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Editorial

WOOD, WIND AND NUCLEAR POWER TO THE GRID

There have been a number of developments in the Finnish energy business recently. The topics have comprised both nuclear energy and wood-based fuels, not forgetting wind power. There is much at stake. The goal is to fight the threat of global warming and to secure the conditions of the future generations, too. Fingrid is involved in the climate and energy efforts by implementing the grid reinforcements required by the new energy solutions and by ensuring that the transmission grid in Finland works reliably.

We have drawn up the capital investment plan for the transmission system with the intention to make the plan as flexible as possible. When new generation capacity is constructed, the grid is ready to receive it. Of course, there are also other issues besides new generation capacity to consider. These include increasing electricity consumption in the entire single market area and local changes in it, decommissioned generation capacity, and, above all, renovations necessitated by the ageing of the present grid in Finland, built to a large extent in the 1960s and 1970s. We no longer view matters from a national perspective but are closely involved in pan-European developments.

In accordance with our capital investment strategy, one or two large nuclear power units and 2,500 megawatts of decentralised wind power capacity can be connected to the Finnish transmission system over the next decade. At first, we will focus on executing all the vital grid projects that will certainly be needed so that there is enough time for grid reinforcements required by individual generation projects.

Of the carbon-neutral methods of electricity generation, nuclear power and wind power have a broader impact on the transmission grid. The significance of other forms of renewable energy production on the reinforcements and operation of the grid is relatively small with regard to their volume, although for example wood chips may carry considerable regional importance. Fingrid's capital investment programme is adapted easily to the solutions adopted, no matter what kinds of decisions concerning nuclear energy the Finnish Parliament makes. We can also be flexible in terms of the investment decisions and schedules of generation projects.

The transmission grid is not only reinforced so as to connect new generation capacity to it. Upgrades are also needed because we must take care of the system security of our power system, and the grid itself is aged in many parts. In the next ten years, we are planning to construct just under 3,000 kilometres of new transmission lines and more than 30 new substations. When we are carrying out the projects, we aim to take the environment into account as comprehensively as possible. The new transmission lines will mostly replace existing lines or run parallel with them, and only a small portion of the new lines need to be built in completely new rights-of-ways.

Expropriation compensations have been an occasional topic of discussion in Finland during the past year, all the way to the ministerial level. The compensation levels are considered to be too low and outdated, especially in terms of forest ground. In many cases, the criticism has been directed at Fingrid, even though we do not decide on the compensations. The expropriation compensation decisions are made by an impartial expropriation committee in accordance with the Finnish act on expropriation so that the unbiased treatment of landowners can be secured.

Transmission lines, just like roads, natural gas pipes and railways, represent indispensable infrastructure in modern society. Fingrid holds the view that a fair compensation should be paid to the landowners for the disadvantage inflicted by expropriation.

We alone cannot carry out the grid reinforcements required by new generation capacity and system security. I believe that we can manage this demanding and extensive work through fluent co-operation with landowners, our customers, constructors and authorities who process the transmission line matters. We need to act sufficiently early so that the processing of expropriation and other permit matters is successful and that all parties are heard. In this way, we all will contribute to positive developments in the fight against global warming.

Pertti Kuronen is Fingrid Oyj's Senior Vice President responsible for grid service.

New challenges of transmission system

Fingrid has been making preparations for additional nuclear power capacity and other new energy solutions in good time. New electricity generation capacity will influence the transmission system, and the capital investments call for external funding, too.

Text by Helinä Hirvikorpi ■ **Photographs by** Juhani Eskelinen and Masterfile

When this article is being written, a decision on additional nuclear power capacity is expected from the Parliament of Finland. The Finnish Government has presented to the Parliament a subsidy package for renewable energy, and also proposed that permits be granted to two new nuclear power units: to Teollisuuden Voima to build Olkiluoto 4 in Eurajoki and to Fennovoima for a nuclear facility in Pyhäjoki or Simo.

Fingrid has been drawing up plans and calculations on the basis of several different scenarios, and is now making preparations to connect one or two new nuclear facilities to the grid alongside the Olkiluoto 3 unit being constructed.

The location of the new units has no bearing on the functioning of the transmission system. Fingrid's grid planning specialist **Antero Reilander** says that the schedules of projects covered by Fingrid's capital investment programme are being fine-tuned at present so that all the line projects can be executed, considering the internal and external resources.

There are separate plans for the grid connection of each nuclear power unit, but the environmental impact assessments will not be drawn up until the Parliament has made its decision on the construction of one or two units and until their locations have been decided. Fingrid is providing for a situation where up to two new units could be complete by the end of the 2010s. The grid connections will be ready about one year before the actual nuclear units.

The plans need to be flexible, because it is impossible to make accurate forecasts of electricity consumption in 10 years' time.

Alongside additional nuclear capacity, there are plans for about 11,000 megawatts of wind power. According to the objective of the Ministry of Employment and the Economy, 2,500 megawatts of this will be constructed by 2020. In 2020, renewable energy would be paid some 327 million euros in subsidies annually. The feed-in tariff for wind power, biogas and small-scale combined heat and power production would account for a considerable portion of this. Other forms of subsidy would include an energy subsidy for small wood and subsidies for electricity generation.

"Nuclear power and wind power do not contribute to continuous power regulation like the other conventional power plants do. Still, electricity generation and consumption must be in a balance at all times," Antero Reilander points out.

What is challenging in terms of the transmission system is that power plants are replaced with forms of generation which cannot be regulated. It is difficult to forecast wind power generation accurately, and the related forecasting tools are being developed at present.

Co-operation and flexible solutions

Fingrid uses electricity market models to anticipate the future transmission needs. Grid planning takes into account even the distant plans at an early stage. The grid development plan has a time span of 10 years, and various scenarios run alongside the plan. The plans need to be flexible, because it is impossible to make accurate forecasts of electricity consumption in 10 years' time. The reinforcements of the 400 kilovolt network, included in the capital investment programme, are planned so that they support as many scenarios as possible.

Fingrid draws up the grid plans together with electricity users, producers and other network companies. "We enjoy good and confidential relationships with the players in this industry, and we receive information from them on their future plans and needs," Antero Reilander says.

"Together with our customers, we think of issues such as ways in which to connect wind power capacity to the grid as effectively as possible. We have sat at the same table with the various parties devising solutions that will serve everyone but that do not cause extra reinforcements."

"In grid planning, Fingrid aims at optimum solutions in terms of both the environment and costs," says Antero Reilander.

Fingrid aims at optimum solutions in terms of both the environment and costs. In his work, Antero Reilander has come to notice that Fingrid's values have provided support in the negotiations with the customers: responsibility, transparency, efficiency and impartiality have turned out be highly practical guidelines.

Financing from the capital market

What about financing? In the next 10 years, Fingrid is facing extensive capital investments of about 1.6 billion euros.

