FINGRID OY'S CORPORATE MAGAZINE | THEME 20 YEARS

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FINGRID

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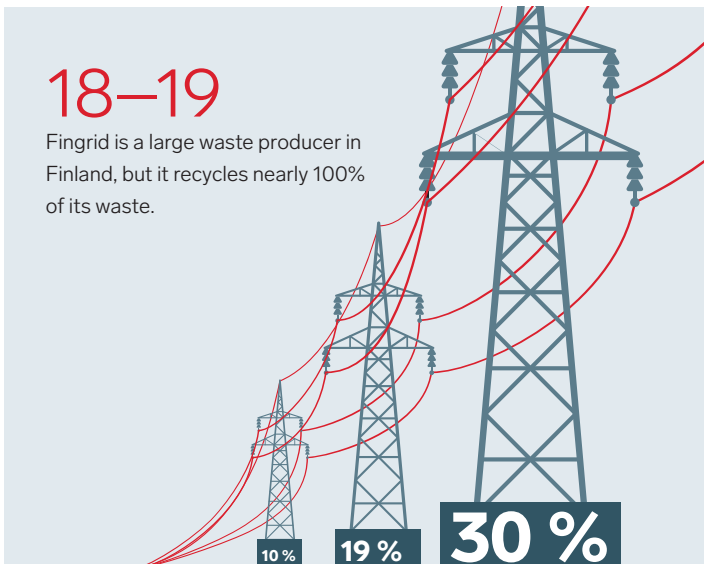
FINGRID 20 YEARS

Contents



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FINGRID

PHOTO | VESA TYNI

Serving customers and society for 20 years

The creation of an electricity market led to the founding of Fingrid 20 years ago. A transmission system operator independent of the competitive business functions was needed to develop an infrastructure that supports market activities. From the very beginning, the principles for operational development were efficiency, fairness and independence. We can take pride in the fact that our own Finnish approach has subsequently received global recognition.

Over the past ten years, ageing of the main grid, constantly increasing electricity market needs, and the change in production structure have increased the pace of investment. Now the budget for our ten-year plans for main grid development can always be measured in billions of euros. It's been essential to find a new way of thinking. Each year, our customers present us with more challenges and provide additional motivation to develop activities. It has also become increasingly important to build cooperation with the authorities in Finland and internationally.

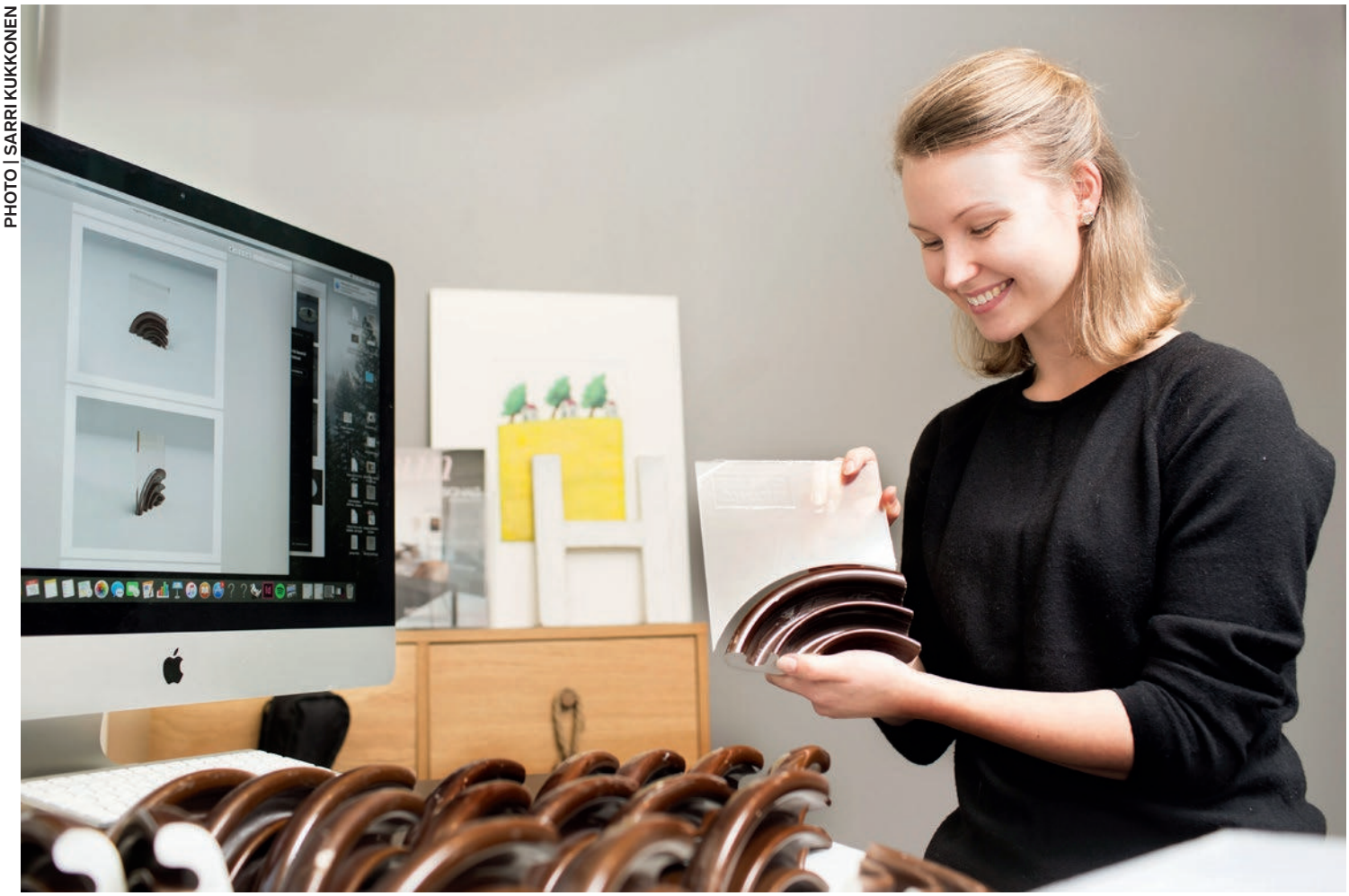
In spite of our success, we still have more dreams for the future than longing for the past. In the midst of changes to the energy system, Finnish society needs Fingrid's expertise and unbiased views. No other actor can match our understanding of electricity market operations as a whole.

The vision of a future energy system based on renewable sources of energy seems more concrete all the time. The bigger problem may involve finding the path that will take us to a sunny future. We have been active in this matter and presented our opinion of the actions needed to save the electricity market. As this magazine demonstrates, there are different views concerning how the electricity market should be developed. One element in this development is involving ordinary electricity consumers in the electricity market and thus supporting the development of a new energy system. In this respect, digitalisation is like a gift from heaven: the new energy system will require much more networking of people and equipment.

This represents a huge change, but one thing will remain the same for us. In the future, Fingrid will still have to earn the trust of society and customers – every day.

Jukka Ruusunen
President and CEO

PHOTO | SARRI KUKKONEN



Hilda Rantanen studies at the Institute of Design and Fine Arts of the Lahti University of Applied Sciences, and her lifetime achievement trophies are based on a quarter section of the Iron Lady's insulator disc, connected to an acrylic plate adorned with a Fingrid engraving.

Trophies for the anniversary year were created by hand

The trophies for lifetime achievement awards presented at Fingrid's 20th anniversary event were constructed from former insulator discs of the Iron Lady transmission line and modern acrylic parts. Designer student **Hilda Rantanen**, who designed the trophies, reflected both modern times as well as traditions and roots in her work.

"Dents and scratches, patinated by time, can be seen in the Iron Lady's insulator discs; I didn't treat the surface at all. The discs have been cut by water jet into four sections to form the bases of the trophies. I selected the beautiful and durable acrylic to complement them. The plates are connected to the bases, and together they create a square crossed by the insulator disc's curve. They harmoniously combine old and new," Rantanen explains.

Fingrid implemented the lifetime achievement trophies in cooperation with students of the Institute of Design and Fine Arts. The starting point for the commission was an old insulator disc, and students could come up with ideas to complement it. Fingrid's jury then selected the winner.

Rantanen says that the design process was demanding before the idea about the contrast, the simple treatment of a difficult material, and the simple form became clear. She sought feedback on her idea at an early stage and made several cardboard and computer models. Economic reasons also guided the work: one disc provided enough material for four trophies.

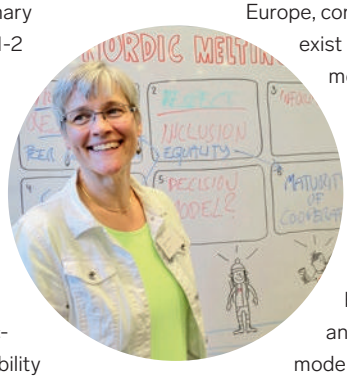
"I spent a long time looking for the form. I understood that traditions and roots, as well as simultaneously aiming at an innovative and fresh future, are important values for Fingrid's identity, and that's what I wanted to express in my work. My aim is that the recipient can be proud of the distinguished career represented by the trophy, as well as the trophy itself. I wanted it to be impressive. The grooves in the disc represent a long career, and the history and development of the entire company, like the growth rings of a tree, or a curving horizon beyond which is the future." •

PHOTOS | MARJAANA KIVIOJA, TERO PAJUKALLIO

A Nordic RSC to be established in Copenhagen

The Nordic Regional Security Coordinator, or RSC, is a joint-Nordic organisation which takes care of operational planning and scheduling. Its task is to deepen Nordic operational cooperation amid changes to the electricity system and operating environment.

A Nordic RSC will be established in Copenhagen using the "joint office" model, to which each transmission system operator will send employees. In the initial stage, the RSC is expected to number 10 people. According to a preliminary plan, Fingrid is expected to send 1-2 workers from Finland to Copenhagen. Other Nordic transmission system operators are: Denmark's Energinet, Norway's Statnett and Sweden's Svenska Kraftnät. The Nordic RSC is expected to begin operational activities in late 2017.



The RSC benefits the electricity markets by ensuring the availability of transmission capacity and helping to preemptively identify situations that could potentially weaken system security at a Nordic level.

This type of organisation of regional operational planning and scheduling between transmission system operators will also become binding through the network code on transmission system operation and Entso-E's decisions. In central Europe, corresponding organisations already exist primarily to facilitate the management of ITC caused by the densely looped transmission grid between neighbouring countries.

Five tasks have been agreed for the RSC: capacity calculation, system security analysis, coordination of cross-border outages, maintenance and development of common grid models and regional short-term adequacy forecasts. The RSC acts as a service provider; each transmission system operator is responsible for system security and will still decide on operation-related activities in its own area. •

Planning Manager Maarit Uusitalo is responsible for Fingrid's contribution to the practical arrangements of RSC's establishment. The start-up meeting took place in May in Copenhagen.

Fingrid tops ITOMS

Fingrid has ranked among the best transmission system operators in ITOMS (the International Transmission Operations and Maintenance Study) for the eleventh consecutive time. Fingrid fared especially well in transmission line maintenance and vegetation management.

Fingrid's success in ITOMS can be explained by the operating models it has chosen and by the effective use of advanced information systems. In the 2015 study, Fingrid was able for the first time to utilise its new asset management system which helps to make even more detailed information available for use.

