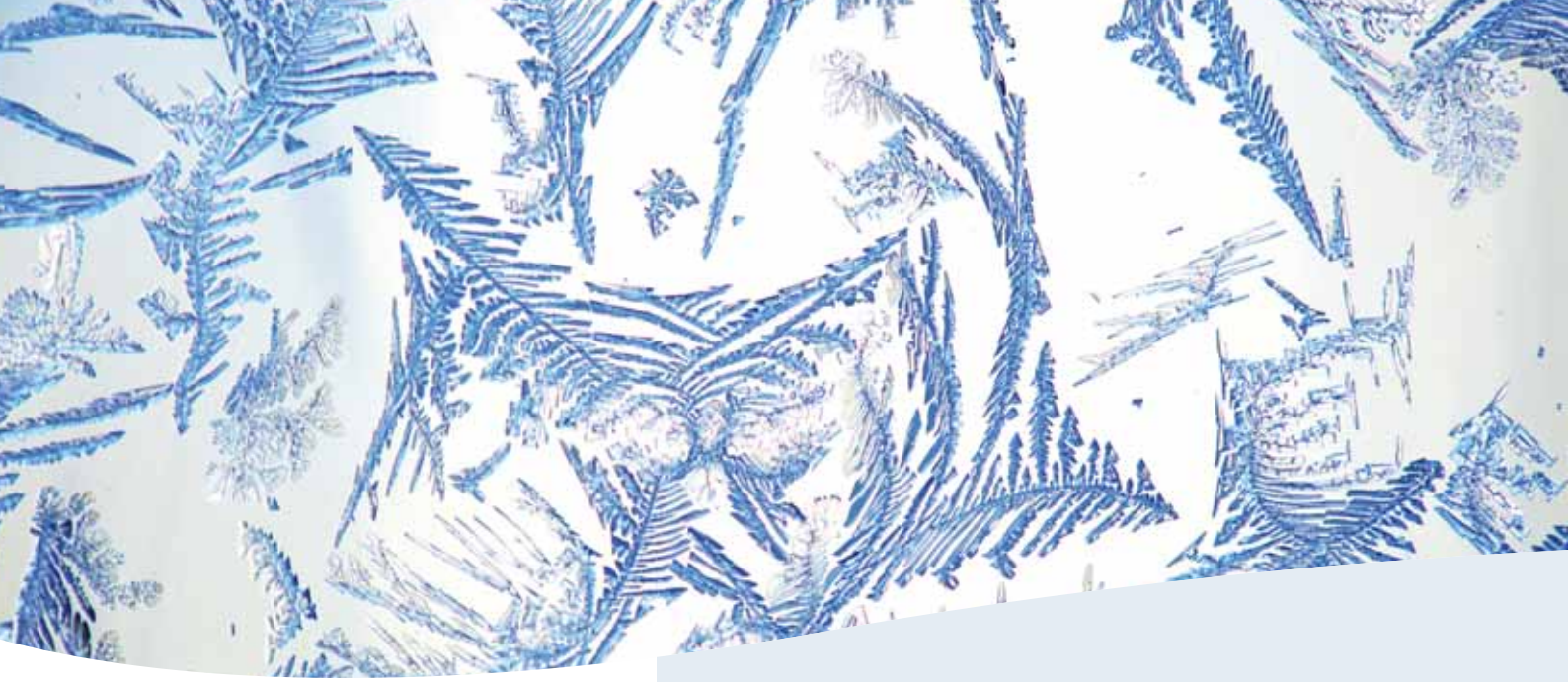
Corporate magazine
Fingrid Oyj **3/2013**

FINGRID

Transmission grid and system security



Nature creates icy works of art when the humidity in the air and the temperature are favourable. Read page 21 for more information on the anatomy of ice crystals and on how Fingrid removes ice from its transmission lines.

FINGRID

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Cover photograph: Advisor Roger Gustavsson works at the main grid control centre, known as the Fingrid control room. The article on page 8 follows Gustavsson and his colleagues at work.
Photograph by: Matti Immonen

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In this issue

EDITORIAL

Contingency planning and risk management

In December 2012, Fingrid moved to new premises in Käpylä, Helsinki. In January, the Hämeenlinna network control centre followed suit and control room operations were merged into one place, the main grid control centre. In practice, day-to-day operations have confirmed that the new, centralised control room is the right solution for reliability. For our customers, the grid control centre means a single point of contact for day-to-day operations.

Risk management and contingency planning are crucial part of system operation. The main grid control centre and power system operation planning unit are constantly thinking about what to do if a transmission line fails or if a power plant suddenly goes offline. What if e.g. a high voltage DC link goes down straight afterwards? What if consumption increases beyond what was predicted for tomorrow? Risks are recognised, preparations are made, and the risks are reduced using any available methods. But that isn't enough. Sometimes things do go wrong despite all our best efforts, and then we have to be able to act fast. In such cases, we need continuity management, which is Fingrid's key development project for next year. We are increasing our capacity to act in situations which threaten grid business, whether that means extensive electrical blackout, a major IT-system fault or perhaps a fire on the premises.

The change in the Electricity Market Act which came into effect in autumn requires network companies to carry out preparations for blackouts and to participate in common preparedness planning. The Power and District Heat Pool provides an excellent basis upon which energy companies can carry out cooperation together with authorities concerning preparedness for disturbances occurring under both normal conditions and during exceptional circumstances. Companies in the energy industry have actively participated in the pool's operations. Good examples of development projects from the last year include the good practices for security of water supply and fuel distribution during electricity outages.

Great efforts have been made over the past year concerning the preparation of European network codes. The European Network of Transmission System Operators for Electricity, ENTSO-E, has drawn up around ten network codes which are gradually being sent to the Commission for approval. Once complete, they will become binding legislation in Finland and influence both Fingrid's and our customers' operations. The network codes for operations are surprisingly detailed. In the future, legislation will guide operations with the aim of ensuring good security of supply. On behalf of our customers, we have striven to influence matters so that the special characteristics of the Finnish electricity system and production mix are taken into account. In my opinion we've succeeded quite well. Once the network codes are ready, we'll still have some work ahead of us. They must be implemented, which means changes to instructions and numerous agreements.

On the threshold of winter, talk often turns to the sufficiency of the electricity supply. During harsh sub-zero cold spells, Finland is still reliant on imports. There is enough electricity for everyone if neighbouring countries have electricity to sell and if cross-border transmission connections are operational. Extensive international wholesale markets are a good mechanism for directing electricity to where it's needed most. It would likely appear in the coming years that the Finnish condensation production capacity will be wound down as a result of profitability and environmental requirements, with renewable production due to increase. The aim of self-sufficiency with regard to electricity production also during peak-load situations is challenging for Finland, and our dependency on imports is likely to remain.

Reima Päivinen
is Fingrid's Senior Vice President responsible for power system operation.

European network codes promote **operational security**

The operational security of the electricity system will be put to the test as the electricity markets expand and the structure of electricity production undergoes change. The common European network codes aim at preserving operational security even in tough situations.

TEXT TIMO KAUKONEN | **PHOTOGRAPH** ISTOCKPHOTO

Everywhere you look, regional electricity markets are merging at an accelerating pace. At the same time, new technologies are being implemented in the production and consumption of electricity. Production is increasingly moving towards forms of production whose efficiency is dependent on the weather. As a result, we need new methods of balancing the production and consumption of electricity. One future solution is to utilise the price elasticity of consumption.

As a result of better functioning markets and as the structure of production changes, the flows in the transmission grids will approach transmission limits; that is, the maximum transmission for each usage situation. This will place new demands on the sufficiency of electrical networks and on the maintenance of operational security. The operational security of the electricity system must remain at a good level in order for markets to expand and for us to widely utilise new forms of production.

Operational security in Finland at peak levels

In Finland, the operational security of the grid has been at an excellent level. There have been no nationwide or extensive grid disturbances since the mid-1970s. This is partly due to the increased looping of the grid and an improvement in the reliability of devices used, as well as more efficient maintenance. Transmission capacity has also been increased through investments into new cross-border connections and through the use of series compensation in existing lines. At the same time, the electricity markets have opened up and are making use of transmission capacity more than ever. For this reason, transmission limits are still reached often, despite being significantly higher than previously. As such, the correct determination of transmission capacity and transmission monitoring and management play a key role in maintaining operational security.

Finland has experienced regional disturbances, however. The latest and most severe disturbance took place in 2011 as storms hit Finland on and after Boxing Day, causing widespread electricity outages lasting days in Southern Finland, as work was carried out to repair damage caused by trees falling on regional and distribution network lines. No trees fell on grid lines, but the disturbances in the regional networks also caused interruptions in delivery along grid branch lines. This resulted in outages in transmission along other branch lines along the main grid until the faults were repaired or fallen trees removed from the lines.

Widespread electricity outage was trigger for European network codes

Elsewhere in the world, extensive grid disturbances occur from time to time. The most recent extensive disturbance in Europe took place in 2006 when a fault caused the Central European networks to split into three partial networks out of sync with each other. Around 15 million people were left without electricity for half an hour. The disruption led to development which aimed at joint activities and an improvement in the real-time visibility of the network status between European Transmission System Operators (TSOs) in severe faults, which can affect several TSOs' spheres of influence. Having been initiated by the disruption, the development work also led to the preparation of European network codes. The common network codes aim at ensuring that we are able to prevent the reoccurrence of a corresponding extensive fault – or at least minimise the probability of such a reoccurrence.

European network codes are prepared in working groups which are part of the TSO cooperation body ENTSO-E. The aim of the codes is to harmonise European practices which affect the operational security and the performance of cross-border connections. Once complete and approved, the network codes will become binding legislation in member states.

First operation codes to come into effect in 2014

The preparation of network codes pertaining to operations, and therefore operational security, is well under way. The first three network codes, *Operational Security, Operational Planning and Scheduling* and *Load Frequency Control and Reserves* are currently being sent to the Commission and member states to undergo the approval process. It is expected that they will come into effect in legislation during 2014. Currently, the preparation of a network code for *Emergency and Restoration* is underway at ENTSO-E. It will make its way through the preparation process and is likely to come into effect within two years.

Considering the probability of disturbances

The *Operational Security* network code sets out general principles for maintaining operational security. One important basic rule is a principle known as the (N-1) principle, according to which the power system should be able to withstand any possible individual fault without experiencing any consequences in another area.

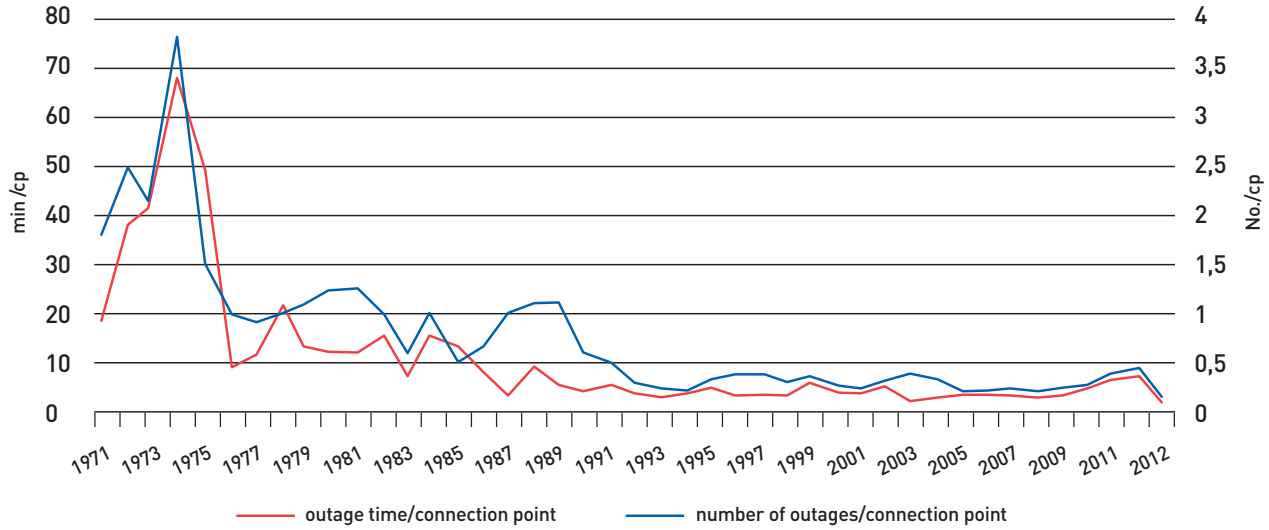
As before, the operational security of the network will be analysed by utilising network models through power flow, fault-current and dynamics calculations as the need arises. Operational security checks to be carried out must be increasingly based on the probability of disturbances and their effects. Each grid company should define the fault situations in its network into Ordinary, Exceptional or Out-of-Range faults. Should the probability of exceptional or out-of-range faults increase significantly as a result of weather conditions, they should be processed as ordinary disturbances. Dynamic fluctuations may also be likely, in which case these should be reviewed and, if necessary, the running of power plants should be adjusted to preserve stability after disturbances.