Turning challenges into opportunities

The foresight report of the Government of Finland on climate and energy policy aspires a reduction of 80 per cent in greenhouse gas emissions from the level of 1990 by 2050. This is a challenging goal. The Finnish energy industry has accepted the challenge and turned it into an opportunity. The energy industry believes in low-carbon electricity generation so that the welfare of Finns is retained.

At the end of 2009, Finnish Energy Industries published its vision extending until 2050. The leading idea in the vision is carbon-neutral production of electricity and district heat in 2050. The Finnish energy industry will bring down its own carbon dioxide emissions as low as practically possible and will contribute to a further decrease in the emissions through an increased use of electricity and district heat in other sectors, too, like transport, heating and industries.

Energy efficiency is in focus in the vision. This is why considerable input in related technology is required. There must also be emphasis on a smart electricity grid, carbon capture and storage (CCS), low-energy construction, and transport driven by electricity.

In accordance with the vision of Finnish Energy Industries, energy use will intensify considerably by 2050. This will take place in applications where electricity and district heat have an important role, such as heating of buildings, electricity use by households, industries and services, and passenger car transport. In addition to these, the end use of energy will intensify for example in industrial processes.

As a result of intensified energy use, the share of electricity in the end use of energy will grow from the present 28 per cent to 42 per cent. The share of district heat will remain unchanged (10 per cent), even though the need for heating in buildings will decrease. In line with improved energy efficiency, the end use of energy will be 21 per cent smaller than in a case where the above measures would not be carried out and energy production would continue in the former configuration.

Versatile generation architecture

The need for electricity and heat will have different trends: the share of electricity in the total energy portfolio will grow while the share of heating energy will decrease. The need for separate electricity generation will increase. By 2050, there is a need to construct 19,000 to 27,000 megawatts of new electricity generation capacity, and non-emission forms of generation will replace some of the energy production based on fossil fuels.

"All the company's capital investments are financed partly through internal financing and partly by issuing bonds in the international and domestic financial and capital markets," says Fingrid's Chief Financial Officer **Tom Pippingsköld**.

Fingrid uses various types of debt issuance programmes: ECP is an international commercial paper programme within which Fingrid issues commercial papers of a maximum of 12 months. There is a corresponding commercial paper programme for the domestic market.

In its long-term funding, Fingrid uses the MTN programme. This is an international bond programme where bonds are issued annually to private investors.

"The MTN programme is our primary source of funding. The programme size is 1.5 billion euros, and to date we have issued about 800 million euros worth of bonds. We utilise the domestic and international commercial paper programmes in short-term funding," Pippingsköld points out.

Fingrid has also borrowed from the European Investment Bank (EIB) and Nordic Investment Bank (NIB).

Tom Pippingsköld points out that Fingrid has relatively high international credit ratings, which is an asset in acquiring funding for the ambitious capital investment programme.

Standard & Poor's has given Fingrid's long-term credit a rating of A+, Moody's A1, and Fitch Ratings AA. A credit rating guarantees access to the sources of funds, and is almost indispensable when working with international investors.

"The company has always endeavoured to retain a high credit rating. This also guarantees a more inexpensive price of money," Pippingsköld says.

When the capital investments are sizeable, it is also important to diversify funding and extend the maturities. The company has not issued large emissions earlier, but this has not been ruled out as part of increasingly versatile funding. The solid liquidity is backed up by Fingrid's cash funds of 200 million euros and the undrawn revolving credit facility of 250 million euros.

Earlier, Fingrid's annual capital investments were at a level of 40 million euros, so the ongoing capital investment projects have brought along new kinds of challenges. Stakeholder communications must be unambiguous, and financial reporting needs to be transparent and conform to the International Financial Reporting Standards (IFRS).

"The company must have a clear strategy, a certain credit story, and systematic procedures vis-à-vis the investors and banks so that it can maintain a good reputation in funding and remain an attractive investment," Tom Pippingsköld states. ■

Wind power will undergo the greatest structural change, since its share will grow tens of times as high as now. Less than half a per cent of all electricity is generated by wind power at present. According to the vision, its portion will rise up to 11 to 16 per cent by 2050, in other words to 15 to 20 terawatt hours.

Nuclear power will have a crucial role in the electricity generation architecture in 2050. It will cater for 40 per cent of all generation. If this goal is to be achieved, new nuclear power capacity needs to be constructed, because of the existing reactors only the Olkiluoto 3 unit, which is under construction at present, will be in use in 2050.

The co-generation of heat and power, which is already utilised extensively in Finland, will have a strong foothold also in the future.

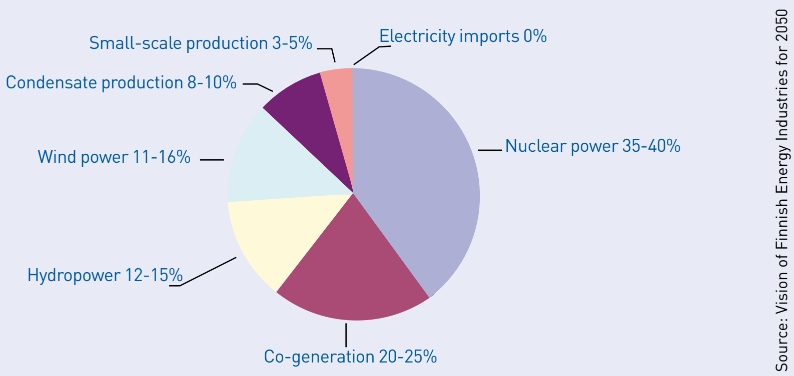
Electricity and district heat will replace fossil fuels and reduce the resulting greenhouse gas emissions in many applications where they are not yet employed comprehensively. The biggest reduction in emissions will take place in transport, where electricity will substitute for the use of fossil fuels by 8 million tonnes of carbon dioxide per year.

Replacing oil heating with district heat and solutions based on electricity, such as heat pumps, will bring the emissions down by approx. 3 million CO_2 tonnes per year. Electricity would substitute for industrial fuels by approx. 1 million carbon dioxide tonnes a year. The utilisation of electricity and district heat in these new applications will reduce the emissions by a total of 12 million CO_2 tonnes annually.

You can learn more about the path of the Finnish energy industry towards carbon-neutral electricity and district heat production at www.visio2050.fi (in Finnish). ■

Text by Tiina Miettinen

Structure of electricity generation in 2050



Wind power into the transmission grid

There is an increasing number of plans for additional wind power capacity in Finland, too. Fingrid is contributing to the related preparations and analyses for connecting large wind turbines and farms to the nation-wide electricity transmission grid.