The International Transmission Operations and Maintenance Study examines operational quality, effectiveness and economy, as well as compares things like the quality and costs of TSOs' grid maintenance. Fingrid didn't receive an exact placing, since the study is not a competition; rather, the aim is to search for the best operating methods and procedures, and to learn from other companies.

The international study is carried out by UMS Group Inc. The study compared the quality and costs of grid maintenance on transmission system operators' grids. ITOMS is considered to be one of the most respected comparative studies in the industry.

Thirty-one TSOs from around the world participated in the 2015 study: 12 were from Europe, five were from North and South America, five were from Australia/New Zealand, and nine were from Asia/Africa. •

Meeting landowners at OKRA

Fingrid attended the summer's biggest event in the agricultural industry, the OKRA Farm Fair, in Oripää in July.

Landowners are vital partners to Fingrid, and the opportunity to meet face-to-face with landowners and other stakeholders is the most important aspect of the agricultural events. Our specialists were at Fingrid's stand answering questions on issues such as construction projects and the wide range of ways in which transmission line areas can be used.

In September, Fingrid participated in the FinnMETKO exhibition in Jämsä, which is the largest trade and sales fair for the heavy machine industry in Finland.•

GRID QUIZ:

The winners of the Grid Quiz from the 1/2016 edition of the Fingrid magazine are: Tero Kallio, Lappeenranta, Kauko Vierimaa, Oulunsalo and Arto Köykkä, Muhos.

PHOTO | JOUKO KIVELÄ

You can follow the movements of Fingrid's sponsored osprey Lalli on the Finnish Museum of Natural History's website at: www.luomus.fi/fi/lalli-satelliittisaaksi and on Lalli's Facebook page: www.facebook.com/lallisaaksi

Lalli the osprey to receive a new satellite transmitter

Fingrid is once again supporting the procurement of a satellite transmitter for Lalli the osprey, who is named after his birth and nesting area in Kokemäki, Satakunta.

Lalli's old transmitter broke while he was in his wintering quarters two years ago, and now a new transmitter will be procured for him to provide data on the bird's nesting behaviour, autumn migration and wintering in the coming year.

After two summers of unsuccessful nesting, Lalli has been successful in his breeding and nesting attempt with a young female osprey in his old nesting swamp in Kokemäki. This makes it possible to tag Lalli with a new, even better satellite transmitter. The satellite osprey is part of a wider research project to investigate osprey migration and basic information on hunting areas. The tagging will be carried out in cooperation between the University of Helsinki's Finnish Museum of Natural History and the Osprey Foundation.

Osprey breeding pairs are often interested in transmission line towers as nesting spots as the towers are located in open, elevated, and peaceful places. Fingrid has encountered osprey breeding pairs nesting in transmission lines more than once. But a nest in a transmission line poses quite a significant safety risk to both the transmission of electricity and to the birds themselves, so the nests have to be removed from the towers once the nesting season is over. The removal of nests requires a special permit from the regional environmental centre. Removed nests are replaced with artificial nests in which the birds can build a new home. However, our sponsored bird Lalli has now begun to nest in his old nesting grounds a safe distance away from electricity transmission lines.

At almost nine years of age, Lalli is a fine specimen of an osprey and has seen and experienced the world on his migration to and from the sweltering heat in Africa. With his new satellite transmitter, Lalli can once again communicate his upcoming journeys to his thousands of followers. •

Get involved in developing Fingrid's online services

We are now searching for customers who are interested in the development of online services to join our Customer Panel. Members of the Customer Panel will be able to give their opinions on development ideas and to be among the first to try out our new online services. Participation in the Customer Panel does not involve any obligations, but members will receive surveys, or e.g. an invitation to an interview concerning Fingrid's online services.

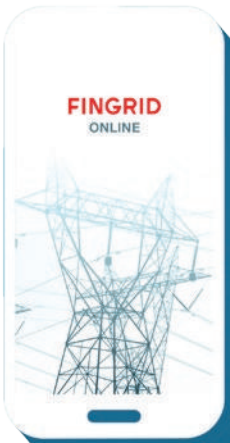
You can sign up to the Customer Panel by sending an e-mail to Development Manager Katariina Saarinen: katariina.saarinen@fingrid.fi •

The Fingrid Online mobile app shows power system status and disturbances

Fingrid has published a new mobile application. The Fingrid Online mobile application brings information on the status of the power system and disturbances to users' Android and iPhone phones. The application has three features:

- Power system status
- Disturbances
- Disturbance notices

The application is available from the App Store and Google Play application stores. •



FINGRID 20 YEARS

Fingrid Oyj – two decades

TEXT | MATTI TÄHTINEN
PHOTO | MIKA KURKILAHTI / A1 MEDIA OY
PHOTOS / HISTORY | FINGRID

THE BEGINNING

Suomen Kantaverkko Oy, now known as Fingrid Oyj, was founded on 29 November 1996. Operative activities at the company started on 1 September 1997. On the previous day, Imatran Voima Oy, Pohjolan Voima Oy and the State of Finland reached agreement on centralising the main grid business and power transmission networks into a single company. Worth more than one billion euros, this was the largest business deal in Finnish economic history at the time. Finland's membership in the EU and the directive on opening up the electricity market, which required separation of electricity main grid transmission from electricity production and sales,had a major impact on the birth of the company.

GROWTH AND COST EFFICIENCY

The company format was changed to a public limited company in order to facilitate the move to international capital markets in the early stage of operations. Funder confidence and a high credit rating made it possible to create a balanced capital structure for a company working in a capital-intensive area of business. The structure is still the same today, but shareholder's equity is currently maintained at approximately 30%.

The reform of the EU Energy Market Act in 2011 meant that Fortum and Pohjolan Voima had to give up their ownership in Fingrid. A deal signed on 19 April 2011 made the State of Finland the largest owner of the company. Finnish pension insurance companies also became owners.

Over a two-decade period, the company's turnover has nearly tripled to more than 600 million euros. Fingrid is also one of the 20 largest corporation tax payers in Finland.

Fingrid's overall effectiveness is based on a business model in which services that can be procured in a market-based manner are outsourced, activities are centralised, digitalisation is productively utilised, and the personnel focuses on basic tasks in their areas of core competence. The effectiveness of Fingrid's operations is also clearly reflected in the fact that the transmission prices applied by the company are among the lowest in Europe.

WORKING WITH CUSTOMERS

As a monopoly, Fingrid has the same contract terms and price structure for all of the customers connected to the grid. The largest customer group is electricity market actors. When selling and procuring electricity, they utilise the Nord Pool electricity exchange, which is partly owned by Fingrid, as well as security of supply and imbalance management. The most important large customers are industry and distribution system operators.

Customer cooperation is a central factor in company operations. With regard to main grid business, Fingrid has implemented an operating model of 12 regional grid plans that directly involves the customers for more than 10 years, with cooperation being handled in, for example, different advisory committees. The ongoing energy changes mean that experts will have to participate in customer work to a greater extent in the future.

TWO BILLION EUROS FOR TRANSMISSION CAPACITY

Fingrid has been building the main grid, cross-border connections and the reserve power required during disturbances at a faster and faster pace. During its 20-year history, the company has invested nearly two billion euros in the main grid, two-thirds of that in the past ten years.

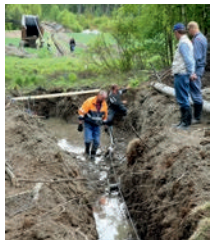
When all of the 110, 220 and 400 kilovolt voltage levels are included, nearly 3,000 kilometres of new transmission line has been constructed. The length of the current grid is approximately 14,200 kilometres, with 49,000 transmission line towers, 300 kilometres of submarine cables and 113 substations.

Important new projects have included replacement of the Rautarouva ("Iron Lady") line, which was Finland's first trunk line when it opened

1996 Fingrid is founded

1999 Fingrid joins ETSO

2003 A large cross-border transmission line to Russia



2006 EstLink 1 to Estonia

in 1929, and the construction of new reserve power plants in Olkiluoto and Forssa. In terms of euros, the biggest investments have been the FennoSkan 2 and EstLink 2 submarine cables, at a combined cost of 300 million euros. Fingrid has been recognised for its success in grid life cycle management on many occasions. The company has always ranked highly in the ITOMS international study of grid maintenance.

The fact that, in terms of monetary value, investments over the past decade are equivalent to about half of the main grid that has been built during the 100-year history of high voltage transmission in Finland, provides a good picture of the company's current investment level.

SYSTEM SECURITY STANDS AT 99.999%

System security management is one of Fingrid's main processes. Its most important target is to maintain a high level of transmission reliability. Maintaining the annual level of 99.999% that has been achieved is an extremely ambitious goal in an increasingly complicated power system operating environment.

Substations in Finland have been unmanned since the early 1980s with the introduction of operation control systems. A nationwide operation control system was implemented in 1997. In 2001, the Grid Control Centre took responsibility for grid management throughout Finland. Centralisation of operations was completed in 2013. The people responsible for the power system, grid management, balancing production and consumption and operational planning now work at the Main Grid Control Centre. These facilities allow for good information exchange and cooperation.

Each year, the Main Grid Control Centre handles the planning and implementation of nearly 2,500 switching schedules, operates in the electricity market, procures loss electricity from the electricity exchange and is responsible for procuring reserves to maintain the power balance, frequency and disturbance readiness.

