3 2023

FINGRID

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

KIMMO MÄÄTTÄ, OULUN ENERGIA SÄHKÖVERKKO AND PASI MANTILA, FINGRID:

"Transmission outages require close cooperation and careful planning."

Main grid planning is our core business

Hydrogen points the way towards the energy market of the future

The technical system requirements for power plants and the network code for grid energy storage will be updated in 2024. "The update will take better account of the technical requirements arising from the growing share of wind power, solar power and grid energy storage," say Expert Lasse Linnamaa (left) and Specialist Teemu Rissanen from Fingrid.

Connecting to the main grid step by step

When a new power plant connects to the main grid, it goes through several steps in the connection process, guided by Fingrid's Grid Code Specifications for Power Generating Facilities.

In the first phase, the connecting party planning the construction of a power plant, such as a wind power plant, must provide Fingrid with various calculations and technical documentation to prove that the plant meets the technical requirements.

This phase also includes very important simulation models describing the plant's operation in the event of a change or disturbance in the grid. These models are used to plan the operation of the power system and forthcoming changes.

When the first phase is approved, the power plant is authorised to supply energy to the grid. For example, wind turbines can be commissioned one at a time and connected to production. Official tests are conducted on the completed power plant to demonstrate that the plant meets the key technical system requirements.

Today, commissioning tests are often monitored on Teams: the turbine supplier can operate the plant, the measurement engineer monitors the measurement devices via a remote connection, and Fingrid's specialists monitor the tests from their offices. Conversely, synchronous machine power plants – i.e. conventional power plants – are often tested on-site and controlled from the plant's main control room with Fingrid's specialists in attendance.

When the tests are complete, the connecting party prepares a report and submits it to Fingrid, along with the final simulation models validated by the tests. Fingrid checks the documentation and models and integrates them into Fingrid's wide-area grid models. If the results are acceptable, Fingrid grants the power plant permission to operate. The plant may then supply energy to the grid until further notice. If any changes are made to the plant, they must be approved by Fingrid again.

A similar connection process is used when power plants connect to a distribution system operator's network, with one exception: as the network operator at the connecting point, the distribution system operator is also responsible for monitoring compliance with the technical system requirements. Fingrid supports the distribution system operator in work such as modelling and the technical interpretation of the requirements. ◆

IN SEPTEMBER 2023, CONNECTION ENQUIRIES WERE SUBMITTED FOR A TOTAL OF 335 GW OF PRODUCTION:

165 GW
of onshore wind power

89 GW
of offshore wind power

79 GW
of solar power

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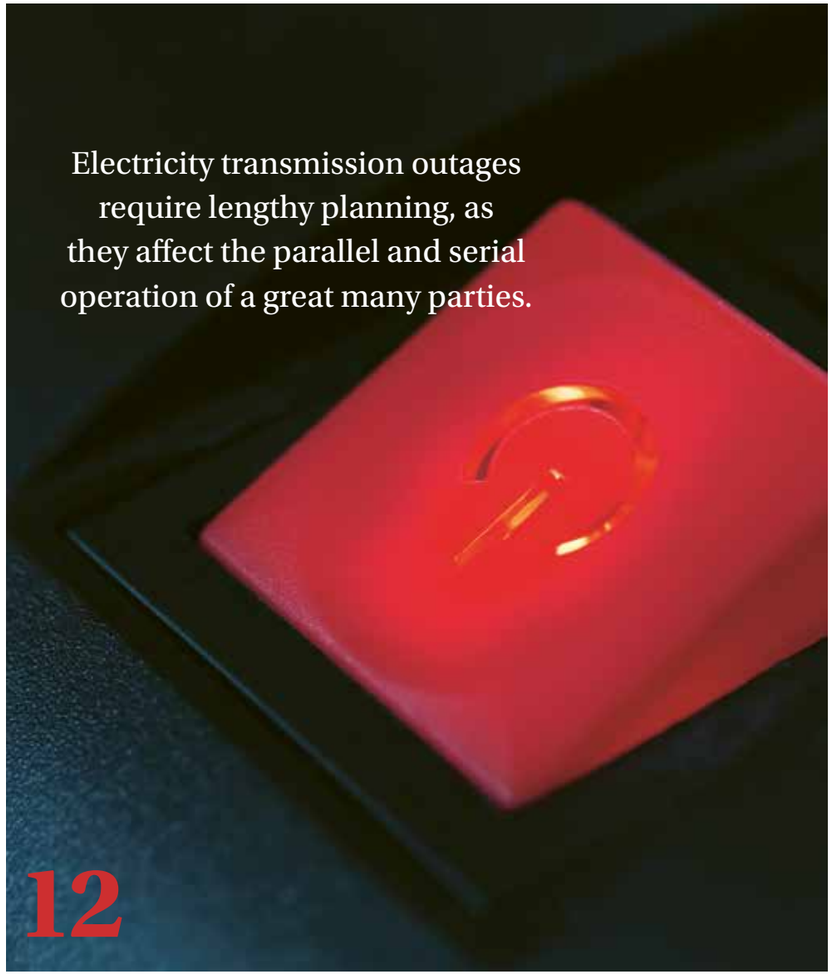
RENEWING
THE ENERGY SYSTEM



REGULAR SECTIONS

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Clean electricity is the cornerstone of Finland's competitiveness

ACCORDING TO statistics from the Confederation of Finnish Industries, the value of green investments planned in Finland has already risen to EUR 200 billion. Clean electricity is becoming a key competitiveness factor and source of wellbeing for Finland.

The energy revolution is triggering a redistribution of industry and industrial jobs. However, there is worrying news from around the world about increasingly generous financial support mechanisms offered by various states in an effort to attract industrial investments and preserve existing structures. It is hard to see how Finland can compete with business subsidies. Competitive advantage must be sourced from elsewhere than the public purse.

Main grid planning and construction is long-term work. Transmission line implementation projects, including permit applications, take a long time, and the completed lines remain in service for about one human lifetime. Rapid changes in the operating environment and the explosive growth in the demand outlook for clean electricity are challenges for main grid planning.

The total volume of main grid connection enquiries has already exceeded 300 gigawatts, and the growth shows no signs of slowing. Over the last three years, Fingrid has substantially accelerated its investment programme for the next ten-year period. More work is going on to strengthen the main grid than ever before.

Visions and scenarios for electricity production and consumption trends are essential tools for main grid planning. It is wise to prepare for various possible future outlooks.

In recent years, Fingrid has opened up its main grid planning to customers and stakeholders. We have published our visions and forecasts of trends and gathered feedback on them. The feedback we have received for this work has been great, and we are thankful for it. Open, inclusive grid planning will continue.

As Finland competes for investments in clean industries, the availability of affordable clean electricity is the cornerstone of the country's competitiveness.

A robust and reliable main grid creates opportunities to connect new electricity production facilities and green industries. Reliable electricity networks and good connection opportunities are among the most important national competitiveness factors for industrial projects needing clean energy.

Even the most generous subsidy policy will be unable to help if new production facilities and industries cannot connect to the grid. Finland should foster competitive onshore wind power and ensure its capacity to build out the main grid.