Text by Antti J. Lagus ■ **Photographs by** Antero Aaltonen, Juhani Eskelinen and Vastavalo

The official goal in Finland is to install 6 terawatts of wind energy by 2020. In accordance with the feed-in tariff proposal being drawn up, this would translate into a power of 2,500 megawatts. Since wind turbines cannot operate uninterruptedly, the actual energy volume is naturally smaller than what the nominal wind power capacity would allow.

"According to calculations received from various sources, there are plans for the construction of wind power of more than 11,000 megawatts. The transmission grid is developed on the basis of a grid vision extending over a period of 20 to 30 years. The grid vision, in turn, is used for drawing up a concrete grid development plan for the next 10 years," says Planning Manager **Aki Laurila** of Fingrid's Grid Development Unit.

The grid development plan is based on the projected growth of 2,500 megawatts in the wind power capacity so that the wind turbines are located in different parts of Finland. Fingrid has drawn up capital investment plans of 1,600 million euros for the next 10 years. These plans cover the costs of reinforcing the grid for the connection of additional wind power capacity and also grid reinforcements necessitated by other types of generation, electricity market and ageing of the grid. What makes planning difficult is the fact that there are different views of the growth in wind power capacity.

When a wind turbine is connected to the transmission grid, it must basically fulfil the same requirements as other power plants, such as nuclear power units or thermal power stations. When planning a new generating unit, it is also analysed how the unit can be connected to the grid.

One of the issues studied in this conjunction is what kinds of reinforcements are needed in the transmission grid, and these reinforcement needs are then also taken into account in Fingrid's capital investment programme.

Grid plans of all projects

Related to the renewable energy package being prepared in Finland, it has also been proposed that a feed-in tariff be paid for wind turbines in excess of half a megawatt. The wind turbines under construction in Finland at present typically represent a range of 2 to 3 megawatts. Several individual wind turbines are usually combined into a single entity. Depending on the location and wind conditions, the peak availability period of a wind turbine is 2,000 to 2,500 hours per year.

The connection of wind turbines to the Finnish transmission grid takes place so that the party responsible for the project builds a connecting line to the agreed connection point. Fingrid carries responsibility for developing the transmission capacity of the grid.

So far, there are no off-shore wind farms in Finland. There are pending projects for such farms in the northern parts of the Gulf of Bothnia, and also further down south outside the towns of Raahe, Korsnäs, Kristiinankaupunki, Pori and Raasepori. A wind farm outside Helsinki has also been discussed.

"We need to take the big picture into account, in other words all pending projects need to be taken into account in grid plans. We monitor studies drawn up of the projects, such as environmental impact assessments. We have also been involved in the steering group for the environmental impact assessments of the projects, for example with the Suurhiekka wind farm. The objective is to ensure that the plans are implemented sensibly so that the system security of the entire power sys-

Fingrid hopes that enterprises planning to construct wind power capacity would contact a network company at an as early stage as possible.

tem is retained and that the transmission capacity of the grid is sufficient," Aki Laurila says.

Co-operation launched at an early stage

Fingrid hopes that enterprises planning to construct wind power capacity would contact a network company at an as early stage as possible so that connection to the electricity transmission grid can take place in a schedule required by the project.

When a wind power project becomes pending, one of the first issues is to find out how the wind turbine can be connected to a distribution network, regional network or to the nation-wide grid. This is one part of the overall project also involving the launching of environmental studies and potentially the EIA (environmental impact assessment) procedure in more comprehensive projects. When the environmental studies are complete and once it has been verified that the project can be implemented, the more detailed planning of the technical method of execution of the connection begins.

"Once co-operation between us and the other project partners is launched at an early stage, issues such as the need to reinforce the grid do not come as a surprise and do not cause delays in the execution of the overall project. We have become well involved in the projects, but new projects become pending all the time," Aki Laurila says.

Even though the main transmission grid has a high electricity transmission capacity, various kinds of technical restrictions may occur depending on the location and the scope of the projects. Both generating units and large consumption units require much transmission capacity. The grid components do not withstand in all cases, so there is a need to construct new lines, transformers or circuit breakers.

Small units to regional networks

According to **Tuomas Rauhala**, Adviser in Fingrid's Research and Development Unit, wind turbines of half a megawatt will not be connected directly to Fingrid's grid. These small units will rather be connected to the network of a local electricity company.

The principle is that the nation-wide grid transmits high volumes of electricity from generation centres to consumption centres, while regional networks serve local consumers and local generation.

Aki Laurila does not deem it expedient or cost-efficient to connect small powers to the nation-wide grid.

"The power generation units to be connected to our grid will be from 10 megawatts up. These units consist of several wind turbines, most likely ones of 2 to 3 megawatts," Tuomas Rauhala says.

System requirements ensure frequency and voltage

Fingrid has specifications for the operational performance of all generating units, intending to guarantee that the generating units work reliably as part of the power system. These requirements also ensure the trouble-free operation of the transmission grid.

According to the requirements, a generating unit must operate within the given voltage and frequency ranges. Fingrid does not impose technical requirements on the smaller wind turbines. The issues concerning such units of under 10 megawatts are primarily recommendations. The actual technical "performance requirements" specify for example how a generating unit must support the voltage and frequency of the transmission grid and how the unit must cope with various disturbance situations. The requirements also cover the technical documentation of the units, with this documentation being available to Fingrid.

Wind power covered in the grid investment programme

The capital investment programme of 1,600 million euros for the upgrading of the nation-wide electricity transmission grid also makes preparations for additional wind power capacity.

The areas with the best wind conditions in Finland are located on the coast of the Gulf of Bothnia between Finland and Sweden. This is why Fingrid intends to upgrade the coastal transmission line to a voltage of 400 kilovolts in the next decade. The transmission line between Kristiinankaupunki and Kokkola has already been built on the basis of 400 kilovolt requirements.

An EIA report has been drawn up of the Ulvila–Kristiinankaupunki line, and the EIA procedure for the Kokkola–Pyhäselkä line is in progress.

The goal is to complete the trunk grid so that it serves wind power and nuclear power generation as well as the electricity market in an ideal manner. ■

Aki Laurila (on the left) and Tuomas Rauhala: "Grid development is about managing the big picture."

Tuomas Rauhala states that the physical boundary conditions of a generating unit are recognised. A conventional example of these boundary conditions is the fact that a wind turbine just cannot maintain the same optimum power at varying wind speeds.

However, wind turbines must be able to contribute to frequency control whenever necessary.

Frequency indicates that electricity production and consumption are in a balance. If, for example, frequency rises dramatically, there is too much electricity generation in the grid and it needs to be restricted. In this case, wind turbines must also be prepared to take less power from the wind and feed a smaller power to the grid. Similarly, for example in the event of a heavy wind front, a wind turbine must be able to reduce its power in a controlled manner.