ELECTRICITY MARKET BORDERS OPEN UP

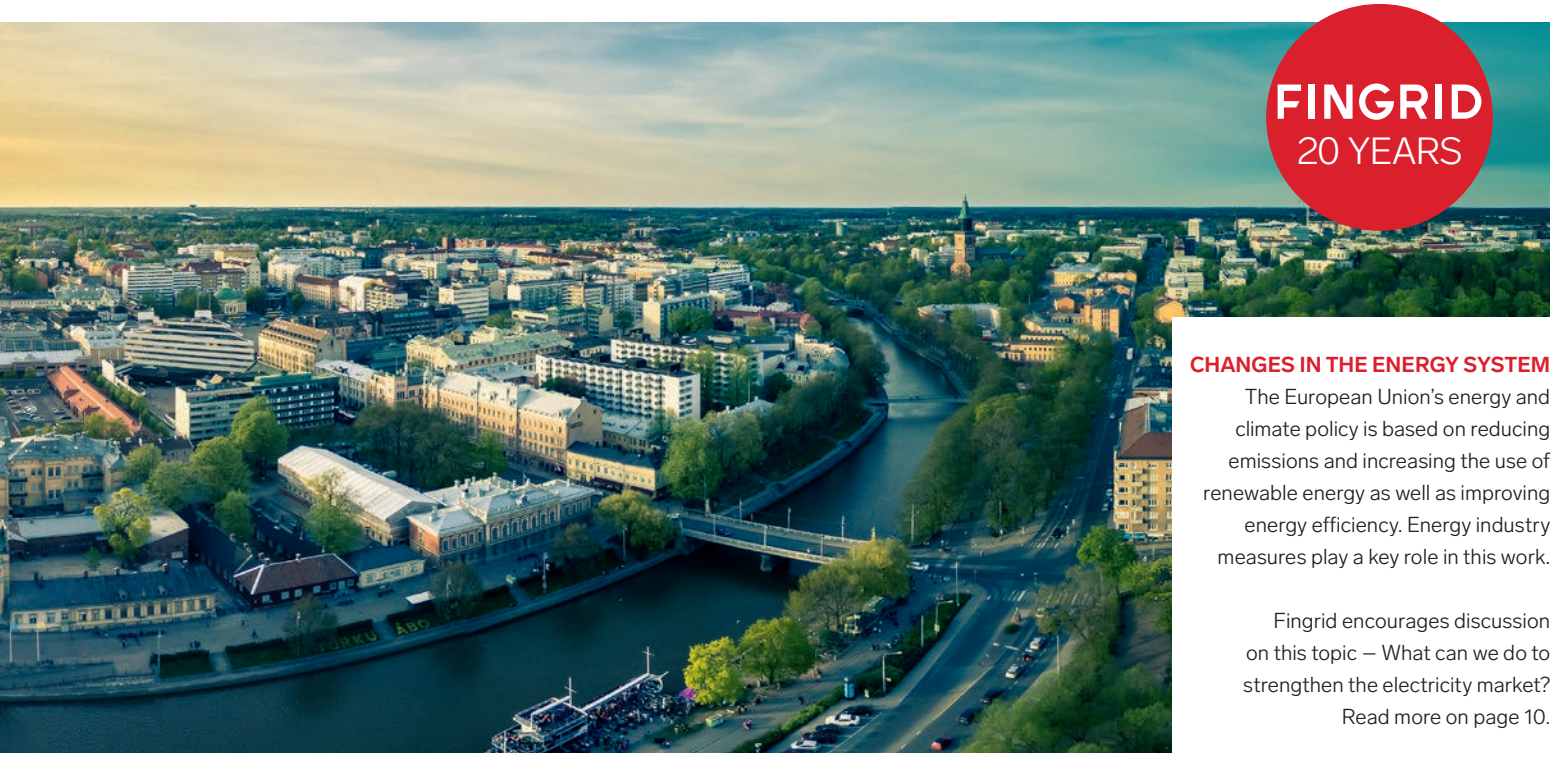
Cross-border tariffs on Fingrid's Nordic connections were phased out in 1999, and Finland became part of the Nordic electricity market as a separate price area. FennoSkan 2 from Rauma to Dannebo in Sweden was completed in 2011 in cooperation with Svenska Kraftnät, and raised transmission capacity to 2,700 megawatts in both directions.

On the eastern border, Russian import reached record levels in 2001 as a result of a contract signed with RAO EES Rossii. Completion of a third 400 kilovolt cross-border interconnector from St Petersburg to Kymi via Vyborg in 2003

2007 Main Grid Control Centre and all control rooms are combined

2011 Swedish FennoSkan 2 from Rauma to Dannebo

2013 Olkiluoto gas turbine power plant is completed



CHANGES IN THE ENERGY SYSTEM

The European Union's energy and climate policy is based on reducing emissions and increasing the use of renewable energy as well as improving energy efficiency. Energy industry measures play a key role in this work.

Fingrid encourages discussion on this topic – What can we do to strengthen the electricity market? Read more on page 10.

also increased imports. For nearly a decade, 11 terawatt hours of electricity was imported per year at full technical operating time. Today, import levels are about 4 terawatt hours per year.

Estlink 1 to Estonia opened in 2006. Cross-border capacity nearly tripled when EstLink 2, a 650 megawatt submarine cable connection, was completed in 2013 and the Baltic countries became part of the Nordic electricity market.

The combining of regional electricity markets during this decade has made Finland part of a market that has an annual volume of almost 3,000 terawatt hours and includes 19 countries and nearly all of Europe in geographic terms.

Fingrid's subsidiary Fingrid Datahub Oy was founded in 2016 to manage the electricity market and retail market party information in particular.

AN INTERNATIONAL AND ACTIVE PLAYER

Fingrid mostly handles domestic tasks, but its operations are very international by nature today.

Fingrid has played a major role in developing European electricity markets. It has been a member of the European Network of Transmission System Operators ETSO (now known as ENTSO-E) since the organisation was founded in 1999, agreeing on issues such as the removal of cross-border tariffs and mutual compensation for transit transmission. This system, in which some 400 million euros change hands, marked the beginning of real electricity market freedom in the entire European region.

Fingrid participates in international research activities in selected technical fields that are important to the company, such as the use of HVDC direct current technology in submarine cables. Comparison studies of best practices in main grid operation also require and facilitate an in-depth level of expert collaboration.

FAIRNESS IS ONE OF THE WORKING COMMUNITY VALUES

Fairness and efficiency were two of the company's values when it was founded, and they are still included in Fingrid's values today. Transparency, fairness, efficiency and responsibility were the outcome of the updated strategy work carried out with the personnel in 2016.

Fingrid's strategy can be summarised in the slogan "Fingrid keeps the lights on in Finland and promotes market functionality through safe and effective investments." The vision in terms of handling these tasks is to set an example for main grid operations.

Fingrid is an expert organisation with some 300 permanent staff. The company's matrix organisation has been developed so that, along with the main processes, the customer, economic and personnel perspectives are also managed as equal entities.

MOVING TOWARDS THE FUTURE DIGITALLY

Fingrid's operative activities are based on telecommunication and data system solutions that ensure efficiency, high usability and security. From the very beginning, Fingrid and its predecessors understood that investing in data and telecommunications systems and their innovative use would facilitate the company's operative efficiency. Digitalisation has been a strong theme in main grid operations for a long time.

The electricity system as such already produces huge amounts of useful information that, when combined with data obtained from the operating environment and digitalisation innovations such as new analytics and visualisation, creates unprecedented opportunities. Fingrid is closely involved in all of this.

Fingrid is continuing along its career path as a company. In terms of main grid development, Finland's fourth strong wave of construction is currently in progress. At the same time, we're preparing to connect a carbon-neutral production network to the grid. These are examples of the challenges being resolved by different parties in the company – now and in the future. •

This history article was written by Matti Tähtinen, who has held several positions at Fingrid and been involved in developing and managing the company's business ever since it was founded.

Jukka Ruusunen

Fingrid opened the discussion on energy policy in 2016: The electricity market needs fixing

The change currently underway in the electricity system requires a new kind of energy policy and stronger markets, Fingrid said when addressing the topic this spring.

TEXT | FINGRID
PHOTO | VESA TYNI

While proposing a number of concrete measures to restore the viability of the electricity market, Fingrid also expects comments and views from industry actors and spokespersons. Comments were requested from Fortum's President and CEO **Pekka Lundmark** and chair of the Green League **Ville Niinistö**; read their thoughts on the following pages.

SUBSIDIES TO RENEWABLE ENERGY DISTURB THE MARKET

Fingrid emphasises that the Nordic electricity system is facing significant changes. The transition to low-carbon electricity production will bring enormous changes.

National subsidy systems have, in a short time, significantly increased the production of renewable electricity on the Nordic electricity markets.

This has caused an energy surplus on the electricity market, as a result of which the market price for electricity has crashed to an artificially low level. Market-based electricity production has had to be phased out. In Finland, the production capacity of flexible condensing power has collapsed and Sweden has made decisions on the premature closing of nuclear power plants.

The opinion of transmission system operator Fingrid is that it should be easier, especially for smaller actors, such as households, to enter the electricity market.
Sinustakin halutaan leipoa sähköntuottaja (We want you to become an electricity producer too; in Finnish) / Talouselämä article 17 May 2016

"These days, the electricity markets don't have the preconditions for market-based investments. This trend is extremely worrying, because the viability of the electricity markets is weakened and the security of electricity supply is under threat," says Fingrid's President and CEO **Jukka Ruusunen**.

In the future, we may be forced to subsidise all electricity production, which would be very expensive to society. Until now, the market mechanism has guided the movements of electricity extremely efficiently.

SEEKING TO END PRICE REGULATION

Along with solutions related to energy policy, the electricity markets must be developed so that they provide the system with market-based flexibility. This means removing all price regulation from the electricity markets. Thus, we'd face more varying

The view is becoming more prevalent among energy policy decision makers that the transition away from fossil fuels shouldn't be slowed down but the functioning of the electricity markets must be better managed during the change.
Haussa joustava sähkön kuluttaja (Looking for a flexible electricity consumer; in Finnish) / Helsingin Sanomat editorial 23 May 2016

The government of Prime Minister Juha Sipilä (KESK) has already intervened in the subsidy system for wind power after realising that the system is too expensive: Finnish taxpayers have been paying a double price for wind power. Wind power has been subsidised with around 265 million euros (May/2016), and the subsidy system will remain valid for several years into the future.
Veronmaksajat voivat joutua tukemaan kaikkea sähköntuotantoa – Tulee pian erittäin kalliiksi / (Taxpayers may have to subsidise all electricity production – it will be very expensive; in Finnish) / Suomen Kuvalehti article 22 May 2016

prices for electricity but, especially in the long term, the resulting cost efficiency would benefit all of society.

In its opening address, Fingrid also presented a number of concrete measures to improve the functioning of the markets during the transition period towards the electricity system of the future. The measures are related to things such as the pricing of regulating and balancing power, power reserve and the linking of retail and wholesale markets. Households should also be able to enter the real-time regulating power market to benefit from demand response.

"I hope that decision makers are brave enough to commit to market-based options on the way to the electricity system of the future. Achieving climate targets is the starting point, but it's also a question of doing it either cost-efficiently and on a market basis, or inefficiently with centralised control," states Jukka Ruusunen. •

Chair of the Green League Ville Niinistö:

The energy future is based on reform

The chair of the Green League **Ville Niinistö** believes that Fingrid is on the wrong track if it "resists small, renewable energy subsidies".

TEXT | MATTI SIMULA
PHOTO | PETRI KAIPIAINEN

Finland should switch to a system based on renewable energy. That's where the rest of the world, the energy market and investments are going. Now we have to find the most cost-effective, market-based way to implement such a system, emphasises Ville Niinistö.

He favours replacing feed-in tariffs with an auction system to speed up the implementation of renewable energy. This system would be maintained by the state.

"We'll be stuck in an outdated, centralised structure if we don't implement new energy on a broad scale. If that happens, Finnish companies won't be able to find domestic markets for their solar, wind and other renewable energy expertise."

ENERGY SUBSIDIES ARE ALSO A BARRIER

Niinistö disagrees with the view that subsidies only apply to renewable energy.

"Fossil fuels receive the most support. Many subsidies encourage industry to continue producing greenhouse gas emissions and prevent the introduction of new solutions. This also includes subsidies for nuclear energy."

Despite this, the former minister of the environment believes that subsidy and tax solutions based on political decisions could be eliminated in 5–10 years.

"In that case all subsidies, including ineffective energy tax cuts that interfere with emissions trading, would have to be dismantled."

He does not agree with Fingrid's view that the national energy policy overemphasises climate targets at the expense of system security and electricity market efficiency.

"System security for the electricity grid is a secondary concern if people let climate warming destroy their environment and economic system."

Niinistö also believes that the market is the most effective way of directing resources when it works efficiently and encourages low-emission energy production.

"Our current market mechanisms are not doing this. We need stricter emissions trading and higher emission reduction targets."

Niinistö calls for energy industry actors to visit Germany and see how "the future works". •

We need stricter emissions trading and higher emissions reduction targets.