Mikko Heikkilä
Manager,
Strategic Grid Planning
Fingrid

FINGRID

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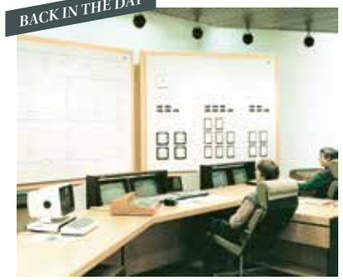
Fingrid to increase its use of green financing

Fingrid has established a green financing framework and a green euro-denominated commercial paper programme.

Fingrid uses green financing to develop and expand the main electricity grid, thereby enabling the transition to a clean electricity system. The new green financing framework integrates Fingrid's sustainable strategy, which will enable Finland to reach its climate goals, more closely into the company's financing.

In 2017, Fingrid became the first Finnish company to issue green bonds. Since then, it has used green financing to fund its investment projects. In the future, green financing will cover all the company's debt financing needs. ◆

BACK IN THE DAY



Grid control centres

WORKERS in grid control centres used to move around much more on the job. Control panels were located in different parts of the control centre – sometimes it was necessary to make connections in the outdoor switching field, sometimes in indoor switchgear, and other times workers went to empty the rain gauge. In the past, line switching was handled by dispatching switching technicians to substations. Nowadays, almost everything can be done via remote control. In days gone by, one of the jobs of the Imatra control centre was to put on a 30-minute whitewater show every Sunday; the Vuoksi River was allowed to run through the reservoir dam to the delight of tourists.

PROFILE

Accelerating pace in the reserve market

Expert Jukka Kakkonen hopes representatives of different technologies will participate in the reserve market.

TEXT MINNA SAANO / PHOTO TERO IKÄHEIMONEN

I work as Customer Manager of Reserve Market Services in the Reserve Marketplaces unit. We set out to expand our work with customers on reserves last winter when we established our four-person reserve customer team.

My job is to serve various companies and identify ways they can participate in the reserve market and support the power system.

The transformation of the power system is increasing the pressure to bring active new electricity market parties to the market to ensure the system works cost-effectively. At the moment, it is important to attract more reserve units of different types, as well as renewable production, which is highly suited to the market. The units could be flexible production or consumption on a megawatt-scale, such as wind power, batteries, hydroelectric power, nuclear power and industry.

My work is rewarding when I can interest companies in joining the reserve market and they begin working towards it. It is nice to find such a win-win opportunity: market parties gain additional income, and Fingrid has more supply on the market.

The reserve market has been more hectic than it was a year ago, costs have fluctuated and are now higher than we are used to. Luckily, companies have become more active – the more parties we have in the market, the more correct the market price is." ◆

WHO?
Jukka Kakkonen

WORK
Expert

FAMILY
spouse and kindergarten-aged twins

FREE TIME
road and gravel cycling, outdoor pursuits

Open data updated

Fingrid's Open Data service, which offers datasets on the power system of Finland and the electricity market, is being revamped. A beta version of the service was released in the summer, offering data such as production and consumption forecasts in 15-minute periods rather than the previous one-hour intervals.

The new Open Data service will offer new datasets and the following additional features:

- Versatile search functionality and examples for searching
- Easy data downloads and the ability to download datasets covering long periods in a single search
- Data catalogue downloads from the user interface and the API
- Better administration of API keys for users of the API

The current Open Data service will continue to operate alongside the beta version until the end of the year, and the old datasets will be transferred to the new service in phases. ◆

Find out more:
beta-data.fingrid.fi/en

Send your feedback:
avoindata@fingrid.fi

Asta Sihvonen-Punkka to become Fingrid's President & CEO when Jukka Ruusunen retires

ASTA SIHVONEN-PUNKKA has been appointed as Fingrid's President & CEO from 1 January 2024. She is currently Fingrid's Deputy CEO and will take up the position when **Jukka Ruusunen**, the current President & CEO, retires at the end of the year.

Asta Sihvonen-Punkka, Lic.Sc. (Econ.), M.Sc. (Forestry), previously served as Director General of the Finnish Communications Regulatory Authority and Director General of the Energy Market Authority. She says she intends to continue on the path paved by Jukka Ruusunen, building Fingrid, the power system and the electricity market purposefully to meet the needs of customers and society.

"We aim to continue as the transmission system operator that provides the best service to its customers while promoting Finland's overall competitiveness. I am delighted to take on this responsibility. The energy sector is instrumental in combating climate change. The transition towards clean energy production creates opportunities to increase investment in Finland, thereby boosting employment and securing people's livelihoods and wellbeing," says Asta Sihvonen-Punkka.

PRACTICAL QUESTION

Why is a stable frequency important for the power system?

The frequency is an indicator of the balance between electricity consumption and production. The frequency is kept stable using reserves such as power plants, demand facilities and energy storages that can adjust their power exchange with the grid. However, the reserve units we currently have will not be enough in the future, says Mikko Kuivaniemi, Head of Power System Reserves, at Fingrid.

TEXT MARJO TIIRIKKA / PHOTO TERO IKÄHEIMONEN

1 What happens if the power system's frequency is not stable?

The devices connected to the power system are designed for a specific frequency and can only withstand certain frequency deviations. If the frequency deviates too much, power plants in particular must be disconnected from the power system to prevent them from being damaged.

A domino effect would occur if the frequency deviations were large enough to disconnect power plants from the grid. In the worst case, it would take down the entire system.

2 What causes the power system's frequency to fluctuate?

Fluctuations are caused by normal variations in electricity consumption and generation that cannot be predicted and balanced in advance. Consumption always fluctuates somewhat, and reserves balance out these variations. In the future, electricity will be increasingly produced using weather-dependent solar and wind power, and the weather cannot be accurately forecast. This causes also normal fluctuations in the power balance.

Faults cause the largest frequency deviations. For example, the sudden failure of an interconnector or a major power plant could cause significant frequency deviations.

Consumption always fluctuates somewhat, and reserves balance out these variations.

3 Why is the need for reserves constantly increasing, and what are the consequences?

More and more reserves are needed due to the energy transition. Production is increasingly variable, more large demand facilities are arising, transmission connections are growing, and some production units with reserve providing capabilities have left the market. Imbalances between electricity production and consumption are more likely to arise, and reserves are needed to balance them out.

We need anyone who is capable to join the reserve market.

Currently, there are occasional shortages of reserves. The situation will only become more challenging in the future. We need more reserves to respond to the needs of an evolving power system.

We need anyone who is capable to join the reserve market: more wind and solar power and new demand facilities, such as electrolysers and electric boilers. We also need more energy storages.

