FINGRID

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FINGRID 20 YEARS

Fingrid held datahub induction events in January. Fingrid's Esa Pietarinen (left) and Lauri Jännes (right) talked with Ari Hallikainen from Enoro Oy at the Helsinki event. Read the story on page 12.

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EDITORIAL STAFF
Telephone: +358 (0)30 395 5267
Fax: +358 (0)30 395 5196
Postal address: P.O.Box 530, FI-00101 Helsinki
Street address: Läkkisepäntie 21, FI-00620 Helsinki
Editor-in-chief: Marjaana Kivioja
E-mail: marjaana.kivioja@fingrid.fi

Design by: Better Business Office Oy
English translation by:
Mester Translation House Ltd

Published by
Fingrid Oyj
www.fingrid.fi

Change of address:
reija.kuronen@fingrid.fi

Cover photograph: Tuomas Rauhala and Timo Kaukonen say that Fingrid has begun to systematically strengthen its HVDC expertise. Read more in the story starting on page 4.
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IN THIS ISSUE

JUHA KEKKONEN RETIRED FROM HIS POSITION AS FINGRID'S EXECUTIVE VICE PRESIDENT ON 1.3.

CHEAP ELECTRICITY – IS THIS GOOD NEWS OR BAD?

In recent months, the capability of markets to balance electricity consumption and production in strongly fluctuating situations has been admirable. Consumption records were broken, wind power production varied greatly, faults occurred in plants and cables. Despite all this, the invisible hand guided production and inter-regional transmissions throughout Northern Europe and handled even the toughest situations.

It's hard to see how some other method, such as central dispatching by transmission system operators, could work as well as the markets. However, the current deterioration of the market mechanism is cause for concern. Price signals do not properly reflect the costs of the system. The wholesale market price of electricity has plunged and many producers have had to close plants. Hardly anyone is considering new investments – not without subsidies at least.

In fact, subsidies are the main reason for the deterioration that threatens electricity markets in the Nordic countries and throughout Europe. The well-intended subsidy policy for renewable energy is having consequences that were very likely not what politicians envisioned or hoped for. In the future, production capacity may not be sufficient to meet consumption in all situations. System flexibility, which refers to the ability to quickly balance fluctuating wind or solar power with other types of production, is decreasing. The power system's inertia is decreasing as well, and this reduces the system's ability to deal with disturbances.

Fuelled by public financing, the structural change in energy production may endanger reliability of supply because old technology is being replaced faster than new technology is being commercialised. Restricting the electricity supply to consumers in normal circumstances would be a new situation for society. It would also be a political hot potato.

What should be done? The key is to strengthen the functioning of the market.

Renewable energy has to be promoted in a more market-based manner. Direct production subsidies should be replaced by, for example, investment subsidies or certificates. The amount of subsidies should be determined on the basis of competition and be fixed-term in nature. That would provide a boost to both electricity and emissions markets.

Corrective measures have to be coordinated on at least the Nordic and preferably the Northern European level. We are all part of the same market, and the actions of one party have an impact on neighbouring countries.

The wholesale market mechanism can be improved by strengthening price signals. Administrative price ceilings and other mechanisms that flatten price fluctuations have to be eliminated. Stronger incentives have to be created for market actors to keep their balance. We also have to consider switching from hourly to quarter-hourly markets.

Retail market roles and processes have to be streamlined. Technology to utilise demand flexibility potential is developing at an astonishing pace, but efficiency is needed for the business case.

In response to the question in the headline: a market price that consistently remains below production costs is bad news. It threatens reliability of supply for electricity, hinders the profitability of new, low-carbon technologies, and therefore also conflicts with long-term consumer interests.

As my 25 years of electricity market development comes to an end, I must say that this work is not quite finished. Although the original market model worked very well in the Nordic countries and in Europe, external conditions have changed. We now have to develop version 2.0 of the market model. There are plenty of challenges ahead – and that will make life interesting for the people who continue this important work. I wish them success in this venture.

Managing disturbances in HVDC connections

The availability of cross-border connections has a direct impact on electricity market operations and subsequently also on the national economy. This is why Fingrid is placing a greater focus on improving the reliability of HVDC connections.

TEXT SUVI ARTTI | **PHOTOGRAPH** MATTI IMMONEN

The Fenno-Skan 1 and 2 and EstLink 1 and 2 high voltage direct current, also known as HVDC, connections from Finland to Sweden and Estonia are extremely important in terms of electricity market operations – as are all other cross-border connections, which also include the two high voltage alternating current connections between Northern Finland and Sweden.

The importance of cross-border connections has increased in recent years, as Finland's dependence on electricity import has risen. Every outage in interconnections – regardless of whether it is planned in advance for maintenance or an unexpected disturbance – prevents electricity from going where the market economy wants it to go.

Although a lot of work has gone into ensuring the operational reliability of HVDC connections, the connections have suffered from disturbances in recent years. As a result, Fingrid has started to systematically reinforce HVDC competence in Finland. Fingrid has recruited two new HVDC specialists, and new, wide-ranging service contracts have been made concerning maintenance for the connections. A new 24/7 on-call system speeds up disturbance clearance and work is in progress to improve the efficiency of maintenance, including annual revision, practices.

The operations of HVDC links has also been made one of the merit pay indicators inside Fingrid: the merit pay for Fingrid employees increases or decreases according to the operational reliability of connections.

Careful consideration of maintenance scheduling

One challenge with regard to scheduling maintenance of HVDC connections is ensuring that transmission outages affect the price of electricity as little as possible. "This is not a simple problem. We can't always find a window when the outage wouldn't affect anyone," says **Timo Kaukonen**, Manager of Power System Operation Planning.

"In recent years, the situation has been challenging, particularly on the Swedish border, which is nearly always subject to a high load. Capacity is rarely sufficient even when everything is working well and the connections are in use. During maintenance, the situation is even more challenging."

An average of 15–20 outages that affect cross-border lines are needed each year. The longer the outage, the greater the impacts on the market. With the exception of annual maintenance, the aim has been to schedule all shorter outages on weekends or at night. Now Fingrid is examining whether annual maintenance, which lasts several days, could also be shortened.

"We can't do everything at night or on weekends. For example, certain work requiring accuracy must be performed in daylight. We also have to take safety into consideration," states **Tuomas Rauhala**, a manager in the Grid Systems unit.

One important target is harmonising practices between neighbouring countries. For the time being, Finland, Sweden and Estonia each have their own maintenance practices.

"At this time, the maintenance cycle for different countries can vary. The objective is to align maintenance so that a connection undergoes maintenance simultaneously and for the same length of time in both countries. This minimises the duration and number of outages."

Changing the energy production structure increases the load on HVDC connections. "As traditional 'button-controlled' production is replaced by weather-dependent production, transmissions will vary even more according to the weather conditions and, on the other hand, from one location to another. The world was a very different place when Fenno-Skan 1 was built in 1989," says Timo Kaukonen.

The variation in transmissions from one direction to another will probably increase even more in the future, which will also add to the challenges associated with outage planning. It is still difficult to predict when an outage would have the least impact on the markets. →

"We have begun to systematically increase our expertise in the HVDC field. In the future, we need an even better insight into what kind of support and help we need from service providers," say Fingrid's Timo Kaukonen (left) and Tuomas Rauhala.

24/7 outage watch

In order to speed up clearance of unexpected disturbances, Fingrid has implemented an on-call system. Fingrid's specialists and service providers will both participate in the on-call system.

The HVDC service contracts recently signed with ABB Oy and Siemens Oy include a requirement for 24/7 on-call readiness. This means that disturbance clearance begins within half an hour of fault detection. The Swedish and German HVDC experts from ABB and Siemens, who have an in-depth knowledge of the technology, are also ready to analyse the causes of a disturbance at two hours' notice.

ABB is responsible for the maintenance of the EstLink 1 and both Fenno-Skan connections, while Siemens handles EstLink 2. The maintenance service contract also includes regular inspections and annual maintenance.

In addition, a seven-person on-call group made up of Fingrid's own HVDC specialists has been established. Each member is on call for one week at a time. If the phone rings, the person on call begins to resolve the disturbance within half an hour – in the middle of the night if necessary.

"If a fault does occur, these new resources have given us the readiness to react to the situation without interfering with other processes. It's important to start the clearance quickly and get the right people involved. Our work stations have a remote connection to all HVDC stations, so we can immediately see what has happened. Then we begin to consider appropriate actions, perform more detailed investigations or take corrective measures," outlines Tuomas Rauhala.

10:30 is decision time

The time of day that a disturbance occurs is significant in terms of its impacts on the market.

"10:30 (EET) in the morning is a critical time, because that's when the markets receive information about the transmission capacity for the next day. We have to make a decision by that time: are we certain that the fault will be fixed during the same day or will it limit the following day's capacity?" says Timo Kaukonen.

Two disturbances that occurred on the Fenno-Skan connections in January demonstrated how well the concept works. "In both cases, we obtained a strong technical perspective on the nature of the disturbance right at the start. By 10 am, we knew that the disturbance would be corrected and this allowed us to provide capacity for the following day's markets."

In recent years, the disturbances on HVDC connections have mostly been short, lasting less than one day. However, there have been cases of disturbances caused by cable damage, with repairs lasting for months.

"The last cable fault was in 2013. The majority of cable faults are caused by something external, such as a ship's anchor or ice," explains Timo Kaukonen.

According to Tuomas Rauhala, the increased resources also improve the level of preparedness for a cable fault. The goal is to further develop preparedness by signing service contracts with the cable companies.

Shared operating models on both ends of the cable

Timo Kaukonen and Tuomas Rauhala feel that it's very important for the operating model on both ends of the cable to be as similar as possible. "We have a saying: 'act as one TSO', which means that try to do

The same targets in Sweden and Estonia

The countries at both ends of HVDC connections have an interest in improving connection reliability. Svenska kraftnät's Operational Planning Manager **Johan Svensson** considers shortening transmission outages on the Fenno-Skan connections to be one of the most important development targets. He believes that this could be accomplished by means of increasing the number of maintenance personnel and ensuring faster open line test measurements in fault situations.

Svensson also states that the lower operating voltage implemented on Fenno-Skan 1 and the resulting reduction in transmission capacity is a precautionary measure to prevent a cable fault that could last for months.

According to **Reigo Haug**, Head of the HVDC and Power Plants Maintenance Unit at the Estonian transmission system operator Elering, improving the operational reliability of HVDC links is one of Elering's spearhead targets. "It is important to plan maintenance with care and implement it in a professional manner. HVDC systems are complicated, technical entities and sometimes faults simply can't be avoided. Therefore, employees that are skilled in fault tracing and repair activities play a key role. The best possible results can be achieved when the expertise of the link owner and the service provider is formulated into a common task force. In the best case, both the link owner and the service provider have sufficient expertise," says Haug.

Both Johan Svensson and Reigo Haug feel that cooperation between countries is extremely important.

"The EstLink 2 project completed two years ago was an excellent example of good cooperation between TSOs, which allowed us to complete this project on schedule and on budget while still achieving the quality targets. This would never have been possible without excellent cooperation," says Haug.

everything as well as if the links only had a single owner."

The thinking has changed from the days when Fenno-Skan 1 was the only HVDC connection linking Finland to the outside world. "We had a Finnish transformer station at one end and a Swedish one at the other, and the main grid owner in each country handled maintenance in its own way."

"Now we have more connections and a completely different market situation. Each connection has to be seen as a single entity," says Rauhala. He believes that cooperation between countries and also with other transmission system operators in the Baltic Sea region is important, and that sharing best practices will have even more significance in the future.

Cooperation has naturally been done for as long as cross-border connections have existed. For example, a Nordic Outage Team has coordinated transmission outages on cross-border connections in the Nordic countries for years. The Nordic transmission system operators present their own plans in the group and check to ensure that the dates are suitable to other simultaneous outages and the market situation. In the future, coordination will be centralised in Copenhagen at a joint office for transmission system operators that will open in 2017. This regional security coordination service provider will plan the system usage and operation in the most effective manner possible for the whole region.