Fortum's President and CEO Pekka Lundmark: A developer role for Finland

According to Fortum Oyj's President and CEO **Pekka Lundmark**, energy policy needs to have a balance between climate targets and electricity market efficiency and security of supply. Finland could be an active supporter and developer of a joint energy policy in the Nordic countries.

EDITOR | ANNELI FRANTTI
PHOTO | FORTUM

"Functional markets are a prerequisite for controlling climate change at the lowest possible cost. When it works well, emissions trading steers emissions reductions to those countries and technologies in the EU where they can be implemented at a low cost, thus making it possible to phase out renewable energy subsidies that skew the market. It can be cheaper to implement the most effective measures – such as investments in renewable energy – in a neighbouring country, which is sometimes challenging in a political sense. In any case, emissions do not recognise borders," says Pekka Lundmark

PRODUCTION SUBSIDIES ONLY AT THE START

Lundmark says that our system is already based on wide-ranging subsidies. It will soon be time to decide whether to extend these subsidies to cover the entire energy sector or to start dismantling them altogether.

"Subsidies are necessary when we want to develop new technologies and bring them to market. However, production subsidies are a very expensive system for that purpose. Another challenge related to subsidy policy is the fact that increasing renewable energy has become an end in itself, even though it should primarily be seen as a climate policy tool and method of achieving climate targets. Overlapping targets have resulted in overlapping control measures, the effects of which are now visible in the functioning of the electricity and emissions markets."

"Finland should be active in terms of supporting and developing the Nordic electricity market and a joint energy policy, because Finnish electricity users have benefited greatly from the joint market."

"All areas of the energy economy – the import, transmission, distribution and consumption of energy – are constantly developing. Consumer behaviour is changing most right now, and this also drives development in other areas. For example, the increase in decentralised production turns consumers into producers and makes them active parties in the electricity market. Digitalisation allows for services on a new scale, and automated consumption flexibility will become a new and important method of balancing the electricity system."

Last winter proved that the existing system has a good tolerance for short-term price spikes and scarcity situations.

PRCE SPIKES ENCOURAGE DEVELOPMENT AND INVESTMENTS

According to Lundmark, price regulation creates a system in which the price of electricity would always be relatively high. Price spikes do not indicate a poorly-functioning market. In fact the opposite is true: when there is scarcity the price rises and the market communicates a need for investment.

"Accepting price spikes is a political choice. For example, when a new electricity market reform was implemented the German government made a commitment to not intervene in price spikes because they encourage investments in flexible capacity, electricity storages, etc."

From the perspective of a large energy actor, Lundmark believes that the current system has a good tolerance for short-term price spikes and scarcity situations, as demonstrated by last winter.

"It's a good idea to remember that electricity users have access to a wide range of different hedging products that reduce the impact of price spikes. We should be more concerned about long-term exceptional situations that disturb market activities for extensive periods. That's where security of supply comes into play." •

Nearly perfect transmission reliability

The keynote speaker at Fingrid's 20th anniversary celebration was **Marjo Miettinen**, owner and member of the board of EM Group. She provides her views on the importance of Fingrid and the future of the electricity market.

TEXT | PÄIVI BRINK
PHOTO | EM GROUP

"The electricity grid is the energy backbone of industrialised society. Electricity is an absolutely essential form of energy, and without it our daily lives would grind to a halt and ICT-based services would be paralysed. We need access to a sufficient amount of electricity at all times. An electricity grid transmission reliability of nearly 100% shows that Fingrid has been successful in its fundamental task, which is maintaining our power system," says Marjo Miettinen.

As part of the EM Group, Ensto participates in safely delivering electricity to the end consumer.

"Fingrid's role as the party responsible for maintaining Finland's power balance at all times means that it has a very central role in our power system. This role will become even more critical as the amount of renewable and difficult-to-predict forms of electricity make up an increasing share of production. Electricity is the foundation of the information society, digitalisation and advanced services. A diverse production structure, efficient distribution and the massive potential for emission-free energy opened up by technology development make electricity the dominant source of energy."

AN ENERGY-EFFICIENT FUTURE IS INCREASINGLY ELECTRIC

"Electronic solutions are replacing less energy-efficient fossil fuel-based systems that are also less advantageous in terms of the environment and economy. This is the case in both industry and transport, where the use of electric energy is growing fast. In lighting, LED technology has almost completely replaced the use of traditional light sources at new building sites. The electricity grid that serves the energy-efficient buildings and electric transport of the future will be a smart marketplace," envisions Miettinen.

Our open transmission connections make Finland a part of the European electricity market. The subsidy policies of other countries also have an indirect effect on us, making it necessary to consider the functionality of our market and especially the sufficiency of capacity. Renewable forms of energy account for approximately 45% of Finland's energy production, with hydroelectric power making up the majority of this.

"In this sense, energy security is very much in our own hands. At this time, wind and solar power make up less than 5% of total energy production, and we can expect this figure to increase. The predictability of wind and solar power puts more pressure on power balance maintenance and challenges Fingrid to find solutions that will further increase the amount of renewable energy. There is a growing need for demand response, which matches consumption with production in a more market-oriented manner. Along with energy review, the question of power balance will receive more attention," says Miettinen. •

Fingrid's challenge lies in finding solutions to further increase the amount of renewable energy.

Fingrid guarantees electricity for bioproduct mill

The Metsä Group bioproduct mill scheduled for completion next year in Äänekoski will produce more than twice the electricity it needs. In order to guarantee system security and adequate transmission capacity, Fingrid is expanding the Koivisto substation located near the mill area and building a new transmission line from Koivisto to the Vihtavuori substation in Laukaa. Metsä Group is also commissioning another transmission line from Äänekoski to the Koivisto station.

TEXT | VESA TOMPURI
PHOTOS | METSÄ GROUP, TMV SERVICE, FINGRID

Jouko Kotilainen
Line Project Manager
Metsä Group

Petri Hämäläinen
Project Manager
Fingrid

Jukka Roponen
Project Manager
TMV Service

The Metsä Group bioproduct mill represents the largest investment in the history of the Finnish forest industry. At a cost of 1.2 billion euros, the mill will have an annual production capacity of 1.3 million tons, mostly in the form of softwood pulp. Forecasts indicate that global demand for softwood pulp will increase from the present 24 million tons to 26 million tons by 2025.

The old pulp mill currently operating at the same location will be phased out once the new bioproduct mill becomes operational. Electricity production capacity in the mill area will increase to 285 megawatts when the new mill starts up in the autumn of next year. All of the fuel for energy production will be biomass, which in practice means that a renewable energy production plant has been added to the mill's production process.

The new bioproduct mill will increase the annual value of Finland's exports by EUR 500 million.

The increase in power will be handled by a generator with an apparent power of 325 MVA, and a new 2.6-kilometre electricity transmission line will also be needed alongside the existing line.

"The new transmission line will provide more security for electricity transmission. The line is also important because we will be selling significant amounts of the electricity produced by the bioproduct mill," says Line Project Manager **Jouko Kotilainen** from Metsä Group.

The equity ratio for the mill under construction will be 240%, which means that the mill can sell 1.4 times the electricity used to meet its own needs. Calculations show that the amount of electricity required by the mill will be equivalent to the electricity consumption of approximately 36,000 ordinary electrically heated houses during the same period of time.

PRECISE EXCAVATION ALONGSIDE A LIVE SWITCHYARD

The new bioproduct mill will increase the annual value of Finland's exports by EUR 500 million. Finland's combined electricity production capacity of some 11,600 MW will increase by approximately 3% as a result of the new electricity production capacity being built to provide the electricity for the bioproduct mill.

"We're building two new bays at Koivisto substation as well as a new main busbar system and reserve power machine. After this work is completed in December, our station will be ready to connect customer's new Äänekoski transmission line to the main grid ," says Fingrid's Project Manager **Petri Hämäläinen.**

"In order to transmit the electrical power produced by the customer to other parts of our main grid, we have a second project that involves building a new transmission line from Koivisto substation to our Vihtavuori substation."

Fingrid arranged a competitive bidding process for the substation work, which was won by TMV Service Oy. Along with installation work for the high voltage systems, the contract includes demanding excavation work in the immediate vicinity of the live and operational switchyard. This requires the contractor to observe very strict vibration limits.

"We've measured the maximum vibration acceleration of 0.5 g where the upper limit is 1.6 g. Staying within these limits ensures that the excavation work poses absolutely no risk to the system security of the production process," says Project Manager **Jukka Roponen** from TMV Service.

The substation extension also includes bus protection, which, along with the construction of a second transmission line, also contributes to improving security of supply to the bioproduct mill and other customers.

A BIG STEP TOWARDS A CIRCULAR ECONOMY

Although Metsä Group is, in terms of electrical energy needs, by far the largest recipient of electricity from Koivisto substation, it has signed the same connection agreement with Fingrid as every other customer. Of course, the stimulus for Fingrid's construction decision was the investment decision made by Metsä Group.

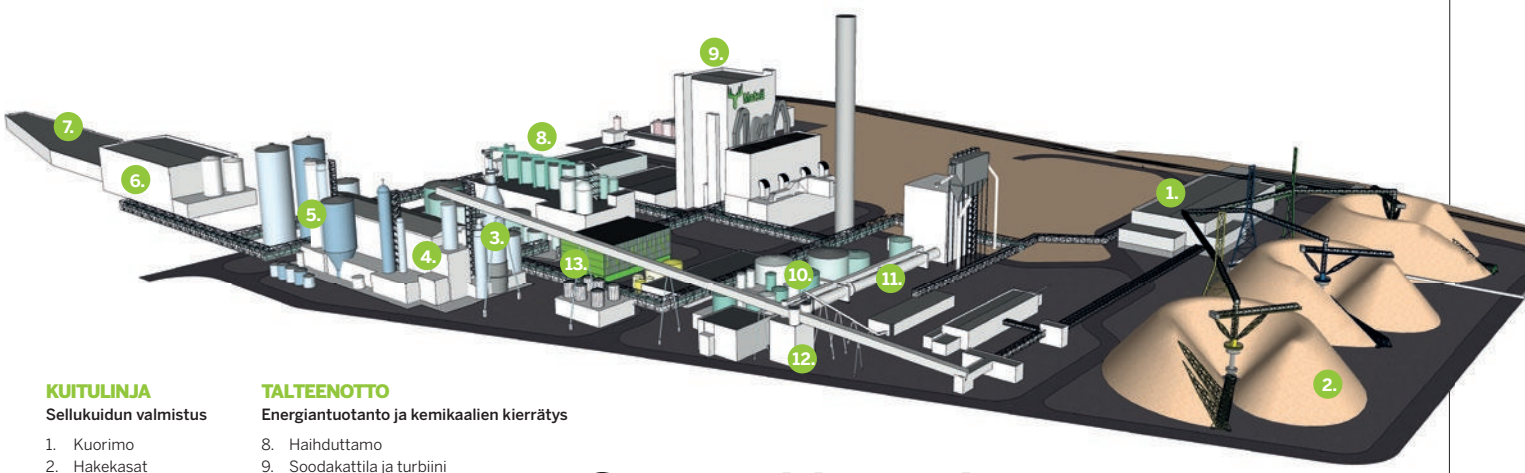
Total electricity production at the new bioproduct mill will be some 1,800 GWh per year. A total of 640 GWh of district heating and steam will also be produced in the process. Approximately 550 GWh of "wood energy" will become available for sale each year, while the mill itself will use the bark from the bioproduct mill to produce biogas.