No individual technology will solve the problem – all units that can adjust their power exchange with the grid should contribute to balancing the power system. ◆

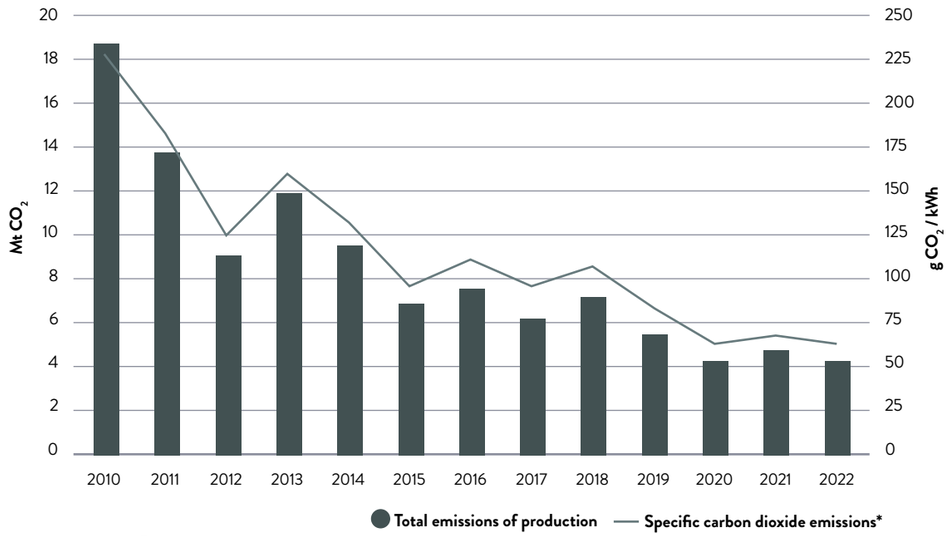
The state of the power system can be tracked online: fingrid.fi/en/power_system_state

ELECTRICITY PRODUCTION BECOMING CLEANER

The transition to renewable energy sources is reflected in cleaner electricity production. Thanks to increasing production, Finland has the means to achieve annual self-sufficiency in electricity production this year and become a net exporter of electricity in the future.

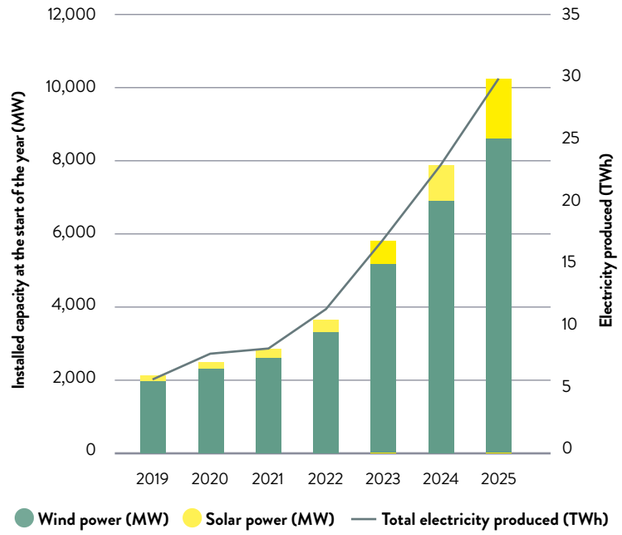
TEXT VALTTERI SALVI / INFOGRAPHIC LAURA YLIKAHRI

Carbon dioxide emissions from electricity production

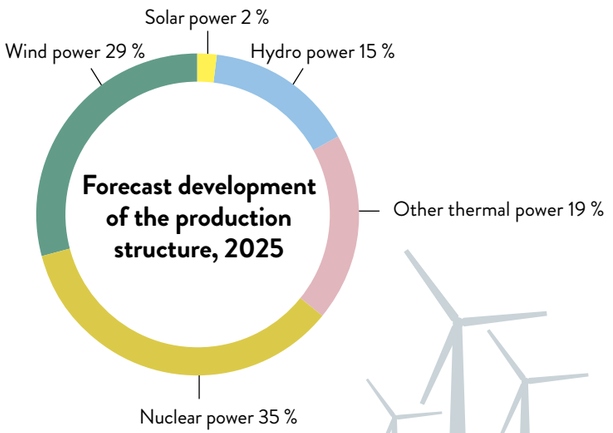


* Carbon dioxide emissions per unit of electrical energy produced. The figure indicates the average amount of carbon dioxide emitted per kilowatt-hour produced in Finland.

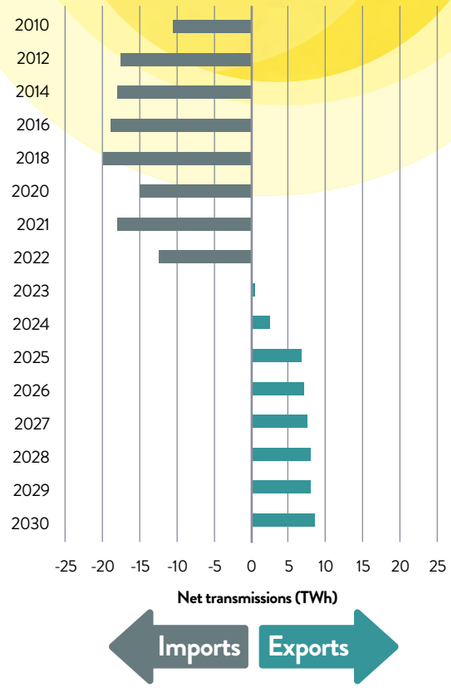
Forecast development of wind and solar power

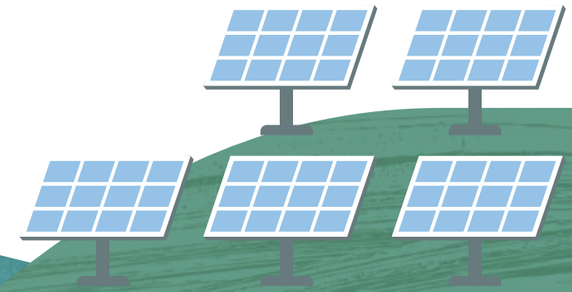


Forecast development of the production structure, 2025



Forecast trend in the power balance





Annual emissions decreased by **14,6 Mt CO_2** from 2010 to 2022. This corresponds to almost **119,000,000,000 km** driven with a new petrol car*.

* Emissions: 123 g CO_2/km

“Transmission outages require careful planning and close cooperation,” say Pasi Mantila from Fingrid (left) and Kimmo Määttä from Oulun Energia Sähköverkko.

THE ELECTRICITY GRID REMAINS STABLE DURING TRANSMISSION OUTAGES

Electricity transmission must be suspended or restricted when parts of the main grid and grid connections are built and renovated. Fingrid plans outages with its customers well in advance. Customers should keep their contact details up to date in the My Fingrid service to ensure effective communication of transmission outages.

TEXT SUSANNA CYGNEL / PHOTOS JUUSO HAARALA

“The transmission outages in Leväsuo in Oulu were a major effort for all the parties involved, but consumers did not notice a thing.”

Kimmo Määttä
Supervisor of the Operation and Maintenance Team
Oulun Energia Sähköverkko Oy

This year has seen a record number of transmission outages in the main grid. Most of the interruptions are related to the investments required to support renewable energy: more and more transmission line connections and substations are needed as the number of wind turbines increases dramatically.