Deviations may be made from the (N-1) principle during changes in connections, during the activation of reserves or if the effects of the disturbance are concentrated in a small area.

Each grid company should plan and monitor in real-time the electrical systems' frequency, voltages, transmission flows and topology situations and exchange necessary information with neighbouring countries. In this way, exceptional circumstances are recognised and grid companies can carry out cooperation to return the situation to normal. The exchange of information during planning and in real-time between parties which are connected to the grid (distribution network companies, producers and consumers) will be improved in order to further improve overall management during changing situations.

An essential component of the maintenance of operational security is well →

AVERAGE NUMBER AND DURATION OF DISTURBANCES AT CONNECTION POINTS (disturbances longer than 1 min)



educated and trained operations personnel, whose training will be developed in a more formal direction. Those personnel who work in power system control room operations must complete an "operator licence" within a set period of time. The planning and development of the training will also be improved by naming an experienced training coordinator for each grid company who will be responsible for the planning and implementation of the training programme.

Outage needs for next year planned by beginning of August

The *Operational Planning and Scheduling* network code sets out in detail how grid companies and other parties connected to the network should carry out joint activities and the exchange of information to achieve good operational security. An important part of this work is the creation of a common European grid model for operational security reviews and the calculation of transmission capacity. The model will be used to calculate transmission capacity for various periods of time: year, week, day and current day. In the future, operational security will be calculated using the common grid model, thereby minimising inaccuracies in results.

A joint schedule and plan for transmission outages should be drawn up in order to guarantee the sufficiency of transmission capacity and for operational security to remain at a good level during transmission outages. In the future, the mapping of the demands for outages amongst parties connected to the network will begin earlier than previously. The plan for the following year should be complete and coordinated in good time before the turn of the year. A party which is connected to the network and which requires outages should submit its outage needs for the coming year to its regional grid company no later than the beginning of August. The TSO will add its own transmission outage needs to the plan and compile a final transmission outage plan for the following year by the beginning of December. Parties connecting to the network and the grid company will further specify the plans as necessary during the autumn before the final plan is completed.

In the Operational Planning and Scheduling network code, operational security is also ensured by preparing for power sufficiency during summer and winter by carrying out corresponding predictions and by taking care of the monitoring of the sufficiency of active and reactive power reserves.

The *Load Frequency Control and Reserves* network code sets out in detail how grid companies should take care of frequency control and the use of reserves in joint operations with other grid companies within the same frequency area. The network code also sets out precise limit values for frequency and parameters related to its maintenance. These parameters will determine the operational security level of the Nordic joint operations network and also the maximum size of a power plant that can be connected to the network.

Will operational security improve in the future?

The network codes will further harmonise the planning of operations and control room operations, which will facilitate the maintenance of operational security. This will require more extensive joint operations between parties. An increase in the exchange of information improves the availability of information in changing situations.

Together, all of these factors facilitate the maintenance of a good level of operational security. At the same time, transmission will fluctuate more than previously and the predictability of situations will become more challenging as new forms of electricity production dominate the industry. Overall, the harmonisation of grid company processes will result in high-quality operational security. ■

KNOW THE TERMS

This column presents and defines terminology in the electricity transmission business and related fields.

EUROPEAN COOPERATION: **ENTSO-E**

In 2008, European grid network companies, or *TSO*s established a joint association called *ENTSO-E (European Network of Transmission System Operators for Electricity)*. The association received official status as an EU institution as a result of an EU regulation which came into force in 2011. It includes 41 TSOs from 34 countries, some outside of the EU.

ENTSO-E's task is to promote the European electricity markets and to ensure that the continent's power system is developed and used in a coordinated and efficient fashion. The association has two different roles: it implements tasks which are set out in legislation but it is also an interest group which lobbies for the interests of its sector in Brussels much like other associations do.

Operations have expanded very rapidly. In addition to official administrative bodies, the association also consists of almost 100 working groups or equivalent bodies, in which around 1,000 representatives from member companies participate. Around 60 members of staff work full time at the ENTSO-E headquarters. Around 50, or a fifth, of Fingrid employees invest in the association's work. Below are some of the key tasks and related terms.

Network codes are currently the largest area of work. Work on nine network codes is under way. Each of these codes sets out the principles and rules according to which TSOs and other parties must act in the relevant sector. The codes apply to things such as connections to the network, the operation of power systems, and markets. ENTSO-E prepares code proposals which are sent to *ACER*, or the *Agency for the Cooperation of Energy Regulators* for a statement. To end, the European Commission prepares the proposal and sends it to a committee comprised of member countries' ministries for approval. This process is called *comitology*. It is important to note that the network codes become binding and extremely detailed legislation.

TYNDP is an abbreviation which refers to the *Ten-Year Network Development Plan*. Every other year, ENTSO-E produces a pan-European plan for grid development. The plan identifies areas of the network which require reinforcements. The plan includes hundreds of investment projects with financing needs up to tens of billions of euros. The largest challenge for the implementation of plans is the slow permit-granting process.

The target model for markets is a description of the structure and rules for single electricity markets. Similarly to Nordic markets, the EU electricity markets will be divided according to time horizon into *day-ahead, intraday* and *balancing markets*. There will also be market places for longer-term *Transmission rights* or equivalent *Contracts for Differences*. The market model is put into effect in two ways: using the aforementioned network codes and through regional *market coupling* projects. There is a political agreement in the EU that the single electricity markets will be implemented by 2014. But it looks like time is running out.

The cross-country *transit* of electricity was facilitated when border tariffs were replaced with a compensation mechanism between the TSOs called *Inter TSO Compensation (ITC)*. ENTSO-E promotes *market transparency* by constructing an extensive, centralised information service for use by market operators. The *European Awareness System (EAS)* helps TSO control rooms to keep abreast of events in neighbouring systems.

Anyone participating or following ENTSO-E's work will come across a large number of specialist terms and abbreviations. Even someone in the industry can feel overwhelmed at times. A brilliant example of this are the concise terms for system reserves (balancing capability of production plants or consumption facilities): FCR-D, FCR-N, FRR-A, FRR-M and RR. Anyone interested can find a glossary for these and over 1400 other terms on ENTSO-E's website at www.entsoe.eu. ■

> "ENTSO-E's task is to promote the European electricity markets and to ensure that the continent's power system is developed and used in a coordinated and efficient fashion."

TEXT JUHA KEKKONEN

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Find out more about the European network codes at **http://networkcodes.entsoe.eu**

THE CONTROL ROOM KEEPS WATCH AS FINLAND SLEEPS

As Finns all over the country are preparing for bed, the night shift at the Fingrid control room, or main grid control centre to use its correct name, is just beginning. Roger Gustavsson, who works in balance management, Juha Tirri, who works in grid management and power system management's Pasi Kaunisto all log the night's events.

TEXT OUTI AIRAKSINEN | PHOTOGRAPHS MATTI IMMONEN

Access control at the Fingrid control room in Käpylä is strict, since this is where society-critical operations are carried out and where Fingrid makes sure that there is sufficient electricity in the country. An experienced control room worker can discern if there is reason for concern just by glancing at the tens of different screens projected onto the control room wall and the clocks, which show the time in three different time zones. Electricity is flowing within transmission limits from Sweden via Fenno-Skan direct current interconnections travelling under the Gulf of Bothnia, and via northern alternating current interconnections, and there is no need to react to the situation by purchasing additional energy from balancing power markets, for example.

As operators, Pasi Kaunisto and Roger Gustavsson, arrive at work in the evening, Juha Tirri has been at work in grid management for almost nine hours already. But Tirri isn't even halfway through his work day.

A twenty-four hour period at the control room is divided into three parts. At night, the control room is usually manned by fewer employees than in the daytime. One operator is on-call in the control centre's break room and can be called on as needed.

For Tirri, who commutes from Akaa to work in Helsinki, 24-hour shifts and nights on call are a suitable form of work.

"The up-side to this job is that once I leave the control room at the end of my shift, I know that I can rely on someone else to take over. I don't take my work home with me," says Tirri.

Instead of working 24-hour shifts, the majority of operators work on a seven-week basis which includes night, evening and morning shifts and a four-week period of office work. During that time, employees can participate in things such as training.

Planned breaks in transmission

Fingrid's control room has succeeded in its main task in the sense that no extensive major disturbance has occurred in Finland since the 1970s. Over the years, the grid has been strengthened and nowadays it's impossible for an individual fault to cause blackouts in the grid, even on a regional scale. But it always pays to prepare for surprises.

"During one of my shifts, both Fenno-Skans tripped. My hands were shaking. That shouldn't have even been possible. But within 15 minutes we were back within transmission limits," says Pasi Kaunisto.

A sudden outage in electricity can cause dramatic consequences, but controlled outages take place continuously.

"We always have outages going on,

since there's never a situation wherein all grid components are functional. There's always on-going maintenance and projects to renew devices and equipment. That requires some advance planning," explains Tirri.

Lots of switchings take place in the control room during the summer, since maintenance and construction work are scheduled for when there's no ground frost. Switchings are often carried out at night, thereby minimising their impact on customers.

Switchings require phone calls to numerous different parties, since a line which has to be disconnected for maintenance could span up to 100 kilometres.

Customer service and forecasting

Approximately 20 operators work at Fingrid in balance, power system and grid management, and almost all of them ended up in their current work through an electrical engineering career path.

Responsibility is carefully distributed. From an outsider's point of view, it would seem that each employee sits in front of his or her own computer, only occasionally interacting with a colleague over the screens. If needed, the operators are able to cover each other. Above all else, work in the control room is about forecasting and monitoring the situation to prevent problems from occurring.

"Voltages have to be regulated in advance before loads increase. After that, we watch and see how the forecasts progress and whether or not we need to carry out any balancing. The need for balancing depends on the weather and season," explains Kaunisto.

An electricity transmission forecast is drawn up based on production and consumption forecasts and Elspot results. If the transmission appears to exceed set limits, attempts are made to change dispatching schedules by telephoning the control room of the Swedish grid company, Svenska Kraftnät, for example.

As a general rule, the control room operates in close cooperation with grid companies in Sweden, Russia and Estonia. In addition to electricity transmission issues, frequency management also requires cooperation from the Nordic countries.

"We mainly speak Swedish with the Swedes, but English with the Estonians. Fingrid has an interpreter on standby round the clock for when we need to make contact with Russia, for example if we can't find a suitable code in the codebook," says Gustavsson.