Metsä Group's Äänekoski bioproduct mill will not use any fossil fuels. All of the wood raw material and production side streams will be utilised. This means that the mill will serve as an important industrial step towards a circular economy.

The majority of the wood raw material will come from Finland. In this case, only softwood from the northern hemisphere meets the quality criteria for long-fibre. This will result in pulp of the highest possible quality. •

Bioproduct mill will not use any fossil fuels. All of the wood raw material and production side streams will be utilised.

ÄÄNEKOSKEN BIOTUOTETEHDAS



KUITULINJA
Sellukuidun valmistus

1. Kuorimo
2. Hakekasat
3. Keitin
4. Pesu
5. Valkaisu
6. Kuivaus
7. Selluvarasto

TALTEENOTTO
Energiantuotanto ja kemikaalien kierrätys

8. Haihduttamo
9. Soodakattila ja turbiini
10. Kaustisointi
11. Meesauuni
12. Kuoren kaasutus
13. Tehdaskonttori

Several bioproducts from the process

Although pulp will be the main product of the Metsä Group bioproduct mill, it will also produce tall oil and turpentine, among other things. The mill has been designed so that lignin can be utilised at a later time, for example, as a raw material for construction products.

Another key part of the investment is bark gasification equipment, which will turn bark into fuel for internal use. This will replace some 45,000 tons of heavy fuel oil each year. Metsä Group's Äänekoski bioproduct mill will not use any fossil fuels whatsoever.

The sewage sludge from the pulp production process will be refined into biogas in a digestion plant being built in conjunction with the mill. This will be sold as traffic fuel by a Metsä Group partner. •

Lignin is *a natural polymer found in wood; it is a component functioning as a binding agent between the fibres. Around 20–30% of wood is lignin, and it gives wood its yellowish colour. Lignin has a mesh-like structure, which makes it difficult to isolate. New methods enable using lignin in materials suitable for composites, surfacing binding agents, and protective layers.*

The many uses of lignin

FORMED IN A RECOVERY BOILER as a side stream of the pulping process, lignin has a lot of existing and future uses in which traditional industrial and construction products can be completely or partly replaced by lignin. There is a good market for lignin in the construction and car industries, where it provides sustainable options for replacing the phenols used in plywood and wood panel adhesives and polyol used in foams. However, good pulp sales are a prerequisite for lignin production.

THE CAR INDUSTRY, especially in Sweden and the United States, has been studying the suitability of lignin as a raw material for carbon fibre for years. Carbon fibre can be produced entirely from lignin. Lignin-based carbon fibre could replace steel, thus making cars up to 50% lighter than they are now.

Another promising area is construction materials, where lignin replaces the synthetic phenols used previously in particle board and plywood adhesives. Lignin can also be used to produce polyolefins, which are subsequently refined into polyurethane foam for use as an insulation material.

Lignin is also suitable for transport fuel and chemicals. Researchers in Sweden are actively studying a technology to refine lignin into a replacement for crude oil that can be used in oil refineries.

LIGNIN IS a side stream of the normal pulp production process, and is burned in a recovery boiler as part of black liquor. A new separation technique makes it possible to utilise lignin, thus reducing the amount of black liquor in the recovery boiler. This decreases the emissions from pulp production, which is beneficial when trying to meet increasingly strict environmental permit conditions that apply to the pulp industry. •

Tons of Fingrid's waste recycled and utilised

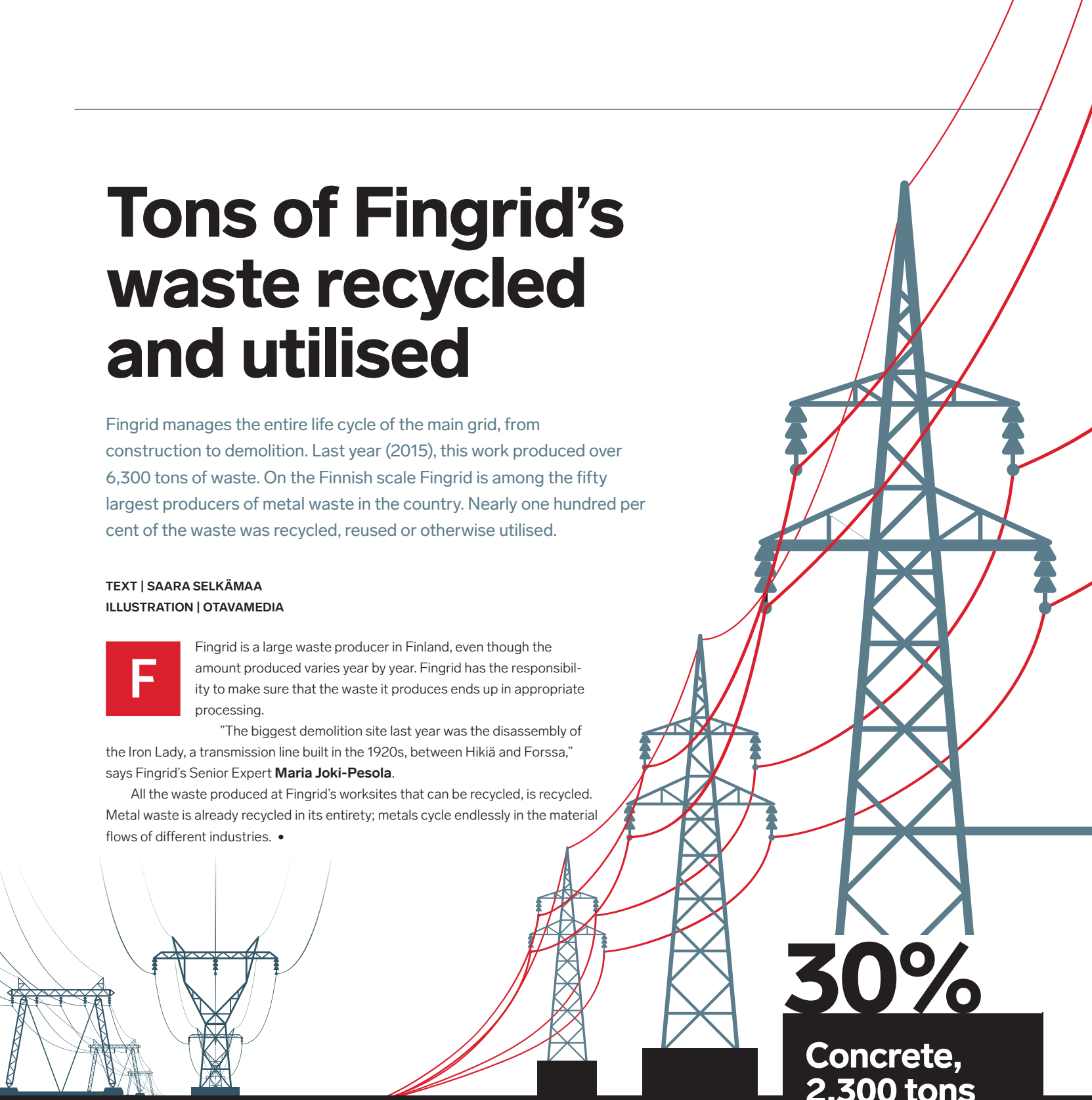
Fingrid manages the entire life cycle of the main grid, from construction to demolition. Last year (2015), this work produced over 6,300 tons of waste. On the Finnish scale Fingrid is among the fifty largest producers of metal waste in the country. Nearly one hundred per cent of the waste was recycled, reused or otherwise utilised.

TEXT | SAARA SELKÄMAA
ILLUSTRATION | OTAVAMEDIA

Fingrid is a large waste producer in Finland, even though the amount produced varies year by year. Fingrid has the responsibility to make sure that the waste it produces ends up in appropriate processing.

"The biggest demolition site last year was the disassembly of the Iron Lady, a transmission line built in the 1920s, between Hikiä and Forssa," says Fingrid's Senior Expert **Maria Joki-Pesola**.

All the waste produced at Fingrid's worksites that can be recycled, is recycled. Metal waste is already recycled in its entirety; metals cycle endlessly in the material flows of different industries. •



30%

Concrete, 2,300 tons
(30% of waste)

- In old foundations
- Concrete is pulverised for reuse
- Used in Finland in construction of roads, sports fields and streets
- Saves natural resources, i.e. the use of virgin stone material

Largest waste components

Calculated in tons, the largest waste components in 2015 were:

10%

Conductors, or Feral 623 tons
(10% of waste)

- On transmission line worksites and at substations
- Feral contains steel and aluminium
- In addition to aluminium, demolition waste also includes another valuable metal, copper
- Aluminium and copper usually end up for reuse in Asia, where the market for metals is large
- Scrap metal is utilised in the foundry industry, for example

19%

Steel 1 200 tons
(19% of waste)

- In substation equipment and structures
- In transmission line towers
- Recycled and utilised in both Finland and Europe
- Used especially by the car industry for component manufacture

Other waste components:

Wood

- Impregnated wood in transmission line towers
- Clean wood in equipment transport packaging
- Impregnated and clean wood are chipped in different places, then both are burned for energy

Oil

- In substation transformers
- Reused as saw chain oil, for example
- Oily waste is also produced in reserve power plant maintenance
- Burned for energy in hazardous waste processing

Glass and porcelain

- For example in insulators and instrument transformers
- Recycled as raw material for glass wool and foam glass products, for example

Good relations with Russia

Yrjö Repo has worked as a Russian-language interpreter and translator since the Kekkonen era.

TEXT | KATI SÄRKELÄ
PHOTO | ARTO WIIKARI

Joensuu native Yrjö Repo began his career at Imatran Voima in 1976. The first unit of the Loviisa nuclear power plant had just been completed and electricity production was launched in cooperation with a Soviet supplier. The contribution made by interpreters was absolutely essential. The partners shared no language, no one spoke English, and all of the worksite meetings and planning were conducted in Finnish and Russian. It took several years to commission the units, and Loviisa 2 began operating in 1980.

President **Urho Kekkonen** and Prime Minister **Alexey Kosygin** of the Soviet Union inaugurated the new nuclear power plant. Repo did not meet the two men personally, because some of his group had to work despite the VIP visit.

"Planning of the third unit at Loviisa went on for several years with the Soviets. However, the unit was never actually built. The accident at Chernobyl and increased opposition to nuclear power probably had an impact on political decision-making," comments Repo.

WORKING IN THE SOVIET UNION

After completion of the Loviisa plant, the Imatran Voima headquarters in Helsinki became Repo's workplace.

"Back in the 1980s and 1990s, I spent a lot of days working in the Soviet Union – in Moscow and the former Leningrad," says Repo.

"My wife and I liked to joke that seeing each other only on weekends for the first three years of our marriage kept our relationship healthy."

Although Repo's main duties involved serving as a translator, he also led trips and helped people understand Russian customs and social rules.

"I took care of the group. My travel companions asked for advice on how to greet their hosts or suitable ways to open a conversation."

"We worked long days, and discussions often continued at the dinner table after working hours. I ate whenever I could while simultaneously interpreting conversations that became increasingly lively as the hour grew later."