All electricity transmission outages require lengthy planning, as they affect the parallel and serial operations of a great many parties. For example, there was an outage lasting more than three weeks on the west coast last summer to allow several working groups to work safely on transmission lines and substations.

“All the work was completed according to the planned schedule and order of work. The transmission outage time announced beforehand was only exceeded by two hours, which is an excellent performance,” says **Pasi Mantila**, Expert at Fingrid.

The Leväsuo substation project and associated transmission line arrangements in Oulu this summer required electricity transmission outages due to the enormous number of customers’ regional network lines and industry connection lines connecting to the substation.

“The Leväsuo transmission outages were a major effort for all the parties involved, but consumers did not notice a thing – they all received electricity as normal. The work was planned in detail well in advance, and Fingrid kept us up to date,” says **Kimmo Määttä**, Supervisor of the Operation and Maintenance Team at Oulun Energia Sähköverkko Oy.

Pasi Mantila emphasises that the major projects would not have been completed on schedule without good foresight, planning, communication and cooperation.

“I would like to thank Fingrid’s customers, contractors and maintenance personnel for their contribution to ensuring that this year’s outages were carried out safely and without compromising system security,” Mantila says.

CONGESTION MANAGEMENT MAINTAINS SYSTEM SECURITY

There may be several transmission outages in the main grid simultaneously, especially in the summer, but efforts are made to schedule and arrange them so they do not jeopardise the system security of the main grid or restrict the transmission capacity. Restrictions to the transmission capacity could limit the effective functioning of the market and raise the market price of electricity.

“The process of planning transmission outages begins several years in advance to ensure it is even possible to implement the outages at the intended time,” says **Mikko Piironen**, Unit Manager at Fingrid.

Under certain circumstances, the electricity transmission capacity may be insufficient during an outage. In this case, Fingrid resorts to congestion management to ensure that the maximum volume of electricity transmitted in the main grid complies with the system security limits: the main grid must retain its ability to withstand the failure of an individual line or production plant.

One frequently used congestion management method is to limit Finland’s cross-border transmission capacity. In practice, this means that only a certain volume of electricity may be imported to or exported from Finland.

Occasionally, one solution is to limit the output of electricity production plants regionally. In other words, electricity producers are told the maximum power they can produce in a certain time window.

“Limiting electricity production or the transmission capacity of cross-border connections is essential to safeguard the main grid’s system security during outages,” Piironen says.

INFORMATION EXCHANGE AND CLOSE CONTACT

During transmission outages, electricity producers and distribution system operators are responsible for implementing production restrictions according to Fingrid’s instructions.

In the Oulu region, Caverion's control centre monitors wind power, among other things, and sets the wheels in motion when Fingrid announces the exact timing of a planned outage.

"We send instructions to every power plant individually and set restrictions. We keep everyone up to date at our end of the line," says **Janne Kiiskilä**, Control Centre Manager at Caverion Industria.

During an outage, the parties exchanged information about the network's status. Kiiskilä says that working with Fingrid has been a smooth experience.

"We share metering data freely and tell them if we notice even a small deviation in the network. And if Fingrid detects a disturbance in the grid, they ask us for data about it, for example," Kiiskilä says.

Transmission outages in a small section of the electricity network are everyday occurrences at the control centre. However, last year's extensive outages affected a larger part of the grid and lasted several weeks. They required thorough planning and will also guide the development of systems and operating models in the future.

"We have gained valuable experience and the opportunity to examine our internal process and refine how we work with Fingrid," Kiiskilä mentions.

KEEPING CONTACT DETAILS UP TO DATE IN MY FINGRID

Transmission outages are planned well in advance and implemented according to Fingrid's annual schedule to ensure a high level of system security in the grid and minimise inconvenience to all parties.

According to the annual schedule, Fingrid sends an enquiry to producers and distribution system operators about the need for transmission outages, so their contact details must be up to date in the My Fingrid service. Sometimes, the customer's designated responsible persons change suddenly, and Fingrid needs the latest contact details.

"Every party should have a contact person for operations in the My Fingrid service and provide details about the control centre that provides operational services so we can contact them if necessary and be sure our information reaches them. The party can then send the information onward to the right people," Pasi Mantila advises.

He advises customers to provide one email address on the service so that Fingrid can send information about transmission outages and restrictions.

Customers can enter their contact details and outage needs into My Fingrid. Fingrid compiles its outage needs and those of its customers by January.

"When we know all the outage needs, we notify all the parties. If necessary, we hold outage meetings to review the arrangements in more detail," Mantila says.

Kimmo Määttä from Oulun Energia Sähköverkko says that meetings were held back in summer 2022 to plan the transmission outages in April 2023. In other words, planning began well in advance.

"Maintaining system security is important to us, so the various options are discussed openly. This is how we identified the best solutions for everyone and could synchronise our schedules with Fingrid," Määttä says.

He encourages every operator to enter their outage requirements in the My Fingrid service in good time so that the outages can be planned – if these things are rushed, it could jeopardise system security and, above all, occupational safety.

"On occasion, we have been asked the previous evening if we could cut off the power to a site for the duration of their work," Määttä says. He adds:

"Work needs to be forecast about one year ahead and communicated to Fingrid. A systematic approach also helps those who are doing the work." ◆

"During a transmission outage, we freely exchange information about the state of the network with Fingrid," says Janne Kiiskilä, Control Centre Manager at Caverion Industria.

Transmission outage schedule on Fingrid's website: fingrid.fi/en/operation_disturbances

Annual transmission outage schedule

- **IN NOVEMBER,** Fingrid emails a transmission outage enquiry to all its connecting customers, asking them to respond via My Fingrid by the end of November.
- **BY JANUARY,** Fingrid coordinates the transmission outages it needs with those reported by customers. Fingrid notifies customers of all the known transmission outages required and their timetables by the end of January.
- **AFTER JANUARY,** the final outage times are agreed upon with customers by email, phone and, in the case of larger outages, at separate outage meetings and customer meetings.
- **NO LATER THAN 21 DAYS BEFORE** the start of the outage, an outage plan is drawn up to finalise the timing, switching of electrical installations, and work taking place during the interruption. System security calculations are also made at this point.
- **NO LATER THAN 9 DAYS BEFORE** the start of the outage, a switching plan is prepared, after which a switching schedule is also prepared for each electrical installation.
- **APPROXIMATELY 7 DAYS BEFORE** the start of switching, Fingrid's outage order is sent to the control centres and operational contact persons providing the outage service. The customer always prepares the switching plans and schedules related to its own electrical installations.

WORLD-CLASS MAINTENANCE

The International Transmission Operations and Maintenance Study (ITOMS) evaluates the effectiveness of maintenance among electricity transmission companies every two years. The study again ranked Fingrid among the top performers in terms of maintenance.

TEXT JAANA KALLIOKOSKI / PHOTO SHUTTERSTOCK

Fingrid's core duty is to ensure the functioning of critical infrastructure and prevent disruptions in Finland's electricity supply.

Fingrid focuses on its core competences, while service providers work on transmission line and substation maintenance.

One of Fingrid's service providers is Omexom, a subsidiary of the international VINCI Energies group. Omexom handles the maintenance and construction of Fingrid's substations.