Fine-tuning operating models

While cooperation regarding electricity transmission is mainly carried →

"The night was uneventful and consisted of routine tasks. I checked, approved and published balance and imbalance power prices by the hour during the night shift. I was surprisingly alert when you consider that this was my first night shift in a while."

ROGER GUSTAVSSON'S NOTES FROM HIS NIGHT SHIFT

Routine shift change. The procurement of loss energy will have to be corrected during the night, if tonight's Swedish voltage problems continue. Based on transmission forecasts however, the night should be fairly calm. It's been almost a week since my last shift, so I browse my e-mails and read the event log from the preceding week. I also examine the procurement of frequency-controlled reserves. Estlink has plenty of free capacity, so there is no need for manual regulation.

23:15 ▸ I telephone the Swedish grid operator. There should be no voltage problems with the planned Fenno-Skan transmission power. The amount of loss energy must be monitored, however.

1:30 ▸ I'm starting to get tired and a little cold. I take a "lunch break" and make some coffee.

1:35 ▸ I return to my computer. I draw up a 24-hour plan for the procurement of loss energy, which is based on the loss energy of previous days, and I check the accuracy of the Elbas logs, that is, electricity trading within the last 24-hour period.

2:10 ▸ I send the Russian connection's reference powers from the previous twenty-four hours to the balance settlement system. After that, I check the balancing power trading from the previous day. I send a report on trade with Estlink to Estonia.

The information in Fingrid's systems concerns balancing and imbalance power prices and balancing volume conflicts with the information on the NordPool website. I have to find the cause of the differences and correct them.

4:00 ▸ The price on the regulating power market drops so that Finnish production reduction bids are eligible for implementation. I call the relevant parties and ask them to carry out their balance offers.

4:10 ▸ Our intranet and e-mail servers go down. I notify server administration of the matter, and the problem is solved in just under an hour.

5:20 ▸ I check the accuracy of the Fenno-Skan dispatching schedule from the previous day with Sweden for the Daily Exchange Report that will be carried out in the morning shift.

out with Sweden, Estonia and Russia, Norway and Sweden are the key countries when it comes to issues concerning frequency responsibility as they produce the most of the regulated form of energy, hydroelectric power. Fingrid mirrors the level of Norway's and Sweden's balancing power bids in Finnish balance bids, and if the price is right, Finnish production plants are encouraged to act – that is, to increase or decrease the plant's power.

"We telephone the regulating power market parties and inform them that the plant has to be regulated up or down. This sort of communication takes place on an hourly basis," explains Gustavsson.

The tools and operating methods used have been developed in the control room over the years. On the other hand, new aspects of operations include an increasing level of cooperation with other countries, and the addition of equipment and devices to the grid which must be monitored.

"There are lots of applications, and there are always more around the corner. For example, we have to have a wind power forecast for wind power, and the accuracy of the forecast is becoming ever more important. There has been great development in calculation programs," says Gustavsson.

A balance service agreement drawn up in 2009 has improved the predictability of balancing power markets. It is a complex field, however, and requires on-going training.

"The last training I participated in took place yesterday and dealt with operation control, as our scada system will be updated with a newer version. Training programmes expound on the tasks of various operations, such as voltage regulation or capacity management," explains Kaunisto.

Working methods can also be improved by employees taking their own initiative.

"It's great in this job if you're innovative, but you can't simply try something out as soon as you think of it. Before taking action, you have to think hard and thoroughly about what you're doing," Tirri says.

We go through a lot of coffee

As the clock ticks into the wee hours of the morning, even night shift veterans can find it hard to keep alert. Having worked in the Fingrid control room for seven years, Gustavsson says that the first night shift is often

"During my shift I made almost 150 phone calls with a total duration of 4.5 hours. A large part of my work day is spent on the telephone as I arrange and inform people of connections. This is a customer service-oriented profession."

"Outages which began in Eastern Finland caused an overload on one transmission line, although production had been procured in advance as a counterpurchase. We had to monitor the issue all night, as we were close to limiting power."

the hardest, but once it's over, you get used to the routine.

"The most difficult time is from 2:00 am until 5:00 am, when you have to really focus. As you might expect, we go through quite a lot of coffee," admits Gustavsson.

Kaunisto, on the other hand, believes that morning shifts are the most demanding, since they can upset your body clock, meaning you often find it difficult to sleep at night.

But though the shifts are long, so are the periods of leave. The men spend their free time with their families and enjoy their hobbies, which include cross-country and downhill skiing, walks, floorball, cycling, rink bandy and motorcycling. Exercise and spending time outdoors also help them to manage in their three-shift work.

Tirri, Kaunisto and Gustavsson are also united in their opinion that shift work can be adapted to family life.

"It requires a little flexibility from your spouse, since we don't always have time off at the weekends. On the other hand, I have more time off than a lot of people. If I have six days off, one day goes towards recuperating, but after that I get right back into the swing of normal family life," says Tirri.

Gustavsson, too, often spends his free time at the playpark.

"Actually, family life is much less constrained and challenging than it would be if I worked here from eight in the morning until four in the afternoon," Tirri adds.

Tirri's 24-hour shift continues even when Gustavsson and Kaunisto have been relieved by the morning shift workers. Once his day ends at half-past one, Tirri might take a thirty-minute nap in the break room before driving back to Akaa. ■

PASI KAUNISTO'S NOTES FROM HIS NIGHT SHIFT

I start my shift by looking through the day's and evening's events and acute matters with the evening shift.

22:00 ▸ The Nurmijärvi reactor goes online to warm up for an outage tomorrow morning.

23:00 ▸ Voltages are regulated downwards as load and transmission begin to drop.

0:35 ▸ A circuit breaker fault alarm comes in from the Tammisto substation. I call the service provider, who goes out to investigate the matter. There is a fault with the circuit breaker's heating. In warm autumn weather, the fault is not acute, so it can be taken care of later.

1:00 ▸ I go through the outage file, clean up the operator's e-mail inbox and enter the transmission limits for tomorrow into the system ready for the morning shift.

3:44 ▸ There is a fault in the Kangasala 400 kV protection communication connection. I leave the matter for the person on-call for the operations control system to take care of in the morning, since the other connection is operational.

5:30 ▸ Voltages are regulated upwards slightly as loads and transmission begin to increase.

6:00 ▸ My network management colleague gets up for the morning shift. We briefly go through the night's events.

6:35 ▸ RAC transmission between Northern Finland and Northern Sweden is forecast to exceed the transmission limit before the hour is up. I call Svenska Kraftnät and we agree that the Fenno-Skan connection will be used to run more electricity to Finland than planned for the rest of the hour.

6:50 ▸ Debriefing of the night's and evening's events with the morning shift.

JUHA TIRRI'S NOTES FROM HIS SHIFT

My shift begins. As soon as the shift has changed over, I carry out grid connections (Keminmaa, Alapitkä, Luukkala, Imatra, etc.)

15:30 ▸ I eat while doing work. I check the upcoming connection programmes and make connections to transformers in Koria.

22:40 ▸ Evening snack. I brought my own food with me. Update and distribution of the Kalajoki–Merijärvi connection programme.

23:20 ▸ I rest in the break room. I have an alarm to wake me up for the night's connections.

2:00 ▸ Kalajoki-Merijärvi connection in line with the connection programme and then the same line is reconnected later.

3:50 ▸ I have a rest break of two hours.

5:50 ▸ Breakfast. Connections between Pulp–Yllikkälä and Lieksa–Uimaharju, and related PSSE network calculations. Update of Uimaharju connection programme.

12:30 ▸ Lunch while I work. Connections (Koria, Pulp–Yllikkälä).

13:30 ▸ The 24-hour shift ends in a shift change where we go through the events which took place and upcoming events with the incoming shift workers.

It pays to **prepare** for the **worst**

Fingrid is to prepare for crises even more systematically. Operating plans in place for worst case scenarios also provide support and guidelines on how to manage less severe crises.

TEXT SUVI ARTTI | **PHOTOGRAPH** VALTTERI KANTANEN

Risks include the loss of premises, equipment or key personnel and extended disturbances in the grid. Fingrid is to prepare even more systematically for these and similar situations through its on-going development project for continuity management.

Preparation for disturbances in the grid and risk management have long been part of Fingrid's operations. Now the aim is to achieve a more extensive and systematic level of preparation.

"Until now, our preparation has focused on safeguarding control room operations and preparing for major disturbances in the grid. Now we are widening our perspective and considering ways to keep vital operations running in various catastrophic situations. We are preparing for major occurrences which could stop our business operations," explains **Vesa Syrjälä**, Fingrid's corporate security manager. He compares continuity management with insurance: you have to have it, but you hope that you never need it.

Risks to be processed as group work

Continuity management was chosen as Fingrid's theme for 2014. The company has examined all factors which could pose a threat to continuity and has selected nine different scenarios for which to prepare. At the start of the year, a project encompassing all personnel will begin and will see an operating plan set in place for each risk.

"A workgroup will be established for each scenario and will investigate the risk from a range of perspectives and then create an operating plan to put into action should the crisis occur. The aim is to implement all the expertise we have in the company," says Syrjälä.

For each scenario, the groups will consider the minimum level of operations which should be kept running in all situations. In addition, they will also determine a recovery period, during which time all operations should reach a certain level. The probability of the event occurring and the price of preparation will also be weighed up. If it is extremely improbable that a certain event will occur, it might not be worth making large financial investments and an operating plan may suffice.

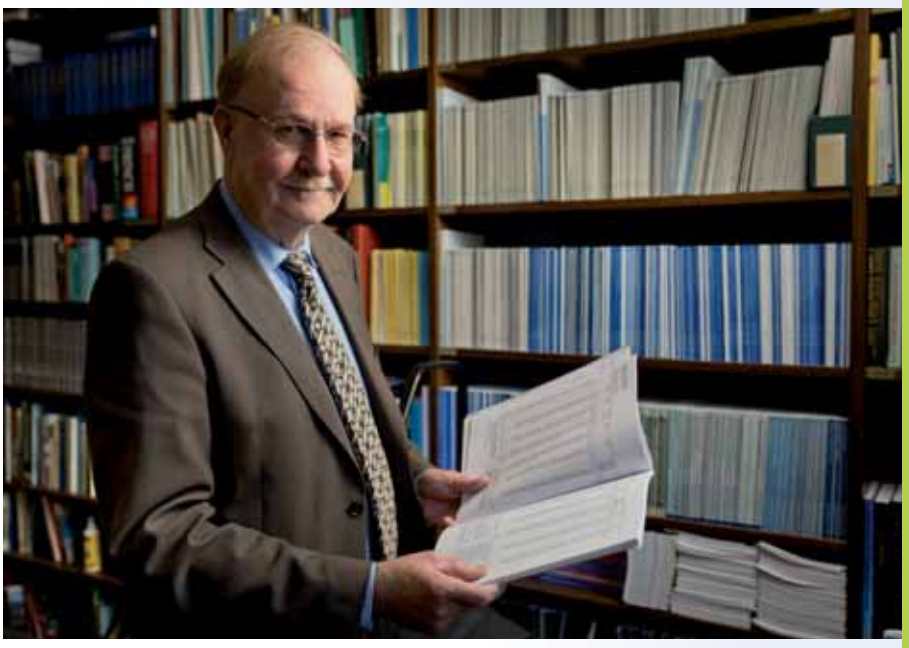
As an example, Syrjälä mentions the loss of premises due to a fire. "It wouldn't be sensible to procure extra premises in case the current ones burn. Instead, we will draw up a ready-to-use operating plan: if we lose our head office, how many people will be in immediate need of a temporary place to work? We can also prepare by creating contacts in advance. We could then utilise those contacts to procure new premises as soon as possible."

The operating plan also contains information on what kind of training is required for personnel and service providers and how to maintain the preparedness. The aim is to make continuity management a part of daily operations.