SOLID COOPERATION BETWEEN TWO COUNTRIES

Although the Soviet Union became Russia and the name of Repo's employer became Fortum, cooperation with the Russians and business trips to Russia continued. Yrjö Repo was there when the Russians participated in delivering the Joensuu power plant in 1986. Later assignments included working with a power plant that the Finns delivered to the St Petersburg region in the late 1990s. Yrjö Repo began working for Fingrid as a business assistant in 2003.

"It feels like my work has become more stable in recent years, perhaps because the electricity business has found its own way of functioning. The market operators have also remained the same in Finland and in Russia, we have valid agreements and the systems work. Earlier on, we never knew where our job might take us in the evening."

Repo's duties still include interpreting, translation and serving as a contact person. Supporting cooperation between the St Petersburg power system in Northwest Russia and Fingrid's power system centres is a central part of his current duties.

Yrjö Repo keeps up with events in Finland's neighbouring country via Russian newspapers and news websites. A good understanding of the culture is essential to avoid bringing up volatile issues at meetings.

"Sports, and ice hockey in particular, is always a safe topic with Russians," advises Repo. He says that Russians really aren't all that different from Finns in terms of business collaboration. They are sincere and easy to talk to.

"For example, Russians are more like Finns than the Swedish people are. In fact, Russians and Finns actually share some similarities in terms of their nature." •

The contribution made by interpreters was absolutely essential. The partners shared no language. No one spoke English.

On 6 December 2015, Yrjö Repo was awarded the Order of the White Rose of Finland and the Cross of Merit of the Order of the Lion of Finland in honour of his career working with Finnish and Russian energy cooperation.

During the 20-year history of the EIA Act, over 700 projects involving the EIA procedure have been launched in Finland. Fingrid's projects number nearly 40 of these.

The interactive aspect of transmission line projects has increased over the years

The EIA values people's opinions and the environment

The EIA procedure of a transmission line project investigates the project's impact on people and nature in the area. Residents are asked to provide feedback on transmission line routes, and the terrain is inspected from several points of view. "We genuinely want to take people and the environment into account and to do things well and in a cooperative spirit. We are constantly improving the flexibility of our EIA process," says Fingrid's Land Use Manager, Ilkka Alm.

TEXT | ANNELI FRANTTI
PHOTO | FINGRID

The EIA, the statutory Environmental Impact Assessment, commences at the same time as the preliminary planning of the transmission line. The EIA ensures that the environmental impacts on the project area and people are identified in time and mitigated early, in the planning of the transmission line route. The aim is to cause as little inconvenience to the environment, landowners and residents in the neighbourhood – without endangering the system security of the main grid and uninterrupted supply of electricity, of course.

"For a successful project, it's essential that people living in the area can influence and state their opinions on transmission line routes in good time. This way, requests for changes can be best taken into account."

In recent years, Fingrid has taken the initiative to increase people's opportunities to have their say. Earlier, information events were only announced in the area's newspapers, as required by law, but now, in addition to newspaper ads, property owners living or spending time at their cottages near the transmission line route are also personally invited to come and hear about the transmission line project. Project planning can also be commented on via Fingrid's electronic feedback system.

"People impacted by the transmission line don't always live in the area permanently, or they don't have access to the local newspaper where the information event is announced. Thanks to the invitations, we have been able to reach people better and open communication channels for dialogue."

ON OTHER PEOPLE'S LAND

Fingrid's transmission lines are mainly located on other people's land. That's why landowners are, numerically, Fingrid's largest interest group. They also provide the company with the most feedback.

"During the EIA process, impacts caused by the transmission line project are investigated for different alternative routes. Finally, decisions on the project are made based on the information produced by the EIA, feedback from people and technoeconomic reviews. As the tower locations are more closely specified, many landowners have been able to participate in the project thanks to early communications. Even at this stage, we try to take possible comments into account", says Alm.

"Fingrid has, on average, 2–3 EIA processes underway each year. The EIA process is always used for transmission line projects involving a 400- or

220-kilovolt line over 15 kilometres long. In smaller 110-kilovolt transmission line projects, a lighter environmental assessment is usually sufficient."

According to statistics, during the over 20-year history of the EIA Act, over 700 projects involving the EIA procedure have been launched in Finland. Fingrid's projects number nearly 40 of these.

THE EIA ACT CAME INTO EFFECT IN 1995 AND IS NOW BEING FURTHER SPECIFIED

The Act on Environmental Impact Assessment Procedure came into force in 1995. Before this, route planning for transmission lines was generally carried out on a map, though still taking landowners, settled areas and the environment into account. Preliminary route negotiations took place between the authorities. Landowners were informed only when planning proceeded to terrain surveys.

"Consequently, requests for changes could only be made at a rather late stage, making their approval uncertain. After all, changing the location of a single tower may have quite extensive repercussions on both sides of the tower. The EIA brought along the desired opportunity for early influence," Alm continues.

The first environmental assessment for a transmission line area, anticipating the entry into force of the Act, was made for a project by Imatran Voima in the Kokkola-Oulu area in 1991.

Likewise, Fingrid's first statutory EIA was made in the Oulu region in 1995.

The EIA of the time was 20 pages in size, while current environmental impact assessments may well be ten times that, with 200 pages and map attachments.

"These days, there are more environmental regulations and demands by people and the environment. The EU has increased the importance of rare species, such as the Flying Squirrel in forests and the White-tailed Sea Eagle on coasts. One example of the increasing significance of natural values is a transmission line project currently underway in Pyhäjoki; the area is very valuable in terms of its avifauna, so exceptionally extensive nesting and migratory bird studies were carried out, taking the values concerning birds as the starting point for planning."

At the moment, the EIA Act is being updated to develop the quality of the EIA procedure and to bring its content requirements up to date. The aim is to increase flexibility in authority operations, as well. For example, the same issues wouldn't need to be investigated in the terrain several times, but information already collected could be utilised in different permit processes. As such, the EIA procedure will be more closely linked e.g. with Natura assessments and project zoning. •

The update to the EIA Act aims at increasing the flexibility in authority operations and utilising information already collected.

Phases:

LAUNCHING A PROJECT

- Preliminary route planning begins
- The EIA procedure isn't a permit process but a tool for planning
- Results of the EIA must be taken into account in the permit assessment.

DRAWING UP AN EIA PROGRAMME

- Presenting the different implementation options and impacts to be investigated
- The project is introduced in public meetings
- Residents can now give feedback to Fingrid and the ELY centre.

ASSESSMENT

The procedure deals with the various options of the project and the impacts on issues such as:

- Human health, living conditions and living comfort
- Soil, water, air, climate, flora, fauna and biodiversity
- Community structure, buildings, landscape, townscape and cultural heritage
- Utilisation of natural resources, and
- Their mutual interaction.

RESULTS OF THE ASSESSMENT WORK ARE COMPILED IN AN ASSESSMENT REPORT

- The report compares the alternatives and feasibility of the project
- The report is introduced in public meetings
- Feedback can still be given to the ELY centre
- Authority statements and opinions are compiled
- The EIA procedure comes to a close after taking an average 1.5 years
- (Demands for large changes require new environmental assessments and slow the project down up to several years.)

AFTER THE EIA PROCEDURE

- Fingrid selects the route for further planning
- Terrain surveys and general planning begin
- Applying for research and project permits as well as the expropriation permit; the EIA is appended to all of them.

Fingrid gives instructions and advice for projects located in the vicinity of a transmission line. A written statement on land use for transmission line icrossings is available free of charge.

What is a transmission line crossing?

A transmission line crossing is a general term for projects where something crosses the transmission line; it can be a road, street, railway, boat channel, ditch, cable, noise barrier etc. Buildings in the immediate vicinity are also included in the crossing. Generally, a crossing is any structure or activity located in the vicinity of a transmission line.

TEXT | ANNELI FRANTTI
PHOTO | FINGRID

What should I do if my worksite seems to cross a transmission line?
"When constructing a road, for example, or considering the location of buildings near a transmission line area, it's a good idea to contact Fingrid as early as in the planning phase. Fingrid gives a written statement, free of charge, on land use, explaining how the project can be implemented near a transmission line. The statement always includes a map," says Fingrid's Specialist **Heidi Oja**.

"The statement can be requested via the map service on our website. You can also call us, and we can give advice over the phone. A written statement on each transmission line crossing is always given."

Is there a rule of thumb on how close to a transmission line it's safe to operate?
"The rule of thumb is that while working, you shouldn't go any closer than five (5) metres to the conductors of a transmission line. That way, the distance to the conductors remains sufficient. However, a typical crossing doesn't exist; each crossing must be assessed on its own merits. We send out about 400 crossing statements a year."

"Sometimes people end up in the transmission line area without noticing, as their worksite expands. In such a case, you should call Fingrid right away and ensure safe working distances to the transmission line.

Likewise, it's essential to communicate with everybody on the worksite about possible hazards relating to the transmission line. When there are several contractors on the site, it isn't enough that one of them has the information.

Why do excavations need special instructions? Or people moving on the water?
"The transmission line crossing can also exist below ground, when for example an underground cable is dug beneath a transmission line. Furthermore, transmission lines have underground structures, earthings. Earthings begin at a tower and can extend from one tower to another, or just for a few dozens of metres. This is one of the reasons excavations need instructions."

"The height of transmission lines above boat channels is marked in the terrain and on the waterway map. Thus, boaters know how high the boat's mast can be for safe navigation under the line." •

Who should I contact?
The request for a crossing statement is sent by email:
risteamalausunnot@fingrid.fi
via the map service on Fingrid's website.
By post:
Fingrid Oyj / Risteämälausunnot
P.O. Box 530 , FI-00101 Helsinki
The statement request requires a map or a ground plan of the project's location, as well as the applicant's name and address, and a phone number for additional

Power quality measurements improve security of supply

In early June, Fingrid provided its customers with a new extranet service for power quality information, thus giving the company's customers an even more detailed and descriptive picture of power quality at their connection points. This makes it easier to monitor the state of the electricity grid and further improve the security of electricity supply.

TEXT | VESA TOMPURI
ILLUSTRATION | FINGRID

The security of electricity supply has become increasingly important as society has become more dependent on electricity. Weather-related phenomena, such as storms and lightning, cause the greatest number of quality problems for main grid customers. Disturbances in the customers' own equipment or an exceptional load can also lead to deviations in power quality.

Electricity loads and electricity production connected with frequency converter technology increase the need for more accurate monitoring of power quality.

"Frequency converter technology is used with wind and solar power. This presents challenges for power quality that can be better monitored with new energy meters," states Specialist **Antti Kuusela** from Fingrid Oyj's Grid Services unit.

In addition to security of supply, power quality involves ensuring that voltage fluctuations in the grid occur as rarely as possible and remain as small as possible. The new quality information extranet service developed by Fingrid means that the process of locating and monitoring these swells and dips in voltage is now more comprehensive and flexible.

The service is made up of graphic screens, tables and event logs. Service users can check the time series and log data for voltage level and flicker at their main grid connection points. Log data allows customers to examine local swells and dips in voltage at different times.

"This ensures that quality deviations in the electricity grid are accurately recorded, which also helps with grid planning and operation and makes it possible to plan and forecast the need for outages and maintenance measures," explains Kuusela.

MORE THAN 1,000 NEW METERS

The replacement of Fingrid's energy meters made it possible to implement this new type of service. The company has recently changed a total of 1,000 energy meters, which have power quality measurement features in addition to their main purpose.