"Our partnership covers substation equipment maintenance, inspections, local switching, minor maintenance work on substation properties, and fault repairs," says **Marko Nauska**, Project Manager at Omexom. Nauska is responsible for the substation equipment maintenance and programme.

Fingrid's next contractual period for basic maintenance will begin at the start of 2024. More information is available to support traditional servicing activities, inspections, maintenance work and fault management.

"When digital condition monitoring is deployed, we will have real-time information on the condition of substation components, so actions can be scheduled for the right times," says **Mikko Jalonen**, Transmission Line Maintenance Manager at Fingrid.

DATA TRANSFERRED WITHOUT DELAYS

According to Jalonen, the work of electricians has evolved over the years.

"They now need to master an increasing number of digital tools, as well as traditional maintenance and repair work."

Nauska also says the partnership with Fingrid has taken some major steps forward in recent years. He says that the most significant development is the Maximo asset management system, which replaced the Elnet network information system.

Previously, the instructions needed to be printed on paper or the computer booted up to find them. Now, the information is shown on the phone's screen.

"The Maximo system enabled the development of an app that all our electricians have on their phones. It shows work instructions and allows electricians to check off completed tasks from their to-do lists. Fingrid receives a report on the work straight away," Nauska says.

Fingrid's maintenance management is based on detailed information in databases about assets. In combination with Fingrid's agile approach, this lays a strong foundation for rapidly developing and adapting systems and operating practices.

"We gain ideas for new experiments and developments from our service providers and by keeping our eyes and ears open to what other network operators around the world are doing and developing," Jalonen says.

Marko Nauska and his team have also been involved in Fingrid's development work.

"Maximo can generate many different reports, such as the success of suppliers in their tasks. Development and feedback go both ways," Nauska says.

In his view, the future is difficult to foresee, but one thing is certain: digital tools will only become more prevalent.

The newest substations already use digital condition monitoring.

"The newest substations already use digital condition monitoring. This provides data and user experiences on where the maintenance team should focus its resources and which things require less attention," Nauska says.

MAIN GRID MAINTENANCE AMONG THE MOST EFFICIENT IN THE WORLD

Since 1995, Fingrid has taken part in the International Transmission Operations and Maintenance Study (ITOMS) to promote good practices. The ITOMS evaluates the effectiveness of maintenance among electricity transmission companies every two years.

Fingrid again ranked among the top companies in the latest survey. The study examined the maintenance activities of 25 network operators in various parts of the world in 2021.

Jalonen says that participating in the study contributes to maintaining the efficiency of the transmission system operator and improving its operations. It also provides an opportunity to compare operations with similar operators outside Finland, as there are no reference companies in Finland.

"ITOMS is a highly diverse forum for exchanging information. We learn about good operating practices and innovations that we can try and adapt to our activities. We are also happy to share our good practices with others. We are regularly invited to talk about condition management in our network." ◆

MAIN GRID PLANNING **IS OUR CORE BUSINESS**

Fingrid conducts and updates numerous studies, analyses and visions to ensure that the power system of Finland remains capable of serving a society increasingly reliant on electricity. This work is main grid planning – Fingrid's core business.

TEXT VESA VILLE MATTILA / PHOTO SHUTTERSTOCK

Grid planning is how Fingrid prepares for a future in which a significant increase in electricity production and consumption will be required to reach climate targets.

"Preparing for growth also means enabling it. Finland would not attract large industrial investments based on clean electricity if our power grid could not cater for them," explains **Mikko Heikkilä**, Manager of the Strategic Grid Planning Unit at Fingrid.

If all the investment plans Fingrid has tentatively discussed with its customers were to come to fruition, electricity consumption in Fingrid would more than double. This would be highly challenging for grid planners, requiring them to prepare plans, make choices and manage uncertainties.

A THREE-PRONGED ATTACK

Fingrid's planning focuses on three key areas: the electricity system vision, the electricity usage and consumption forecast, and the main grid development plan.

Fingrid invests EUR 300–400 million in the main grid annually.

The electricity system vision examines development scenarios for the coming decades, focusing on the big picture.

"Fingrid's forecast of electricity use and consumption, updated twice a year, frames the next decade's trends in more tangible terms," Heikkilä says.

"These two information sources and our discussions with customers planning new connections help us prepare the main grid development plan. In practice, this represents our investment programme for the next ten years."

SEEKING SOLUTIONS TOGETHER

Elenia, a network service company, serves 438,000 customers in more than 100 municipalities in Kanta-Häme, Päijät-Häme, Pirkanmaa, Central Finland, South Ostrobothnia and North Ostrobothnia.

"We have a lot of plans, designs and projects for connections to our network and the main grid, especially due to the increase in renewable energy production. We work with Fingrid on these almost weekly," says **Jorma Myllymäki**, Elenia's Executive Vice President responsible for the networks business.

"The key is to reconcile and schedule the plans of both parties so that neither has any nasty surprises."

According to Myllymäki, Elenia also needs Fingrid's insight into nationwide trends. After all, Fingrid and Elenia share a common goal: making Finland a leader in clean energy.

Based on the planning work, Fingrid invests EUR 300–400 million in the main grid annually. The investment programme for the next ten years stretches to about EUR 4 billion.

INCREASINGLY OPEN PLANNING

More and more information and collaboration is required as the basis for grid planning. Accordingly, Fingrid has made its planning work more open.

"We often publish our plans during the preparatory phase and ask customers and partners to comment on them," Heikkilä says.

"Their feedback has prompted us to increase the amount of offshore wind power in our long-term scenarios and begin preparing for offshore wind power investments, for example."

Heikkilä says that open grid planning provides customers with insight into the development of the power system overall, as well as regional grid planning:

"Customers can influence both of these." ◆

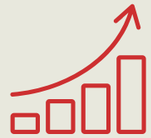
Fingrid's grid planning

ELECTRICITY SYSTEM VISION
Presents the opportunities provided by electrification in Finland, the development required in the main grid, and the solutions for such development in the coming decades via four scenarios. Prepared every two to four years.

MAIN GRID DEVELOPMENT PLAN
A plan required by law, presenting the development required in the main grid and the planned investments for the next ten years. Updated every two years.

FINGRID'S FORECAST OF ELECTRICITY PRODUCTION AND CONSUMPTION
Used for purposes such as estimating the grid development required in the near future. Updated twice a year.

HYDROGEN ECONOMY PROJECT
A joint project involving Fingrid and Gasgrid Finland to study the opportunities presented by electricity and hydrogen transmission infrastructure and the impacts on the energy system. The project will be completed in autumn 2023.



TEN-YEAR NETWORK DEVELOPMENT PLAN (TYNDP)
A joint long-term power grid plan made by the European grid organisations. Prepared every two years.

OFFSHORE DEVELOPMENT NETWORK PLANS
An international marine grid plan currently being prepared for the Baltic Sea region. Due for completion early next year.

SPARRING AND DIALOGUE

The electricity system vision and main grid development plan are key tools for the Council of the Oulu Region, which uses these documents and map services to prepare its regional plans.