More precise wind forecasts improve grid control

Electricity generation and consumption are kept in a balance in the power system at all times. Wind power brings an additional component to the management of power balance, and here Aki Laurila highlights the importance of wind forecasts. If reliable wind forecasts are available in real time, Fingrid's Power System Control Centre can make better preparations for controlling the situation to equilibrium. In view of the entire power system, the controls for the system should be carried out where this is most advantageous.

The situation can also be enhanced by improving the capacity of the transmission grid so that it serves the electricity market even better. This facilitates the integration of renewable power generation.

"Grid development is about managing the overall situation. We should not forget that there are major ongoing nuclear power projects in Finland; these call for the upgrading of the grid. The better the connections and the larger the available area, the easier the electricity transmissions to wherever electricity is needed at a given moment," Aki Laurila says.

Fingrid conducts close co-operation with its customers and other project parties and also with the regional councils which are responsible for regional land use plans. The regional councils contribute to the preconditions for the construction of wind power capacity. ■

Electricity needed in mining

The mining industry is experiencing a revival. Several mining projects have been launched and completed in Northern and Eastern Finland in recent years. Large mines, such as the Talvivaara nickel mine, boost regional economic growth and improve employment figures. Electricity is an important factor in the operation of the mines.

Text by Tiina Miettinen ■ **Photographs by** Juhani Eskelinen and Talvivaara Mining Company archives

The mining industry is one sector of the extractive resources industry, which also covers the rock material industry and natural stone industry. Copper, zinc, chromium, nickel and gold are extracted in Finland. The ores are processed for the needs of industries such as the steel, electrical, electronics and telecommunications industries.

The products of the extractive resources industry – stones, metals and minerals – are used everywhere: in building and environmental construction, computers and mobile phones, industrial products and equipment, agriculture, environmental protection and utility articles.

There were 47 mines and quarries in Finland in 2009. Seven of these were metallic mineral mines, 17 were limestone quarries or mines, and 23 were industrial mineral or commercial stone quarries. The extractive resources industry has long traditions in Finland, but the industry declined gradually in the 1980s. This millennium has brought along a new rise, and the industry is in a boom period.

Several mining projects are in progress in Eastern and Northern Finland. Finland also houses active processing industry, such as the efficient zinc plant in Kokkola in Western Finland.

Mines create jobs and stimulate the local business structure. As an example, Talvivaara Mining Company employs almost 400 persons, in addition to whom hundreds of employees of subcontractors and suppliers work in the mine area daily. The mine also has a considerable indirect employment impact.

"This is a growth business, and the

outlook is good. Steel consumption in the Western world is at least 500 kilos per person per year. Since the standard of living is on the increase in developing countries and especially in China, the demand for metals is bound to grow. We need to exploit the more expensive and difficult raw material deposits, too, which raises the price," says Talvivaara's CEO Pekka Perä in commenting on the outlook of the business.

The Talvivaara nickel mine in Eastern Finland is a new mine, with one of the largest known deposits of sulphide nickel in Europe. The mining rights in the region were originally granted to Outokumpu in 1986. Outokumpu sold the mining rights to Talvivaara in February 2004.

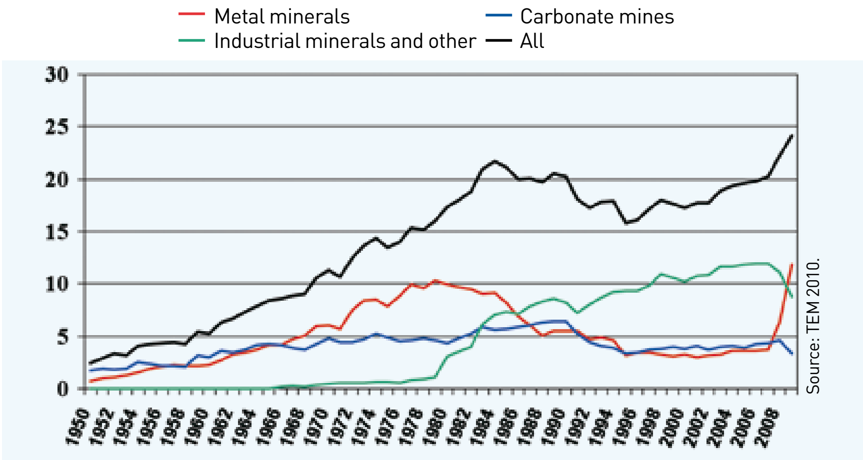
The price of electricity is an important consideration for Talvivaara Mining Company, even though CEO Pekka Perä says that the company can show the lowest electricity consumption in the world when proportioned to the metal volumes produced.

In the transaction, Talvivaara received access rights to the testing and research data concerning the deposit. Talvivaara applies the bioheap leaching method for dissolving the metals out of the ore.

"It was clear right from the outset that the deposit cannot be utilised by using the conventional physical method. We bought the mining rights for Talvivaara in 2004; there was a bunch of 10 people of us. First we drew up the feasibility studies and acquired financing through a special issue directed at investors. The plant started to produce metals in 2008," **Pekka Perä** says.

"The launching of mining operations is a calculated risk. A small gold mine requires capital investments of 20 to 30 million euros, while a large mine, such as Talvivaara, requires 700 million euros. We knew what we were getting into. The most difficult part in establishing a mine is to find the ore; we knew that the deposits were there."

Mining in Finland 1950–2009



"Now we are doing fine, the production levels are rising and profitability improves gradually. However, the products in this industry are valued in dollars and the costs in euros, so there is an exchange risk, especially since the prices of metals fluctuate considerably," Pekka Perä states.

Separate "block" for uranium

The Talvivaara mine is a complex deposit, in other words it contains multiple metals. The quarried ore contains not only nickel and zinc but also copper and cobalt. The company has submitted an application to the Finnish Government for a permit required by the Nuclear Energy Act to recover uranium as a by-product. The environmental impact assessment concerning the recovery of uranium is in progress.

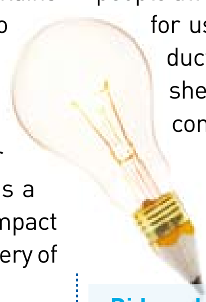
"Uranium is purely a by-product. We crush the stone, dissolve it in the same way as normally, and introduce an extra "block" to recover the uranium. The goal is to launch uranium production in 2011."

Pekka Perä has firm opinions about increased electricity generation capacity in Finland. Electricity is a major factor of production for Talvivaara, too; electricity accounts for more than 10 per cent of its costs. Talvivaara has an 80 megawatt link to the high-voltage transmission grid, and in line with increased production the need for power will grow up to 45 megawatts.

"Proportioned to the metal volumes produced, we have the lowest electricity consumption in the world. Despite this, the price of electricity plays a role in terms of the expansion and development of the company. It's a simple fact that an inexpensive price of electricity improves the operating conditions of industries," Pekka Perä argues.