"In other words, these meters have sufficient measurement capacity to provide us with a large amount of big data for processing. Powerful information systems play a key role when it comes to compiling measurement data about voltage fluctuations and other power quality properties throughout the main grid," says Energy Measurement Specialist **Olli Taipale** from Fingrid.

Taipale also reminds us that the metering point of the energy meter must be taken into account when examining quality information. It can also be located in the distribution grid rather than at the main grid connection.

The actual energy meters represent the best possible energy measurement accuracy class of 0.2S. When measuring power quality information, the same energy meter represents Class B of the power quality measurement standard (IEC610000-4-30). With regard to time series for power quality measurements, approximately 4.3 million events per day are currently collected in the database.

Power quality information from energy meters provides extensive monitoring material related to power quality at the connection points. If significant deviations in power quality are detected at a connection point, a thorough power quality measurement is performed with a separate analyser brought to the site. •

Power quality information from energy meters provides extensive monitoring material related to power quality at the connection points.

How the customer benefits from the new extranet

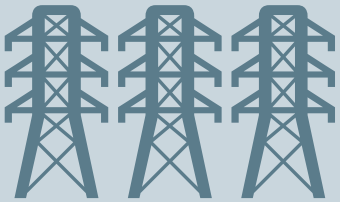
MONITORING THE STATUS OF THE ELECTRICITY GRID:

- DIPS AND SWELLS IN VOLTAGE
- FLICKER AND VOLTAGE TIME SERIES
- OUTAGES AND MAINTENANCE PLANNING

RENEWABLE ENERGY PRESENTS CHALLENGES TO SECURITY OF ELECTRICITY SUPPLY

WEATHER RISKS TO SECURITY OF SUPPLY INCREASE

INFORMATION TECHNOLOGY AND QUALITY METERS CAN IMPROVE RISK MANAGEMENT



TRANSMISSION RELIABILITY OF THE MAIN GRID

99,999%

Ensuring security of supply is vitaland preparedness in exceptional circumstances

The Power and District Heat Pool is a voluntary cooperation body between authorities and energy companies whose role it is to ensure the preparedness of the national power system in normal circumstances, in severe disturbances which occur under normal circumstances, and in exceptional circumstances.

Security of supply and preparedness in exceptional circumstances were discussed at the national preparedness day from several perspectives. The event also celebrated 60 years of the Power and District Heat Pool.

TEXT | KATI SÄRKELÄ
PHOTO | VESA TYNI

Director-General Riku Huttunen.

In his speech, Director-General at the Ministry of Economic Affairs and Employment **Riku Huttunen** gave an overview of society's security of energy supply. The targets in the Government Programme also steer the security of energy supply, and one key project is the energy and climate strategy, which extends to 2030, outlining the cost-efficient transition to renewable energy.

According to Huttunen, the transition to carbon-free energy must be controlled and energy sufficiency must be safeguarded in the changing situation. He considers it good that there is support for renewable energy production and innovative projects.

"The amount of biofuels is increasing in both traffic and in the production of heat and electricity. The use of fossil fuels is ever decreasing, and the loss of condensing power plants will reduce the significance of coal."

President and CEO **Jukka Ruusunen** then presented Fingrid's concern from an electricity market development perspective.

"Electricity market functionality is also a security of supply issue. We need to consider how to fit national interests together with the joint Baltic Sea region's interests or European interests."

Ruusunen pointed out that as modern society is built to be increasingly dependent on electricity, we must be able to store electricity better than ever. Before future production and storage technologies become commonplace, we have to take good care of sufficient energy production and infrastructure.

Read more about the "What can we do to strengthen the electricity markets?" discussion initiated by Fingrid on page 12.

THE POWER AND DISTRICT HEAT POOL IS COMMITTED

The Power and District Heat Pool plays a key role in preparedness for crises and exceptional circumstances, and according to monitoring reports, its operations have been satisfactory.

In his speech, CEO of the National Emergency Supply Agency Raimo Luoma shed light on the Power and District Heat Pool's formation, its history and its modern day operations.

Representatives of the Finnish Defence Forces Lieutenant Colonel Janne Rautiainen and 1st Lieutenant Engineer Kati Kettunen explained about security of supply in a military environment.

Centre: Director-General of the Ministry of Economic Affairs and Employment Riku Huttunen; right: Fingrid's Reima Päivinen, responsible for power system operations.

The pool has a common goal: Coordinating the whole requires strong, industry-specific competence from representatives of various parties.

"A close and committed partnership between private and public sector actors can be seen in the emergency supply organisation," says **Raimo Luoma**, CEO of the National Emergency Supply Agency.

Nowadays there has been a move away from material preparedness towards the safeguarding of critical infrastructure and processes. Cyber security is also one of the challenges we currently face.

Luoma highlighted the importance of Nordic cooperation. "Regional preparedness operations changed along with the regional administration reform, and this is expected to have an impact on the future structure and operations of the emergency supply organisation."

Representatives of the Finnish Defence Forces Lieutenant Colonel **Janne Rautiainen** and 1st Lieutenant Engineer **Kati Kettunen** explained about security of supply in a military environment. Like modern society, the Finnish Defence Forces' operations are heavily dependent on electricity. A shovel is the only piece of modern equipment that does not require electricity to work, joked Kettunen.

"Operational reliability is highly dependent on the availability of electricity and efficient batteries, and the level of consumption rises in subzero temperatures.

Electricity safeguards combat endurance and troop self-sufficiency. In field maintenance, it is essential to anticipate what is needed and when. Maintenance is largely based on replacement equipment.

The Finnish Defence Forces' operations are steered by environmental targets and sustainable development.

Kati Kettunen became the first female member of the Power and District Heat Pool in 2015.

"I represent the Finnish Defence Forces, but of course the pool has a common goal. Coordinating the whole requires strong, industry-specific competence from representatives of various parties." •

Striving for good system security

The System Operation Guideline was approved by the EU member states in a vote on May 2016, and most of the joint requirements will take effect in 2017.

TEXT | TIMO KAUKONEN
PHOTO | FINGRID

The System Operation Guideline, formerly known as network codes, sets minimum requirements and joint harmonised operational codes for transmission system operators (TSO), distribution system operators (DSO) and electricity producers and consumers. Other requirements for TSOs include compiling more detailed common methods and operating methods (methodologies), regarding which stakeholders will be publicly heard before they are sent to the authorities for approval.

WILL SYSTEM SECURITY IMPROVE?

The new Guideline will harmonise operational planning and control activities and thus contribute to maintaining good system security. Increased information exchange and continuous cooperation in, for example, a regional system security coordination office, will also improve the situation.

Market expansion and the spread of new forms of electricity production in the industry mean that electricity grid transmissions and operational situations are in a state of constant change, which makes them difficult to forecast. Although it will still be impossible to completely avoid power system disturbances in the future, the new rules provide a good framework for keeping the system security of the electricity system at a quality level.

MONITORING BECOMES MORE COMPLICATED, QUALITY IMPROVES

One of the basic principles of system security in the future will continue to be the so-called (N-1) principle, according to which the power system should be able to withstand any possible individual fault without experiencing any consequences in another area. Deviations may be made from the (N-1) principle during changes in connections, during the activation of reserves, or if the effects of the disturbance are concentrated in a small area.

System security will still be reviewed using network calculation software based on European grid models, so that the calculations focus more on the probabilities and impacts of the faults being examined.

Fault cases are classified as ordinary, exceptional or out-of-range. If the probability of exceptional or out-of-range faults increases significantly as a result of weather conditions, they should be included in system security reviews. Dynamic oscillations should also be examined and the operational situation of the power plants changed if necessary in order to maintain stability after the disturbances.

MORE INFORMATION EXCHANGE AND TRAINING

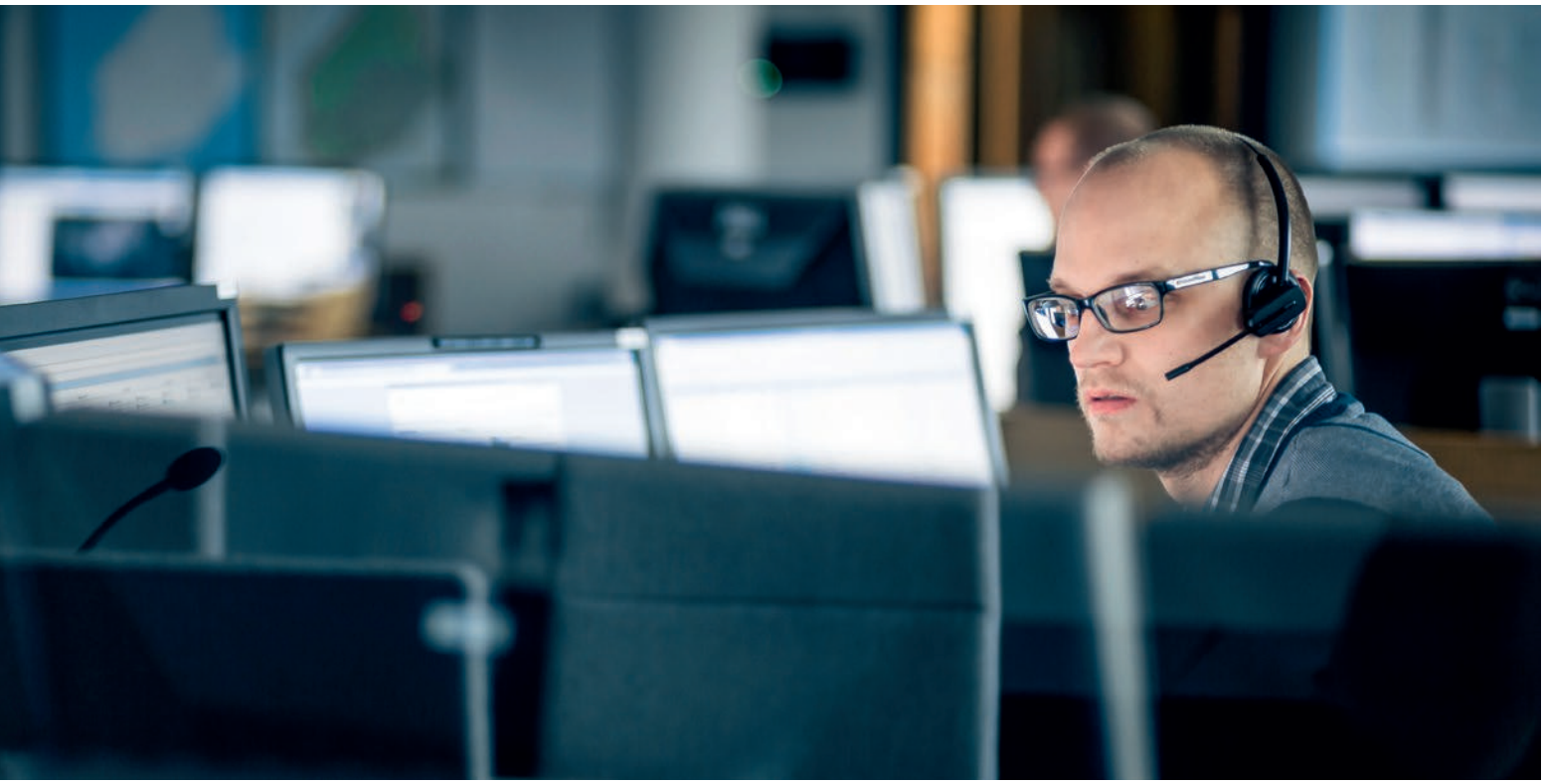
Each TSO should plan and monitor the electrical system's frequency, voltages, transmission flows and connection status in real time and exchange necessary information with the TSOs in neighbouring countries. This makes it possible to identify exceptional circumstances rapidly so that TSOs can cooperate to restore the situation to normal.

