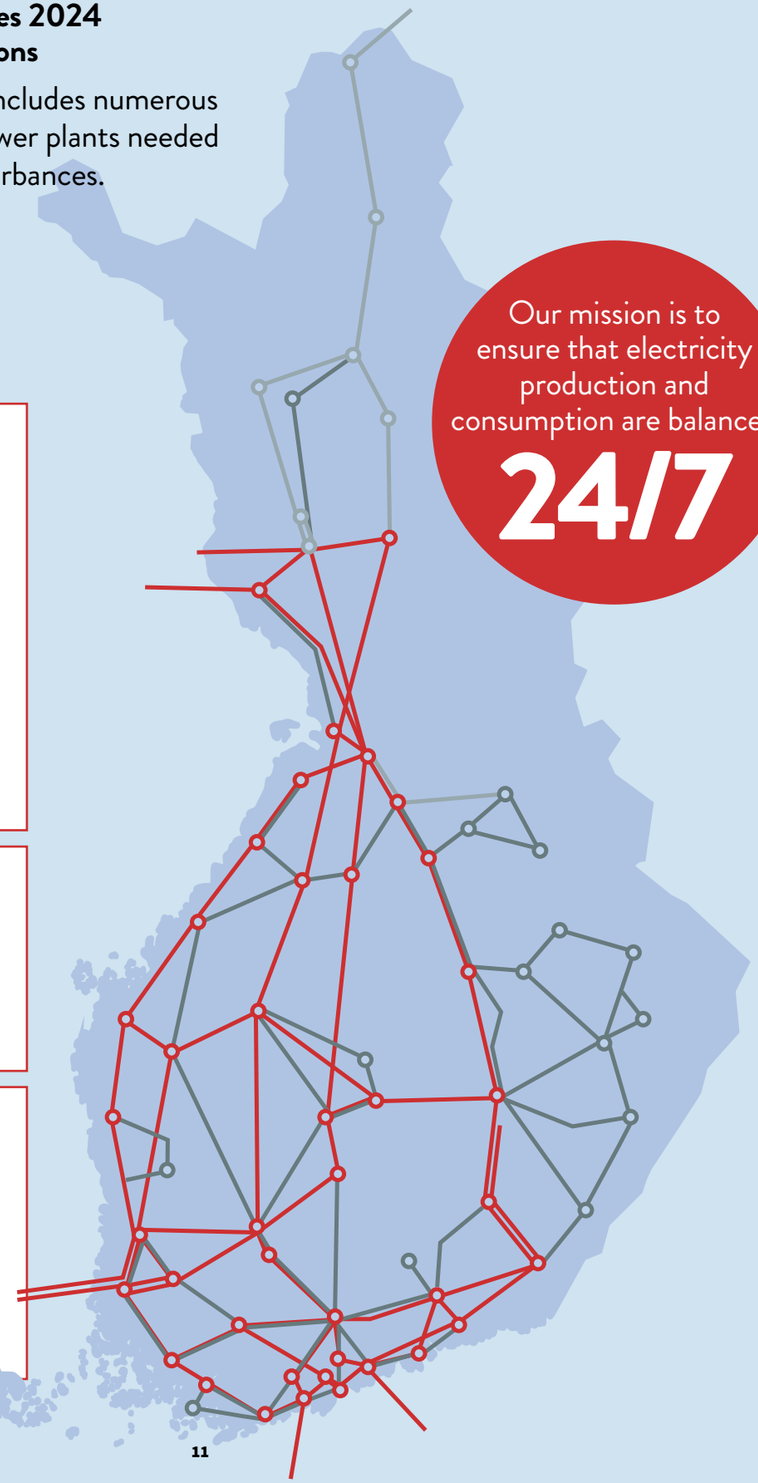


**Aino Holdingyhtiö Ky is owned by the State pension fund, Elo Mutual Pension Insurance Company and OP Insurance Ltd*

Main grid transmission lines 2024 and cross-border connections

In addition, the main grid includes numerous substations and reserve power plants needed in the event of severe disturbances.

- 400 kV transmission line
- 220 kV transmission line
- 110 kV transmission line



Our mission is to ensure that electricity production and consumption are balanced **24/7**

WE also own the international connections of the main grid together with Sweden, Estonia and Norway. The power system of Finland is part of a joint Nordic power system connected to the Central European system with DC connections. Finland's connections to neighbouring countries are also DC connections. We ensure that Finland's international connections have sufficient transmission capacity for the market's needs.

WE are actively working to develop both Nordic market opportunities and European electricity markets, while safeguarding national interests.

A FUNCTIONAL electricity market benefits all actors in society, including consumers. By promoting the functionality, efficiency and reliability of the electricity market, we ensure that Finns continue to receive the cheapest electricity possible.

THE GRID IS EXPANDING AT PACE —WHERE AND WHY?

Building new transmission lines is an important step to improve the vitality of a municipality. Right now, many more connection enquiries are made than connections can be realised. Therefore, the main grid and its connections are only built where the customers have project permits and construction can begin.

TEXT SUSANNA CYGNEL / ILLUSTRATION JUKKA FORDELL

A strong grid enables new industrial projects and investments in municipalities. It attracts businesses and creates jobs—strengthening the vitality of the region for decades to come. Many municipalities currently have hopes to strengthen the grid, and the green transition will increase needs.