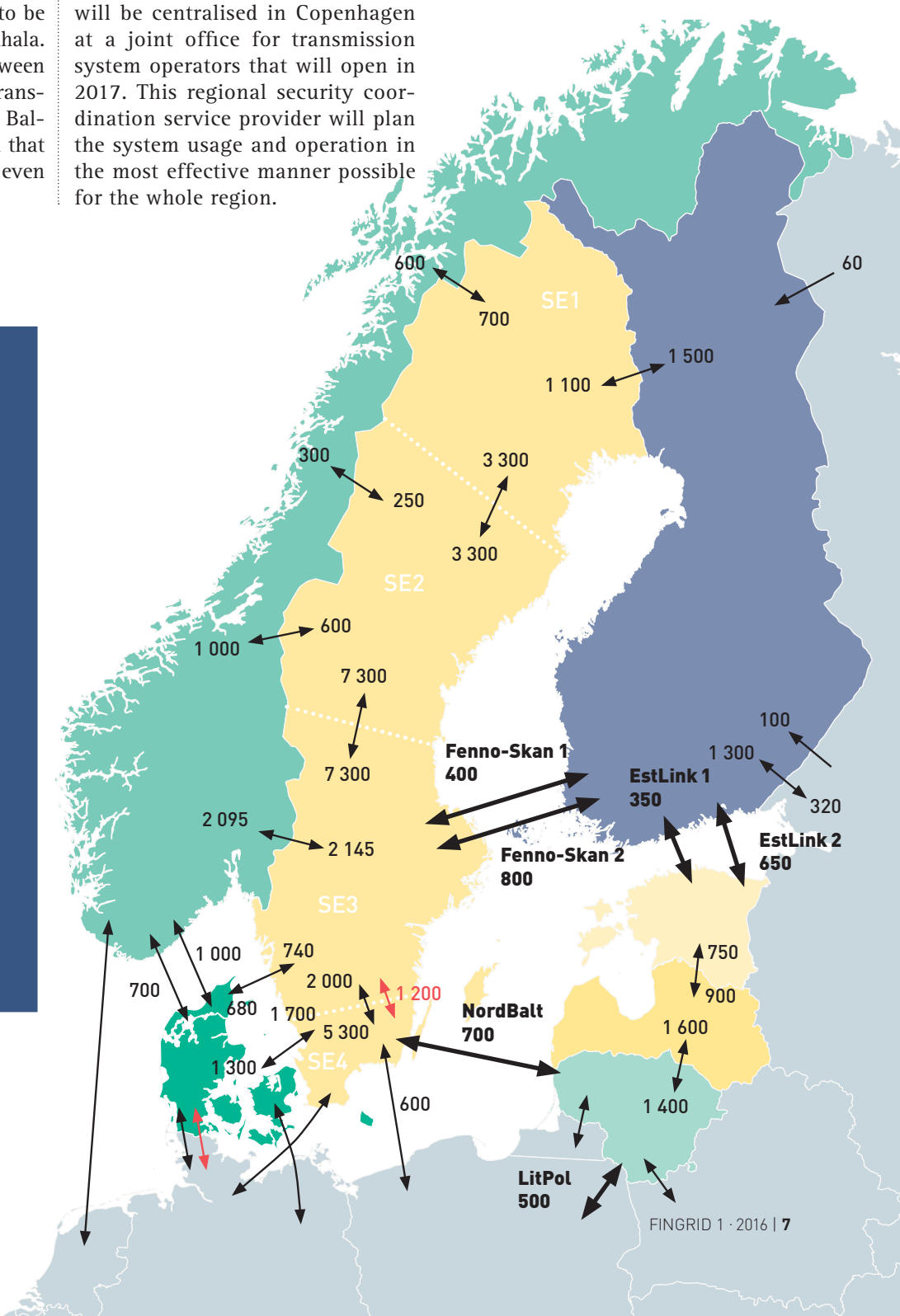
Cooperation with both Sweden and Estonia runs smoothly. Fingrid has proposed new practices to Sweden's Svenska kraftnät and Estonia's Elering, both of which now have ongoing competitive bidding processes for HVDC service providers. "We have regular discussions and we work together to further matters."

FACT

The transmission connections in the Baltic Sea area will improve this spring when two important new HVDC connections – NordBalt between Sweden and Lithuania (700 MW in capacity) and LitPol between Lithuania and Poland (500 MW) – enter commercial use.

NodBalt and LitPol originated from the same planning project as EstLink 2. Created as a result of the BEMIP (Baltic Energy Market Interconnection Plan) project that aims at improving cross-border connections in the Baltic area, the new transmission links received investment support from the European Union. EstLink 2 was implemented two years ago, and now all three of the key investments specified as the outcome of the BEMIP project are available for use by electricity markets in the Baltic Sea area.

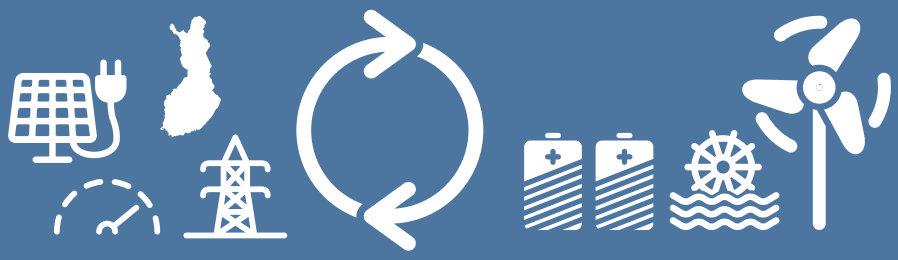
According to Fingrid's Market Development Manager **Juha Hiekkala**, NordBalt and LitPol are important parts of the Baltic Sea electricity market entity and also influence the transmission situation on Finland's borders.



In pursuit of a Nordic energy strategy

Nordic transmission system operators have a clear message for energy ministries: the countries have to join forces in energy policy decision-making.

TEXT SUVI ARTTI | **ILLUSTRATION** BBO



The Nordic electricity system is facing significant changes. The change in the energy system requires closer regional cooperation.

"The transition to low-carbon electricity production means huge changes that no single country can implement on its own," says Fingrid's President and CEO **Jukka Ruusunen**.

The transmission system operators in Finland, Sweden, Norway and Denmark have compiled a joint strategy that stretches to 2025. Now the transmission system operators have proposed to the ministries of those countries that a stakeholder forum be established in conjunction with the Nordic Council of Energy Ministers to outline actions and enhance their implementation.

Regional cooperation is also one of the goals of the Energy Union planned by the EU. A joint Nordic voice will be needed when the European Commission begins to present questions and issue guidelines to the regions.

"What is the Nordic position? Who will create the vision, who will respond to questions? Right now, the Nordic countries are like a company without a leader – the coordination is missing," says Ruusunen.

Future decisions are being made now

Big decisions have to be made: Will the selected system be based on supporting renewable energy or will it be market-based? "We hope that the Nordic countries will be at the forefront in this matter. The world will be completely different in 30 years. The related decisions are being made now," explains Jukka Ruusunen.

He states that no country can visualise energy issues alone, because countries are so strongly linked to each other in terms of energy.

"The market mechanism controls electricity movements in a highly effective manner. This winter, prices remained low even though we had very cold weather, first in Finland and then in Norway and Sweden. Our concern is that this mechanism will be lost if the market is destroyed."

"Policies in neighbouring countries cannot conflict with each other. If one country makes a decision about subsidies, it will immediately influence the

other countries as well. This will determine whether or not market-based investments can be made in the entire region. It doesn't matter how much wind power Finland has, but how much there is in the whole market. At this time, Sweden's wind power is pushing Finland's condensing power out of the market."

According to Ruusunen, politicians are not aware of this in any of the Nordic countries, and each country has developed its own policy.

Transmission system operators do not make political decisions, but they can explain what will happen to the system in different alternatives. "We ensure the adequacy of transmission capacity and system functionality. We create the infrastructure so that the system will work regardless of political decision-making."

Finland drives cooperation

Jukka Ruusunen believes that Finland now has a good opportunity to take a strong role in promoting cooperation because, under the leadership of Minister of Economic Affairs **Olli Rehn**, Finland is chairing the Nordic Council of Energy Ministers this year.

The first step in the right direction has already been taken. In January, the Nordic Council of Ministers commissioned **Jorma Ollila** to do a strategic review of the energy sector in the Nordic countries. The purpose of this review is to clarify how Nordic cooperation on energy can be most effectively developed over the next five to ten years.

According to Ruusunen, Nordic cooperation is a natural starting point, but the eventual target is the entire Baltic Sea area. "The region is becoming closer as Sweden strengthens its links to the Baltic countries. Once we get Nordic cooperation going, it can then be extended to the whole Baltic Sea area. This would give us a strong voice that Brussels would certainly listen to."

Towards the electricity market model of the future

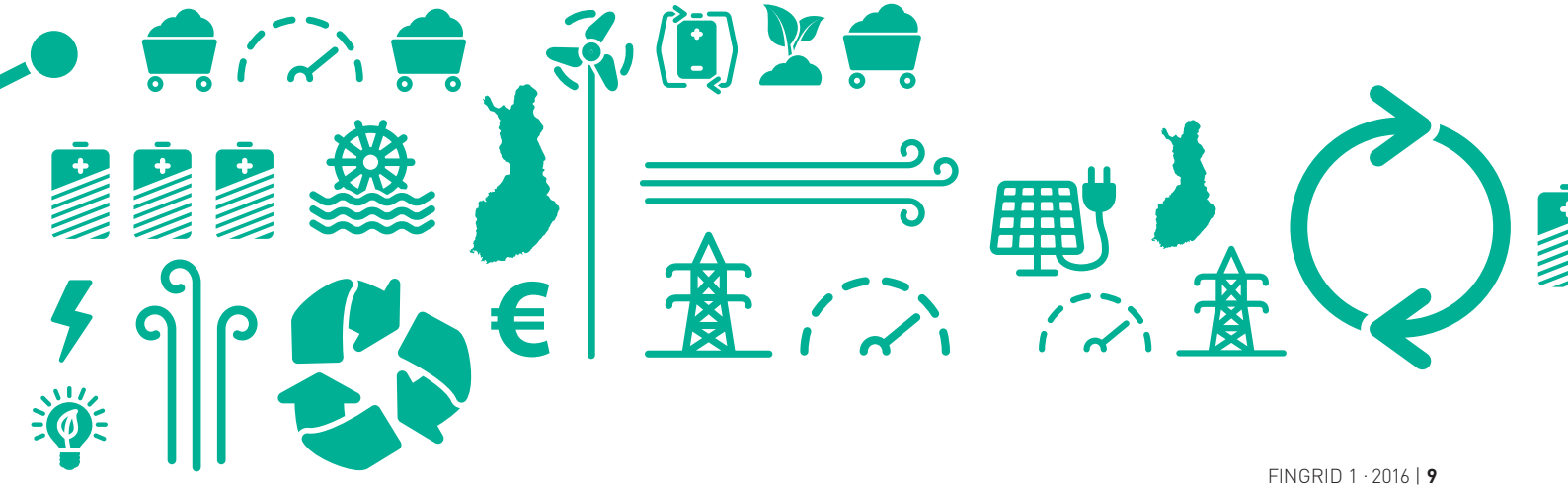
Fingrid is currently drafting discussion papers concerning the direction in which electricity market models are developing. The proposal aims to initiate discussion which will form the basis of a model developed together with customers.

TEXT SUVI ARTTI | **ILLUSTRATION** BBO

The current Nordic electricity market model has come to the end of the road – or at least to a crossroads. Support for renewable forms of energy are disrupting price formation and there are no incentives for market-based investments.

"The electricity market is facing an increasing number of challenges. We are faced with a choice: should we take a step in a more market-based direction or should we move towards a more centralised system? Should we trust in markets or in central control?" asks Fingrid's Market Design Manager **Juha Hiekkala**.