The exchange of planning information and real-time data between parties connected to the grid will be improved in order to bring overall management to a better level in operational situations that are changing more than ever.

An essential component of the maintenance of system security is professional operations personnel, whose training will be developed in a more formal direction. People working in power system control room tasks must have a valid operator certificate. The planning and development of the training will also be improved by naming an experienced training coordinator for each TSO, who will be responsible for the planning and implementation of the training programme.

EARLIER OUTAGE PLANNING, MORE ACCURATE CALCULATION

In terms of operations, the Guideline specifies in detail how TSOs and other parties connected to the grid should handle cooperation and the exchange of information to achieve good system security. An important part of this work is the creation of a common European grid model for system security reviews and the calculation of transmission capacity. The model will be used to calculate transmission



The people responsible for the power system, grid management, balancing production and consumption and operational planning work at the Main Grid Control Centre, which is located in the Käpylä district of Helsinki. These facilities allow for good information exchange and cooperation.

The exchange of planning information and real-time data between grid parties will be improved in order to bring overall management to a better level in changing operational situations.

capacity for various periods of time: year, week, day and intraday. This minimises errors in calculation results because all of the calculation parties have access to the same, more accurate input data.

A common plan and schedule for transmission outages will be compiled in order to help ensure adequate transmission capacity during outages and preserve a good level of system security. In the future, the mapping of outage needs that cause restrictions in transmission will begin earlier than previously. A party which is connected to the grid should submit its outage needs for the next year to its transmission system operator by 1 August.

Parties connected to the network and the TSO will further specify the plans as necessary during the autumn before the final plan is completed by 1 December.

System security is also ensured by preparing for power sufficiency during summer and winter by performing the corresponding forecasts and ensuring that the adequacy of active and reactive power reserves is monitored.

MORE ACCURATE PARAMETERS FOR FREQUENCY CONTROL

With regard to frequency control and reserves, the Guideline provides more specific details concerning how TSOs should handle frequency control and the use of reserves in cooperation with other TSOs within the same frequency area. The Guideline also sets limit values for the frequency and for the reserves associated with maintaining it and for their parameters. These parameters will help to determine the system security level of the interconnected Nordic grid and also the maximum size of a power plant that can be connected to the grid.

NORDIC REGIONAL SECURITY COORDINATOR (RSC) WILL OPEN IN DENMARK IN 2017

The EU Guideline requires that regional security coordinators (RSCs) be established to ensure cooperation. The new RSCs will produce services for the TSOs, which will still be responsible for system security and the required control room actions.

The common RSC for Nordic TSOs will be set up in Copenhagen and will begin operating at the end of 2017. The Nordic RSC will produce services for TSOs in the following areas:

- Creating a common grid model
- Calculating transmission capacity
- Performing system security analyses
- Planning the scheduling of outages
- Analysing power adequacy for short and mid-length periods of time. •

Transmission line areas are full of potential

Although Fingrid's transmission line areas carve out over 60,000 hectares of Finnish land, their limitations are far outweighed by their potential. Transmission line areas offer a foundation for a wealth of potential applications.

TEXT | SAARA SELKÄMAA
PHOTO | FINGRID

We can even support the achievement of national targets, such as natural diversity.

The main grid managed by Fingrid includes approximately 14,000 kilometres of transmission lines and over 63,000 hectares of transmission line areas, of which approximately 52,000 hectares are forest, approximately 10,000 hectares are field and approximately 1,000 hectares are bodies of water. Fingrid has redeemed restricted rights of use to the transmission line areas.

"Fingrid does not actually own the land underneath the transmission lines, but it does take care of clearing," explains **Max Isaksson**, a Special Adviser at Fingrid.

The landowner can use the area in many ways as long as use does not disrupt the maintenance of transmission lines and providing that electrical safety is taken into account.

Fingrid extensively views all of its transmission line areas via its ecosystem service approach. The ecosystem service refers to material or immaterial benefits produced by nature and which are advantageous to people, society and nature. This approach aims to highlight concrete benefits of transmission line areas, such as berry-picking and cultivation.

"By utilising transmission line areas appropriately we can even support the achievement of national targets, such as natural diversity, explains Fingrid's Environmental Adviser **Tiina Seppänen**.

A MEADOW OF RARE SPECIES

Transmission line areas are cleared regularly. Light and open areas are important to species which have suffered as a result of the decrease in meadows. For example, the Pohtola transmission line area in Tampere is managed to protect the endangered false heath fritillary butterfly. Another rare species that thrive in transmission line clearings is the rattle grasshopper. Many small mammals and predators also make their homes in or on the fringes of transmission line areas.

Sometimes a transmission line area is located in a place that makes it difficult to manage using machinery. Four-legged summer workers have been called in to help.

"You can tell it's summer at Fingrid when you see the sheep head out into the transmission line areas to cut the grass," says Seppänen.

Sheep have grazed on Luoto island in Nokia and in the Hätilännotko green area every summer since 2010.

A CHRISTMAS TREE FARM OR A GOLF COURSE

Transmission line areas are used in a wide range of ways such as for exercise, hiking, farming, research, education, gravel-taking, gardening and beekeeping, to name a few. Depending on the landowner's wishes, a transmission line area can either be utilised or simply be pleasing to the eye.

The overwhelming majority of transmission line areas are forest. Forest areas allow for hiking, berry-picking and mushrooming, not to mention Christmas tree farming. Thanks to their good visibility and low-lying vegetation, transmission line areas are also suitable for hunting.

Although transmission line areas are already used diversely, there is potential to make even better use of the areas. Transmission line areas can also be used in surprising ways. In Imatra, for example, there is a golf course under the transmission lines. Frisbee golf is also possible in transmission line areas. Just make sure that you throw and catch away from the transmission lines to avoid the ball or frisbee from becoming stuck or damaging the transmission line insulators. •

Read more:

Fingrid's report Voimajohtoalueiden ekosysteemipalvelut (Ecosystem services of transmission line areas; in Finnish)
www.fingrid.fi

Fingrid is a pioneer that initiates discussion on topics related to its industry. In this series, we participate in the discussion by highlighting electric novelties and current phenomena.

Do you want to suggest a novelty product or current topic for this series? Send your ideas via the Shortcuts link on our front page at www.fingrid.fi. People who send ideas participate in a prize draw for linen towels by Jokipii.

Braving the board

This year has introduced balance boards, or balance scooters, also known as electric people movers, on sidewalks and in traffic. Fingrid's thesis worker **Jesse Majuri** volunteered to test the novelty.

TEXT | ANNELI FRANTTI
PHOTOS | VILLE RINNE

M Majuri, who examines wind power in his thesis, had received a Deal With It balance scooter, or hoverboard, by Extension for testing a couple of days earlier. In the photo shoot, he was already riding the board like a pro.

"It was quite the balancing act in the beginning. The board moves forwards and backwards when I lean in the direction I want to go. It's better to start on level ground, because when I went uphill the first time, I lost control of the board and nearly fell. Care is needed and always wear a helmet," he says.

Majuri thinks it's nice to drive around on the board. The hoverboard's big, ten-inch wheels mean that it goes over small bumps without a hitch. The smaller, 6.5-inch wheel size is more challenging on stone pavement, for example. Parking presents a problem; where can you leave it?

"It isn't easy to lock the board onto anything, and you definitely can't leave it out in the rain." Carrying the nearly ten-kilo board is hard work, too. Thus, the board is at its best as a leisure-time vehicle and for joyriding. •

See Jesse's test video: www.fingridlehti.fi

DEAL WITH IT -BOARD:

- *Weight 9.5 kilos*
- *Price about 500 euros*
- *Speed max. 15 km/h, comparable to pedestrians in traffic.*
- *Operating range 15-30 km*
- *Charging time 2-3 hours*
- *It's best to be present during charging. The board is disconnected as soon as charging is finished.*
- *Electric people movers were approved for traffic use in Finland at the start of 2016.*

Pekko Vehviläinen is a Doctor of Technology, consultant for digital healthcare services and the most quantified man in Finland.

Smart grids in our bodies and control rooms for health robots

Did you know that in our bodies, we have a smart grid: the circulatory system? It's an evolutionary product over 600 million years old; it came about as coelenterates (creatures such as sea anemones and jellyfish) evolved into bilateral animals. The development of the circulatory system was necessary for the evolution of organisms, because until then, communication between cells was based on a chemical reaction, diffusion. Diffusion, however, requires that the cells be adjacent, and as a reaction, it is slow. Compared with diffusion, the circulatory system is much faster and more efficient in transmitting energy and information. Thanks to the circulatory and nervous systems, cells were able to evolve and specialise into more complex organs. At the same time, the organism's ability to explore and modify its habitat improved.

The task of the circulatory system is to transfer oxygen and glucose for use by other cells. It's also an information channel, in which hormones travel from glands to their different tasks. Moreover, the capillary system participates in the regulation of the body temperature. But could the circulatory system be even better and smarter?

Nanorobots are an innovation created by technological development. In the future, they can travel in the network formed by our blood vessels. There are ideas to task medical nanorobots with delivering and targeting medication. Robots could also destroy cancer cells as well as deliver insulin and other hormones. Swiss and Israeli researchers have already developed a nanorobot which moves in a fluid thicker than blood using its small fins. The robot receives its instructions with the help of a magnetic field. On the other hand, a magnetic field is somewhat clumsy and may not be easily accessible outside a hospital. That's why an alternative energy source for nanorobots is being sought, for example among fuel cell technologies. So-called biofuel cells have already been manufactured in laboratories; but at the moment, their large-scale use is hampered by challenges in energy production.

Smart implants are an intermediary stage on the path towards nanorobots. A project by the United States Department of Defense is especially interested in launching physiological functions that prevent infection in the nervous system and the spine, as well as affecting the resistance to stress and the prevention of depression. Naturally, the aim is to improve the fighting ability and recovery of soldiers.

In a project initiated by the EU, the aim is to make the small devices in a human body to work together using an extremely small but energy-efficient microchip. Participating business parties include pacemaker, hearing aid, insulin pump and inner ear implant manufacturers.

Digitalisation and nanotechnology are taking big steps forward. It's easy to see that the natural networks in our bodies, the circulatory, nervous and lymphatic systems, will be monitored and complemented with the help of technology. Using collected data, we can ourselves monitor the status of our bodies much more precisely in addition to natural pain and hunger signals. The greatest benefit of nanodevices, however, is achieved when they are connected with each other inside the body and can be linked to an information network and thus to service providers. In the future, the prevention and treatment of serious illnesses will become easier, and perhaps even heart attacks can be identified and entirely prevented.

Nanorobots can travel in the network formed by our blood vessels. They could also destroy cancer cells as well as deliver insulin and other hormones.

It's exciting to follow this development and to see how traditional sciences, engineering and medicine benefit each other. It's already obvious that the doctors of the future will monitor the health processes of their clients in a control room, online and 24/7, instead of clumsy and random doctor's appointments. •

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

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