Fingrid knows the wishes and needs of municipalities. The total volume of electricity production and consumption connection enquiries has reached 500,000 megawatts, which is an enormous number when Finland's peak consumption is about 15,000 megawatts.

The grid develops in collaboration:

THE MAIN GRID creates competitiveness

WIDESPREAD distribution of electricity production and consumption is in the best interest of Finland as a whole

COLLABORATION enables reasonable land use and smooth permit processes

CUSTOMER NEEDS drive main grid investments

"Being prepared to satisfy everyone's wishes is an impossible task. That is why we build the main grid as projects mature. Fingrid's connection planning progresses side-by-side with projects, but not well in advance," says **Jussi Jyrinsalo**, Senior Vice President at Fingrid.

When a region has more plans that are further advanced in permitting, it is more certain that users will come to the main grid and Fingrid can confidently prepare system reinforcements.

"If there are a large number of smaller project ideas coming to the same region, for example wind farms, it is not the end of the world for us if a single customer project goes under. But a big customer project, for example a large consumption site, can fall through for some reason, and then we will have invested in system reinforcements for no reason," explains Jyrinsalo.

He hints that if a municipality wants a stronger main grid in its area, it should promote the permit procedures for electricity production and consumption projects and support projects in all possible ways. Fingrid should be kept up to date with the progress of the projects.

"Unfortunately, wishes to promote the vitality of a municipality and build a strong network in advance for possible future needs are not sufficient grounds. The necessary permits must exist, and the customer project must be advanced enough in order for the connection to be added to the network plan."

"We are building the main grid as projects mature."

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

ALREADY EUR 4 BILLION IN INVESTMENTS

Fingrid's investments have grown tremendously with the green transition. Over the next 10 years, Fingrid will invest approximately EUR 4 billion in the grid. In the previous 10-year development plan, the figure was EUR 2 billion.

Investments are needed, as the grid is being strenghtened from the west and north to the south: The west coast has wind power, complemented by electricity imports from Sweden, and in Southern Finland, the need for electrical power is growing constantly.

"The capacity of the main grid from the north to the south should double in ten years, which means several new 400 kilovolt transmission lines," Jussi Jyrinsalo mentions.

RESIDENTS AND DECISION-MAKERS ARE CONSULTED

A new transmission line project is a significant opportunity for municipalities to develop the infrastructure and increase regional vitality. Residents and landowners, on the other hand, can be upset by large construction projects, as construction sites primarily travel through private land.

However, all parties are consulted at different stages in design and construction, and then municipal residents can share their views. Involvement and interaction with locals are key to the success of the project.

"We want to hear a wide range of comments from local residents and municipal decision-makers. Everyone's opinion is important because our goal is to achieve the best possible solution that takes into account different interests. Not all environmental impacts are visible from a computer, and we generally do not know the areas ourselves," says Expert **Eero Kujanen** of Fingrid.

A main grid construction project is initiated through an EIA, which looks at the impact of the project on the environment, land use and social life.

The EIA is a tool for planning transmission line routes. The process is designed to ensure that local views and regional needs are taken into account.

"Our goal is that a transmission line project serves local needs and the interest of society as a whole."

Eero Kujanen
Expert, Land Use and Environment
Fingrid

Fingrid expropriates the right to use land for the grid in return for the compensation specified by law. The Expropriation Act will be reformed to increase the compensation by 25%.

"The purpose of the expropriation procedure is to compensate the landowner for all financial losses. In addition, the amendment to the Expropriation Act provides extra compensation. Although the situation is not always easy, we believe that the reform will increase the sense of justice—after all, the legal project has been pending for years," says Kujanen.

FLEXIBILITY IN FINLAND'S INTERESTS

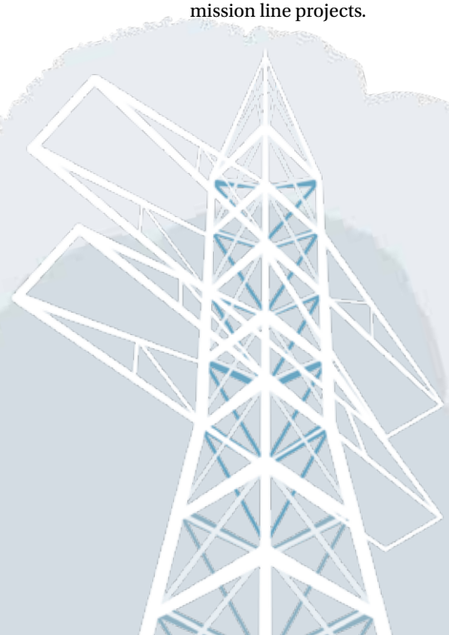
Municipal town planning is emphasised in transmission line projects.

Careful town planning that takes into account the long-term needs of the main grid makes it easier to build transmission lines and improves the municipality's land use planning.

"Our goal is that a transmission line project serves both local needs and the interest of the whole society," says Kujanen.

Also, the reliability of the grid should be ensured, even though transmissions are growing steadily and there are increasing numbers of users. Many types of flexibility in both electricity consumption and production are becoming more valuable.

"More flexibility is now required in order for Finland to succeed. For example, the locations of projects should be considered from this point of view: if, for example, an industrial plant needs to be located near a port, nothing can be done about it, but it would be possible to place a data centre or battery more freely," Jyrinsalo adds. ◆



FINGRID'S SOLUTIONS TO ENSURE NETWORK ADEQUACY

A RECORD number of transmission line and substation projects to support network adequacy and the energy transition

REFORM of the main grid fees to encourage electricity production and consumption facilities to be located closer together

High pressure to reinforce the grid

EASTERN FINLAND is now facing large issues related to enabling new electricity production and consumption and the adequacy of the grid.