The project has a working name of *Future market design* and is Fingrid's outline of alternative electricity market development paths. The work →



was carried out in Fingrid's working groups. The core group for the project consisted of Hiekkala, Electricity Market Specialist **Mikko Heikkilä** and Senior Specialist **Satu Viljainen**. Supporting them were experts from Pöyry Management Consulting, led by **Stephen Woodhouse**.

A market-based or centralised system?

The discussion paper outlines two alternative scenarios. In the market-based model, the choice of production technology would be dictated by emissions fees. The markets would favour those energy production methods that are profitable. Price spikes could be steep and the price of electricity could momentarily reach up to the value of lost load.

"This alternative requires a change in energy policy. The market-based model will not function unless we stop using the existing support system and even drastic fluctuations in prices must be approved politically. In this scenario, low-carbon energy production would be driven in particular by CO_2 emissions pricing," says Juha Hiekkala.

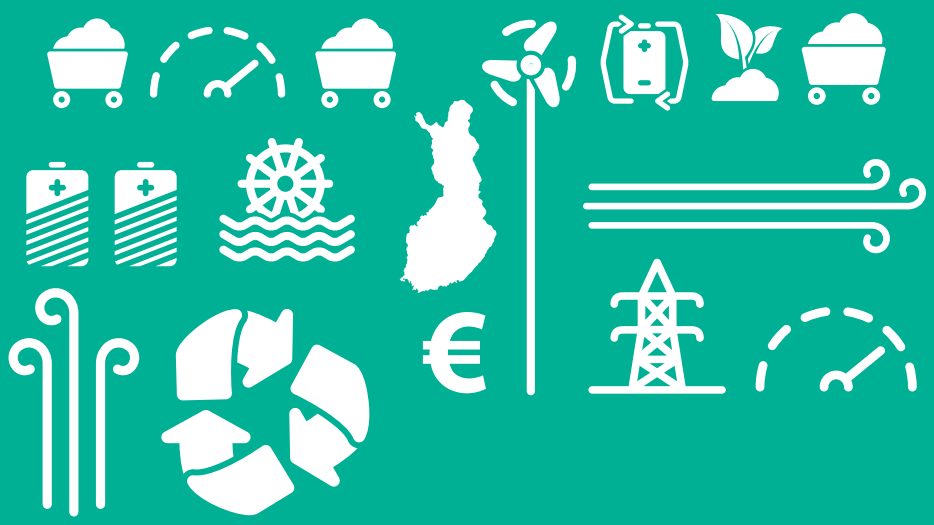
The market-based alternative requires us to accept that there is not always sufficient electricity. "One key detail that is left unspecified in Finland is the target level for the security of supply. What kind of level of security of supply are we aiming at? Should we accept that sometimes there are situations in which there's not enough electricity for everyone?" asks Mikko Heikkilä.

In the second alternative, the energy system would be more centrally controlled. The adequacy of production capacity would be ensured through administrative decision-making as to how much electricity production capacity is required. Both power and energy would be traded. Operations would be more centrally planned than they are currently. In this scenario, market actors' role and the nature of their activities would change fundamentally.

Problems with the existing market model were identified in a "summer package", or energy market development policy, published by the European Commission last summer. The Commission's package outlined the direction markets should take. The same themes also came up in joint strategy work between Nordic transmission system operators. Fingrid's proposal considers how to implement these principles in practice.

Whichever model is chosen, it takes time to change things. "The world won't change in an instant; the transition to a new, more market-based model, for example, would have to take place in stages and in all Nordic countries. There will certainly be a need for a peak load capacity-style system during the transition periods. Completed investments into supported renewable energy will have such an influence that targeted capacity support, such as peak load capacity, would be part of even the market-based scenario at least during the transition period," says Mikko Heikkilä.

"Should we accept that sometimes there are situations in which there's not enough electricity for everyone?"



Customer perspectives are needed

The discussion paper outlining Fingrid's vision will be published in early May, after which time comments from interest groups are welcome. Satu Viljainen emphasises that there is a need for discussion and that customers' comments bear great significance.

"The paper is not meant to be Fingrid's standpoint; instead, it aims to initiate discussion on the alternatives for electricity market development. We are very happy to receive any and all comments from customers. The paper presents a group of concrete procedures relating to matters such as imbalance power pricing and reserves. We hope to learn more about customers' perspectives on these and other matters."

The schedule is expected to progress such that there will be time to provide comments and feedback until the start of the summer holidays, with work on the results beginning after the holidays. "Once we've received the comments, we'll publish a summary of them for further discussion. We will take development work forward together with our customers and transmission system operators in neighbouring countries," says Viljainen.

"Transmission system operators cannot change energy policy. We hope that these issues are dealt with in other forums. If political decision-makers take the matter further, our work will be made much easier," sums up Juha Hiekkala.

Fingrid's idea competition ends with Innovation Garage Day

The winner or winners of the idea competition in Fingrid's Maintenance Management 2020 project will be announced in May.

As part of the Maintenance Management 2020 project, Fingrid organised an open idea competition aimed at finding fresh approaches and ideas for developing main grid maintenance. A total of 36 ideas were submitted, 10 of which were selected for further development.

The companies that advanced to the second round developed their proposals during January-February on the basis of more detailed questions from Fingrid. The competition culminated at the Innovation Garage Day held in early March, where Fingrid's jury learned more about the selected idea proposals.

"During the day, we heard about a lot of new and bold ideas that have plenty of potential. Brainstorming ideas across industry boundaries is an excellent way to create new innovations," says Fingrid's Technology and Development Manager **Jussi Matilainen**.

The competition winner or winners will be announced at the Asset Management Day in May, after which they will have the chance to develop and pilot their ideas in cooperation with Fingrid.

Transmission lines that are not part of the main grid have been sold

A total of 250 km of lines that do not belong to the main grid have been sold by Fingrid to its customers.

In accordance with the Electricity Market Act, Fingrid named its main grid in March 2015, which means that it specified which sections of the network owned by the company belong to the main grid and which do not. Certain parts of the network owned by Fingrid remained outside the main grid because they did not meet the main grid criteria as defined in the Act. The alternatives were to sell these lines to customers who are served by that particular part of the network or to turn the lines into line connections or high-voltage distribution networks.

The parts of the network that remained outside the main grid – a total of 250 km of lines – were sold in 2015; the last deal was made on 31 December. Thus, Fingrid did not have to launch high-voltage distribution network activities separately from its main grid operations.

As the main grid develops and the way of using lines changes, similar cases will come up in the future as well. The customers who use these lines will be given the chance to purchase them.

Adequacy of electricity not at risk during consumption peaks

Finland set a record for electricity consumption during the cold snap in January.

Electricity was sufficient to cover consumption peaks in the 2015–2016 winter. A new consumption peak of 15,105 megawatt hours was reached at 5–6 pm on the Thursday following Epiphany. At that time, domestic electricity production was 10,874 megawatt hours and net import was 4,321 megawatt hours. The previous electricity consumption record, just under 15,000 megawatt hours, dated back to 2011.

The electricity system had a normal usage situation during the consumption peak and no disturbances occurred. In commercial terms, import capacity from Sweden and Russia was almost completely utilised. During the week of the consumption peak, Estonian transmission was mostly export, but this changed to import during Finland's consumption peak.

Power plants that are within the scope of peak load capacity arrangements were not needed to safeguard adequacy of electricity during the winter.

DATAHUB PROGRESSES STEADILY TOWARDS ITS GOAL

A datahub to meet the information exchange needs of the electricity retail market is now one step closer to realisation. The next stage is specifications for the IT system and integrity of data.

TEXT OUTI AIRAKSINEN | **ILLUSTRATION** LINDA SAUKKO-RAUTA | **PHOTOGRAPHS** OLLI HÄKÄMIES

There was a strong sense of team spirit in the air when electricity retail market actors met at datahub induction events in January. Held in Vantaa, Oulu and Jyväskylä, the events involved a day of reviewing the datahub business processes that have been refined in the industry's joint working groups.

The main functions of datahub are the transmission and storage of meter data obtained from remotely-read meters and implementation of harmonised market processes.

"Our working group had really good team spirit. It was positive to notice that rather than getting hung up on the current model, we took an open-minded approach to the question of whether things could be done differently," says Customer Management Manager **Tiina Leppälahti** from Helen.

Leppälahti was part of the working group that considered distribution network processes, and believes that datahub will be of immense benefit to the industry. "Our only concern is the schedule, which is very tight. We have a lot of work ahead of us and not much time to do it," says Leppälahti.

Among other things, the grid companies will save money when imbalance settlement moves from the companies to datahub.

Less manual work

Although the will and need to harmonise functions was strong, the process working groups had to admit that it is not always possible. For example, grid companies will continue to maintain individual service price lists for disconnections and connections in the future. Data protection matters also presented challenges for datahub functions.

"The principle when planning the process work was to automate all mass transactions and transactions that currently involve a lot of manual work. The process working groups were also good at finding special cases that occurred once every 10 years, but we decided not to automate them at this stage," says **Minna Arffman**, who is the service manager responsible for information exchange services at Fingrid.

Now the project has already specified what kind of information will be in the datahub, how it will be linked to business needs, and who will have access to the information. For example, in the future a supplier will be able to see comprehensive data about the metering point when making a contract. The next item on the agenda will be the functional and technical specifications for datahub, after which each party will have to roll up its sleeves and get down to work.

"Once the technical descriptions for information exchange have been completed, companies in the industry can move forward with their own plans. They can start thinking about how their own system and operating method should change in order to work with a datahub," says **Pasi Aho**, who is running the project at Fingrid.

Cleaning up data is the first step

The correctness and integrity of data has been identified as one of the key success factors and challenges for datahub. It became clear during the process work that some companies in the industry have significant deficiencies in their information systems with regard to, for example, personal identity numbers, which must be entered into the datahub in order to individualise customers. A migration working group is now being established to support the process of ensuring data integrity.

"The required data content has already been specified, so the project can move forward in that respect. Even now, companies can ensure that they ask customers for their personal identity numbers in conjunction with everyday activities. Then we can move on to cleaning up older data and consider how the datahub can be taken into account in future system changes," explains Aho.

According to Aho, the migration work will challenge the industry to

"We took an open-minded approach to the question of whether things could be done differently."

Tiina Leppälahti, Helen

ensure that data quality is on a good level. A good example of this is Norway, where Elhub uses a very strict program to guarantee the correctness and integrity of data.

In any case, it is clear that data quality in the datahub will be better than it is now. This will be ensured by building automation into the information system, which will, for example, flag deficiencies or errors in metering data and prevent the storage and transmission of incorrect data.

A follow-up group as a link to the industry

The datahub project will continue to be developed in working groups with representation from the entire industry. A follow-up group that meets four times per year will bring industry perspective to the project.

"The work done in the project so far has been excellent and the team spirit in the industry has been exceptionally good," says Fortum's **Timo Liiri**, who represents electricity suppliers in the monitoring group.

He is particularly appreciative of the operating method, which eliminated rivalry by seeking benefits for all of the parties. Of course, difficult issues still lie ahead.

"Datahub is a great opportunity to renew and increase the efficiency of operations and improve service quality."