Some of the scenarios relate to a major disturbance in the electrical grid and will be processed in further detail

than previously. "A disturbance caused by a technical fault requires different procedures than, for example, a disturbance caused by an icy storm where a huge number of transmission lines can be blown down. Disturbances which are caused deliberately are a risk of their own. An operating model will be created for all scenarios."

under normal circumstances, such as cyber threats, pandemics and various major disturbances in the electrical grid. "Continuity management is an essential part of operations for grid owners. Extreme weather conditions are becoming more and more common and the number of storms is on the increase. Fingrid's basic task of 'keeping the lights on in Finland' is part of national emergency supply in itself," says Kananen.



CEO of the National Emergency Supply Agency Ilkka Kananen explains that there is an ongoing NESA project concerning cooperation for critical, round-the-clock control rooms. The aim is to develop the exchange of information between control rooms in various industries.

Network companies must prepare for storms

According to **Ilkka Kananen**, CEO of the National Emergency Supply Agency, continuity management is today's preparedness planning. "Preparedness doesn't have to be, nor should it be a separate issue from business operations. It doesn't have to be challenging; it can be connected to normal operations."

The focus of security supply used to be preparation for exceptional circumstances, but now preparation is undertaken for severe disturbances occurring

The new Electricity Market Act which came into effect in early September set a general obligation of preparedness for grid owners in case of disturbances and emergencies. According to Kananen, there has long been a corresponding obligation in place for companies working in the telecommunications and financial industries.

"The majority of electrical grid companies have made preparedness plans before, but now the obligation of preparedness has been put into law. After a transition period, the plans will have to meet certain criteria."

The National Emergency Supply Agency has the new official task of directing network companies and carrying out monitoring to ensure that preparedness plans are up-to-date. "We →

FACTS

TOOLS FOR CONTINUITY MANAGEMENT

The National Emergency Supply Agency maintains and develops security of supply in Finland. Its operations are divided into seven sectors: information society, transport and logistics, food supply, energy supply, healthcare, financing and critical industrial production. There are 24 pools responsible for operational preparedness. The preparedness and preparedness plan for the production, transmission and distribution of energy production is led by the energy economy pool, whose Chairman is **Reima Päivinen**, Fingrid´s senior vice president for power system operation.

To aid companies and organisations who are critical to security of supply in continuity management, the National Emergency Supply Agency has developed the HUOVI portal which provides tools, instructions and training for the development of risk management and continuity management. The portal can also be used to distribute documents and to establish projects.

"HUOVI won't carry out continuity management on the company's behalf, but it is a tool which facilitates and supports companies' operations. One of the portal's services is an analysis to help companies to assess their level of preparedness in comparison to other actors and to recognise the most important areas for improvement," explains **Ilkka Kananen**, CEO of the National Emergency Supply Agency.

He believes that there has been a clear need for this kind of tool. The portal has been in use for three years and already has around 2,300 users.

Another NESA project which promotes continuity management is SOPIVA, a preparedness concept which is based on agreements and which also helps to take continuity management into account in commercial agreements between companies.

have long given directions and models for preparedness. Now all plans are to be harmonised to the same level, and at the same time, companies will be able to learn from each other. Those companies who have come a long way with their planning may introduce their good practices to other companies," says Kananen.

Service providers for electrical grid owners play a significant role in preparedness for disturbances and Kananen sees them as critical to the field. Previously, electricity companies were responsible for the construction and maintenance of electrical networks as part of their own organisation, but nowadays these activities are outsourced. Kananen is grateful that service providers are motivated in taking care of the national emergency supply and are strongly involved in the National Emergency Supply Agency's pool activities.

The important role played by service providers is also visible in Fingrid's continuity management project. "We take the entire service chain into account. Our grid construction and maintenance operations are entirely outsourced, so we also have to prepare for the loss of a service provider, or even for a strike," explains Vesa Syrjälä. "The project will be visible to service providers as a survey at the very least. We will contact them and inves-

Fault repair exercise in Sweden

In fault repair exercises carried out last spring in Åsbro, Sweden, Nordic operators carried out joint exercises in case of major disturbance for the first time.

TEXT SUVI ARTTI | **PHOTOGRAPH** RISTO UUSITALO

A field exercise organised in March gathered together over one hundred participants from the Nordic countries. The exercises were attended by grid operator companies from Finland, Sweden, Norway and Denmark as well as service providers from these countries. Also attending were Swedish regional transmission network companies, Swedish volunteer organisations and participants carrying out their non-military service.

"Joint desktop exercises have been organised in the past, but the joint-Nordic field exercise was the first of its kind," explains **Kari Lindholm**, a regional manager at Fingrid, about the exercise that was part of the larger Elövning 2012 exercise.

Work after a blizzard

The initial situation for the exercise was a scenario in which a powerful blizzard passes over Scandinavia one weekend, causing icy rain and snow. In Sweden, the grid sees major damage: over 250 towers on 13 transmission lines have been blown down or damaged. Over one million consumers are left without electricity. Traffic is almost at a standstill in Southern and Western Sweden, and phones are not working. The distribution of foodstuffs and fuel has come to an almost complete halt.

The aim of the exercise was to repair the damaged electricity grid and relieve the disruption caused to society by the disturbance, and to improve and practice cooperation between different organisations and authorities.

During the exercise, 400 kilovolt and 132 kilovolt transmission lines were constructed side by side, with eight towers constructed for each line. Eltel Networks Sverige was responsible for the construction of the 400 kilovolt line while Vattenfall Service was responsible for the construction of the 132 kilovolt line.

Altogether, there were eight groups: Five from Sweden and one each from Finland, Norway and Denmark. Four Empower and two Eltel Networks engineers were present from Finland.

Different kinds of fault repair towers

Representatives from different countries brought their own fault repair towers to Åsbro and erected them during the exercise. Fingrid brought 400 and 110 kilovolt fault repair towers.

"The towers we use are slightly different from the "Canada towers" used in Sweden, Norway and Denmark. The Canada tower is comprised of modules and can be erected using a crane, scissor crane or a helicopter. The tower is made from aluminium, so it is lighter

tigate how certain matters are taken care of."

Eureka moments and recovery plans

Vesa Syrjälä expects "many eureka moments" in the coming year.

"Although we have always carried out good work concerning preparedness, I nevertheless believe that the group work will produce lots of issues we hadn't previously taken into account. If procedures which can be deemed critical are brought up, they will be implemented. Some may require investments while others can probably be implemented through a revision of our procedural guidelines."

Syrjälä points out that continuity management is also information management – making sure that important information is in the right place and that sufficient people know where to find it.

Once the scenario work is complete, Fingrid should have a "recovery plan" for various crisis situations. But continuity management doesn't stop there. "As the world changes, new threats may emerge and as such, continuity management will continue to be part of our daily routine. We actively monitor our environment and will update our plans as necessary." ■

Fingrid brought 400 and 110 kilovolt fault repair towers to the exercise in Åsbro. Here they are erecting the 400 kilovolt tower.

than our steel fault repair towers," explains Kari Lindholm.

The Norwegians brought a helicopter to the exercise and used it to erect towers. The Canada tower is an excellent solution in difficult terrain which heavy equipment cannot traverse.

The exercise also proved the structure of the fault repair tower used and developed by Fingrid in 1997 to be functional. "In the exercises we saw that professionals can be familiarised with the erection of our fault repair towers in a single day."

Language skills put to the test

According to Kari Lindholm, the exercise went excellently. "Employees at Nordic companies had the rare opportunity to physically get together and practice for a fault situation. At the same time, we saw that erection work was successful despite differences in towers and despite language issues."

A common language emerged after some initial teething problems. "The Finnish engineers didn't speak Swedish, but working in a foreign language was one of the tasks of the exercise. The Finnish group contained a Swedish contact person, with whom the engineers had to be able to communicate. They had a vocabulary list of some of the most important terms in the industry to help them."

All in all, the exercise was considered a success. "Service provider representatives found the experience to be good and appreciated that they were able to see operating methods that differed from the ones that they are used to," summarises Lindholm. ■

Requirements for generators **guarantee grid reliability**

During the last year, Fingrid has worked on an update for the national requirements for generators. The new requirements (known in Finnish as VJV2013) came into effect from the beginning of November this year.

TEXT SUVI ARTTI | **PICTURES** ISTOCKPHOTO

The most visible change in the new requirements is the process for the approval of a power plant to connect to a grid, which will be more clearly defined than it is now. The grid connection process comprises several stages and aims to ensure, in advance, power plants' resilience to grid disturbances in further detail than previously.

Several factors are behind the new requirements, with the most significant being a change in the structure of electricity production. "The grid cannot function without power plants which create voltage on the grid and support its frequency. Both new, very large nuclear power plants and decentralised smaller production facilities such as wind farms are under construction. Regulation of both of these production methods is limited; once online, a nuclear power plant runs at full capacity and wind farms only produce energy when weather permits. In addition, wind farms do not run in sync with other generators and as such, do not inherently support the grid in various disturbances. As a result, the grid will be weaker than in traditional circumstances under which all power plants support the grid while producing electricity," explains Fingrid's senior vice president **Jussi Jyrinsalo**.

Update to pave the way for European grid regulations

VJV2013 has taken into account the upcoming European network code "Requirements for Generators" (RfG) compiled by ENTSO-E. The requirements are currently awaiting approval by member states as part of the comitology process and are expected to come into effect in 2014. The network codes will become binding legislation and all national requirements and guidelines will have to be updated to correspond with the new regulations. The VJV update is also affected by Finland's new Electricity Market Act, which places increased emphasis on reliability and on preparedness for exceptional circumstances.

The European grid regulation requirements will apply to even smaller generators than previously. "Our regulations apply to a minimum of 0.5 megawatt generators, but in Europe certain basic requirements will even apply to 800 watt generators. The reason for this is a significant increase in the amount of small-scale production and consequent problems. In Germany, for example, a huge number of solar panels have been disconnected from the grid due to relatively small frequency changes. As a result, we've realised that we also need basic requirements in place for small generators," says Jyrinsalo.

Long transmission lines create extra challenges

In the sparsely populated Nordic countries, the grid is even more vulnerable than it is in densely populated areas. "We have long transmission distances to span, with production and consumption focused on certain areas. The transmission lines between these areas are long, and the production clusters are large in relation to overall consumption. If there's a disturbance, it is more likely to influence a larger area than in Germany, for example," says Jussi Jyrinsalo.

"In order for us to be able to keep the grid reliable, operational and capable of transmission, we have to carefully determine what kind of disturbances individual power plants have to be able to withstand. By setting the requirements, we can ensure that power plants can withstand certain basic disturbances without going offline."