"Eastern Finland would require significant investments in the expansion and strengthening of the high-voltage power grid. The network infrastructure has been designed for consumption and not for production needs, but as demand for clean energy production increases, the situation has changed," says **Arto Nieminen**, CEO of Järvi-Suomen Energia Oy.

For example, wind power cannot be built in Eastern Finland on the same scale as in many other parts of Finland, because the power plants may interfere with border control and radar activities. Therefore, electricity must be imported from elsewhere.

According to Nieminen, merely expanding the main grid is not the only solution, because it is too expensive and would be insufficient. Functional regional and distribution networks are also required.

"The Electricity Markets Act imposes strict requirements on delivery reliability. That is why investments need to be systematic, long-term solutions."

In order to improve the high-voltage regional network, approximately EUR 10 million of investments have been calculated annually in Järvi-Suomen Energia's region over the next 13 years. Nieminen emphasises that public support is essential to the implementation of projects of this size.

"The clean transition will not proceed without working networks. Fingrid's role is critical in the main grid, but investments in distribution and regional networks are also needed."

Second connection to improve the security of supply

ALSO IN Turku, the adequacy of the regional power grid has been considered. Turku is connected to the main grid at one point, but in the future, another connection would increase the security of supply and capacity.

"Turku is a growing city, and the green transition will certainly increase demand. The enquiries in Turku are for data centre and battery plans, but the main grid connection is becoming full," says **Tomi Toivonen**, CEO of Sähköverkot Oy at Turku Energy.

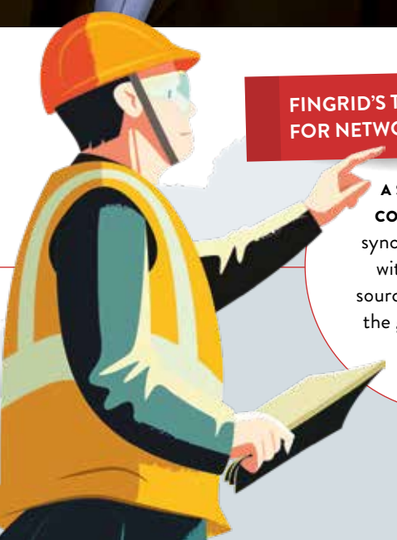
Fingrid plans a connection to Raisio in 2031 and, according to Toivonen, it could offer Turku a solution to increasing demand.

"These long-term solutions support sustainable growth in the region," Toivonen says.

He also hopes that if the main grid in the Turku area is strengthened in the coming years, it is important to check and, if necessary, strengthen and expand the 110 kilovolt distribution network.

Toivonen reminds municipal decision makers of the importance of active interaction also in the direction of the electricity distribution company.

"For example, discussions about data centres should start as early as possible so that we can take them into account in general and network planning. The permit processes should also be started in a timely manner so that construction is not delayed due to the permit procedures," Toivonen says. ◆



FINGRID'S TECHNICAL SOLUTIONS FOR NETWORK ADEQUACY

A SYNCHRONOUS COMPENSATOR is a synchronous machine without an energy source, and it stabilises the grid's voltage and frequency

A STATIC SYNCHRONOUS COMPENSATOR is a power electronics-based compensation device that stabilises grid voltage

New **SERIES COMPENSATION EQUIPMENT** for transmission lines. The series compensation technology is used to increase power transmission capacity by reducing transmission reactance

SHUNT COMPENSATION. A technology in which the addition of capacitors to different voltage levels increases the north-south transmission capacity

INCREASE IN THE TRANSFORMATION RATIO of 400 kV substation current transformers

DYNAMIC LINE RATING (DLR) for measuring the current carrying capacity of the transmission line in real time under different weather conditions

DATA CENTRES WANT TO BE IN FINLAND

Our country's location, reliable grid, and abundance of renewable energy attract data centres. In turn, they can produce heat in the local district heating network and provide grid balancing services.

TEXT KATARIINA KRABBE / PHOTOS FINGRID, SHUTTERSTOCK AND ATNORTH

Data centres host large computers and servers that run data transfer, cloud services, and artificial intelligence. They consume a lot of electricity.

Founded in 2009 in Iceland, atNorth designs and builds energy-efficient data centres, especially for artificial intelligence and high-performance computing. The company has data centres in Finland, Sweden and Denmark and Iceland.

"Due to the rapid development of artificial intelligence and high-performance technologies, demand for data centre capacity is growing rapidly, so we have ambitious growth targets in the Nordics," says **Anna Kristín Pálsdóttir**, Director of Development at atNorth.

A 40-megawatt data centre will be completed in Espoo this spring.

In Finland, the company operates two data centres which it purchased from Advania two years ago: one in Vallila, Helsinki and one in Nihtisilta, Espoo.

A third 40-megawatt data centre will also be completed in Espoo by the end of March. In addition, a data centre being built in Myllykoski, Kouvola, will come online at the end of the year. It initially has a capacity of 60 megawatts, but when it is fully complete, this will increase to several hundred megawatts.

“We prefer locations where the use of waste heat contributes to the circular economy and lowers the carbon footprint.”