Talvivaara is a new mining company, and with the present deposits mining can continue there for as long as 46 years.

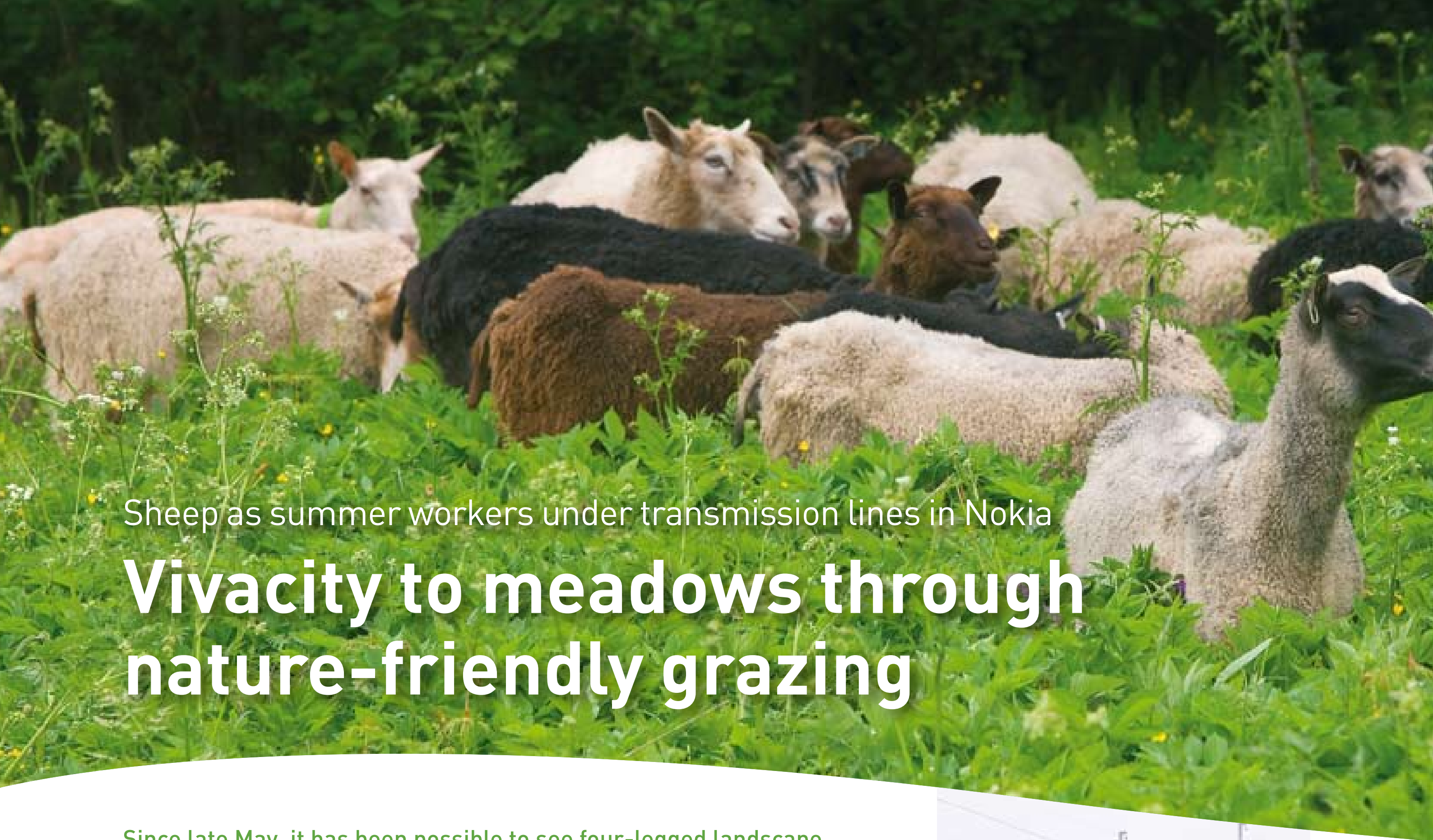
"How many employers can state that they can provide work for that long a period? Of course, our company is still young and calls for certain mental growth, because we are hiring new people all the time. Now it is important for us to continue to launch production and improve our balance sheet," Pekka Perä sums up the company's topical issues. ■



Did you know that:

Several different mines are needed for the manufacture of an incandescent lamp bulb. The glass envelope is made of silicon, sodium carbonate and lime. The bulb contains a gas mixture of nitrogen and argon, which prevents the filament from burning.The filament itself is made of tungsten, and it rests on thin copper-nickel support wires. Slightly thicker copper conductors transmit electricity from the stem of the lamp to the filaments. The stem can be made of brass, which is an alloy of copper and zinc, or aluminium.

Source: Advertisement of Association of the Finnish Extractive Resources Industry in newspaper Kauppalehti on 7 November 2008.



Sheep as summer workers under transmission lines in Nokia

Vivacity to meadows through nature-friendly grazing

Since late May, it has been possible to see four-legged landscape managers on the go in Nokia. The grazing sheep under Fingrid's and Vattenfall's transmission lines are carrying out indispensable clearing work, thereby helping in conservation of biodiversity.

Text by Maria Hallila, Tiina Miettinen ■ **Photographs by** Harri Hinkka

The project is a joint effort of many partners to combine the support for small entrepreneurs and the utilization of transmission line undersides. A flock of thirty ewes owned by farmers **Oiva Mäenpää** and **Marjukka Ohra-aho** was transported from their organic farm in Hämeenkyrö in a horse transport trailer to the Luoto island that belongs to Natura 2000 network. After a drive of nearly 40 kilometres, the sheep still had a boat trip of 50 metres ahead.

It was definitely a relief for the sheep to disembark after a tiresome trip as there was a luxuriant, leafy 10 ha grassland waiting for them in the destination. Oiva Mäenpää was more than happy to get his flock to a fresh grassland.

"Fencing of the pasture during the spring was a strenuous job all right, but our five-year contract is now valid and the sheep seem to get along well," he reported after the first grazing week.

The flock consists of two Finnish breeds: "suomenlammas" and "kainuunharmas". The Mäenpää farm also rears a breed referred to as "ahvenanmaanlammas", but because of the horns, the breed is not suitable for grazing in places with no daily supervision. According to the farmer, there is a risk that the sheep get stuck by their horns in the fencing net.

Fostering biodiversity values

Environmental management with rural methods has turned out to work well in the development of open, meadow-like areas. In addition to Luoto, the

Sheep as grazing animals

The sheep are gregarious animals that like to flock together. They are ruminants that graze as per a precise diurnal rhythm, the whole flock at the same time. The pasture is divided into separate sections for grazing, resting, drinking and moving.

The sheep prefer to eat young and leafy plants. Since young willows belong to their favourite nutrition, they excel at the prevention of sprout forest growth.