FACTS

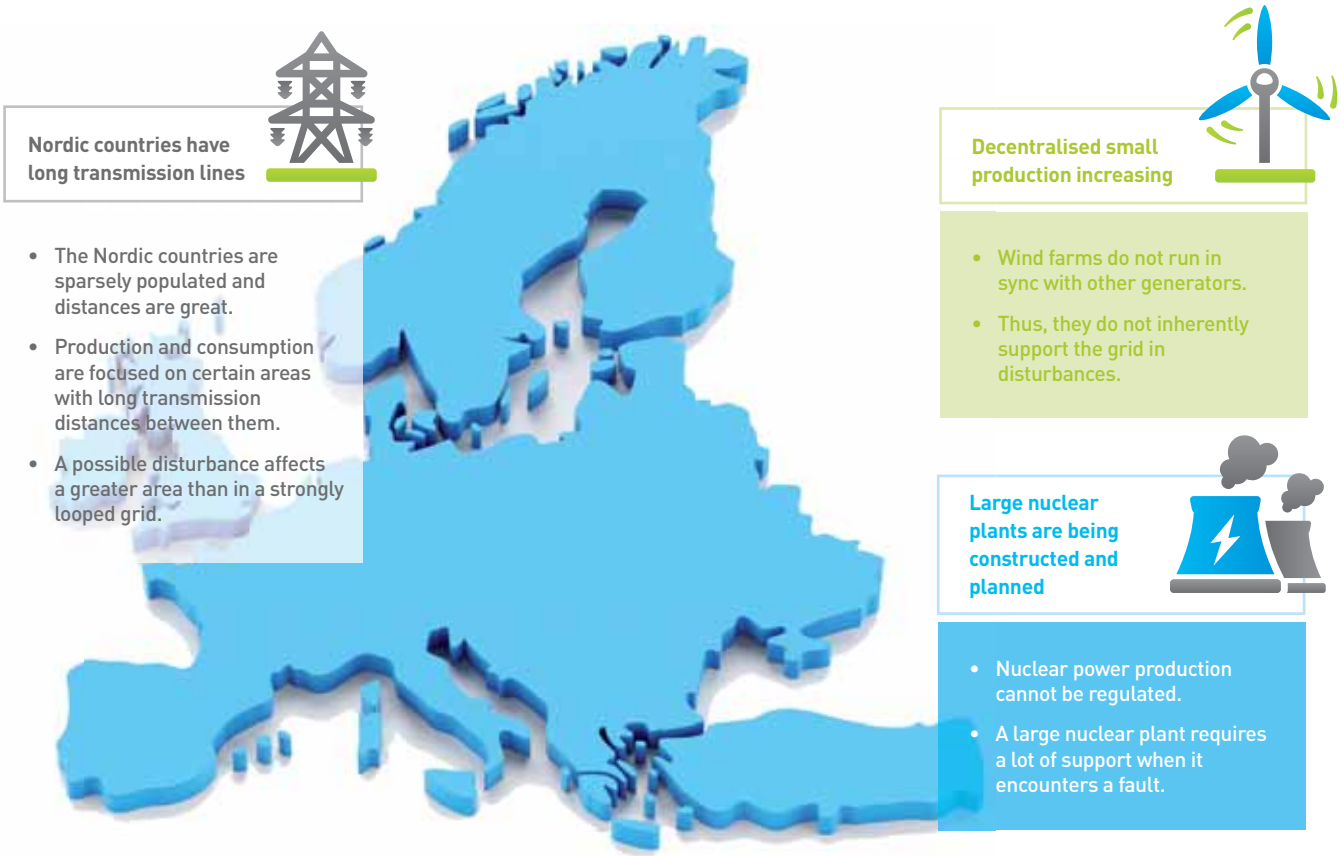
PHYSICS DETERMINES A POWER PLANT'S MAXIMUM POWER

In the General Connection Terms (YLE2013), the greatest permitted stepwise power change is defined as 1,650 megawatts when planning new power plants, which in practice, limits the maximum power produced by the largest power plant unit. According to studies, the network cannot withstand a larger change in power without the frequency dropping too much in the Nordic grid.

"The system simply cannot withstand larger plants. The management of even this amount of power change poses a great challenge as the structure of production changes and as the grid's resilience to disturbances weakens," says Jussi Jyrinsalo.

He says that the limitation is based purely on electromechanics. "The grid frequency drops as a large unit goes offline and the size of the change depends on the natural capacity of other power plants in the Nordic countries to support the frequency. The situation has to be managed such that it does not result in outages for end customers."

ELECTRICITY PRODUCTION TRENDS WEAKEN THE GRID



"Ideally the situation would be that numerous mid-sized power plants would produce electricity for the grid and simultaneously support the grid. But the current trend means that large power plants require more support when they encounter a fault, and at the same time, small wind farms provide no support for the grid. However, it's not feasible for Fingrid to build its own power plants for the sole purpose of supporting the grid," adds Jyrinsalo.

He believes that the role of cross-border lines in keeping balance will become more important in the current situation. If power plants cannot be regulated sufficiently, neighbouring countries will act as a buffer. Fingrid is also researching other possibilities of supporting the grid, such as developments in battery technology.

Fingrid to inspect compliance with requirements

The preparation of VJV2013 has raised questions amongst Fingrid's customers as to whether the new requirements will apply to power plants which are already connected to the grid. "The basic idea is that they won't apply to existing power plants. We won't be requiring the same things retrospectively of existing plants. Instead we will be focusing on checking that the power plants already on the grid comply with the requirements which were set for them at the time," explains Jyrinsalo.

In order to find out whether existing power plants comply with specifications, Fingrid is sending surveys to the power plant owners on the plants' resilience to disturbances. If a plant does not meet specifications, Fingrid will require the matter to be rectified. "Our customer committees are currently involved in discussions about how to monitor the compliance and about possible sanctions."

One of the changes arising from the new network codes is that the Energy Market Authority will become the highest body which monitors the implementation of specifications. Until now, Fingrid alone was able to issue derogations if a customer was unable to comply with a certain specification for justified reasons, and if Fingrid was of the opinion that the grid would withstand such a deviation from the specifications.

New obligations also for distribution network companies

Until now the monitoring of compliance with specifications for the operational performance of power plants was carried out in practice by Fingrid alone. When necessary, Fingrid has also advised power plant owners which are connected to the distribution grids. From now on, distribution network companies will also be responsible for monitoring VJV requirements. Furthermore, the European network codes will set distribution network companies a new task in defining their own regulations and guidelines and monitoring their implementation. This requirement will, as will other RfG requirements, come into practical effect in 2017 after a transition period.

"Until that time, network companies will have to draw their own interpretations from network codes. Preparations on a national scale are likely to be carried out as a joint effort, in which Fingrid is ready to be involved," says Jussi Jyrinsalo.

"There is also need in Finland for consultants in the industry as network connection issues are complex and require an understanding of both power plant and grid operation. In Germany, for example, such consultants are already in place helping to implement grid connections that comply with the codes," he adds. ■

Putting the **customer's needs** first

Fingrid's theme for 2013 has been the development of customer service, with the aim of placing customers' needs at the core of our operations.

TEXT SUVI ARTTI | **PHOTOGRAPH** JUHANI ESKELINEN

Fingrid has requested help in developing its customer service from some of the best experts in the industry – the customers themselves. "We've investigated what kind of service and cooperation is expected from us. Based on discussions, we will improve our practices and services," promises customer manager **Petri Parviainen**.

In addition to discussions with customers, the matter has also been dealt with in customer committees and in Fingrid's internal workgroups. "We've divided customers into four main groups to whom we wish to offer a more targeted service: network companies, electricity producers, electricity users and electricity market operators. Each group has its own needs and expectations in relation to Fingrid," explains Parviainen.

Electricity market operators have now been given their own group alongside existing customer groups. "Though we don't always have a contractual relationship with electricity market operators, we consider them to be our customers and would like to provide them with better service. As a result of changes in legislation brought about by reforms, we are more involved with retail markets than we were previously," explains **Juha Hiekkala**, market development manager.

"Hopefully the results of customer service development will be lead to an improvement in how we listen to the customers. Our customers assume that basic matters are nevertheless taken care of well. But they expect more of us, and we are aiming to meet their expectations," says Hiekkala. ■

In October, UPM representatives told Fingrid what they would like to see happen. For UPM it's important that Fingrid is active in ENTSO-E and keeps its customers up to date with current issues. From left, manager Pekka Tynkkynen from UPM, executive vice president Juha Kekkonen from Fingrid, manager Anne Särkilahti from UPM, and Fingrid customer manager Petri Parviainen and Jussi Jyrinsalo, senior vice president responsible for customer operations.

Grid services to **gain more power**

Grid services' reinforced team has promised to invest even more in customers' needs.

TEXT SUVI ARTTI | **PHOTOGRAPH** MATTI IMMONEN

Grid services' areas of responsibility include subscription connections, reliable electricity transmission and grid management during faults and changes.

Fingrid's sizeable investment program and increased wind power plans have kept the grid services team busy. "The big investment program brings it with a lot of changes, and we have to agree with customers on how to manage those changes. At the same time, the number of connections and enquiries, especially pertaining to wind power, has increased," explains customer manager **Petri Parviainen**.

Now the team will receive reinforcements as **Risto Ryynänen**, **Niklas Löf** and **Antti Kuusela** join the team. Ryynänen will become a customer manager at the start of 2014 after having acted as project manager on a large EstLink 2 direct current connection project. Though his task field will change, he says that the nature of the work is largely the same in both positions.

"I consider project management work to be a kind of customer management work, even though the two jobs are fundamentally different. When dealing with large projects, there are lots of customers and interest groups who have to be kept up to date and with whom we have to be able to communicate. Good communication skills are important in both tasks, and actually, there are lots of similarities between the two jobs: searching for a solution, changing situations, and consulting with various people and groups," says Ryynänen.

Niklas Löf joined the grid services team as a customer connection advisor in autumn 2013. Löf is new to Fingrid but has experience with customer connections from "the other side of the table" at his previous position at Fortum Sähkönsiirto Oy, where he worked as a project manager on numerous substation and transmission line projects.

"Working at grid services means I face many interesting challenges. Customers ask a wide range of questions, some more technical than others, and together we try to find solutions which satisfy both parties. Thanks to my previous position I'm able to understand our customers' needs very well, which I think helps in finding common ground," says Löf.

Power plant advisor Antti Kuusela also joined the team in autumn 2013. He previously worked as an advisor concerning specifications for the operational performance of power plants and power quality analysis as part of Fingrid's power system planning. His job description will remain fairly similar with regard to technical issues, but his task field will take him closer to the customers.

"It feels natural to move to grid services since the share of customer connections from power plants has significantly increased as the number of wind power connections has undergone strong growth. It is essential to verify power plants' technical compliance with specifications together with the customer in order to secure the reliability of the customer's power plant and indeed the entire power system," explains Kuusela.

Interaction is increasingly important

Petri Parviainen promises that customers will see the new model and increase in number of contact persons as faster service and an increase in interaction with Fingrid.

"During construction and maintenance projects, for example, we will have time to better accommodate the customer's needs while changes are made to the grid. And even if we come to the same conclusion as we would have otherwise, the customer will receive better information on how such solutions are decided on during transmission outages."

In the future, there will be three customer managers: Petri Parviainen, **Jarno Sederlund** and Risto Ryynänen. "Some of our customers will see a change in contact person, but the change will affect only a small amount of people. We will inform customers of any possible changes at the start of next year," says Parviainen. ■

Fingrid's grid team at your service! Here are the new customer manager Risto Ryynänen (left), customer connection advisor Niklas Löf and customer managers Petri Parviainen (sitting) and Jarno Sederlund. Power plant advisor Antti Kuusela is missing from the picture taken at the Anttila substation.

Changes lie ahead for **electricity market services**

Fingrid will offer electricity market operators a wider range of services.

TEXT SUVI ARTTI | **PHOTOGRAPH** JUHANI ESKELINEN

According to market development manager **Juha Hiekkala**, the customer operations reform project came at just the right time for electricity market services. "We are undergoing changes which will see the focus of our operations move closer to customers in any case."

Reasons for the reforms include markets extending to the European level and changes brought about by legislation. "The Nordic markets have been a prime example of market integration, but the Nordic countries are a small player on the European scale. We operate responsibly, as though Finnish market operators have given us freedom to act in Europe. We want to be actively involved as the markets change and keep our customers up to date."

In the new model, electricity market services are divided into four "main products", which are: electricity market functionality and development, balance services, electricity market information exchange and the management of guarantees of origin. Of these tasks, Fingrid is already used to carrying out electricity market functionality and development and balance services. A reform of the balance service is expected as we move to Nordic balance settlement. Electricity market information exchange and the management of guarantees of origin on the other hand are new tasks for Fingrid which are a result of changes in legislation.