Anna Kristín Pálsdóttir
Development Manager
atNorth

In total, there are currently twenty data centres in Finland, and more will come. Finland is regarded in many ways as an attractive location—not least because of the strong and reliable grid.

“Finland also has plenty of renewable energy and a cool and even climate, which enables the use of energy-efficient cooling systems. In addition, Finland has excellent fibre optic connections and low-latency communication networks, which in addition to a skilled workforce make Finland an ideal location for data centres,” adds Pálsdóttir.

CLOSE TO POWER PRODUCTION

Fingrid’s main grid and the proximity to electricity production make for an attractive location for a data centre.

Pálsdóttir says that the proximity to sustainable electricity and the main grid is important to the company as it can reduce costs and enable direct connections that benefit both the producer and the consumer.

“In addition, enough land is needed for investment, good network connections and the market should be close by. In Finland, just like in the other Nordic countries, the criteria are easily met, as there is a lot of affordable renewable energy available.”

Open dialogue already in the design phase is important with local service providers, municipalities, electricity and energy companies, and Fingrid.

“We equip our data centres with advanced cooling and heat recycling systems to maximise energy efficiency. That is why we prefer locations where the use of waste heat contributes to the circular economy and lowers the carbon footprint,” says Pálsdóttir.

At both atNorth sites under construction in Finland, waste heat is recycled into the district heating network in cooperation with the local energy company.

DEMAND-SIDE MANAGEMENT IS POSSIBLE

As the share of wind power in electricity production increases, the system becomes increasingly dependent on the weather. Consequently, the role of demand-side management is also emphasised as part of a functioning power system.

It would be good to get data centres involved in demand-side management.

“We plan to integrate grid balancing services into our model solution. Dynamic load management could allow us to perform non-critical tasks outside of peak hours to balance the supply of electricity,” says Pálsdóttir.

She explains that data centres can also adjust their energy consumption or production to adapt to network frequency fluctuations Fast Frequency Reserve (FFR) solutions.

“In addition, data centres can store excess energy in their backup system batteries when the grid has an oversupply and feed it back into the grid during times of high consumption.” ◆

atNorth is building a data centre in Myllykoski, Kouvola, which will ultimately have a capacity of several hundred megawatts. Illustration.

The Grid Code Specifications for Demand Connections will be redefined

The energy transition is challenging the grid code specifications, as lots of new converter-connected production and consumption are connected to the grid at a fast pace.

“**WE** have just defined new grid code specifications for power plants and energy storages, but now that the consumption side is also undergoing a change, we will redefine the specifications for consumption during 2025,” says **Teemu Rissanen**, Expert at Fingrid.

The new specifications will apply especially to new data centres, electric boiler plants, hydrogen plants and other industries.

“As we develop our specifications, we actively seek to discuss with different stakeholders and understand what the specifications mean to them in practice and what the real solutions are.”

The balance of the power system is threatened if large consumption plants fall off the grid in the event of a network failure. Therefore, a fault ride-through requirement is being prepared. Another significant requirement defines how quickly consumption can be returned to the pre-failure active power level. In other words, the aim is for consumption to have resilience similar to power plants to keep the system balanced.

“These are new things for consumption facilities. For data centres, this means, for example, designing UPS hardware and software according to the specifications.”

Other new requirements may apply, for example, to frequency or voltage regulation and controllability. Fingrid is also interested in the data centre’s load profile.

“For example, in AI training, the need for power can vary dramatically and suddenly, while the load on a data centre from more traditional data processing and storage is quite steady.”

A MAMMOTH ON THE WAY

2 January 2025: The transformer is transferred onto a train at Vuosaari harbour.

4 January 2025: The transformer is transferred from the train to a lorry at Otalampi.

TEXT MINNA SAANO / PHOTOS TERO IKÄHEIMONEN

Transporting a transformer weighing hundreds of tonnes to a substation by road requires precise planning. Before the route is clear, inspections, modelling, geometry, negotiations and often also infrastructure construction or repair are required.

The basic prerequisite for choosing a new substation location is that the transformer can be transported there," summarises Fingrid's Senior Expert, Construction, **Mikael Wiren**.

Transformers are brought to Finland on ships. They are transferred from the port by train as close as possible to the destination. From the train track, the transformer is loaded onto a lorry for the last part of its journey.

The transformers are purchased with delivery to the site, but Fingrid ensures that there is a path to the substation on the ground.

"It can take 15 minutes to find a route or maybe as long as 5 years. Much depends on whether the infrastructure requires intervention, such as building a new bridge," Wiren says.

It is very demanding for the route: a transformer ready for transportation weighs 300 tonnes, is 6.5 metres high and 3.5 metres wide.

There are often bridges that pose challenges when choosing a route if the transformer cannot fit under the bridge or if the bridge cannot withstand the weight of the transformer. Road widths and elevation differences should also be taken into account, as the route must not have very steep uphill or downhill slopes; the transformer needs to get up the hills and the brakes must be able to withstand going downhill.

The structure of the road may also be inadequate to withstand heavy transport.

"It can take 15 minutes to find a route or maybe as long as 5 years."

Mikael Wiren
Senior Expert
Fingrid

BRIDGES ARE BOTTLENECKS

Once the route has been planned, Fingrid obtain an advance transport permit from the Centre for Economic Development, Transport and the Environment. The carrier, in turn, obtains the actual transport permit closer to the time.