"This usage also calls for two-way dialogue and cooperation, both of which have increased in recent years," says **Erika Kylmänen**, the Council's Environmental Manager.

"We inform Fingrid of the developments required in the main grid in our region and the local trends and preconditions for wind and solar power and the hydrogen economy."

Kylmänen says that the main grid development plan circulated for official comments already includes lots of information from them.

"Fingrid's visions and plans are admirably analytical. This is a strong foundation for us to build on together."

HYDROGEN
PAVES THE WAY TOWARDS THE FUTURE ENERGY MARKET

TEXT ARI RYTSY / PHOTOS SHUTTERSTOCK, GREEN NORTH ENERGY OY AND TERO IKÄHEIMONEN

The hydrogen economy represents a great opportunity for Finland, driven by clean electricity production, the rapid growth of wind power, and a reliable main grid. The green hydrogen market will also require a new hydrogen transmission grid.

In 2020, Neste announced its decision to stop refining oil in Naantali. This put the wheels in motion at consulting and engineering company Elomatic, which is now planning a new use for the plant site.

The original plan drawn up by Green North Energy, a project development company established by Elomatic, was for a EUR 15 million hydrogen investment.

The Naantali hydrogen plant, now undergoing an environmental impact assessment (EIA), has had its production capacity and value increased twice already. According to **Jussi Ylinen**, Green North Energy's CEO, the company currently has designs for 280 megawatts of electrolyser power and an investment of approximately EUR 600 million.

"After the trial runs are completed, we aim to begin production in 2027 at 50 per cent capacity. This will be increased once Fingrid has completed the planned transmission line reinforcements in the Raisio region," Ylinen comments.

FOR THE INDUSTRIAL AND MARINE FUEL MARKETS

Green North Energy's hydrogen plant in Naantali is a scalable plant concept that can be replicated to produce green hydrogen and ammonia using renewable electricity.

Green ammonia will replace fossil-based ammonia, a critical chemical in industry and agriculture, which is essential for the security of supply. Green ammonia will also become an emission-free alternative to marine fuel.

Naantali is an excellent base for a hydrogen plant because the product can be transported from the Port of Naantali by sea. The availability of electricity is another crucial factor for production.

"It has been said that our hydrogen plant is similar in scale to the city of Tampere. This gives you a pretty good idea of how much electricity we will need in the future. Finland's strong main grid and Fingrid's measures to provide the electricity

"A strong main grid and Fingrid's measures to safeguard electricity transmission are important for our business," says Jussi Ylinen, CEO of Green North Energy.

It is promising to see several hydrogen projects advance to the environmental impact assessment stage this year.

transmission capacity are important business enablers for us," says Ylinen.

THE HYDROGEN BOOM WILL INCREASE THE NEED FOR ELECTRICITY TRANSMISSION

Green North Energy is a part of the Finnish hydrogen journey, familiar to **Jussi Närhi**, Specialist in Strategic Grid Planning at Fingrid. The growing demand for clean hydrogen in Finland and in global markets is increasing the need for electricity. This is reflected in the number of new connection enquiries received by Fingrid.

"Hydrogen could be produced close to wind power plants and transmitted to industries in a hydrogen pipeline," says Jussi Närhi, Specialist in Strategic Grid Planning at Fingrid.

"Renewable electricity production development is looking quite good. Now, we are awaiting more decisions on industrial consumption investments so that everything can proceed at the same pace. It is promising to see that many hydrogen projects have advanced to the environmental impact assessment stage this year," Närhi says.

Fingrid will continue to develop the main grid systematically over the next decade by investing approximately EUR 4 billion in total.

Despite these major investments, Närhi says that if the hydrogen economy grows in line with the most optimistic forecasts, the main grid will eventually be pushed to its limits. One way to support the growth of hydrogen economy is to build a hydrogen infrastructure.

"Wind power production is increasingly centralised in Northern and Central Finland, while many hydrogen plants are planned for Southern Finland. This means that green electricity must be transmitted long distances from north to south. One option is to produce hydrogen by electrolysis close to wind power plants and transmit the hydrogen gas to industries using a hydrogen pipeline," Närhi says.

FINLAND INVOLVED IN THREE HYDROGEN PIPELINE PROJECTS

Hydrogen transmission infrastructure would revolutionise energy transmission capacity, especially along the north–south axis, as a large hydrogen pipeline could have a transmission capacity of up to 13 gigawatts.

Hydrogen transmission infrastructure would enable hydrogen to be stored in the hydrogen pipeline, which in turn could offer flexibility in the electricity and energy markets.

Sara Kärki, Senior Vice President, responsible for hydrogen development at Gasgrid Finland, the state-owned gas transmission system operator

"A national and cross-border hydrogen transmission infrastructure would open the door to competition and market development."

Sara Kärki
Senior Vice President, Hydrogen Development
Gasgrid Finland

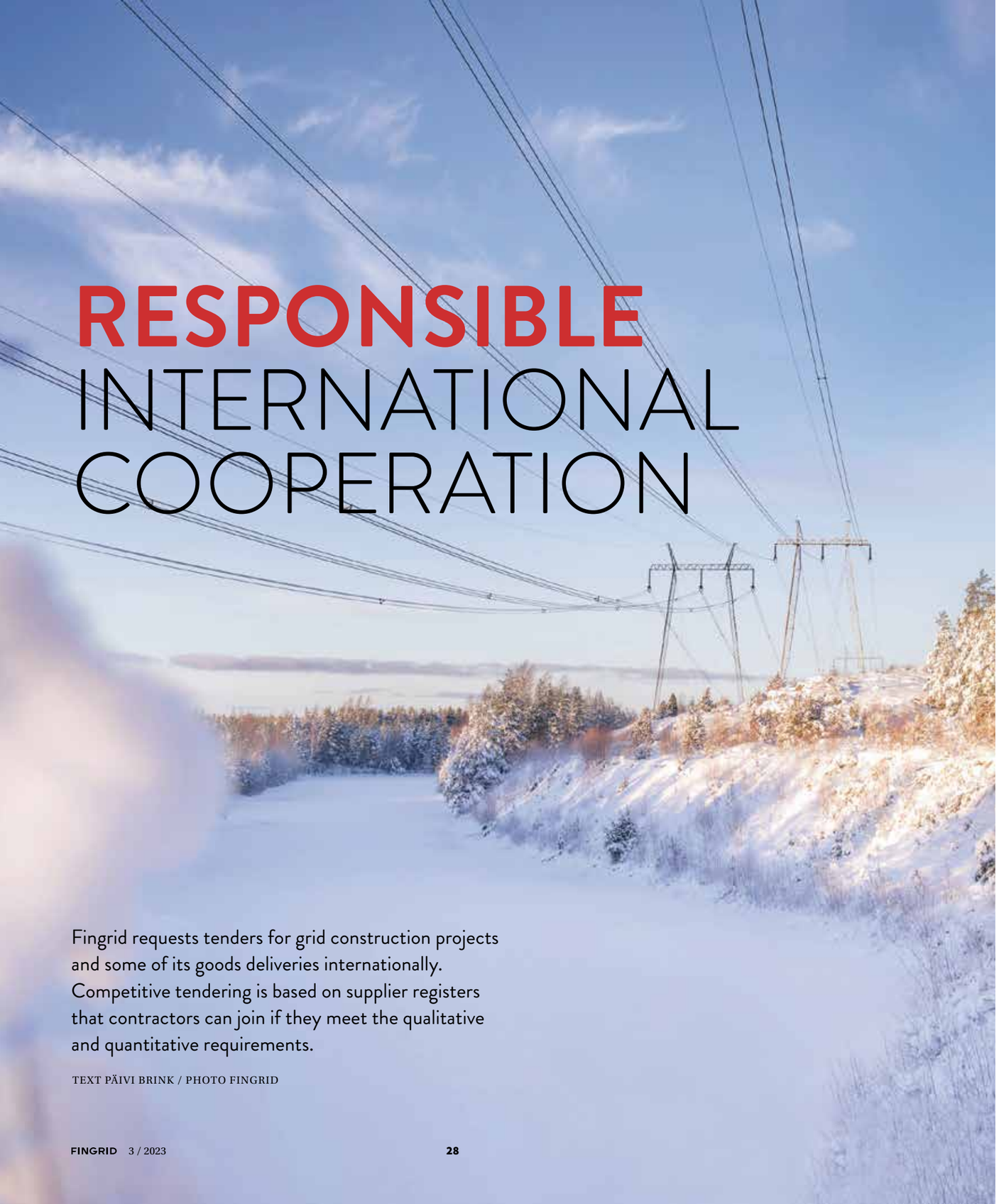
company, points out that a hydrogen network would make investments in the hydrogen economy more attractive in a way that would benefit the entire hydrogen value chain.