"We will systemise and clarify our interaction towards customers. The process is still ongoing, but each service will have its own contact person," says Hiekkala.

Retail markets a new area for Fingrid

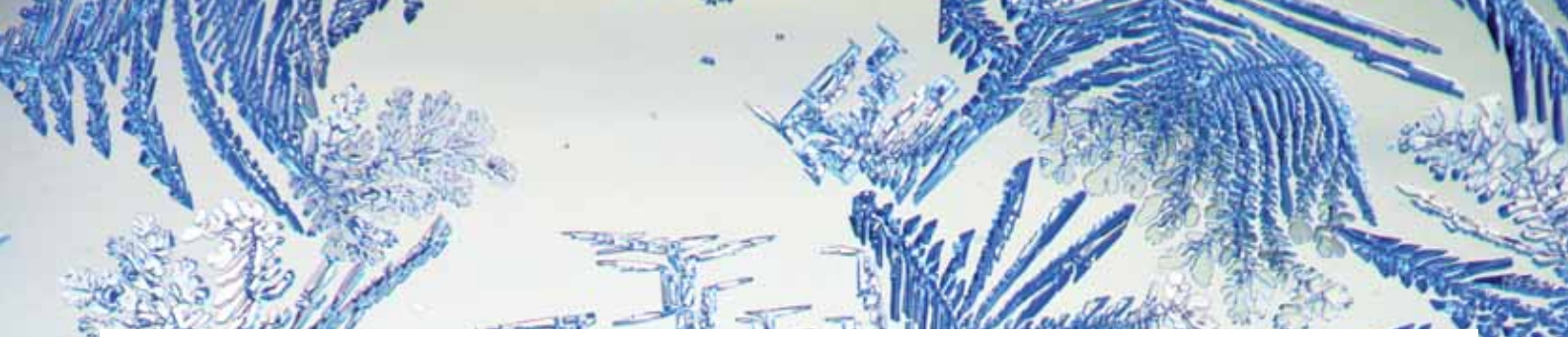
Electricity market information exchange is a new service which will bring Fingrid a large number of new customers: of the service's approximate 200 customers, around one hundred are new. "Retail markets are a new area for a grid company, and we have a lot to learn," Juha Hiekkala says.

Minna Arffman began work at Fingrid in September and will begin to lead the service. "This is a brilliant opportunity for us. In Finland it's rare to get the chance to develop and create an entirely new information exchange service on the electricity retail markets. I can't say it will be easy, but it's definitely going to be interesting."

Juha Hiekkala and Minna Arffman intend to take Fingrid's electricity market services to the next level.

For the last ten years, Arffman has seen the electricity markets from a network company perspective working for Elenia, so she's familiar with an operator's point of view. "At Elenia, I had the opportunity to see and participate in all kinds of interesting tasks. In recent years I headed the electricity market information exchange team."

"Our services will promote procedures relating to information exchange and the development of message standards. We will set up our own service centre whose customers include all electricity suppliers and distribution system operators. Electricity market operators will have among other things the chance to ensure they have the correct message exchange instructions and operating method through our advisory and customer service," explains Arffman. ■



Wintry **works of art**

Some of the most beautiful sights in the winter are the patterns formed by ice crystals on windows, tree branches or the surface of a pond. But ice isn't always welcome.

TEXT SUVI ARTTI | **PHOTOGRAPH** VASTAVALO

A symmetric ice crystal is an example of a perfect natural formation. Ice patterns on windows are an enchanting sight which can draw your attention for hours.

The symmetry found in ice crystal formations is due to nature's method of organising matter into the state of smallest energy, explains researcher **Aku Riihelä** from the Finnish Meteorological Institute. "Ice is formed from oxygen and hydrogen. As they freeze, water molecules stick to four of their neighbours, forming a hexagonal shape."

The anatomy of a frost flower

Beautiful hexagonal ice crystals or snowflakes are formed when the temperature and humidity reach favourable levels. "Hexagonal snowflakes are formed in a cloud where the temperature ranges from -10 to -16 degrees Celsius. For a frost flower to form on a glass surface, the temperature of both the air and the glass has to be suitable," explains Riihelä.

Different kinds of ice crystals form at different sub-zero temperatures. Depending on the temperature, either plate-shaped or needle-shaped forms occur. In temperatures colder than 22 degrees below zero, the crystals form lengthways and between 22 and 10 degrees below zero they develop widthways. But between minus ten and minus four, the crystals form lengthways again, while in warmer temperatures they develop widthways.

"Ice crystals form on glass when moist air cools sufficiently and the condensation deposits into ice crystals. Various structures, such as glass or a blade of grass act as cores around which the crystals freeze as they freeze to a colder temperature than the surrounding air due to exothermic radiation. This is when the frost caused by ice crystals forms," says Riihelä.

Riihelä's work does not involve studying ice crystals closely; instead, he specialises in analysing ice from remote distances: he is writing a doctoral thesis on determining the reflective power, or albedo, of snow and ice using satellites. "The albedo of snow and ice indicate the melting point of the ice and directs the snow surface energy balance. The darker the snow or ice is, the more it has thawed. We can use satellites to analyse the status of the Arctic ice cap and study climate changes in the area."

Long periods of cold mean lots of work for ice removers

Snow and ice are also a part of **Jarmo Lahtoniemi**'s job description. Lahtoniemi works as a transmission line specialist for Fingrid in Eastern Finland. If ice accumulates on transmission lines it can cause problems if not removed. Ice removal begins once around ten centimetres of ice has gathered on the lines. Removal usually begins around the turn of the year and continues on until the end of February.

This coming winter, work will be carried out safely and rapidly with a helicopter and ice removal tool made from a composite insulator. "We had good experiences with this new method last year. It makes work considerably faster as ice loads can be removed during inspection flights," explains Lahtoniemi.

He describes what collects on the transmission lines as somewhere between snow and ice. Snow crown-loads on the other hand, are not a problem for Fingrid as falling snow does not usually accumulate on transmission lines. Snow crown-loads may have an effect on the distribution of electricity if a tree falls under the weight of the snow and lands on a transmission line, but Fingrid's tree-proof lines will remain unaffected.

Lahtoniemi says that the optimal weather for the accumulation of ice is a long but humid cold period. The reason for the humidity is unimportant.

Fingrid systematically monitors the accumulation of ice on transmission lines throughout the winter. To aid monitoring, it uses the Finnish Meteorological Institute's ice load model which shows the areas in which weather is optimal for accumulation and how quickly changes are to be expected. The largest amount of accumulation usually occurs near the eastern border, but last winter the highest amount was exceptionally in the Bay of Bothnia. It is relatively rare for ice loads to cause disruption to electricity distribution. ■

Exceptional circumstances in **Ostrobothnia**

The grid is more susceptible to disturbances than usual during modification and construction work. Due to careful advance planning, Fingrid's major project in Ostrobothnia has succeeded without disruption, despite a prolonged period of exceptional circumstances. Last year, a rare disturbance caused an electricity outage during maintenance work in the Vaasa region.

TEXT MAARIT KAUNISKANGAS | **PHOTOGRAPH** LENTOKUVA VALLAS OY

"When reliability issues are taken care of properly, no-one notices the outage. But if something goes wrong, everyone notices," says Fingrid's senior power system operation planning specialist **Aila Itäpää**. Luckily, disturbances causing outages in electricity transmission are fairly rare in the grid, and it's even rarer for them to affect normal consumers.

Many factors behind the Vaasa electricity outage

In order to ensure reliability, the grid adheres to a "next fault" operating method. No external factor alone is able to cause a disturbance that would lead to an electricity outage in the looped grid network. But in exceptional circumstances, such as when the grid undergoes modification or construction work, the grid is more vulnerable than usual. It was precisely this kind of situation in August 2012 during which a grid disturbance caused an electricity transmission outage in the Vaasa region. The 63,000 residents in the area experienced a nine-minute electricity outage, which was too short to cause a dramatic effect on the residents' day-to-day lives. In contrast, an electricity outage of even a few minutes can cause significant problems for industrial plants.

The electricity outage that momentarily shut off the Vaasa region was due to a disturbance which occurred in the 220 kilovolt transmission line between Kristiinankaupunki and Tuovila. There was maintenance work under way in Seinäjoki which meant that there was an exceptional connection situation in the grid.

"We couldn't find any trace of a technical fault. The disturbance was unusually prolonged due to the connection situation and was, in this case, able to cause an electricity outage. Under normal circumstances this kind of disturbance, possibly caused by a tree branch or bird, would not have caused an interruption in electricity transmission," Aila Itäpää explains. As such, there was no single cause for the disruption; the disturbance was the result of a number of factors. In order for the network to function flawlessly even in exceptional circumstances, all possible factors have to be mapped and preparations for various situations have to be made in advance.

Major project to strengthen Ostrobothnia network

Exceptional circumstances caused by major network construction projects may last up to several weeks. Exceptional circumstances have already been experienced in Ostrobothnia, and more are expected as Fingrid carries out work to strengthen its network between Kristiinankaupunki and Oulu. The project is the largest transmission line project in the company's history, with construction costs totalling around EUR 110

million. A 400 kilovolt transmission network spanning 212 kilometres will be constructed alongside or in place of the 220 kilovolt transmission lines, which are already outdated from a technological point of view. The work is expected to be completed during 2016.

Ostrobothnia needs a new transmission network since the consumption and production of electricity in the area have both increased at dizzying speed. More electricity production is scheduled on the western coast, to be sourced from both nuclear power and wind power. In order for wind farms to be easily connected to the network, some of the existing 220 kilovolt transmission lines in the area will be converted into 110 kilovolt lines.

Electricity markets will also benefit from the renewal as the increase in north-south transmission capacity will help Finland to remain a single-price area. Though recent years in the Nordic countries have been good with regard to hydroelectricity, it is impossible to transfer more electricity to Finland than connections allow. There has been a need for additional capacity in the north-south transmission network for a while.

Four-week long exceptional situation taken care of successfully

Preparation for a transmission outage begins with a close inspection of the situation in the area. Areas can differ wildly from each other, so there are no instructions for preparation in place that would broadly apply to all areas. Preparedness plans are made for each transmission outage.

In autumn this year, when a new transmission line was under construction between Ulvila and Kristiinankaupunki, one of the area's three transmission lines was taken out of use for the four-week period. Two of the lines functioned as normal during that time.

"We aim to carry out our operations so that it's possible for the area to remain operational, even if a serious fault occurs. Forecasting requires the careful planning and monitoring of electricity transmission. We had agreed in advance on procedures to undertake if the demand for transmission began to increase," says Aila Itäpää.

One of the ways in which we had prepared for the exceptional situation was to agree with three power production plants in the area that they would be prepared to rapidly produce additional power if necessary. One of the plants was the Kristiina condensation electricity power plant which, under normal circumstances, is usually run when the market price of electricity is sufficiently high. The Vaskiluoto and Seinäjoki district heating plants, on the other hand, produce heat as needed.

"There was potential for problems throughout the entire four weeks, but in the end everything went fine," says Itäpää. September turned out to be a good time to carry out grid modification and construction work. Power plants usually go offline for maintenance in the summer when the demand for electricity in Finland is at its lowest. This year, the weather was also favourable into the autumn, with September being warmer than usual.

"It is of course easier to carry out work on transmission lines in summer than it is in autumn due to the warm weather. In addition, electricity consumption is also at its lowest in summer. But summer brings its own problems, such as thunderstorms and lightning strikes, which can cause severe disruption and disturbances," Aila Itäpää points out. ■

Close cooperation **with Fingrid**

"We have carried out close cooperation with Fingrid concerning operation planning. We prepare for exceptional circumstances by taking into account both Fingrid's outages and our own outages caused by network construction and maintenance work," says **Jukka Rajala**, CEO of EPV Alueverkko Oy in Vaasa. Together with Pohjolan Voima, EPV Energia part-owns the Vaskiluoto and Seinäjoki power plants.