For a preliminary transport permit, the Finnish Transport Infrastructure Agency issues an opinion on the durability of the bridges, the Centre for Economic Development, Transport and the Environment issues an opinion on the load-bearing capacity of the state's roads, and cities issue opinions on their infrastructure.

If the permit is declined, another route must be found. If the decision is conditional, work must begin to address the terms and conditions.

"It is possible to negotiate road repairs, culvert and asphalt replacements, support structures or other issues with different parties. For bridges, there is no room for negotiation, because the

6 January 2025: The transformer arrives in Hepokorpi.

Transformers are the heaviest loads on the road. Every year, four or five transformers are driven to their destinations at substations.

Ester oil transformer arrived in Hepokorpi

THE ester oil transformer arrived at the Vuosaari harbour on 2 January, where it was taken by train to Otalampi station in Vihti. From there, the transformer was loaded onto a lorry for 30 km of road transportation to Hepokorpi, Espoo.

Project Manager **Juho Salonen** of Fingrid characterises road transport as challenging.

"There were steep hills, crossings, bridges and tight bends along the way. All the little details were reviewed in advance: bridge crossings and underpasses, how to get round the corners and how to turn at crossings."

Before the transportation date, electric wires were moved if they could block the transformer and tree branches were cut back. The weather forecast was also watched with apprehension.

"Winter transportation always presents its own challenges. In particular, slipping can cause difficulties, especially on steep hills. We were lucky with the weather, and this time it favoured transportation."

On 7 January, the transformer was successfully moved from Otalampi to its destination in Hepokorpi in a few hours.

In the spring, another ester oil transformer will be brought to the substation along the same route.

bridge can either withstand a load or not based on calculations," Wiren says.

ROUTES WITH A LONG LIFE CYCLE

A substation has a service life of 80 years, and the transport route used by the transformer must have the same life cycle. A new transformer may be needed to replace a broken one, or power demands may increase, such that additional transformers are needed in a substation.

"There are a lot of cases where the original routes are out of use. Inspection for transport may show deterioration of a road or bridge so that it can no longer withstand the weight of the transformer. In the future, more preparations will be needed for these kinds of situations as the traffic infrastructure ages."

It is important to be vigilant about life cycles. If there is an opportunity to improve a route in connection with the construction of infrastructure, it is good for Fingrid's route planners to be involved. ◆

Watch a video of a transformer travelling from Vuosaari harbour to Hepokorpi, Espoo *(In Finnish)*.

Fingrid Oyj

Increasing demand for GREEN FINANCING

The green transition in Finland requires investments in the main grid. Fingrid is using significant amounts of green financing to fund them.

TEXT VESA VILLE MATTILA / PHOTO SHUTTERSTOCK

The increase in climate and environmental risks globally impacts societies, the economy and business operations.

Green financing can be used to develop a sustainable business. It refers to financial activities, products and services that promote environmentally sustainable projects, development and economy.

The background is the sustainable funding classification scheme, known as the taxonomy, under the European Union's Green Deal. For example, it defines the requirements for a sustainable business and which activities are considered sustainable.

WORTH MORE THAN EUR 1 BILLION

The cleaning of our country's electrical system, together with sustainable operating models, enables Fingrid to use green financing. In 2017, it was the first Finnish company to issue a green bond.

Since then, Fingrid has sourced green financing worth more than one billion euros in the international debt capital, commercial paper and loan markets.

"We use green financing extensively to implement our investment programme," says **Jussi Pohjanpalo**, Group Treasurer at Fingrid.

REPORTING IS IMPORTANT

According to Pohjanpalo, there is a more permanent and broader financier group available for a company using green financing than for regular funding.

"The larger the group of investors a company reaches, for example, at a bond emission, the more it can affect the cost of financing."

Green financing requires both increased corporate responsibility and more transparent and accurate reporting.

Sustainability targets already have a significant role to play in guiding many actors. Investors, on the other hand, want to understand the company and get accurate information about its progress on the sustainability journey. At the same time, they can reduce their own risks and achieve their sustainability goals.

DO YOUR HOMEWORK

Pohjanpalo advises green financing applicants to do their homework well and understand the prerequisites for a sustainable business in their operations.

"In the preparation phase, the company should develop its own green financing framework. It presents its activities and justifies the projects for which green financing is sought."

Pohjanpalo points out that, among other things, the company must explain how it intends to use the funding proceeds, what the measurable impact of green funding is and how it is reported. ◆

Ultracapacitor provides electricity in milliseconds

An ultracapacitor in a hydropower plant can store and discharge electricity very quickly. It is able to meet the new and increasingly stringent requirements of the frequency containment reserve for disturbances.

TEXT MATTI VÄLIMÄKI / PHOTOS UPM AND VEO

Electricity production and consumption must be in balance at all times. If production is suddenly lost from the power system, or if, for example, transmission connections are damaged, balancing power and reserves are required. To prevent the frequency of the grid from deviating too much from the normal frequency range, the reserves must be able to react quickly.

Elisa Alanen, Specialist at Fingrid, says that in the autumn of 2023, new activation requirements took effect in the frequency containment reserve market for disturbances (FCR-D), further tightening the speed criteria.

"Hydropower plants will be able to participate in the FCR-D market with implementations according to the old requirements as long as their current prequalification tests are valid. At the longest, the permit is valid until 2028, according to the requirements of the time of the current prequalification."

Alanen estimates that the majority of hydropower plants will not be able to meet the new requirements at their current capacity if they do not invest in new technology. However, they may still be able to participate in the balancing of the grid with other reserve products that do not require the same high speed.