It is advisable not to let young lambs to clear bushes and scrubs alone. They need some ewes to teach them how to reach and utilize delicious top parts of the highest bushes and saplings for their nutrition.

The adult sheep are fit to graze in dry, low-productive areas but not in moist or wet areas, which they prefer to avoid.

Source: www.laidunpankki.fi

Oiva Mäenpää carried 30 sheep to the island of Luoto to manage the landscape.

The Luoto island is a valued combination of non-built lakesides, groves and tiny meadow patches. Groves account for over a third of the whole area which is rich in flora and birds.

Some of the grove areas are included in the national grove preservation program. The island provides a habitat for a couple of European white elms and exceptionally many linden trees. Some meadows have been covered with trees or grown full of them, but the rest will be kept in condition by mowing. Sources: www.ymparisto.fi and www.nokiankaupunki.fi

town of Nokia, the Nokia parish, Fingrid, Vattenfall and the Pirkanmaa Centre for Economic Development, Transport and Environment have made a grazing contract on another joint management object – a green area called Hätilännotko in the midst of a built-up area. The responsible partner for management design and arrangement of the pastures is ProAgria Pirkanmaa in a project that tests the combination of landscape management and profitable environmental entrepreneurship.

Landscape management is aimed at maintaining and promoting biodiversity and landscaping values by restoring in places the openness of the island's old pastures and by promoting the vitality of its meadow flora. It is often difficult to take care of objects with significant natural and landscaping values by means of machines. However, it is easy for grazing animals to find a proper way to move in such challenging fields.

Grazing is an efficient way of taking care of rural regions also in built-up areas. Well-kept environment enhances biodiversity and landscape as well as makes the living environment more attractive.

Substitute environments for meadow flora

Fingrid's involvement in the grazing project relates to its long-term research program designed for determining for instance environmental impacts of the clearing work on transmission line areas.

"Intensive farming has resulted in a steep drop in the number of meadows and set meadow plant species in danger of extinction, but studies show that transmission line undersides regularly cleared by power companies could serve as potential substitute environments for endangered species," says Fingrid's Environmental Adviser **Tiina Seppänen**.

According to her, the Nokia's grazing project is a practical survey of how to utilize special subsidies to agriculture in the application of research results to practice; in other words in clearing and grazing. An additional motive in Fingrid's involvement was a wish to support small entrepreneurs and versatile use of transmission line undersides.

Entitlement to a special subsidy requires a five-year dedication to the project. The management of the pastures in Nokia is financed by the town of Nokia, Fingrid and Vattenfall for the period of 2010-2014.

Rural advisory association ProAgria has developed a Laidunpankki Internet service to promote grazing co-operation and to provide a link between the cattle and sheep owners needing additional pastures and those needing landscape management. The objective is to add contractual co-operation which is useful for both of these groups. ■

The rest of the way took place by boat accommodating five sheep at a time.

Benchmarking to broaden the horizons

For more than 10 years now, transmission system operators in almost 30 countries have measured their maintenance expertise and cost efficiency by means of the ITOMS* benchmarking survey. Alongside revealing the success factors of transmission system operation, the co-operation has also been an asset in other respects.

"Being involved in these efforts has really broadened my horizons. At present, I perceive the world from a wider perspective than just a few years ago," says Fingrid's Maintenance Management Manager Marcus Stenstrand, who is a member of ITOMS' Steering Group Committee.

Text by Maria Hallila ■ **Photograph by** Juhani Eskelinen

In his early membership in the Steering Group Committee, an American colleague gave Marcus Stenstrand a pair of fine, shining spurs. These were a symbolic token of gratitude, because Stenstrand had introduced a great number of ideas to the committee, hence spurring things into motion.

"Some of the ideas have been put into practice, but I did not yet fully see the big picture in those days. I viewed the matters too much from Fingrid's perspective or the Nordic perspective," Marcus Stenstrand admits now, five years later.

Same game, different rules

The Steering Group Committee of ITOMS comprises four members representing North America, Asia/Pacific, Continental Europe and British Isles, and Scandinavia and the Baltic countries.

Marcus Stenstrand is seemingly enthusiastic about the co-operation, which yields much but also requires much. The committee members live in different parts of the world, which is why even the basic practical arrangements of the work require considerable flexibility; as an example, the telephone conferences often take place at unorthodox hours.

"Above all, this work has taught me to grasp that there are many smart procedures elsewhere in the world. The first precondition of mutual understanding is to recognise the cultural differences. At first glance, some procedures may seem strange, but in their own environment they are quite rational and feasible," Marcus Stenstrand says.

As he has become acquainted with the operation of dozens of transmission system operators together with national and cultural differences, Marcus Stenstrand has come to understand that TSOs everywhere are engaged in the same game but the rules may vary.

"Maintenance for the Finnish transmission system represents the spearhead in this industry. To support maintenance, we can compile and produce information which is considerably difficult to accumulate for example in the USA, China or Australia."

According to him, the work of TSOs is so closely bound to the structure and regulations of surrounding society that many TSOs have no chance to reach the top quarter in the benchmarking unless legislation in the relevant countries is amended.

To the core of problems with transparency

For eight consecutive times, Fingrid has attained a top league position in the ITOMS benchmarking survey, which is arranged regularly every second year. According

to Marcus Stenstrand, this success is a crucial cornerstone when Fingrid's international image is being built.

"We are proud of our good results, but also highly conscious of the fact that you can easily slide down from the top. This is why we aim to keep our feet on the ground."

Marcus Stenstrand says that the confirmation received from the benchmarking – that Fingrid does things in the right way – provides considerable support for Fingrid's present and future operations.

"It is also prudent to update regularly our position with respect to the situation globally," he says in listing the benefits of the benchmarking.

He regards the transparency of the ITOMS survey as especially valuable. The TSOs involved in the benchmarking do not compete with each other, so the matters can be processed without concealing the problems.

"You always learn from problems," Marcus Stenstrand points out.

"Even though our procedures have turned out to be excellent, decision-making benefits greatly from the fact that we know how the other successful companies have solved common problems encountered by all TSOs."

National assets in reliable care

The efficiency of maintenance is an important link in a more comprehensive chain which is valuable for society at large: management of grid assets. Fingrid has worked diligently in recent years to secure the quality of that entire chain in a competent manner which fulfils international standards. The hard work has paid off, since

"Maintenance for the Finnish transmission system represents the spearhead in this industry."

at the beginning of June Fingrid was granted the PAS 55 (Publicly Available Specification 55) certificate for infrastructure asset management, a respected and internationally recognized certificate of qualification.

Marcus Stenstrand has had a focal role in this topical process, too, involving actively up to half of Fingrid's personnel.

"We are the first infrastructure company in Northern Europe to have certified its asset management process," he says.