"Hydrogen infrastructure can connect producers and consumers, enable hydrogen production and consumption to be located flexibly in various places," Kärki says.

She says hydrogen infrastructure would make operators less dependent on individual producers or consumers, thereby reducing operating risks.

"A national and cross-border hydrogen transmission infrastructure would open the door to competition and market development. This would benefit the Finnish hydrogen market and allow hydrogen producers to gain new customers outside Finland."

Gasgrid is involved in three separate projects aiming to foster the emergence of a hydrogen transmission grid and an open hydrogen market in the Baltic Sea region. A hydrogen network connecting Finland, Sweden, the Baltic States and Central Europe would mean the creation of a new hydrogen transmission infrastructure and hydrogen market in the Baltic Sea region by 2030. ◆



RESPONSIBLE INTERNATIONAL COOPERATION

Fingrid requests tenders for grid construction projects and some of its goods deliveries internationally. Competitive tendering is based on supplier registers that contractors can join if they meet the qualitative and quantitative requirements.

TEXT PÄIVI BRINK / PHOTO FINGRID

Under EU competition legislation, competitive tendering processes in the energy sector are international. Fingrid has a record number of construction projects underway, so there would not be enough Finnish workers for all the projects," says **Ritva Laine**, an experienced client in competitive tendering procedures and Senior Project Manager at Fingrid.

Fingrid accepts the companies whose operating practices it has audited for inclusion in the register before the competitive tendering process begins. At present, the contractors are all European companies and requests for tenders are only sent to companies in the register.

Fingrid conducts worksite audits of all its contractors in Finland while work is underway, inspecting the on-site conditions, occupational safety and working time procedures.

Finland's climate makes work challenging, as the winter is cold and dark.

"Many foreign companies are surprised to learn that winter is the best time to build transmission lines due to our boggy soil. In the summer, the ground is too soft for heavy-duty vehicles in many places," Laine says.

"Many foreign companies are surprised to learn that winter is the best time to build transmission lines due to our boggy soil."

Ritva Laine
Senior Project Manager
Fingrid

SUPPLIERS ARE ALWAYS AUDITED

In addition to contractors, projects require materials, such as towers and components, conductors and transformers. These are delivered from all over the world. Contractors make most of the purchases themselves. Fingrid ensures that the companies are technically competent and pass social audits.

For example, Fingrid orders large system transformers for substations and conductors for transmission lines. EU competition law regulates the company's direct procurements of goods.

Fingrid conducts technical audits itself, but it uses a third party and local auditors for social auditing. They know the local legislation, language and conditions. The working conditions, working hours, remuneration, management system and freedom of association are assessed for each company.

"We often use the same contractors and suppliers when we are satisfied with their work," Laine says. ◆

Experiences in Finland

Fingrid asked three European contractors to talk about their experiences working in Finland.

1 **Which Fingrid projects have you worked on?**

2 **What challenges did Finland's climate and nature present for these projects?**

3 **What was it like to work with Fingrid?**

CONTRACTORS' EXPERIENCES IN FINLAND

Ajdin Skejic, Project Manager, Tecnolines, Italy:

1. Tecnolines has worked on two projects in Northern Finland: In 2022: part A of the 400 kV Aurora Line, 73 km and 6.5 km of modification work. In 2023: 110 kV modification work in Isohaara.

2. The conditions were often very difficult for climbing towers and working 30 metres above the ground where the wind makes it feel even colder. Working in freezing temperatures affects the progress on the worksite. Fingrid requires employees to have thorough training and familiarise themselves with the weather conditions before starting work.

3. Working with Fingrid has been excellent. They are always available and always answer our questions. The monthly worksite meetings have been very good for our projects and resolved any outstanding issues. We were positively surprised by how quickly solved practical issues related to landowners, for example.

Daniele Bertussi, Contract Management Director, Tamini Trasformatori, Italy:

1. In 2023, Tamini has been involved in the MUU6 and MUU8 projects, supplying seven Fingrid substations with transformers equipped with power supplies for internal consumption.

2. In our ongoing projects, we have taken the Finnish climate into consideration from the outset, as it affects the design of the transformers we supply. The winter weather caused some challenges in the transportation and installation phases, but we overcame them without any difficulties thanks to our extensive experience in the field.

3. The cooperation between Tamini and Fingrid has been very open, fair, fruitful and mutually appreciated. In the near future, we will supply Fingrid with 400 MVA and 400 kV transformers filled with synthetic esters.

Francisco Javier Ortega Quesada, Site Manager, Elecnor, Spain:

1. Elecnor has worked with Fingrid on two projects: In 2021 and 2022, we worked on the 400 kV Petäjävesi–Pyhänselkä transmission line, known as the Forest Line. In 2023, we have worked on the Tuovila substation, another 400/110 kV conversion, and this project is ongoing.

2. The foundation work was the main challenge in both projects. The hard, frozen ground makes the work much more complicated. Progress has slowed, as we have needed machines to heat the ground and chip away the frozen soil. In addition, the performance of our employees was significantly hampered by the temperature, snow and icy conditions.

3. I have had good experiences working with Fingrid on their projects. They have experienced experts who facilitate the work on-site.

TEXT SAMI LAAKSO / PHOTO MATTI IMMONEN

The electric vehicle charging network as a disturbance reserve

The rapidly expanding charging network for electric vehicles can be harnessed as a disturbance reserve to support the power system.