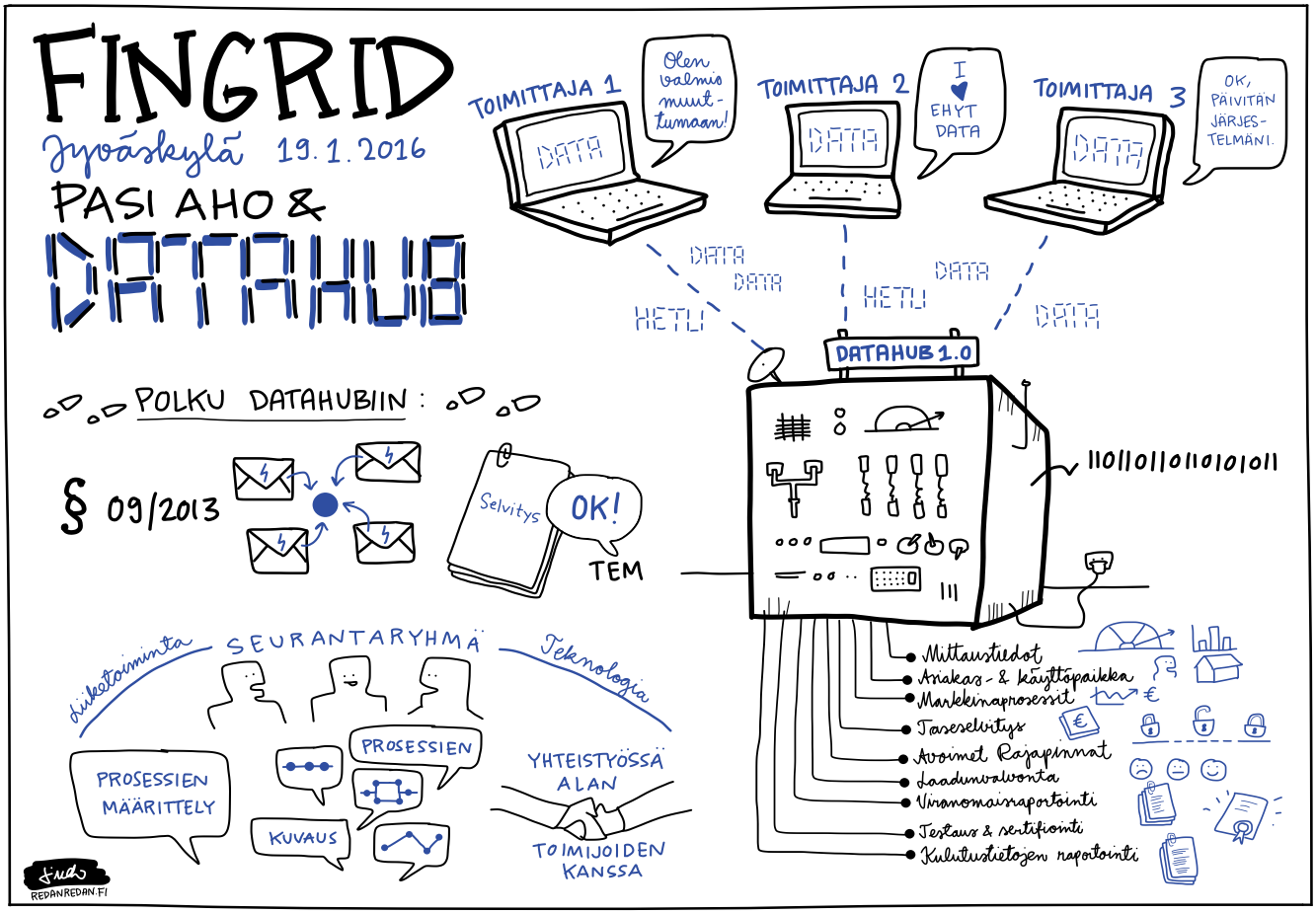
Timo Liiri, Fortum

Liiri sees datahub as a great opportunity for the entire industry to renew and increase the efficiency of its operations, enhance process functionality, improve service quality, and provide customers with completely new services. "One concern may be that the customer viewpoint tends to be overlooked in these matters, even when we are sincerely trying to find easy solutions for the customer."

Liiri feels that system change needs should be seen as an opportunity rather than just another way to reduce costs.

"System development will increase the costs for the actors in any case. Information systems never last forever, and their development is part of the normal process. If datahub is successful, the amount of manual work will decrease and process quality will improve, which means that the investments will eventually pay for themselves."

Right now, it appears that procurement of a datahub may be reality at the end of this year, with implementation set for 2019.



ELECTRICITY MARKET CHALLENGES ON THE AGENDA

Asta Sihvonen-Punkka is Fingrid's new Senior Vice President for markets, and on her desk lie questions that concern the entire European electricity system.

TEXT MIRA MUURINEN | PHOTOGRAPH KRISTIINA HEMMINKI

→ You worked as FICORA's Director-General since 2011, and before that you spent a long time working as Director-General at the Finnish Energy Market Authority, the Energy Authority's predecessor. What got you interested in the position of Senior Vice President for markets at Fingrid?

I held various positions working for the state for almost thirty years, of which over fifteen years were spent as an agency head. I thought it would be great to try out a slightly different career path in the corporate world. I have fond memories of my time in the Finnish Energy Market Authority and I had also followed the development of the energy industry since then. This position hit the nail on the head: it offered the opportunity to return to electricity market issues and to utilise my skills with domestic and European market matters.

Asta Sihvonen-Punkka began work at Fingrid in January 2016, taking over from Juha Kekkonen, who is retiring. Operative responsibility was transferred to her in early March.

→ In the Finnish Energy Market Authority and as chair of the European Energy Regulators' electricity working group you had a great vantage point of what was happening on electricity markets. How did the electricity markets develop during that time?

Between 2007 and 2011, I acted as chair of the electricity working group for the regulators' cooperative body ERGEG, which preceded ACER. The focus was on how to get markets to integrate – at that time, the European electricity markets were only just beginning to take shape. Now there are also questions concerning renewable energy and its support system, adequacy of power, capacity mechanisms and market flexibility. The focus of the markets is moving closer to the operating hours. Now there is discussion on how the market model should be constructed in order for it to be able to take into account fluctuations in production. The existing model is based on energy and it faces challenges caused by support mechanisms and changes in the structure of production.

→ Is it possible to make the energy system more environmentally friendly on market terms?

It is possible, but the transition to a low-carbon world must be a controlled one. Modern society will not accept that there isn't always enough electricity available. We also need guaranteed capacity to balance fluctuations in production and to reliably produce electricity during periods of peak consumption. As intermittent production increases, we also have to increase the flexibility of the electricity system.

→ What other challenges does electricity market development currently face?

Big challenges include ensuring power adequacy and increasing market flexibility. When it comes to increasing flexibility, one underutilised area is demand response. We must be able to utilise measurement data and smart networks, which should be accompanied by economic incentives. Tariffs must offer clearer economic incentives to electricity consumers. The retail market model must support this development. It must also be easy for consumers to control their consumption, and for that we need applications and equipment.

Another issue is overlapping support and control systems, such as emissions trading and feed-in tariffs. Feed-in tariffs increase investments in renewable forms of energy and, when used extensively, force down the wholesale market price of electricity. This can be seen in e.g. Germany, Denmark and Sweden – the effects can be felt in common markets. This in turn means that the construction of non-supported new production capacity is unprofitable. The situation is problematic, since part of the existing capacity is reaching the end of its service life. Emissions trading is an effective and technology-neutral method of reducing emissions. Other support systems for renewable energy counteract its impact by drastically lowering the price of emission allowances.

→ How can we deal with these challenges?

Electricity market control mechanisms and support systems should be reviewed as a joint entity. We must primarily trust in market-based solutions and minimise the distortion of the markets by various support systems. Conditions are favourable, since a new energy and climate strategy is being drafted. In addition, we need strong commitment to regional and at least joint-Nordic targets.

→ There has been discussion of consumers playing a more active role on the electricity markets. How do you see the role of small production and demand response in the future?

The consumer is becoming central to the electricity markets, especially via demand response, but also through small-scale production using solar panels and windmills. The consumer is currently a kind of a missing piece in the electricity market model puzzle, but this is rapidly changing. The availability of information and development of various applications is taking development forward in leaps and bounds. Datahub is due to be taken into use in 2019 and will improve retail customers' participation on the markets and in demand response.

→ How have you settled in at Fingrid?

Very well. All of my new colleagues, and especially **Juha Kekkonen**, have helped me to settle in and helped me to familiarise myself with both my work and in-house practices. Several people I got to know earlier on in my career are now my colleagues. Fingrid has demonstrated itself to be a nice, dynamic working environment as I expected.

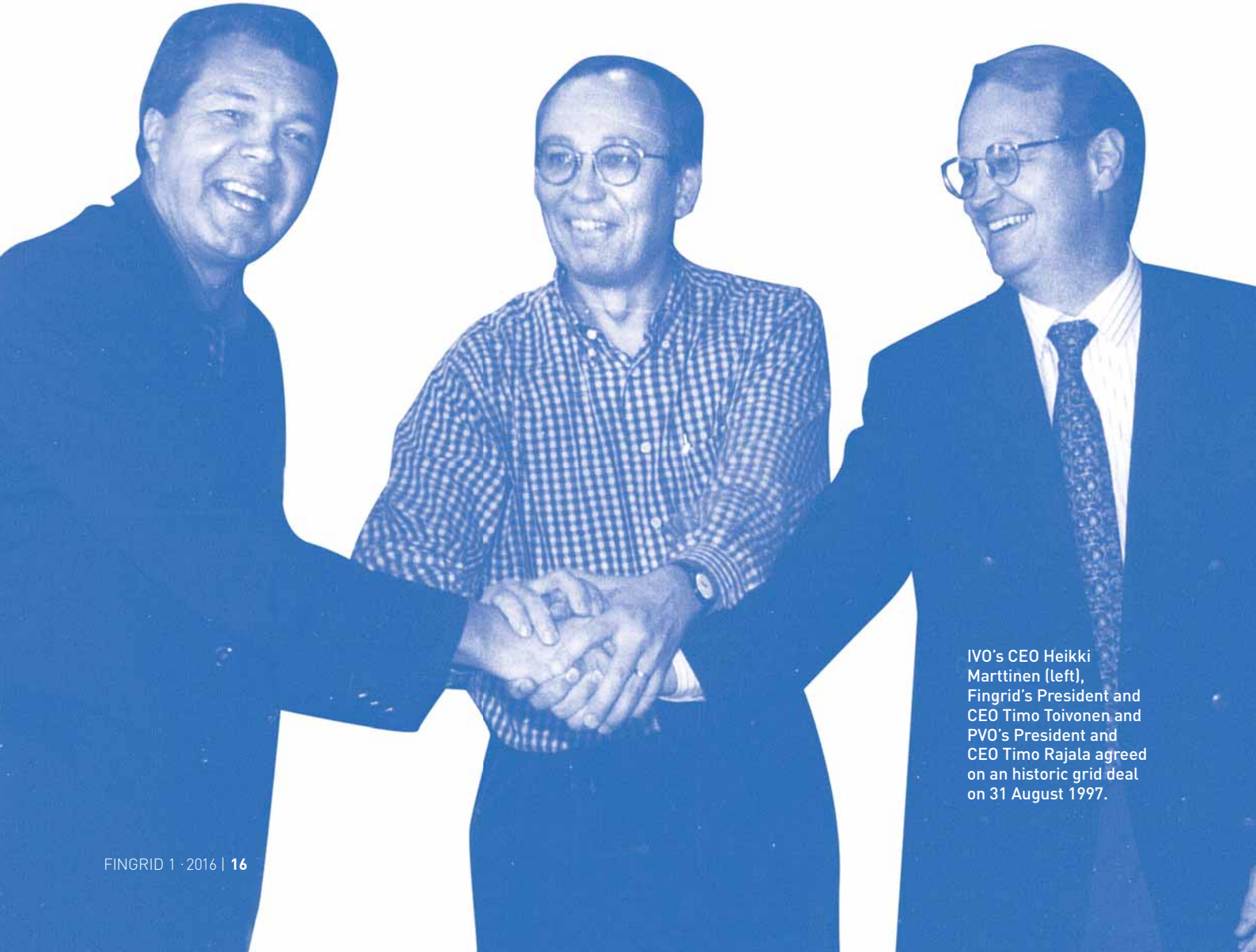
→ Do you find that you take your work home with you?