Certification of asset management is a tool for quality assurance. To date, it is primarily used in its country of origin Great Britain, and in Continental Europe and Australia.

Marcus Stenstrand says that it is especially important for a company with a monopoly status to indicate that it takes good care of its duties, obligations and assets.

"The trust shown by our stakeholders – such as owners, customers, landowners and the general public – has an increasingly important role in terms of our operations."

Transparency and subtle approach

The importance of stakeholder relations is reflected in many ways in the work of Fingrid's maintenance management manager. Especially an increasingly transparent attitude and mode of operation vis-à-vis the landowners is a requirement, which, according to Marcus Stenstrand, is highlighted in conjunction with maintenance and vegetation clearance work every year. He says that he has conducted the most challenging discussions in his work career in these kinds of matters.

"We have already done much. At present, we aim to work in an extremely subtle manner as we travel on landowners' land."

Marcus Stenstrand also estimates conservatively that increasing the transparency of communications and changing the procedures may yield results little by little.

"People most often contact us when they have something to ask or when they wish to present criticism, but last year we also received some positive feedback from vegetation management work."

He says that there is actually relatively little negative feedback considering that the area of Fingrid's transmission lines to be cleared of vegetation annually is 6,000 hectares.

Marcus Stenstrand feels that the input in intensified vegetation clearance work has been correctly allocated in recent years, because trees falling on transmission lines or trees which grow up to the line only cause a maximum of one failure annually in Finland. "This is the best result anywhere in the world."

On the move by nature

Marcus Stenstrand's work and free time have at least one thing in common: being on the move. His day at work typically involves at least two to three meetings, usually in the Helsinki region, but often also in international contexts abroad.

He is also out and about with his family. His own trips on a motorcycle have become fewer apart in recent years, but trips by the whole family in a caravan or otherwise have an important part in his life.

"We are not focusing on planning our interior decoration – at least yet," Marcus Stenstrand says with a smile.

For him, busying with his children is an efficient way to uncouple his thoughts from work matters – that's life management at its best. ■

According to Marcus Stenstrand, being involved in the Steering Group Committee of ITOMS has been an efficient lesson in criticality. "Normalisation is the key: how to compare reliably highly varied matters or phenomena," he summarises one of the basic problems involved in the benchmarking.

*ITOMS = The International Transmission Operations & Maintenance Study

Research, innovation and persistent efforts used for getting

RID OF CORROSION PROBLEMS IN GUYS

Fingrid wishes to overcome a comprehensive and long-term problem in the Finnish transmission grid: corrosion of steel guy anchor rods used in transmission line structures. The phenomenon stems from chemical or electrochemical corrosion, and both conventional and new methods are employed to fight it.

Text by Maria Hallila ■ **Photographs by** Juhani Eskelinen

Anyone walking in a transmission line area in Finland during the past couple of years may have noticed a group of people working on the guys of a tower. The work team was probably inspecting the condition of the underground guy structures.

Such inspections have been carried out on more than 1,000 towers during the past two years. Towers susceptible to guy corrosion are typically located on soil which conducts electricity well, such as clayey soil and in areas of so-called black clay on the coastal regions.

The towers inspected have been selected primarily on the basis of the electrical conductivity of the soil. This is why several consecutive towers may be subject to the inspection, but in other cases the inspection may only concern individual towers.

The inspected towers are usually located on fields, which is why the teams working on guy corrosion begin their work after the growing season and finish their inspection in April before the sowing season. In this way, a minimum of disadvantage is inflicted on farming. Landowners are informed in advance of the inspections involving excavation work, and the goal is also to find out from the landowner the most suitable route to a tower location.

Corrosion is the number 1 enemy of underground steel parts of transmission line towers. **Mikko Jalonen** and **Kari Lindholm** presenting a corroded double eye-link.

The guy corrosion problem first emerged on the transmission lines of Imatran Voima (IVO) in the 1980s. The phenomenon caused the toppling of a few towers, and investigations into it were launched shortly, with the foundations of thousands of towers dug open to replace the underground steel parts. In addition to insulation, which is the foremost method to prevent corrosion at present, other methods were also experimented with in those days.

At the beginning of this millennium, Fingrid continued IVO's work by starting the corrosion studies of towers on high-voltage transmission lines that had not been studied earlier. By 2005, the structures in the risky towers on these lines had also been replaced. However, the problem did not disappear as a result of these extensive repairs and refurbishments, but the same problem was noticed again in the guy structures within one year from the completion of the previous project.

The ongoing guy corrosion project is progressing one line at a time, and the objective is to protect the guys properly in one go. Measurements are also carried out during the excavation work so that the situation can be analysed and consequently to establish a better idea of the nature of the phenomenon. Studies in the next year are planned annually on the basis of the research findings.

The most critical component in terms of corrosion is the steel anchor rod of approx. 2 metres, referred to as a double eye-link. One end of the link is attached to the concrete guy anchor to keep the tower erect. The underground steel parts of the towers have been replaced with new ones in conjunction with the excavation studies. Various methods are used in conjunction with the replacement work to prevent subsequent corrosion in the guy anchor rods. At the end of the project, underground steel parts will have been replaced on some 6,000 towers

Corrosion in guy anchor rods

The phenomenon is caused by two different types of corrosion:

In chemical corrosion, the surface of the metal reacts directly with the surrounding soil material.

In electrochemical corrosion, the corrosion takes place in the electrically conductive soil (electrolyte) as a result of an electric current created by a galvanic couple. The less noble metal corrodes as it is dissolved into the electrolyte and as it releases its electrons to the more noble metal.

In transmission line structures, a galvanic couple is created between the earthing electrodes made of copper and the guy anchor rods made of steel, causing corrosion in the steel rods.

of the total of 48,000 towers in Fingrid's grid.

A considerable amount of research and development work has been conducted during the past decades to control guy corrosion. The issues studied in recent years include the suitability of various steel grades and composite materials for use in underground guy structures. However, none of these has turned out to be completely without problems. There have also been studies into measurement methods which would enable an analysis of the underground structures without having to dig down to the guy structures.

The most recent innovation which has just been turned into a commercial product is a concrete guy pillar which eliminates the corrosion risk and also reduces the risk of collision damage. These concrete pillars developed with Betroc Oy, Insinööritoimisto K. Sahla and Eltel Networks Oy will be installed on both new transmission lines and at risky locations of existing lines in conjunction with replacement work. ■

Decades of work with transmission lines led to a significant innovation. In May, Fingrid rewarded Eltel Networks' Transmission Line Specialist **Jorma Hentilä** for an idea which resulted in the product development of a guy pillar made of concrete. The new type of structural solution helps to prevent both corrosion problems and collision damage.

Fingrid's Senior Adviser Mikko Jalonen and Project Manager Kari Lindholm have been interviewed for this article.