Electric vehicles are becoming increasingly widespread, and the trend will only continue. Today, there are approximately 180,000 rechargeable vehicles in Finland out of a total of approximately 3.2 million vehicles. Transport will account for significant electricity consumption in the future, but it may also be an important resource for the power system.

Liikennevirta Oy's cloud-based management system for electric vehicle charging devices can control charging points in real time, so they can be used as disturbance reserves to support the power system.

Smart technology monitors the power system constantly and can react quickly to deviations. For example, it can respond if the frequency in the power system falls too far and the power balance is jeopardised.

"This creates a virtual power plant that can help the power system of Finland in the event of a power shortage," explains **Juha Karppinen**, Director of Energy Services at Liikennevirta.

Reacting does not mean interrupting charging. Instead, the charging power at a large number of charging points could be decreased – for example, from 11 kilowatts to 9 kilowatts – for a few minutes.

"Small and brief reductions in power can make a big difference when lots of cars are charging. The aim is to avoid a situation in which the power system of Finland suddenly runs out of power and parts of it need to be shut down," Karppinen says.

The management system can respond quickly. Half the capacity designated as a reserve can be activated within 5 seconds, and the entire reserve can be available within 30 seconds. This operating model safeguards the quality of the power system, and people charging their vehicles will not notice a small, short-term power reduction. Nevertheless, it provides enough time to activate other disturbance reserves.

In the future, Liikennevirta's technology will enable consumers to schedule charging outside the price and consumption peaks.

"If we can adjust the network's total power more effectively without disrupting the charging and use of electric vehicles, we can reduce the negative impact on the power system, even when large numbers of vehicles are charging. In fact, the impact could be positive for the power system." ◆

SAVING THE WORLD

The energy sector and its key player, Fingrid, will facilitate the green transition as long as we play our cards right, according to Jukka Ruusunen, who will retire at the end of the year.

TEXT KATARIINA KRABBE / PHOTOS SAMPO KORHONEN

Jukka Ruusunen, Fingrid's President & CEO, has witnessed a transformational shift in the energy system and electricity markets over the course of his career. When he began working as a researcher at the Helsinki University of Technology, Imatran Voima was the only energy company producing electricity in Finland in the 1980s and 1990s, in addition to industrial electricity generation and local companies.

"The electricity market was opened up in the mid-1990s. This altered my career plans. I had planned to get into industry – onto the front line – when things began happening in the sector," he recalls.

Ruusunen moved to Imatran Voima and got involved in the process that led to the creation of Fortum. Monopolies began to be broken down. Fingrid was established in 1996.

"The country needed a transmission system operator that would allow all other operators equal access to the grid, and so the cornerstone of the electricity market was born."

At the turn of the millennium, it became apparent that the energy sector needed to reduce its carbon footprint, so the emissions trading scheme was created. Energy companies needed to consider how to turn it into a competitive advantage.

"Fingrid is an operator whose success or failure reflects on the society surrounding it."

"Companies needed to create models and mechanisms for operating in the market. They analysed the market and focused on risk management."

FINGRID'S IMPORTANT ROLE

Ruusunen was invited to take up the position of Fingrid's President & CEO in 2006.

Change was in the air. Reserve power was built, along with links to Finland's neighbouring countries.

"The biggest topic of discussion was how to connect the large nuclear power units then on the drawing board – Olkiluoto 3 and Fennovoima – to Finland's grid."

At the same time, Fingrid was tracking improvements in the competitiveness of wind power around the world.

"Suddenly, the technology took a huge leap forward. Turbines grew taller than the highest Finnish forests, so there was suitable land for wind power plants all over Finland."

People also began taking climate change seriously and setting targets for reducing carbon

emissions. Finland's strategy is to become carbon neutral by 2035.

"It is no longer enough just to reduce emissions from the energy system. We need a lot more clean electricity to eliminate the emissions from industries, heating and transport."

"This may sound like a tall order, but it is one of the most important projects for our planet. Fingrid is an operator whose success or failure reflects on the society surrounding it."

SWARM INTELLIGENCE WORKS

Finland now has a good opportunity to be at the forefront of the green transition, handle electrification successfully and eliminate emissions from industry, heating and transport.

"It is now important to sort out the permits and financing for electricity consumption so that they can start making investments," Ruusunen says.

"There is plenty of potential for wind power production, so more electricity can be produced if someone wants to use it. We really hit the jackpot when this technology was developed: production facilities are quick to build when the need arises. If we had to build large, centralised units, we would be struggling to keep up."

Finland has the expertise to get things going. Another advantage is that in a small country, operators in different fields maintain a dialogue. In the future, Finland will need investment and labour from abroad.

"The most important thing now is not to let opportunities pass us by. Fortunately, the new government has pledged to promote permits. The market seeks an equilibrium if it is allowed to do so."

Ruusunen traces the path of development directly from the liberalisation of the electricity market to the present day.

"If our future rested on the decisions made by a single company, things would not look good. It is much easier to make decisions with the help of swarm intelligence in small bites when there are lots of actors involved." ◆

CLEARING VEGETATION increases biodiversity

Regular vegetation management around transmission lines improves electrical safety and transmission reliability and also maintains vital open habitats for many animal and plant species. TEXT FINGRID / PHOTO HARRI NURMINEN

Finland has almost 34,000 hectares of rights-of-way for high-voltage lines, also known as transmission lines. This land is cleared regularly – on average, every six years. Approximately 6,000 hectares of transmission line rights-of-way are cleared annually.

In addition, trees in the transmission line's border zone are cut to the expropriation height so they do not touch the lines if they fall. Such trees are either felled or sawn back to size every 10–25 years.

"We have treated a lot of border zone vegetation in recent years, so there will be less of this work in the near future," says **Tero Ojarinta**, Maintenance Manager for vegetation management.

Vegetation management helps ensure electrical safety: clearing reduces the risk of power cuts, minimises fire safety hazards, and makes the grid easier to maintain. Fully cleared areas also offer vital habitats for many endangered animal and plant species.

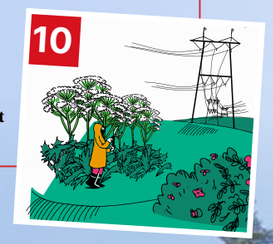
PUTTING TRANSMISSION LINE RIGHTS-OF-WAY TO USE

Landowners can choose to utilise transmission line rights-of-way for economic activity or to promote biodiversity and scenic value.

For example, a wetland or grazing area for wildlife could be established in a transmission line right-of-way. As the maximum height in the area must remain low, it is also suitable for cultivating Christmas trees or natural products and flowers that attract pollinating insects.

Meadowland also enables cattle to graze in the area. This results in increased biodiversity, while the animals naturally take care of the landscape. ◆

See the idea cards for landowners (in Finnish): fingrid.fi/ideakortit



Try the updated Tuntihinta (Hourly Price) app!

FINGRID'S TUNTIHINTA MOBILE APP allows you to track the exchange price of electricity and postpone using electricity-intensive devices until prices go down.

THE NEW VERSION of the app for Android and iOS is available in app stores.

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