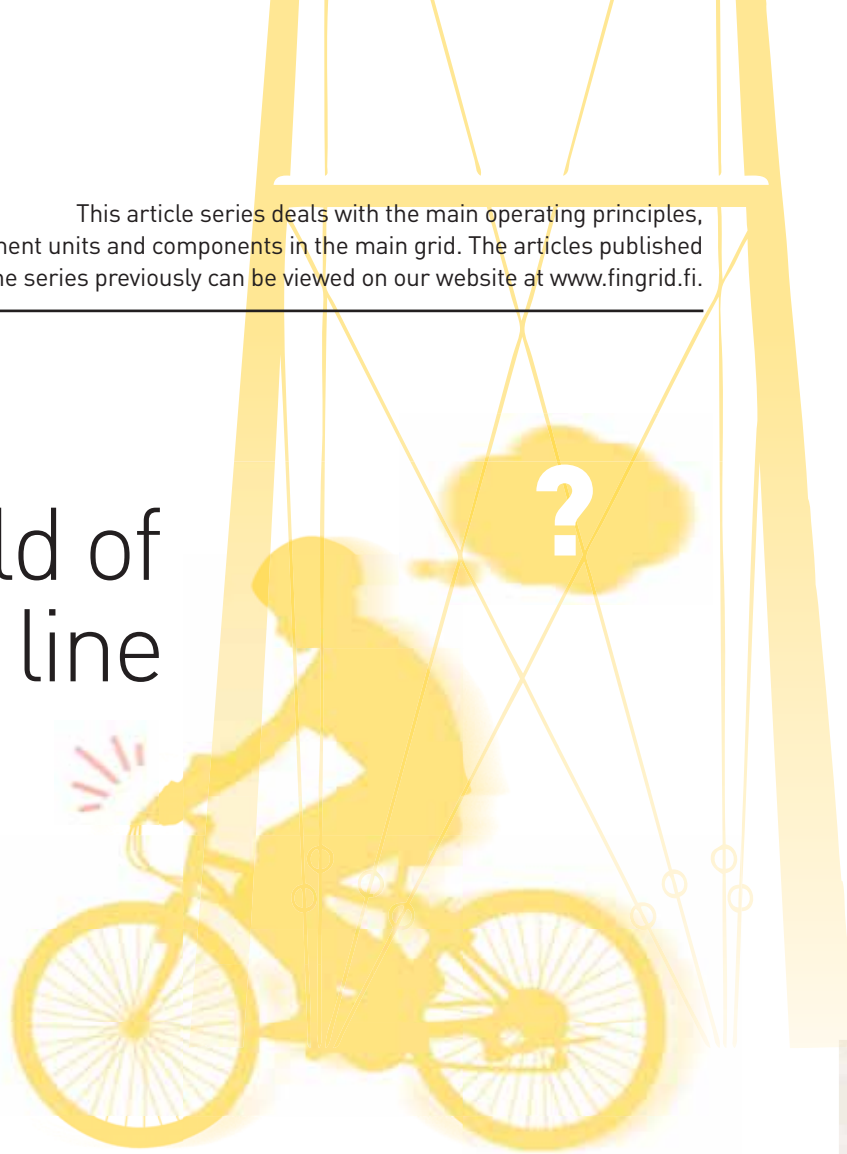
According to Rajala, the four-week break in transmission last autumn went well. There have been no electricity transmission outages or other significant disturbance this year, either, despite Fingrid constructing new transmission lines in the area. "They've clearly prepared sufficiently for exceptional circumstances, during which disturbances may result in larger problems than they would normally."

"Next year will see challenges because of the transmission line project, so our close cooperation with Fingrid will continue." ■

GRID ABC

This article series deals with the main operating principles, equipment units and components in the main grid. The articles published in the series previously can be viewed on our website at www.fingrid.fi.

The electric field of a transmission line



Enquiries are occasionally sent to Fingrid concerning phenomena occurring underneath transmission lines, such as sparks which can feel like tingling, or small electrical shocks from metal objects. The reason for these harmless sensations is the transmission line's electric field.

TEXT MAX ISAKSSON

The voltage in a transmission line creates an electric field between the line's conductor and the earth, with the strength of the field dependent on the conductor's voltage. Electric fields are usually measured in kilovolts per metre (kV/m). Fields are not evenly distributed but are instead at their most powerful on the surface of the line and at their weakest at ground level. When passing underneath a transmission line, the strongest field is in the middle of the span, where the lines hang lowest. The strength of the field is smaller near the pylons where the lines are higher and also decreases the further away a person moves from the line clearing. The strength and distribution of the field vary according to the number of circuits, voltages used, phase sequences, number of lines and their distances from both each other and to the ground. One of the properties of a transmission line's electric field is that an object entirely insulated from the ground within the electric field's sphere of influence will become electrically charged.

The conductor in an electric field

Conductive materials such as metal and carbon contain free electrons which are normally uniformly distributed throughout the entire object. An electrical charge which is brought near to the conductive material settles on the surface of the object, especially on protruding parts, since particles with the same charge sign repel one another. In these cases, the potential all over the object is the same and the surface of the conductor is therefore an equipotential surface. Inside the conductor, the strength of the electric field is zero, since otherwise the field would move the charges until they would cancel out the field. There is no electric field within a hollow conductor. Near the charged surface of a conductive object, the lines of the electric field depart from or approach perpendicularly to the surface, since a component aligned with the surface of the electric field would move the charges until they cancel out the component.

Electric influence or electrostatic induction

When an isolated, non-charged conductive object is brought into an electric field, the charges in the object redistribute themselves onto the surface of the object. Freely moving electrons move against the field and the other half of the object remains positively charged. This phenomenon is known as electric influence or electrostatic induction, which is based on interaction according to Coulomb's law. The electricity is redistributed in the conductor by an influence from an external field. This redistribution of charge continues until the field which is created by the charge redistribution and oppositely aligned to the external cancels out the external field inside the object and nearby.

The human body also acts as an electrically conductive object at frequencies below 100 kilohertz, meaning that humans also become charged in electric fields. Usually we don't notice this when passing underneath a transmission line. But a person using footwear with strong, thick soles may be well insulated from the ground. In such cases, you may feel a weak spark which clings to an earthed object, such as an iron rod stuck into the earth. Small electric shocks occur when charge which has accumulated on the body is discharged upon touch. The same effect can be felt when taking off clothing made from articial fibres.

Why can I feel tingling when I cycle?

Cyclists have contacted Fingrid saying that they have experienced tingling when riding underneath 400 kilovolt lines. The tingling occurs because the ground, bicycle and cyclist are all insulated from each other and form a difference in charge in the transmission line's electric field. The conductive object moving within the electric field – in this case, a bicycle, induces electrical charge. These are unable to discharge since the rubber tyres on the bicycle insulate the bike's metal components from the ground, especially in dry weather. Charges created in this way cause a certain potential between the charged frame of the bicycle and the ground. When a person moving through an electric field is electrically insulated from the bicycle frame through handlebars, saddle, pedals and footwear, a charge and potential also form on the cyclist. The cyclist's potential is different from the bicycle's potential, as the cyclist is, e.g., vertically, a different object from the bike itself. In those places where a small air gap between an uncovered part of the cyclist and the bicycle – such as between the fingertips and handlebars – a difference in potential between the cyclist and bicycle can result in a spark discharge. This discharge feels like a tingling sensation. The tingling is not caused by the fingertips touching the handlebars, but instead by them almost touching it. A similar discharge can also take place between a bare shin and the bicycle frame.

Discharges in themselves are harmless, but may feel unpleasant. You can avoid discharges by touching the metal handlebars of the bicycle with your bare hands while cycling underneath the transmission lines. This causes both the cyclist and the bicycle to have the same potential, preventing discharge from occurring. Another alternative is to make sure that all uncovered parts of your body are insulated using gloves or other clothing, or keep sufficient distance between the metal parts of your bike. ■

IN BRIEF

Power line carrier technology no longer used

The last power line carrier system in the main grid was taken out of use in September.

A data transmission era came to an end in September as the main grid's last power line carrier device was disassembled from the transmission line between Ivalo and Varangerbotn in Norway. The dismantling of the connection took place in connection with a basic renovation carried out at the Varangerbotn electricity substation. For the new connection, Fingrid constructed around five kilometres of optical cable running from the Utsjoki electricity substation across the border to Norway. Originally the aim was to remove the device a year earlier, but the status of the Norwegian network meant that the necessary outage had to be cancelled and the decommissioning of the device was moved back a year.

Transmission line carrier devices have been used for data transmission for in excess of 70 years. The device used by Fingrid and removed in September, was representative of 1980s technology. Later on, a new generation of digital carrier devices was developed, but Fingrid has moved on to using fibreoptics for data transmission.


PHOTOGRAPH ARI SILFVERBERG (ON TRIPOD)

Ari Silfverberg checking the fibreoptic cable extension on the Norwegian line in Utsjoki.

"A fibreoptic connection operated independently of possible disruption to the transmission line. In addition, the transmission capacity of fibreoptic lines is almost unlimited," explains telecommunications manager **Ari Silfverberg**.

In addition to fibreoptic connections, radio link connections are also used for data transmission. Fingrid's telecommunications network is used to control electricity substations, for transmission line protection relay connection needs, electricity substation broadband connections and for intra-branch telecommunications.

Fingrid is involved in the autumn migration of Lalli the Osprey

Fingrid's sponsored osprey spends his winters in Africa.

The western Finnish satellite osprey working group tagged a male osprey which had nested in Kokemäki using a satellite transmitter in July. The joint project between the University of Helsinki's Finnish Museum of Natural History and the Finnish Osprey Foundation is part of extensive research to gather information relating to the migration and hunting areas of the osprey.

Fingrid has been involved in supporting the satellite transmitter for the osprey, known as Lalli, and monitors the "sponsored osprey" as he journeys to his autumn home. As far as is known, Lalli will head for the distant wetland areas in Africa over 6,000 kilometres away from his nesting area in Satakunta.

Moving from a home in a tower to an artificial nest

Fingrid has encountered a pair of osprey nesting in transmission lines more than once. Since the osprey builds its nest high up in treetop branches near areas rich in fish, it has taken to building its nests on top of transmission line towers, which are often located in open, high and peaceful places. Understandably, a transmission line tower can seem an irresistible nesting place for an osprey pair.

But a nest in a transmission line poses quite a significant safety risk to both the transmission of electricity and to the birds themselves, so once the nesting season is over and the birds have departed for Africa, we have had to remove the nests from the towers. The removal of nests requires a special permit from the regional environmental centre. Artificial nests are built near the sites of removed nests, providing the birds with a place to build a new home for the next nesting season as soon as they return to Finland.

Information on osprey behaviour

The research information produced by Lalli is also useful when man-made structures and nature come face-to-face. Information on the bird's behaviour supports Fingrid's work planning technical solutions for various projects and maintenance. Fingrid wishes to follow the bird's activities and increase information on the osprey's behaviour and its living conditions, all the while bearing its responsibility to keep the lights on in Finland.

You can read more about Lalli the satellite osprey's history and autumn migration in Finnish and in English from the University of Helsinki's Finnish Museum of Natural History webpage at: **www.luomus.fi/english/zoology/satelliteospreys/lalli/autumn2013.htm**

As this article was being written in November, Lalli was fishing on the island of Madeira.

PHOTOGRAPH JOUKO KIVELÄ

Two-way trade was tested on the Russia – Finland 400 kV interconnections

One of the four DC-links in Vyborg with the capacity of 350 MW was tested for electricity transmission from Finland to Russia.