When you enjoy your work, you end up thinking about it even in your free time, but I consider it a positive thing. My family are very good at making sure I have other things to think about, too. I have three children and my youngest, who is 14, still lives at home. I exercise a lot in my free time; I run and, weather permitting, go cross-country skiing in Paloheinä, where I live. In summer, we spend time on a boat we share with our friends. We have been boating together for almost 30 years. We spend some time in summer at my parents' cabin in Savonia.

THE BIRTH OF A TSO

This year marks 20 years since Imatran Voima, Pohjolan Voima and the State of Finland signed the charter to found Suomen Kantaverkko Oy. Before the company began its operative activities the following year, the parties had tough times agreeing on the details, in particular on the value of cross-border connections and tariffs. The outcome of that agreement was one of the world's most efficient transmission system operators.

TEXT SUVI ARTTI | **ILLUSTRATION** ANSSI KERÄNEN | **PHOTOGRAPH** JUHANI ESKELINEN



IVO's CEO Heikki Marttinen (left), Fingrid's President and CEO Timo Toivonen and PVO's President and CEO Timo Rajala agreed on an historic grid deal on 31 August 1997.

Prior to the founding of a transmission system operator in Finland, the country's transmission grid was controlled by the state-owned Imatran Voima, and Pohjolan Voima which was primarily owned by private industry. Both parties and their subsidiaries (IVS and TVS) built the grid based on their own needs. The majority of the country's main transmission grid, including interconnectors to other countries, were owned by IVO.

Private industry had joined forces to counterbalance IVO in electricity production and transmission in order to ensure that industrial plants could obtain the necessary supply of electricity from their own power plants. However, IVO still had the sole right to foreign trade in electricity, a fact that did not please the industry.

"For years, industry had tried in vain to import electricity from Sweden. However, IVO opposed it by arguing that cross-border connections are part of its procurement assets, in the same manner as power plants. Sights were then set on Russia, where matters had progressed so far that PVO had already laid the foundations for towers for a Russian border line," recalls **Juha Kekkonen**, who retired in March from his position as Executive Vice President responsible for electricity market development at Fingrid. This plan was never realised. The founding of a transmission system operator resolved the situation and Fingrid eventually completed the Russia connection.

"It was difficult to create competition in Finland when IVO had so strong a position. The only quick way to create competition was to open the borders. Thus, putting the transmission grid and cross-border connections under the control of a neutral transmission system operator was a key move in terms of creating markets," states Kekkonen.

At that time, he was director of the energy market division at the Ministry of Trade and Industry and led the preparation of the Electricity Market Act. While the act was being prepared, work was also in progress to establish a transmission system operator. This could not be accomplished by law but only by means of voluntary deals. Kekkonen was also closely involved in this process.

No champagne celebrations

Suomen Kantaverkko Oy, later known as Fingrid Oyj, was founded on 29 November 1996. The company's operative activities began the following year, on the first day of September. Juha Kekkonen recalls that there was uncertainty about launching the activities right up to the last night.

"When preparing the deal, it was the cross-border connections that caused the most friction. Their value during the monopoly period was one thing, but another thing once the markets opened. How to ensure that they pro- →

FACT

Both the state-owned energy production company Imatran Voima Oy (IVO) and private industry separated grid activities from electricity trade in the early 1990s. IVO established IVO Voimansiirto Oy (IVS) in 1992. The companies behind Teollisuuden Voimansiirto Oy (TVS) were Pohjolan Voima Oy, Etelä-Suomen Voima Oy, Etelä-Pohjanmaan Voima Oy, and Oy Nokia Ab.

vided the new operator with income that reflected the price paid for them?"

Kekkonen says that a number of dramatic phases were associated with connecting the grids. "The grid deal was originally meant to be signed at the Finnish Club on 29 August 1997. Everything was supposed to be ready that Friday for the company to start operations on Monday. But at the last moment, the industry refused to sign the deal due to some unclarities regarding cross-border tariffs."

The documents weren't signed and the champagne bottles remained closed. That same day, the board of Suomen Kantaverkko Oy left for a weekend strategy seminar in Lapland that had already been booked earlier. There, the contract was reworded into a form that satisfied all the parties. Upon their return, the contract documents were signed on 31 August 1997 at Helsinki-Vantaa Airport, with no champagne.

According to the deal, Suomen Kantaverkko Oy purchased the main grids and related business from IVO and PVO for a total price of 6,800 million Finnish marks. At the time, this represented the largest business deal in Finnish history.

Pertti Kuronen, who recently retired from his position as leading specialist at Fingrid, worked as a planning manager in the brand new transmission system operator. He recalls the exceptional situation on 29 August 1997, when people leaving work had no idea what would happen to their job on the following Monday. "**Timo Toivonen** told us to also prepare ourselves for the worst."

No IVS cardigans

To begin with, industry was somewhat suspicious about the ways the new transmission system operator serves different market parties. "Industry was afraid that neutrality wouldn't be realised when more than 80% of Fingrid's personnel came from IVO," says Pertti Kuronen.

"However, Fingrid earned the trust of all the market parties by proving that the operator didn't favour any single body but worked equally on behalf of all customers."

Ownership of the transmission system operator was divided so that no one party – IVO, PVO or the state – gained a dominant position. The state owned 12%, IVO and PVO 25% each, while insurance companies had a combined 38% of the transmission system operator. "From the industry perspective, the state and IVO were one and the same. Therefore, the combined share of the state and IVO had to be less than 50%. As the state originally owned 80% of the main grid, the deal was good for industry," states Juha Kekkonen.

Pertti Kuronen recalls that neutrality was maintained very strictly in the new company. "No signs of the old companies were permitted. For example, people weren't even allowed to wear their IVS cardigans at the office. The new transmission system operator stopped buying services from former owners, and everything had to be done independently."

An efficient operating model right from the start

Juha Kekkonen feels that creation of the operating model for the new transmission system operator was a success. This was aided by the fact that both camps had already separated grid activities from electricity sales in the early 1990s. "Both IVS and TVS were quite 'slim' companies. Their personnel was made up of specialists who commissioned practical work from outside the companies. At the start, Fingrid had some of its own maintenance staff, but by the 2000s they had also been outsourced and the company became a company of specialists. Today, Fingrid is one of the world's most efficient transmission system operators, and the seed for this was sown by the actions of its previous owners."

Kekkonen was happy to leave the ministry to join Fingrid and continue with the electricity market development work. "I saw that the transmission system operator would play a key role in further development of the market."

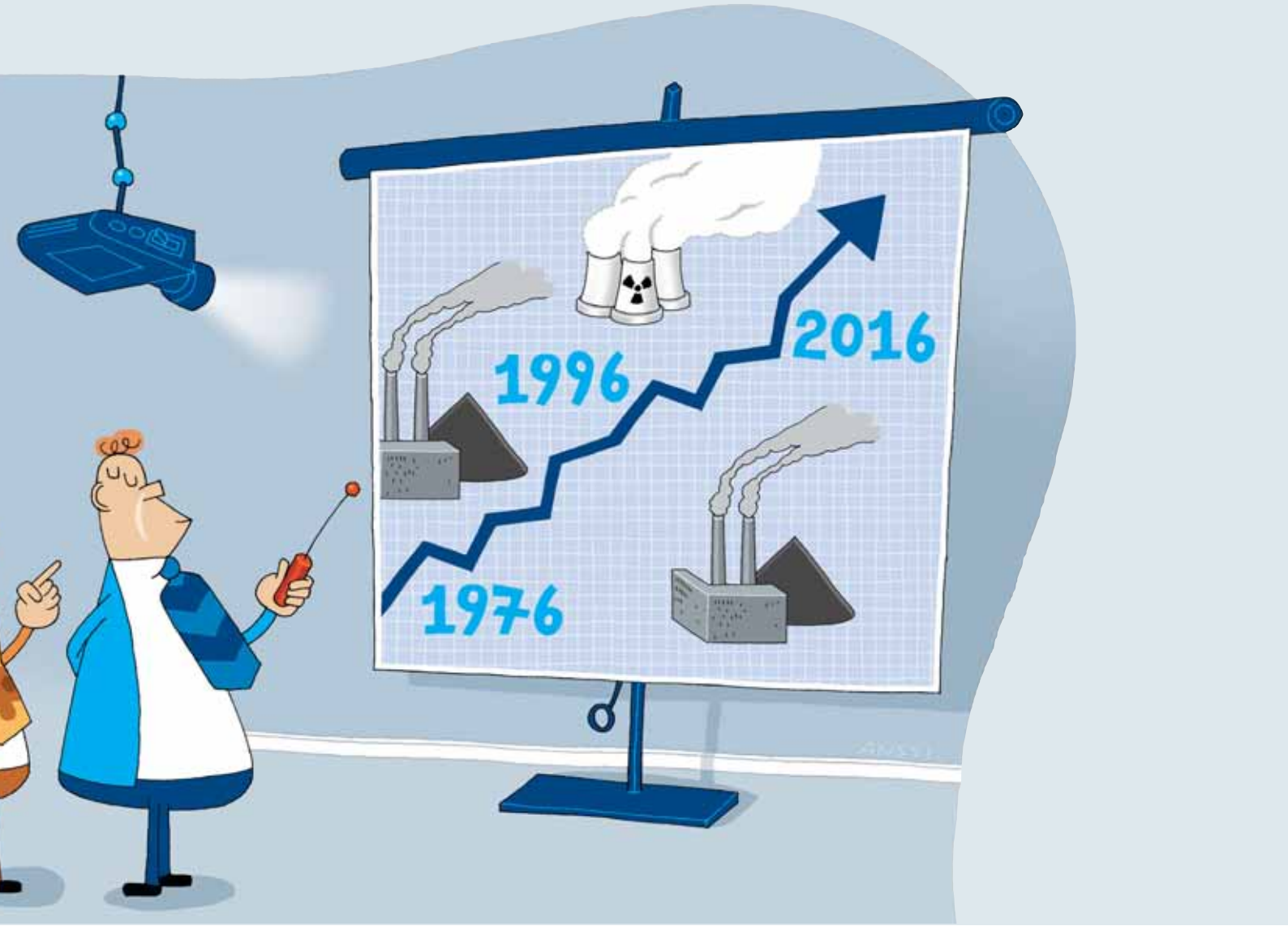
"In the latter half of the 1990s, we forecast the construction of five large power plants over the next five years."

The objective was the Nordic electricity markets that we were only just opening up. A neutral actor was needed to develop the markets and this is exactly what the new transmission system operator was. All international development lay ahead of us and Fingrid was actively involved in that work.

Consumption forecasts were high

Twenty years ago, the world was a very different place than it is today, not least with regard to energy production. This is clearly evident in an early Fingrid grid review that stretches to 2016.

"At that time, the starting point for plans was a forecast that set electricity



consumption at 100 terawatt hours in 2016. Peak consumption was expected to be some 18,000 megawatts," explains Pertti Kuronen. In reality, electricity consumption in the Finland of today remains far below those figures: annual electricity consumption is approximately 84 terawatt hours and the all-time peak consumption is a little over 15,000 megawatts.

"Fingrid's early plans were based on the assumption that growth would continue and no major disturbance factors were on the horizon. Even a 1,600 megawatt power plant was manageable because there was so much other production and there was no discussion of closing power plants. In the latter half of the 1990s, we forecast the construction of five large power plants over the next five years," says Kuronen. The only part of the plan that was in fact realised was an increase in imports from Russia. In contrast, large coal and gas power plant projects were shelved one after the other. Nuclear power became a major factor," states Pertti Kuronen.

According to Juha Kekkonen, the growth optimism was very strong at that time, which is understandable in light of development up to that point. "The electricity consumption curve had increased year after year, so no one ever considered that the growth would stop or consumption would decrease."

At that time, no one guessed that power plants would be closed and the whole production system would have to be changed to a low-carbon system. There were no signs of a structural change in industry or in the energy system, and climate issues were still a long way off. Now the situation has changed and managing large production plants will be even more challenging in the future. Further increases in renewable energy production will alter the entire power system.