Solutions for hydropower operators who will be interested in the FCR-D market will include batteries, ultra capacitors, fast control and adjustment solutions.

ULTRACAPACITORS HAVE A LONG LIFESPAN

In the summer of 2022, UPM Energy introduced an ultracapacitor in two hydropower plants. The power plants are in Katerma in Ontojoki, Kuhmo, and Kallioinen in Sotkamo.

According to UPM Energy's Development Manager **Juha Haromo**, the 3 megawatt installation is the world's first in a hydroelectric system. Capacitors are already old, familiar and proven technology.

"The ultracapacitor stores energy inside two flat surfaces electrostatically, which means it can be discharged into the grid very quickly—in just milliseconds—using inverter equipment. After the initial minutes, the hydroelectric power takes control and continues to balance the power system. The entity is managed by a top-level control system that leverages modern digital functions and automation," he describes.

According to Haromo, the major advantage of an ultra capacitor is that it does not actually wear out, even when charged and discharged. An ultra capacitor has a longer lifespan than an electrochemical battery.

"Unlike a battery, the installation does not contain rare earth metals," he points out.

UPM Energy's experience with the ultra capacitor is so positive that the pilot project is moving forward.

In the summer of 2025, a 6 megawatt ultra capacitor will be taken into production use at the Kuusakoski hydropower plant.

Kemijoki Oy also has an ultra capacitor at the Kurkiaska hydropower plant, and PVO-Vesivoima Oy has one at its Kierikki power plant. ◆

Juha Haromo
Development Manager
UPM Energy

"Unlike a battery, the installation does not contain rare earths."

Hybrid regulator reduces wear on machinery

AT HYDROELECTRIC plants, a change in the grid frequency causes mechanical movement of the turbine mechanical governing system, which wears down the machinery.

The automation and electrification company VEO has been looking for a solution using the hybrid regulation of hydropower turbines.

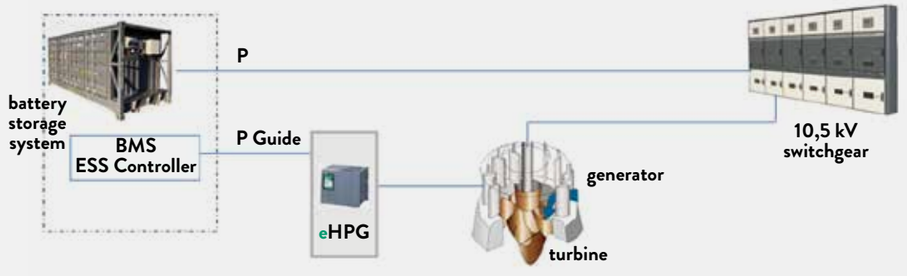
Jukka Kelloniemi, VEO's Lead Engineer, says that in the solution, some of the electricity required is produced with a turbine and some with energy from energy storage system — the turbine and energy storage work at the same time and same governor.

"The hybrid governor can control and guide the use of the energy storage system to eliminate a significant share of the mechanical movements of the turbine regulation devices. It also allows for the fulfilment of new reserve rules and additional income from the reserve market."

The hybrid governor continuously calculates the power required for the FCR product and selects which part of it is produced with the turbine and which part with the energy storage system. The controller can use capacity from the energy storage system within the desired limits and manage the energy capacity so that the regulation can be kept on at all times. Energy management works in such a way that it does not interfere with the maintaining of the balancing reserve (FCR).

"In the event of disruption, the hybrid governor could also support the grid in island operation so that the power plant and the undisturbed part of the grid could remain live," says Kelloniemi.

The hybrid governor is currently used at Kemijoki's Kurkiaska hydropower plant with a super capacitor and in a system formed by Helen's Mankala hydropower plant and battery storage system.



“The tester’s job requires problem-solving skills and a desire to learn new things all the time. These are the best parts of my profession,” says Valtteri Laine from Omexom.

COMMISSIONING ENGINEER NEEDS PROGRAMMING SKILLS

Maintenance of substations in the main grid requires various inspection, maintenance and preventive measures. Fingrid is supported by commissioning engineers, one of whom is Helsinki-based Valtteri Laine.

TEXT MARJO TIIRIKKA / PHOTOS SAMPO KORHONEN

Omexom’s Commissioning Engineer Valtteri Laine arrives at Fingrid’s Tammisto substation in Vantaa at seven in the morning with relay testing equipment.

First, he disconnects the electricity from the 110 kilovolt bay in a controlled manner so he can work on it. The power supply is replaced with electricity from elsewhere to ensure safety and non-stop disruption. Then the real work starts.

Today, he is conducting warranty testing on protective relays to ensure they are working correctly before the warranty period expires. Testing is done by simulating various fault conditions with the testing device.

The work is now largely done electronically. The secondary systems are becoming more and more technical and the work includes a lot of programming. Therefore, a computer with a variety of software is an essential tool for the commissioning engineer.

Laine was interested in technical studies but ended up in the electrical sector half by accident after getting into Metropolia University of Applied Sciences in Helsinki to study electrical power engineering after upper secondary school.

Testing is done by simulating various fault conditions with the measuring device.

At the beginning of his career, Laine worked on projects for Fingrid where he learnt about systems as a whole.