The technical testing of bidirectional transmission was carried out successfully. The total amount of energy transmitted was about 2,5 GWh with a maximum power of 350 MW. The technical testing of bidirectional transmission will continue during autumn 2013.

Fingrid, the Russian JSC Federal Grid Company of the Unified Energy System and the Russian JSC System Operator of the United Power System are preparing technical and commercial conditions for a two-way trade between Finland and Russia. Currently electricity can only be transmitted from Russia to Finland.

Vyborg converter station.

Landowners give Fingrid a good grade

The results of a new company image survey directed at landowners shows that Fingrid is known as a reliable, competent and responsible company. Fingrid's overall grade as an operator has improved since last year.

The name Fingrid is well-known. In the survey, respondents were asked to name energy and electricity companies, and 77% of all respondents stated that they had heard of Fingrid.

Of those who knew the name Fingrid, 91% evaluated the company either positively or neutrally. The most positive of all towards Fingrid were landowners on whose land Fingrid's transmission lines are located. Of those respondents, no less than 92% evaluated Fingrid either positively or neutrally.

Fingrid particularly evokes an image of professionalism, reliability, openness and responsibility.

Land Use Manager **Ilkka Alm** finds several points from the survey results, which were good across the board, with which the company can be especially satisfied.

"The overall grade achieved by Fingrid shows that our work has borne fruit. Open and honest operations are part of our principles. Although robust working methods sometimes have to be used in transmission line work, we do endeavour to listen intently to the opinions of landowners."

"I am especially pleased that the highest marks of all were given to use precisely by those people on whose land we are installing our power lines," says Alm.

"The survey highlights the desire of landowners to receive correct and reliable information about projects. Co-operation can and should be improved. In particular, the proactive communication and agreement of ongoing projects and work are of primary importance."

Fingrid regularly surveys landowners to find out their opinions of companies in the energy sector. According to the survey completed in the autumn, the grades awarded to Fingrid given by landowners improved in all measured areas in comparison with the previous year's survey.

Significant benefits in use of remote monitoring of transformers and circuit breakers

The PI remote monitoring system used by Fingrid for the real-time monitoring of the status of transformers and circuit breakers has already produced significant benefits and savings.

Fingrid systematically gathers data on the transmission network and its components for things such as maintenance. The main purpose of data acquisition is to ensure that the different sections of the grid are in good condition and meet the requirements set for network reliability.

Grid maintenance aims at network security, reliability and cost-efficiency. One effective and easy-to-use tool which Fingrid uses for this purpose is the real-time monitoring of the status of transformers and circuit breakers.

Two transformers have been saved using online status monitoring: one at the Alajärvi transformer substation and the other in Koria.

In Nurmijärvi, too, a faulty transformer was disconnected in a controlled manner thanks to early fault detection. The old transformer could not be saved, but it was disconnected from the network without any disturbances or steep costs. Since the fault was detected in good time, the old transformer was replaced with a new one in a controlled manner.

The online remote monitoring of circuit breakers on the other hand ensures that SF_6 gases remain inside devices and do not leak, which would endanger the functionality of the equipment, or have a detrimental effect on the environment as a greenhouse gas. Even small leaks were detected during the warranty period, and so we were able to demonstrate the obligation to repair the equipment under warranty to the manufacturer. Remote monitoring also supports the EU's goal of reducing emissions of fluorinated greenhouse gases.

In practice, the remote monitoring system provides operation control with continuous information on the status of transformers and circuit breakers in a clear, visual format. Monitoring over the long-term helps to discern trends, which experts can use to detect even small changes in the functionality of equipment. Monitoring is pre-emptive, which helps to detect faults which develop slowly over a period of time. This allows us to prepare for possible faults and the necessary procedures well in advance.

For switchgear, the PI system allows for the optimisation of a renovation and maintenance programme for electricity substations, as the online information is combined with historic information to provide information on the number and severity of faults, maintenance and product support.

POWERED BY ELECTRICITY

In this column, Fingrid employees share their experiences of devices which run on electricity. Communications Manager Marjaana Kivioja put some small LED lights to the test.

LIGHT IN THE DARKNESS

After a light summer, the darkness of autumn and winter never fails to surprise us. But small, electronic devices can bring some light to the dark season.

TEXT MARJAANA KIVIOJA | **PHOTOGRAPHS** TIMO LEMMETTI

LED lights have rapidly gained ground as an affordable way to increase safety and are used in reflectors and on bicycles, for example. LED lights are considered to be environmentally friendly and have a long service life, as they consume low levels of energy.

When choosing a LED light, remember the following:

- A good service life for a LED light is at least 25,000 hours.
- Its energy efficiency grade should be at least A+.
- Consider replacing halogen lights with LED lights.
- A LED is also the right choice if you want to avoid lights which contain mercury.
- A LED light pays itself back in energy savings in just 12–36 months.
- LEDs may not be sorted along with normal household waste; instead they should be sorted as waste electrical and electronic equipment.

Can a tiny LED emitter cast enough light into the dark? I tested a range of LED lights.

LED bicycle light

This handy and compact packet contains two LED lights which are attached to a bike using rubber loops. The bright white light is attached to the front of the bike and the red light goes on the back. Both lights can be set to flash. My ten-year old son loved the lights, which are easy to attach to the handlebars and rack. When he arrives at school, he can simply remove the lights and put them in his pocket. "These are good lights, do you think I could have a whole row of them lined up on the handlebars?" he

asks, clearly delighted with them. Technically it isn't illegal to use the flashing light setting, but the red light can only be used on the back of the bike. My son needed reminding of that a few times, but the light is good, easy-to-use and affordable for a child who has a tendency to misplace his belongings. Recommended by mum.

LED reflector

The Road Traffic Act obligates pedestrians to use an appropriate reflector. At first, the soft LED reflector feels a little

flimsy, since it's attached by a clip to the edge of my pocket. I wonder if the cars will see me out walking in the dark? The LED light in the reflector is actually not the most important issue. It's essential that the reflector hanging from my jacket meets the set requirements. The reflector's CE marking and EN 13356 code guarantee that the reflector isn't just a toy and that you really are visible in the dark.

The LED light in the reflector proves its usefulness once I reach my door: I used it to help find the lock on the door.

Solar-powered table light

The last LED put to the test was a LED table light which works either using a solar panel or through manual charging. The lightweight light charges its mini-battery using the last rays of autumn sunlight. You can boost the charge by winding the crank on the side of the lamp. The kids enjoyed charging the light using the crank, but the noise began to get on the adults' nerves. The light was handy for finding your way to the toilet in the middle of the night instead of just fumbling in the dark. And it provides enough power for a quick visit outside. Not bad!

Sources:
Motiva, Lampputieto and Liikenneturva

JOY OF WORK

Let's be thankful for the **polar night**

We're used to thinking that the dark, winter period of polar night is awful. But really, it's just a matter of perspective. What good can the darkness offer you?

I was on a business trip in Kuopio. After my presentation I went back to my hotel room, put on my trainers and went outside. It was evening and dark had already fallen, but I wanted to run to Puijo tower. The road was icy and there was no separate pavement for pedestrians. Complete quiet surrounded me, and the snow-decked firs all around had a calming effect on me. I felt like they could help me to escape all the hustle and bustle, stresses and strains and winter melancholy. I enjoyed being alone and in peace after such a hectic, people-filled day.

So thank you, polar night, for swooping in and offering us a hiding place, an escape. And not just for me, either; even dirt is let off the hook as you hide all the dust and dirty streaks on the windows.

But there are two sides to every coin. Some of us suffer with seasonal affective disorder (SAD), which can trigger depression. Susceptibility to SAD is partially down to genetics, and partially down to the human body producing too much melatonin. Symptoms of SAD are more common in women than in men, but around the age of 60 it begins to equal out. A sweet tooth might also be a symptom of the disorder. If you find yourself suffering from SAD symptoms, you might need to fuel up on light. It helps to enjoy some bright light from a special lamp or outdoor light as early as possible in the morning.

On the other hand, low melatonin production can cause a weakening in the immune system and a range of health problems, such as a high pulse and disruption in the secretion of insulin. As a result, we should all make sure that we make the most of both the light and the darkness!

As we age, our ability to produce melatonin weakens, but the secretion of feel-good hormones also decreases. It's well worth combining bright light therapy with exercise.

Bright light helps combat an increase in carbohydrate cravings and tiredness while exercise can help lift your mood and your physical condition. It doesn't matter what kind of exercise you do, as long as your pulse is raised and you become a little out of breath. One hour of exercise three times a week – that's not so bad, is it?

So what else can we do to cheer ourselves up? Do something nice every day. Find yourself a hobby that you really enjoy. Attend some cultural events; art can provide new perspectives and insight into daily life. Take care of your relationships, since social interaction can provide protection against depression. Why not give your relationship a boost by presenting a good friend or your spouse with a list of all their best qualities? Just write down everything you appreciate about them. It's bound to make you feel better, too. I got the idea from **Esa Saarinen** around twenty years ago. And it's taken me this long to thank him for the idea. Better late than never...

Remember to enjoy nature. If you can't make it outdoors and out of the city yourself, just relax on the sofa and take a mental trip there. Even that will slow your pulse, lower your blood pressure, increase both your attention span and feel-good hormone production and even strengthen your immune system.

So enjoy the seasons! To quote **Saima Harmaja**'s "Syysmetsä" (Autumn Forest) poem: "What wild and wonderful joy! To drink in the potent earth and breathe the pure wind of the sky." ■

Marja-Liisa Manka, M.Soc.Sc., Ph.D., has served as a professor in work welfare at the University of Tampere since 2004. Before that, she worked as an entrepreneur, head of further education centre, and as training manager at Saarioinen Oy, among others. In 2011, she was elected the social scientist of the year and an advocate of good world of work. She has also written books on the topic, most recently "Työnilo" (2012).

GRID QUIZ

Competition to the readers of Fingrid Magazine

Answer the below questions and send your reply by fax (number +358 (0)30 395 5196) or mail to Fingrid no later than 31 January 2014. Address: Fingrid Oyj, PL 530, 00101 HELSINKI, FINLAND. Mark the envelope with "Grid Quiz". Among all those who have given right answers, we will give three marquise-fabric shoulder bags designed by Ristomatti Ratia for Marimekko as prizes by drawing lots. The answers to the questions can be found in the articles of this magazine.

1. What does the ENTSO-E abbreviation TYNDP stand for?

- A ten-year network development plan.
- The network code preparation process.
- The target model for markets.

2. How can you avoid the tingling feeling in your fingers when cycling underneath a transmission line?

- By wearing a bicycle helmet.
- By riding as fast as you can.
- By touching the metal part of your handlebars with your bare hand while cycling past or by wearing gloves or mittens.

3. What is the name of Fingrid's sponsored osprey, which is monitored using a satellite transmitter?

- Ingrid
- Kauko
- Lalli

4. When was the most recent major disturbance in the Finnish grid network?

- In the 1960s
- In the 1970s
- In the 1990s

5. What is the name of the principle which states that a power system should be able to withstand any possible individual fault without experiencing any consequences in another area?

- (N-1)
- VJV2013
- YLE

6. What are the new tasks for Fingrid's electricity market services?

- The balance service and the development of electricity markets.
- The exchange of information on the electricity markets and the management of guarantees of origin.
- Ensuring operational security and managing the grid network during disturbances and periods of change.

7. In Finland, which body manages the preparations and preparedness planning for the production, transmission and distribution of energy?

- The National Emergency Supply Agency
- Fingrid
- The energy economy pool

Prizes for the previous Grid Quiz (2/2013) have been sent to the following winners who answered correctly: Marjut Honkavaara, Helsinki; Kari Linnamäki, Rovaniemi; Tapio Sormunen, Joensuu.

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