Is forecasting the future as easy today as it was 20 years ago? Probably not, according to Kekkonen and Kuronen. "The near future looks very different than it did in the 1990s. We will have more demand response, decentralised small production and consumer communities. We'll already have to prepare for the challenges the transmission system operators will face in 20 years."

Welcome to the **network code forum**

A new discussion forum provides up-to-date information about network codes.

TEXT SATU VILJAINEN

One year ago, this magazine predicted that the first network code would take effect during 2015. That prediction was correct and the pace is picking up this year.

Fingrid has established a discussion forum related to the implementation of network codes. The forum will meet regularly and is open to all stakeholders. The objective is to increase the openness of main grid owner work and promote discussion about the impacts of European legislation on Finnish and Nordic electricity market actors.

The forum will meet three times per year to spend an afternoon addressing current issues related to network codes. Fingrid will convene the forum and handle the preparation work. Each participant can influence the content of the events by proposing topics for the agenda. The Energy Authority will also have the opportunity to speak at the forum.

The first forum focuses on market codes

The idea of a network code forum was launched last autumn, and the forum met for the first time on 17 March 2016. The topics of the first forum focused on market codes in particular. Changes in the Nordic electricity markets will occur because, for example, Capacity Allocation and Congestion Management (CACM) will allow exchanges to compete in the electricity markets. EPEX SPOT has applied for a permit to begin exchange activities in the Nordic countries. Nordic transmission system operators are currently working together to consider the best way to implement the market entry of several exchanges in practice. For market actors, the change will probably become visible at the end of 2017. Future meetings of the network code forum will deal further with this subject.

The first forum also addressed the length of an imbalance settlement period. This topic was already examined at the beginning of the year in the form of a survey organised by ENTSO-E. Finnish actors were very active in terms of this survey, and our thanks go out to all participants! This topic will also be taken up in the future as preparation of the energy balancing guidelines progress.

Stakeholders will be kept up to date

As the network codes take effect, new operating models will be developed and new requirements implemented, which will guide connection to the electricity system and system use as well as electricity market activities. Many of the new methods require approval from the Energy Authority. According to the current estimate, approval will be required for more than 100 methods. For the sake of comparison, Energy Authority approval was earlier required in six matters related to the general terms for grid services, including balance service terms and connection terms.

Stakeholders have the legal right to be heard prior to the implementation of new operating models and requirements. We will organise workshops in conjunction with the network code forum, thus providing stakeholders with the opportunity to learn more about the issues under preparation.

Further information about network code forum activities and current issues is available on the Fingrid website under the Customers tab.

You can register by sending an e-mail to the following address: *verkkosaannot@fingrid.fi.*

New method for calculating cross-border transmission capacity

In cooperation with Nordic main grid owners, Fingrid is developing an alternative CNTC method for comparison with the flow-based method.

In 2012, Nordic main grid owners launched a project related to the flow-based method of calculating the cross-border transmission capacity of the electricity grid. The project involves examining the suitability and impact of the method for Nordic electricity markets.

A CNTC (Coordinated Net Transmission Capacity) method is now being developed for comparison with the flow-based method. The two methods will be compared during the autumn, and at the end of the year Nordic main grid owners will decide which calculation method to propose to the Nordic supervisory authorities.

EUROPEAN COOPERATION

PRESENTING NETWORK CODES

Network codes are rules compiled by the European Network of Transmission System Operators for Electricity (ENTSO-E). Their purpose is to harmonise the European electricity markets. This column will present the network codes one at a time. The code this time is *Forward Capacity Allocation.*

The FCA Guideline aims for electricity markets that **function in the long term**

The Forward Capacity Allocation (FCA) Guideline is one of three network codes for electricity markets.

TEXT HEIDI UIMONEN

The FCA Guideline covers the calculation and allocation of transmission capacity to the markets at intervals longer than the day-ahead market and regional price hedging. It is based on a continental European model in which transmission system operators sell transmission capacity to market actors on annual and monthly basis. However, exceptions are possible.

Hedging against price differences between bidding zones must be possible

The FCA Guideline states that market actors must have sufficient possibilities to hedge against the risks of price differences. These hedging products for price differences are long-term transmission rights auctioned by transmission system operators, which can be used to hedge against price differences in neighbouring bidding zones. There are two kinds of transmission rights: physical and financial transmission rights. Physical transmission rights are physical transmission capacity that can be used for bilateral electricity trade or sold on the day-ahead market. Financial transmission rights are pure financial products, the value of which are the price difference between two bidding zones. Transmission rights are auctioned on a single European marketplace applying the harmonised allocation rules for long-term transmission capacity.

With the exception of Denmark, transmission rights are not sold in the Nordic countries and price hedging is based on forward contracts traded on the electricity markets, such as system price futures and Electricity Price Area Differential (EPAD) futures. In this case, market actors trade hedging products with each other. The strength of this Nordic model lies in its reliable system price, which provides a strong reference price for all electricity agreements.

According to the FCA Guideline, the Nordic model will still be possible if, after consulting the market actors, the regulatory authorities decide that the current financial markets offer sufficient hedging possibilities. If an assessment shows that the financial markets do not offer sufficient hedging possibilities, the regulatory authority will ask the transmission system operator to either grant transmission rights or ensure that enough other long-term hedging products are available to support the electricity wholesale market. The method has not been specified in detail, but it could mean active participation of the transmission system operator in the financial market.

Possible changes in 2018

The FCA Guideline was approved at a comitology meeting at the end of October 2015, and is currently waiting for approval by Parliament before entering into force. Regulatory authorities must assess the hedging possibilities within six months of the FCA Guideline taking effect. After this process, we will have more information about the effects of the guideline in Finland. If the regulatory authorities find that hedging possibilities are insufficient, the transmission system operators shall propose a suitable model. At the earliest, implementation of a model approved by the regulatory authorities would take place in 2018.

The FCA Guideline also specifies methods for calculating transmission capacity at the monthly and annual level. The transmission system operators calculate transmission capacity regionally using the common European grid model and data provided by generation and consumption. These methods complement the transmission capacity calculation principles presented in the Capacity Calculation and Congestion Management Guideline (CACM).

Branch lines

– AN ELECTRICAL PART OF THE MAIN GRID

Branch lines are a special feature of the Finnish electricity grid. Their tree-proofness is particularly important, as the impacts of a fault in a branch line can be significant on a regional scale.

TEXT MIRA MUURINEN | PHOTOGRAPH VALTTERI KANTANEN

Power plants, factories and distribution networks are generally connected to the main grid by means of substations. In order to ensure system security, many transmission system operators around the world do not permit direct connections to the transmission line.

In Finland, however, the geographic transmission distances for electricity are long and substations are far apart. If connections were only possible via substations, the lines would have to run parallel to each other for long distances. Since building parallel lines is not feasible from the viewpoint of the national economy, Fingrid allows connections to the 110 kilovolt transmission lines that it owns.

The lines connecting to the main grid, also known as branch lines, are a fixed part of the main grid in electrical terms, which means that disturbances in them may affect other actors located far away from the fault location.

Switching devices increase operational reliability

A branch line can be connected to the main line in a fixed manner or by means of switching devices. Connection is only possible on Fingrid's 110 kilovolt network and is subject to certain boundary terms. Some 50 customers have connected to Fingrid's transmission lines via 200 branch lines.

Fingrid specialists **Niklas Löf** and **Mikko Nykänen** explain that a disturbance in a single customer's branch line can affect many other parties.

"A fault in a branch line causes a disturbance throughout the transmission line section to which the branch line is connected. Fingrid's network is meshed, which means that when electricity transmission is cut off on one line, electricity moves through the main grid via another route. Branch lines, on the other hand, are radial in nature and don't always have alternative connections. Several distribution network companies can be connected to a single Fingrid 110 kilovolt transmission line, and when a fault occurs the disturbance can be significant on a regional scale," says Löf.

System security can be improved by adding switching devices to the branch line. A disconnector can be used to separate and earth a branch line, after which voltage can be restored to the main line. A fault in a branch line equipped with a protective circuit breaker is automatically limited and the voltage is restored to the main line very quickly.

The General Connection Terms of Fingrid require the use of switching devices on all branch lines that are more than two kilometres long, and at least a load-breaking disconnector is required for connections of more than seven kilometres. If the length of a branch line exceeds the distance between the connection and Fingrid's closest protective circuit breaker, the customer must equip the branch line with a protective circuit breaker.

"When renewing transmission lines, we strive to upgrade all existing connections to comply with the current General Connection Terms and thus improve system security," explains Löf.

Maintenance and disturbances have to be reported

The Electricity Market Act requires maintenance of the 110 kilovolt electricity network so that network operation is not disturbed by trees falling on transmission lines or growing along the right-of-way. Although the owner of a branch line is responsible

for its tree-proofness, branch lines are a fixed part of the main grid and have a direct impact on its system security. As a result, Fingrid collects information from its customers concerning maintenance of branch lines and disturbances occurring on them.

If a tree falls on a branch line despite maintenance measures, Fingrid sends the customer a request for clarification regarding the disturbance and further measures. The Main Grid Contract that took effect at the beginning of 2016 obliges Fingrid customers to also report to the company on branch line maintenance measures at 5-year intervals.

"We have received feedback telling us that the reporting takes a lot of work – especially when some customers also collect the same data for their own reporting systems. However, once the data has been completed for the first time, updating it doesn't take long," says Niklas Löf.

Bringing tree-proofness to the same level as on the main grid

Fingrid's goal is to ensure that branch lines are as tree-proof as the main grid.

"We're constantly working to improve the tree-proofness of the main grid. However, some main grid disturbances are caused by branch line faults, and in that area Fingrid and customers have a shared interest in transmission reliability," explain Niklas Löf and Mikko Nykänen.

Fingrid and branch line customers use many of the same service providers, so the criteria and operating methods in clearing work are often consistent. According to Nykänen, Fingrid is also asked to provide advice and share its experience concerning maintenance measures.

"We have certain proven operating models for maintaining transmission lines and rights-of-way that are subject to continuous development. We're always ready to help our customers if they think that our experience would be beneficial."

However, there is always room for closer cooperation.

"Our objective is to deepen cooperation and increase processing-related discussion and exchange of information. 110 kV lines owned by customers and Fingrid are often located close together and sometimes even on the same landowner's property. This means that coordination of work would be beneficial for both parties," says Nykänen.

The aim is to create a concrete operating model for cooperation during this spring. "Once we get started, we will certainly be asking customers for their opinions."

Lack of switching devices prolongs disturbance

Trees that fell on a Fingrid customer's branch line last November caused an exceptionally long disturbance in Juupajoki, which is located in the Pirkanmaa region of Finland. The disturbance affected the main grid for several hours.

"The customer's branch line had no switching device, so the trees that fell on the line had to be cleared before electricity from the main grid to the Juupajoki substation could restored," explains Niklas Löf.

The disturbance affected some 2,000 end users for an estimated 90 minutes.

From energy glutton to demand response leader

Electric heating of detached houses has long been considered an energy glutton. However, studies show that electric heating can be a significant demand response resource.

TEXT MIRA MUURINEN | **ILLUSTRATION** ANSSI KERÄNEN

Homes heated with electricity were already taking part in demand response in the 1980s. When industry used a lot of electricity during the day, night electricity was a cheaper option for consumers. In addition, the capacity-oriented wholesale electricity tariff encouraged local electricity companies to reduce peak power by means of active load control. This is why electric heating in many homes had automation that allowed the transfer of heating to more reasonably-priced hours of the day.

The electricity system and electricity markets have changed a lot in the past 30 years. Condensing power production has been joined by new

"About 15% of Finland's peak consumption is the kind of electric heating that could be controlled."

weather-dependent forms of production, such as wind and solar energy. The risk of a power shortage has simultaneously increased. Now, the industry is turning to households once again: could electric heating take up the slack once more?

Triple the potential

Fingrid was one of the commissioners of an extensive study concerning the opportunities of demand response. The study was performed by Lappeenranta University of Technology, Tampere University of Technology and Tampere University of Applied Sciences. According to **Samuli Honkapuro**, Professor of Electricity Markets at Lappeenranta University of Technology, electric heating can play a significant role in demand response.