“For the electricity sector, I recommend starting with the big picture, i.e. what kind of subsystems the overall system contains. It is important to know how they are meant to operate before you can understand why they are malfunctioning.”

PROGRAMMING AND PROBLEM SOLVING

The relays used to be electromechanical, but today they are based on microprocessor technology and contain circuit boards. The commissioning engineer´s job requires strong IT management and programming skills.

“The installations are more technical than ever, and the work now includes a lot of programming, for example,” says Valtteri Laine.

“We do all sorts of logic inside the relay, but the programming is much simpler than what coders do. I design some electrical circuit diagrams and make small changes myself. However, the actual designers are a separate profession.”

The commissioning engineer’s work in both maintenance and commissioning requires problem solving, which is good for Laine. Challenges make the work interesting.

“Different customers use relays or protection devices from different manufacturers. So the manuals have been read several times.”

The commissioning engineer’s job also requires an understanding of electrical and occupational safety, since field workis done at substations. Preparatory work or reports can also be written remotely.

IN THE RIGHT INDUSTRY

Valtteri Laine says that he enjoys being a commissioning engineer. In addition to problem solving, he lists constantly learning new things and variety as the best parts of his job. The colleagues are also nice.

“There are like-minded people working in the industry. If necessary, we can help even a competitor,” Laine reveals.

He is also satisfied with the pay. Although the small number of experts keeps the salary high, there is a flip side: because there are not enough experts, the workload may at times become high.

Laine strives to keep his working days to eight hours. However, he is sometimes called out to fix faults.

In the case of a power outage or work necessitated by a power outage, he does not go home until the fault is corrected and the electricity restored.

“There are like-minded people working in the industry. If necessary, we can help a competitor.”

Does it sometimes happen that an electrician accidentally cuts the electricity?

“There are those who have or will accidentally cut off the electricity. You have to remember that people do these jobs. If the electricity is momentarily lost, it will be restored. Often the biggest impact is on the worker’s professional pride.”

When the relay testing equipment has simulated a variety of fault conditions sufficiently, Laine returns the 110 kilovolt network to normal operating conditions and packs his things. It is time to continue testing at the next site. ◆

Secondary systems automatically keep the network online

SECONDARY system maintenance maintains the main grid’s protection, control and automation systems. Ensuring this requires various inspections, updates and maintenance where Fingrid is partnered with Omexom.

In practice, secondary systems are used to remotely monitor and control the main grid. More than 30 people work with secondary systems at Fingrid.

Most troubleshooting is initiated remotely by Fingrid’s secondary system 24/7 standby.

“Approximately one quarter of suspected faults identified require physical checks at the stations. In these cases, we include Omexom in the investigations. However, the majority of the work ordered from suppliers is proactive inspections and small-scale alteration work,” says **Jukka Kotisaari** Manager, Maintenance Management, at Fingrid.

The secondary system maintenance of the main grid is divided into three regions: Northern, Central and Southern Finland.

NEW EXPERTS

Antti Vainionpää from Omexom says that the company has about 30 commissioning engineers. About half of them work for Fingrid.

The commissioning engineers must have a bachelor’s degree or studies in university.

“They require a growing number of skills as the grid is changing towards a cleaner energy system. Traditional testing of protective devices is no longer enough. Commissioning engineers need to understand the overall systems in depth.”

Vainionpää also emphasises designing, automation and protection skills. There is a high market demand for the few experts in the field.

“We built a secondary systems training centre in Vantaa, which was completed in January. Our goal is to attract new people to the industry and train commissioning engineers who also have automation and designing skills. We are talking about multitalented commissioning engineers in secondary systems.”

The Omexom Institute Finland Secondary Systems Training Centre focuses on substations and especially on secondary system protection, automation, secondary design and digital substations.

PRECISE WORK in the heart of the grid

The commissioning of substations and transmission lines involves several important steps to ensure safety and the functioning of the grid. In this process, seamless collaboration between Fingrid's specialists, contractors and the main grid control centre is key.

TEXT ARI RYTSY / PHOTOS VEERA KORHONEN

Commissioning takes place in Fingrid's various projects almost weekly throughout Finland. The work starts already before the actual commissioning date, which means that **Maria Nortema**, Expert, Grid Operation in the Southwest Finland region for Fingrid, has planning meetings with the contractor.

Prior to the commissioning date, it is ensured that the required documentation is in order and the installation has been tested.

"Fingrid is responsible for monitoring the construction of substations and transmission lines, while contractors carry out the actual construction and installation work. Collaboration begins in the early stages of the project and remains close throughout the construction and subsequent commissioning," Nortema says.

A commissioning programme is prepared for each project together with the contractor and reviewed point-by-point on the commissioning date.

The first step is to review the documentation required for commissioning, such as the signed commissioning inspection records, completed installation inspection records, and deficiency lists. A visual inspection is then carried out to ensure, for example, that the additional earthing has not been left connected and that all excess items have been removed from the area.

MAIN GRID CONTROL CENTRE LEADS COMMISSIONING

Once it has been confirmed that everything corresponds to the requirements of the outage order, Fingrid's grid operation specialist grants the main grid centre permission for commissioning.

The operator at the main grid control centre remotely controls the substation's switchgear according to the switching schedule one switch device at a time using the power control system. During switching, the switching supervisor's and the switching operator remain in contact by phone.

"The switching operator is the switching supervisor's eyes and ears at the station. If the power control system receives alarms from the substation during switching, switching is suspended and the situation is resolved before continuing," Nortema says.