"About 15% of Finland's peak consumption is the kind of electric heating that could be controlled. Controlling a load of this size has an impact. For us, the situation is not acute yet but, for example, development in Germany indicates that as the share of inflexible wind and solar power increases on the markets, opportunities for consumption flexibility must also be assessed for households."

At this time, some 1,000 megawatts of the demand response potentially available from electric heating of households is within the scope of control. According to Honkapuro's estimate, this could be tripled by means of installation modifications to heating plants.

"All households now have remote electricity meters with the readiness to control loads. In the best case, this would only require reprogramming."

Electric heating has been considered an inefficient method of heating, and heat pumps would in fact be a more energy-efficient alternative. However, Honkapuro believes that electric heating is worth utilising as a demand response resource for as long as it is used by households.

"When the use of heat pumps becomes more common, they can be controlled for demand response purposes in much the same way," states Honkapuro.

The chain has to be in good shape

The demand response potential of electric heating has been tested in pilot projects implemented by Fingrid, Fortum Oyj, Helen Oy and There Corporation Oy. There Corporation brings installable software to homes while Helen and Fortum provide the service to their customers.

"Each party represents a single area in the demand response chain. We need functional markets and technologies that enable consumption control and the exchange of information. We also have to be able to develop demand response into a working service," sums up **Markus Logren**, who is Development Manager at Helen.

Fortum's Product Manager **Heli Lummaa** says that consumers already have access to services that control home heating according to the electricity spot price. The pilot projects studied whether household loads can be offered to Fingrid's demand response marketplaces, especially for the balancing power market and frequency-controlled disturbance reserve market. There Corporation's Head of Sales **Ilkka Palola** is satisfied with the end result.

"We learned that household electric heating demand response is technically possible. The response times are so fast that the loads are well suited for both the marketplaces that were set as the target."

More benefit for consumers

Electric heating demand response is easy to implement technically and does not cause any disturbance to the resident. Why aren't all electrically heated Finnish houses already within the scope of demand response?

There Corporation's Ilkka Palola makes demand response sound simple.

"We offer automation that transfers household electricity consumption to the most reasonably priced hours. In cooperation with the energy company, the automation can be utilised for demand response once consumers have given permission to communicate information and control consumption."

So much heat is stored in the building itself and, for example, in warm service water, that the consumer doesn't even notice brief shutoffs in heating. Fortum's Heli Lummaa and Helen's Markus Logren say that the feedback received from customers who participated in the pilots was nearly all positive.

Lummaa, Logren and Palola see service development as a bigger challenge. Demand response has to be turned into an easy service with added value that reaches all the way to the end user.

"The important question is how to get people excited about new services and change their behaviour. The consumer has to benefit from participation in demand response," explains Logren.

According to Palola, the current low price of electricity may not motivate consumers to behave in a cost-conscious manner. In any case, all parties believe that consumers will play a larger role in the electricity markets of the future.

"We want to offer the consumer an easy way to be actively involved in energy markets and influence their own energy footprint – and in that way influence the society as a whole," says Lummaa.

Monitoring electricity consumption

Electricity is an essential part of modern life. However, we rarely stop to think about everything that we need electricity for in our daily life. Fingrid's Customer Manager **Jarno Sederlund** and his 13-year-old daughter **Sara** kept a record of their electricity consumption for two days in January.

TEXT MIRA MUURINEN | PHOTOGRAPHS MATTI IMMONEN

FACT

Electricity consumers: A four-person family with three sporty children who enjoy turning up the heating and taking hot showers.

Home: Post-war single-family home built in 1959 with an area of 250 square metres. The house features water-circulation radiator heating and an electrical boiler with a capacity of 1,500 litres and heated by night electricity, a heat-retaining fireplace and an air-source heat pump on the bottom floor.

Initial situation: The family has an electricity contract based on hourly price and a Tuntihinta mobile application with an alarm limit that is in active use.

Objective: To keep a diary and monitor electricity use, especially that of the daughter Sara and father Jarno, for two days.

Test period: 15–16 January 2016. The test period coincided with some very cold days (11–17 degrees below zero).

Sara

FRIDAY 15 JANUARY 2016
8.26 Bedroom LED lamp, 10 min (0.0005 kWh)
8.45 Kitchen light, microwave, toaster and TV (total 0.33 kWh)
9.05 Bathroom halogen light (0.001 kWh)
9.15–14.00 School
14.20 Microwave, oven 20 min, TV 3.5 h (total 1.0 kWh)
17.15 Living room energy-saving lamp 15 min, bedroom LED lamp 45 min (total 0.003 kWh)
18.30–20.00 Football practice
20.35 Shower 5 min (electrical boiler) and shower light (total 0.301 kWh)
20.40 Bedroom LED lamp 2 h, phone charging 2 h (total 0.025 kWh)
23.00 Humidifier turned on for 11 h (1.0 kWh)

SATURDAY 16 JANUARY 2016
11.20 Microwave and toaster (0.1 kWh)
11.32 Shower 5 min (0.3 kWh)
11.36 Hair drying 8 min (0.3 kWh)
11.50 Phone charging 30 min, TV 1 h (total 0.025 kWh)
14.30 Friend visiting, lights on in fitness room 30 min (0.005 kWh)
18.45 Bedroom light 4 h (0.01 kWh)
19.00 and **22.30** Phone charging 2 h (0.02 kWh)

Total consumption approx. 2 kWh

The Sederlund family wakes up at the same time as the rest of Finland on a freezing January morning. The effects of turning on lights, computers and the coffee maker can be seen in their electricity consumption statistics. Electricity consumption in Finland on the Friday of the test period was highest at 8 am, peaking at 13,718 megawatt hours.

When consumption peaks, the price of electricity is also at its highest. For example, the SPOT electricity price on Friday morning was some 25 euros per megawatt hour at 5 am, but between 8–9 am the price had increased to more than 120 euros per megawatt hour.

The Sederlund family's electrical boiler is heated by night electricity. As a result, the household's consumption is still more than 13 kilowatt hours of electricity at 6 am. At 8 am, when electricity consumption in the rest of Finland is peaking, the Sederlunds' consumption has dropped to a level closer to 2 kilowatt hours.

A second clear peak in electricity consumption and the SPOT price occurs at 5–7 pm on weekdays when the working day ends and people are doing a variety of household chores that require electricity. From 5–6 pm, the Sederlund family also has its oven, hot plate, radio and lights turned on.

Heating accounts for the most consumption

Electricity is a commodity for many people, and they pay little attention to consumption. "We often leave the TV and lights on in different rooms, and a lot of devices are 'hibernating," says Jarno Sederlund.

The Sederlunds' electrical boiler consumes the most electricity – up to 100 kWh of electricity on very cold days. "Fortunately, it operates at night, when electricity and transmission are cheap," states Jarno Sederlund. During the test period, heating the sauna and car also accounted for a lot of consumption.

"Charging phone batteries seems to be the most repetitive cause of electricity use for adults and children. On a yearly level, it takes more electricity to charge a smart phone than to operate a refrigerator," notes Sederlund.

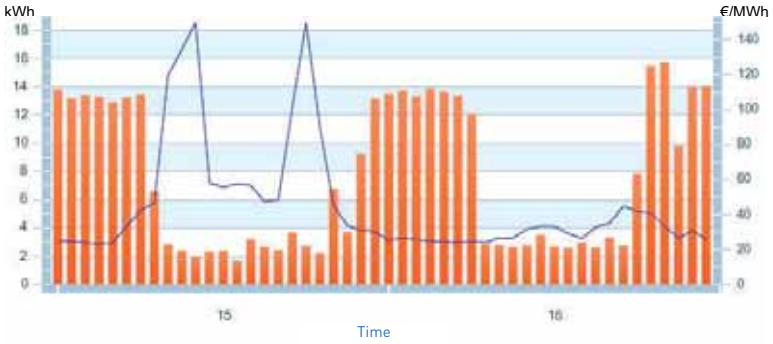
Jarno

FRIDAY 15 JANUARY 2016
0.00–6.15 Phone charging (0.02 kWh)
6.15–6.40 Bright light lamp (0.02 kWh)
6.30 Morning news on TV 10 min (0.005 kWh)
6.40 Shower 5 min and electric shaver (total 0.35 kWh)
7.00 Microwave, toaster and coffee maker (total 0.01 kWh)
7.15–8.00 Working at home on laptop, laptop charging (0.3 kWh)
7.30–8.10 Car plugged into heater (1.2 kWh)
9.00–17.00 At work
Meeting with a customer, e-mail, work-related phone calls. Laptop in docking station, mobile phone charging. Office lights turn on automatically. Lunch at workplace restaurant, coffee from vending machine. Car plugged into heater 16–17.10. (Total 2.145 kWh, with car heating accounting for 1.6 kWh)
17.30–18.00 Cooking: oven, hot plate and fan turned on. Kitchen and living room lights and radio turned on (total 0.5 kWh)
18.30–20.00 Coaching at Sara's football practice (in a nearly warm hall)
20.30 Vacuuming 15–30 min (0.05 kWh)
21.00 TV 2 h (0.4 kWh)
22.00 Dishwasher, express programme (0.5 kWh)
23.00 Phone charging all night (0.02 kWh)
23.00–24.00 Bedroom light on and reading the Remes book "Jäätyvä helvetti" (0.01 kWh)

SATURDAY 16 JANUARY 2016
9.00 Shower 10 min (0.5 kWh)
9.30 Toaster, coffee maker and kitchen radio 1 h and music on phone via Spotify (0.01 kWh)
10.30 Vacuuming 15–30 min (0.05 kWh)
11.00–11.15 Car plugged into heater (0.5 kWh)
12.30 Microwave, hot plate and fan. Lights turned on in kitchen and living room, kitchen radio on (total 0.5 kWh)
18.30 Overnight guests, lights on all over the house and also in the guest room (0.05 kWh)
18.30–21.00 Sauna and electrical boiler turned on (15 kWh + 15 kWh)
19.00–22.00 TV (0.6 kWh)
22.00–22.30 Dishwasher on (0.5 kWh)

Total consumption approx. 4 kWh

Electricity consumption for the Sederlunds 15.–16.1.2016



Use
Total: 364.59 kWh
Average: 7.60 kWh
Minimum: 1.65 kWh (13.00 on 15.1.2016)
Maximum: 15.77 kWh (20.00 on 15.1.2016)

SPOT price (€/MWh)
Average: 45.23 €/MWh
Minimum: 23.28 €/kWh (3.00 on 15.1.2016)
Maximum: 150.01 €/kWh (10.00 on 15.1.2016)

Source: Hourly report from Helen

The peaks in electricity prices that occur on weekdays are not evident on weekends. Like many other Finnish families, the Sederlunds heat their sauna on Saturday evening. During the test period, electricity consumption in Finland peaked from 6–7 pm on Saturday evening, with consumption hitting 13,738 megawatt hours.

Monthly monitoring is worthwhile

Expert **Päivi Suur-Uski** from Motiva says that the consumption data for the Sederlunds is typical of similar sites.

"In electrically heated homes, room temperatures and water use habits play an important role. A one-degree change in temperature has a five percent impact on heating costs. It's worth using wood heating and a heat pump in addition to checking the seals on windows. It's also a good idea to adjust natural ventilation according to the season and ensure that the electrical boiler has the right settings," suggests Suur-Uski.

Jarno Sederlund believes that minor changes could provide savings of 5–10% on the family's household electricity bill. "We could check the temperatures of the fridge and freezer and adjust the background brightness on the TV. It would also be easy to reduce heating costs by using our heat-retaining fireplace more."

The fireplace was actually in use on Saturday evening. "We tried cooking without electricity and roasted sausages and marshmallows in the fireplace."