The commissioning of a new transmission line or substation affects the entire grid. That is why outage planning is especially important for large projects with multiple commissioning phases.

Planning assesses which work stages require outages and determines the duration of the outage and the impact on customers. A precise schedule of work and outages is prepared well in advance of construction work.

"The need for outages at substations varies depending on whether it is a new 'green field' station or a renovated substation. Transmission outages for new builds are usually simpler and shorter in duration. On the other hand, renovated substations require more bay and transmission line interruptions as the work progresses. They can take several weeks per transmission line," Nortema says.

When a new transmission line or substation is commissioned, it affects the entire grid. "Outage planning is also very important," says Maria Nortema, Expert, Grid Operation at Fingrid.

A new substation or transmission line increases the transmission capacity or reliability in its impact area.

RELIABLE AND SAFE ELECTRICITY

When planning the operation of Fingrid's power system, the commissioning of a new substation or transmission line is prepared by studying the procedures and outages required.

Outages are coordinated at a suitable time together with the grid operation specialist in the area.

In addition, a busbar division is specified for the new substation. Planning of the busbar division is an essential part of commissioning that affects the reliability of the substation. It defines how loads are distributed between busbars and reduces the impact of a fault on the grid.

"A substation's core usually has one or more busbars through which the power transmitted by transformers and transmission lines is transmitted to customers or the next substation. A well-planned busbar division is a prerequisite for maintaining sufficient reliability in the grid and delivering electrical energy to customers safely and reliably," explains **Joni Järvinen**, Specialist, Transmission Management, at Fingrid.

"A well-planned busbar division is a prerequisite for maintaining sufficient reliability in the grid."

Joni Järvinen
Transmission management specialist
Fingrid

A new substation or transmission line typically increases the transmission capacity or reliability in its impact area.

Operational planning ensures that the new section of the grid has been through calculation models and provides the intended benefits, either in the form of higher transmission capacity or better reliability. ◆

TEXT PÄIVI BRINK / PHOTO ELERING

Small and open to changes

Changing from one synchronous area to another was the project of the century for Elering, Estonia's TSO. The regional cooperation is seen as one of the most important aspects of power system operation.

Elering's main responsibility is ensuring the reliable operation, development, and management of Estonia's electricity and gas transmission systems. We manage and maintain the high-voltage electricity grid to ensure an uninterrupted supply of electricity," says **Märt Allika**, Elering's Head of Energy System Control Centre.

As a TSO, Elering ensures system stability and security. They also support the development of energy markets by providing services like data exchange, enabling market participants to trade electricity and gas efficiently.

Estonia's population is 1.4 million and their all-time peak electricity consumption is 1,600 MW.

Baltic power systems have historically been part of a Russian-controlled synchronous area.

To mitigate the risk to the Baltic States' energy security, the project was initiated to synchronize the Baltic power systems with the Continental-European power system and to build or renovate infrastructure, such as transmission lines. The changing from one synchronous area to another was done the second weekend in February this year.

DIRECT POWER SYSTEM CONNECTIONS WITH FINLAND AND LATVIA

The Estonian electrical system and gas grid is interconnected with European systems. The regional cooperation is seen as one of the most important aspects of power system operation.

Estonia has direct electricity connections with Finland and Latvia. Two EstLink links connect the Baltic electricity system with the Nordic electricity market.

"The EstLink connections have been an example of outstanding regional cooperation. The recent problems with cables may influence the electricity prices in Estonia and other Baltic countries for some months, but we will have enough electricity," Märt Allika states.

TOWARDS 100% RENEWABLE ENERGY CONSUMPTION

Elering invests in expanding and modernising the electricity and gas transmission networks to meet future energy needs.

"In Estonia, there are already 1,100 MW of solar parks and 700 MW of wind parks, and the grid is equipped with its first batteries. In addition, there are around 1,350–1,400 MW of reliable conventional generation."

There are some limitations to the building of wind parks, due to the disturbances they cause to the radar systems of the Estonian Defence Forces. The Estonian state is taking measures to mitigate this challenge.

The shift to green energy means that Elering needs to strengthen the grid. ◆

Read the whole article: fingridlehti.fi

Links between Finland and Estonia

THERE are two undersea high-voltage direct current (HVDC) links between Finland and Estonia and a third will be constructed in the near future.

EstLink 1: The 350-megawatt EstLink 1 transmission cable between Estonia and Finland, which runs under the Gulf of Finland, started operating in December 2006.

EstLink 2: EstLink 2, from Püssi in Estonia to Porvoo in Finland, was completed in 2013. The submarine cable has a capacity of 650 megawatts and is 145 kilometres long.

EstLink 3: Elering and Fingrid are planning a third submarine cable connection. The capacity of the connection is estimated to be between 700 and 1,000 megawatts and it is expected to be completed by 2035.

Welcome to the reserve market!

A CONSTANT BALANCE is required between production and consumption in the power system. Imbalances are corrected in real time using power system reserves, and more and more reserves are needed.

Offer flexible power production, consumption or grid energy storage to the reserve market. You will contribute to balancing the Finnish power system and gain new earning opportunities.

Fingrid will be happy to provide further information fingrid.fi/reservimarkkinat

Calculate how much you could earn in the reserve market fingrid.fi/reservituottolaskuri *(in Finnish)*

System developer! This spring, we will open a support site that will guide your company into the reserve market. Save the address: developers.fingrid.fi

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