According to Päivi Suur-Uski, the best time to assess electricity consumption is the summer, when there is no heating consumption. "Then it's easy to see the impact of idle load by turning off all the devices that are in idle state, such as modems and set-top boxes, for a single night. Regular consumption monitoring on, for example, a monthly basis helps people understand their own energy use."

The consumption for Jarno and Sara was not measured but estimated using methods such as Motiva's example figures.

WHAT ON EARTH?

This column introduces terms relating to main grid operations.

Bird markers on transmission lines

Warning markers can be seen in different places on transmission lines: red or white obstruction markers near airports to make the lines visible to aircraft and black or orange bird markers, which are intended to prevent birds from colliding with the lines. Bird markers are installed on the routes of migratory birds or in the vicinity of nesting sites or other special locations.

A bird marker is a hollow, plastic ball of about 20 cm in diameter that is made of two hemispheres. The two halves are hinged on one side and the marker contains a spring-operated mechanism to lock the marker in place.

Birds don't collide with main grid lines nearly as often as they do with distribution network lines, because main grid lines are thicker and more easily detected by birds. However, the individual overhead ground wires on transmission lines are thinner than current conductors, just 10–20 mm in diameter. Bird markers are installed on these overhead ground wires.

Birds are very good at avoiding lines at the last second. Their success depends on the bird species, area, transmission line structures, prevailing weather conditions, and other factors affecting visibility. Installing bird markers on transmission lines has been proven to reduce collisions by up to 50–90%.

3 MELO
2 SELLEE
1 SEITENOIKEA

Traditional Finnish nomenclature can often be seen in the names of Fingrid's substations.

TEXT MIRA MUURINEN

Fingrid owns approximately 110 substations. When customers' substations are included, the company's database contains more than 1,500 stations. Each of them has its own unique name and letter identification code.

Finding a suitable substation name

A substation name is selected with care and is usually decided when planning of a new station begins.

A substation is primarily named on the basis of its location, but when the same place has several substations the name is derived from other place names used in the area.

Expert **Antero Reilander** used to serve as the official "Substation minister", but Specialist **Niklas Löf** has since taken over the job of christening substations.

"Our own preliminary substation designer or a customer representative proposes a name to me and I make sure that the name is not already in use. If the name has been taken, I can suggest some other name. I also offer a list of abbreviations that are available and suitable for the name," says Löf.

The names chosen for Fingrid and customer substations are preferably Finnish and as clear and unambiguous as possible with regard to spelling. The name also has to be suitable for a substation.

"Substation projects are big investments, so the name must be appropriate. For example, we had a serious discussion when a substation was located right next to a place called Palovaara (Fire risk). We eventually decided that using this name for a substation simply didn't give the right impression," says Reilander with a laugh.

From Asmunti to Sellee

Tiina Manni-Lindqvist, who is a name planning expert at the Institute for the Languages of Finland, praises Fingrid's procedure for naming substations.

"For the most part, Fingrid appears to favour the nomenclature used in the area. In this case, the names are genuine, traditional names and observe local usage. For example, at one time it was common to use new names adapted from the old names for railway traffic locations and post offices. These names often differed from common practice in the area in question.

Fingrid's custom of checking conjugation of the name with local residents is also proper in terms of name planning. For example, Manni-Lindqvist says that according to old collection data in the Names Archive, in Ranua the name *Asmunti* is conjugated as *Asmunnin* in the possessive form while local people reported that the *Asmuntin* form is also used. Located in Tornio, *Sellee* conjugates plurally, using the form *Selleissä* when people are *in Sellee* and *Selleisiin* when they are going *to Sellee*.

Since Fingrid utilises the old place names, many names have interesting stories associated with them.

For example, rather than having something to do with winning the lottery, *Seitenoikea*, which is located in Hyrynsalmi, takes its name from rapids that have seven straight sections. According to an old saying, the rapids thus had to be navigated "seven times to the right and seven times straight ahead". "*Melo* is in Nokia and takes its name from the former *Melonsyöstävä* rapids, a name that reflects the fact that navigating these rapids required exceptional strength and paddling skills," explains Manni-Lindqvist.

Naming is a matter of safety

The reason for Fingrid's clear naming policy is above all related to safety.

"The entire common electricity grid is jointly used by Fingrid and the customers, so it is of utmost importance to be certain that we are talking about the same stations and sections of transmission line. When carrying out switchings, it is a matter of safety for all parties and, for example, the rescue authorities, to know exactly which station is involved," says Reilander.

Reilander and Löf remind people that it's a good idea to agree with Fingrid on naming a substation at an early stage.

"It's important to check the name and confirm it while planning a project. Then the plans and work descriptions made during the construction phase can also be found under the right name later on."

COLUMN

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

NEURAL NETWORKS AND AI: TERMINATORS OR MOTHER TERESAS?

"*I'll be back*". One of the most famous quotes in film history was uttered by a Cyberdyne Systems 800 series robot, model 101. We know him better as the terminator portrayed by **Arnold Schwarzenegger**. What made the robot powerful and efficient was its intelligence, a neural network processor.

When the film first came out over thirty years ago, such an oddity was pure fantasy, something that could only become a reality in the distant future. But the future is now.

The line between human and machine is becoming blurred. The opening kick at the World Cup championships in Rio de Janeiro was taken by a biomechanical combination of human and machine. A paraplegic teenage boy used the power of his mind to control an exoskeleton to take the kick. I myself have a subdermal microchip in my hand which contains my Bitcoin account data. Refraction errors in my eyes were corrected through laser surgery, and the first artificial eyes with pixel monitors are already in use.

Last year, the United States' Defense Advanced Research Projects Agency (DARPA) requested permission to connect a microchip to a soldier's brain.

In 2004, the same research agency organised a competition for autonomous vehicles. The vehicle's task in the competition was to navigate from point A to point B across the desert along a relatively simple route. Not a single vehicle succeeded.

Now, 12 years later, Google's and Tesla's vehicles drive autonomously in normal traffic. Last year, the state of Nevada issued the first traffic permits for autonomous trucks. But what will happen when we begin to use neural network technology in other fields? Or connect artificial intelligence to humans.

Terminator fascinated us, and it keeps intriguing me. I majored in automation technology and artificial intelligence. In my Master's thesis, I merged fuzzy logic decision-making with a neural network to analyse optical measurement data. In my doctoral thesis, I used the neural network developed by Finnish professor **Teuvo Kohonen** to optimise mobile telephone network activity. Even back then, artificial neural networks were state-of-the-art technology, but recently, a quantum leap in neural networks called deep learning technology has emerged.

IBM, Microsoft, Apple, Amazon and Google are actively exploiting this new technology. Two years ago, Amazon released its own phone with a camera that can identify various objects. The phone can recognise any product and compare it with Amazon's product range. Should the product please the customer, it can be added to a mobile shopping cart. What you see is what you shop. Moreover, Google can understand your speech with the help of neural networks. If you browse the web with the Chrome browser, you may have wondered why some of the adverts include items that you have just discussed. It is your phone eavesdropping you.

Google's Picasa image application automatically recognises human faces on your computer's hard drive. Even though facial recognition technology has not been launched for Internet searches, it is clear that national security organisations make use of facial recognition when analysing video streams from security cameras. IBM's supercomputer analyses patient medical records, financial data, purchasing behaviour, and recommends holiday destinations and suitable travel insurance plans. Microsoft's activity tracker compares your health data to your Outlook calendar, and its image recognition algorithms outperform human capability.

Neural networks, used in accordance with Internet services and searches, give us an unforeseen and powerful tool. As humans, one of our greatest strengths is our ability to recognise the changes in our environment and interact with them. Neural networks are computer algorithms that now can do the same thing independently. When we connect them directly to the human brain, we can talk of an entirely new species, cyborgs or Homo digitus.

Jussi Valtonen's Finlandia award-winning book "He eivät tiedä mitä tekevät" (They Know Not What They Do) describes a seamless interaction of the human brain and the Internet. Contrary to the book title, us in the corporate world and in the field research, we know exactly what we are doing. Technology can create terminators, but it can also help us. Cures for several severe illnesses or disabilities are now possible due to our collaboration with technology. It is up to us to decide what we let out from Pandora's box.

GRID QUIZ

Competition to the readers of Fingrid Magazine

Answer the questions and send your responses by fax (number +358 (0)30 395 5196) or mail to Fingrid no later than 15 May 2016. Address: Fingrid Oyj, PL 530, 00101 HELSINKI, FINLAND. Mark the envelope with "Grid Quiz".

Three winners will receive handy mini-speakers equipped with a USB connection – great for using with a smart phone! Answers to the questions can be found in the articles in this issue.

1. Why is it important to obtain information about disturbances in cross-border connections before 10:30 am?

- The service personnel eat lunch at 11 am.
- Information about the following day's transmission capacity is provided to the markets at 10:30 am.
- The Nordic Outage Team, which coordinates transmission outages on Nordic cross-border connections, meets weekly at 10:30 am.

2. Why was the contract for selling the main grid to Fingrid signed at the last minute, one day before the company's operative activities began on 31 August 1997?

- The contract documents were forgotten in Lapland.
- The parties could not reach agreement on the new grid plan.
- Matters related to the cross-border connection tariff were negotiated until the last minute.

3. What is special about the branch lines of Finland's main grid in comparison to other countries?

- Many transmission system operators around the world do not permit direct connections to the transmission line.
- In Finland, the maximum length of a branch line is longer than elsewhere in Europe.
- In Finland, the requirements for tree-proofness are stricter for branch lines than for the main grid.

4. How much does a change of one degree in indoor temperature affect the heating costs of an electrically heated home?

- About 1%.
- 5%.
- 10%.

5. Which of the following is a Fingrid substation name?

- Asmunti
- Palovaara
- Melonsyöstävä

6. What are flow-based and CNTC?

- Methods for calculating demand response potential for electric heating.
- Methods for calculating cross-border transmission capacity.
- Methods for calculating transmission loss.

7. Finland's electricity consumption record was set on 7 January 2016 at 5–6 pm. At that time, electricity consumption was

- 4,231 megawatt hours.
- 10,874 megawatt hours.
- 15,105 megawatt hours.

Prizes for the previous Grid Quiz (3/2015) have been sent to the following winners who answered correctly: Tero Kallio, Lappeenranta; Kauko Vierimaa, Oulunsalo; Arto Köykkä, Muhos.

A new look for Fingrid's jubilee year

On 29 November 1996, Imatran Voima, Pohjolan Voima and the State of Finland signed the charter to found the transmission system operator. The deal signed on the last day of August in the following year was the largest in Finnish history at that time. This is how the Fingrid transmission system operator got its start.

This year, we're celebrating Fingrid's 20 years of serving as a model of main grid operations. In honour of the jubilee, Fingrid's look has been thoroughly renewed, with a dynamic red selected as the new theme colour. The new symbol is designed to create a streamlined and consistent Fingrid image. Our new look sends a message about our values: transparency, impartiality, efficiency and responsibility.

The new look was developed by **Jaakko Vanto**, from the Marker Oy creative design agency. Fingrid will gradually launch its new red look during spring 2016.

FINGRID

Läkkisepäntie 21, FI-00620 • P.O. Box 530, FI-00101 Helsinki
Tel. +358 30 395 5000 • Fax +358 30 395 5196 • www.fingrid.fi

Hämeenlinna
Valvomotie 11
FI-13110 Hämeenlinna
Finland
Tel. +358 30 395 5000
Fax +358 30 395 5336

Oulu
Lentokatu 2
FI-90460 Oulunsalo
Finland
Tel. +358 30 395 5000
Fax + 358 30 395 5711

Petäjävesi
Sähkötie 24
FI-41900 Petäjävesi
Finland
Tel. +358 30 395 5000
Fax +358 30 395 5524

Rovaniemi
Teknotie 14
FI-96930 Rovaniemi
Finland
Tel. +358 30 395 5000
Fax +358 30 395 5611

Varkaus
Wredenkatu 2
FI-78250 Varkaus
Finland
Tel. +358 30 395 5000
Fax +358 30 395 5611