Cameras to support switching operations

Fingrid will be utilising more and more camera technology at its substations. The goal is that by 2025, all substation disconnectors and earthing switches are controlled in remote operation by using camera surveillance. At present, the control of these devices must be verified on site.

Fingrid is probably the first transmission system operator to utilise camera technology for this purpose. All disconnectors of transformer and switching stations will be equipped with motor-drive mechanisms and remote operation as well as a sufficient number of cameras to verify the status of the disconnectors and earthing switches. The project does not cover disconnectors installed at places other than substations.

The reform will expedite the clearing of disturbances which is carried out manually from the control room, because the control of the switching devices can be carried out without the presence of a local switching operator at the substation. This will shorten the duration of outages considerably and reduce the financial disadvantage caused by an outage. The execution of the planned outages will also be intensified, which will give cost savings. Personnel and occupational safety will be enhanced, because the switching operations do not need to be carried out on site and there will be less driving to substations, some of which are located quite far away. Furthermore, the device and area control of the substations will be improved in terms of issues such as transformers, substation buildings and gates.

The control cameras will be installed in conjunction with construction and renovation projects at the substations, which explains the quite long period of execution of the overall project. If some substation will not be subject to a comprehensive project in the near future, camera surveillance for it will be implemented as a separate project.

Fingrid has already installed cameras at some substations, but with these the coverage of camera surveillance in terms of the status of disconnectors and earthing switches needs to verified and, if necessary, supplemented with new cameras or by changing the installation of existing cameras.

The number of cameras required at a substation varies from three to more than ten, depending on the scope of the substations.

"In 2010, it is possible to have camera-monitored switching operations at some 20 substations. The costs of implementation vary from one substation to another, but the average costs are about 40,000 euros per substation," says **Kimmo Kuusinen**, Manager of Fingrid's Network Control Centre. He also provides further information on the project. ■

Camera surveillance image showing the feeder disconnector of the 400 kilovolt line from the Huittinen substation towards Olkiluoto.

The camera image is focused on the contacts of one phase of a single disconnector.

Yllikkälä–Huutokoski transmission line

Project adding to northbound transmission capacity

Fingrid is constructing a transmission line of over 150 kilometres in the lake district in Finland, between Yllikkälä in Lappeenranta in South-Eastern Finland and Huutokoski in Joroinen. The project is part of Fingrid's long-term grid development plan making preparations for transmission capacity required by the European electricity market, new nuclear power units and decentralised wind power capacity.

Text by Maarit Kauniskangas ■ **Photographs by** Juhani Eskelinen, Sami Kuitunen and FutureImageBank

The Yllikkälä–Huutokoski transmission line will add to the transmission capacity from South-Eastern Finland to the north. Why is there a need for additional capacity from South-Eastern Finland to the north?

"There is an abundance of electricity generation capacity in South-Eastern Finland, and the region is also served by transmission links from Russia. As a result of a structural change during the recent years mainly in the wood-processing industry, electricity consumption in the regions of Kymenlaakso and South Karelia has decreased, thus raising the electricity surplus in the area. Moreover, new electricity generation capacity has been constructed in the area, most recently the new power plant at the Kaukas Mills in Lappeenranta," says Fingrid's Planning Manager **Aki Laurila**.

More generation capacity is also under construction elsewhere in Southern and Western Finland. This will change the power transmissions in the grid so that a smaller portion of the excess electricity in South-Eastern Finland will be transmitted to the west, while at the same time there is a greater need to transmit electricity to the north.

There are also plans for generation projects and cross-border line projects, which, if implemented, will increase the need for transmissions between Yllikkälä and Huutokoski. Such projects include wind turbines in Southern Finland, new nuclear power units, and the EstLink 2 submarine cable between Estonia and Finland.

"Even though the present Yllikkälä–Huutokoski transmission line is in a good condition, its capacity is not sufficient. The new transmission line run-

"We have negotiated with both summer house owners and landowners on how to mitigate the disadvantage caused by the new line," Antti Linna says.

The route and impacts of the new line have been communicated to the landowners and local residents in the various stages of planning. In the photograph, local residents of Savitaipale following Antti Linna's presentation.

Yllikkälä–Huutokoski transmission line project

- The ballpark figure for the project is 50 million euros.
- Schedule: Ready in the spring of 2013.
- In addition to the transmission lines, two substations – Yllikkälä and Huutokoski – will be built.
- The contract is divided into two parts: Yllikkälä–Visulahti (Mikkeli) and Visulahti–Huutokoski.
- Stages:

1. Removal of trees and clearing of vegetation. Fingrid arranges the joint sales of timber, with Fingrid paying for the logging and taking care of the sales of timber. Land owners taking part in the joint sales obtain the full sales proceeds for the timber.
2. Foundation work.
3. Transport of tower supplies to the site, assembly of towers.
4. Erection of towers.
5. Installation of conductors.
6. Final cleaning.

Base map © Affecto Finland Oy, Karttakeskus, Permission L5211/10

ning parallel with the existing line will improve the system security of the grid. Even in a failure situation, electricity transmission will not be interrupted, because the other line will remain in operation. Moreover, when one line is being repaired or maintained, there is no need for an outage, because the other line is still operational," Aki Laurila points out.

Route of new line

The present 400 kilovolt (kV) transmission line between Yllikkälä and Huutokoski is 153 kilometres long. Between Yllikkälä and Savitaipale as well as between Mikkeli and Huutokoski, there is also a 110 kV line parallel with the 400 kV line. Fingrid intends to construct a new 400 kV transmission line parallel with the existing lines and partly on double circuit towers with the 110 kV line. This is why a completely new right-of-way does not need to be cleared in the terrain. However, the existing right-of-way needs to be widened.

"More than half of the 400 kV transmission line between Yllikkälä and Huutokoski will be built with double circuit towers with the 110 kV line. The first 17 kilometres from Lappeenranta will be built together with Lappeenrannan Energiaverkot Oy. The subsequent approximately 70 kilometres of the line until Mikkeli will be built parallel with the existing 400 kV transmission line, and about 10 kilometres on double circuit towers in co-operation with Järvi-Suomen Energia Oy," says Fingrid's Project Manager **Antti Linna**.

The 110 kV line from Mikkeli to Huutokoski will be dismantled and replaced with 400 and 110 kV double circuit towers.

"That Mikkeli–Huutokoski 110 kV line is fully usable. By dismantling it and using double circuit towers, we can minimise the widening of the right-of-way on this part of the line," Linna says.

The route of the new transmission line has been planned so that it causes a minimum of disadvantage to the environment. Not a single residential building has been left on the route of the right-of-way.

However, the plans to widen the right-of-way have caused opposition among the local landowners. The right-of-way in the southern part will become more than 30 metres wider. The original right-of-way with a width of over 60 metres in places plus border zones of 10 metres on each side will be widened to have a width of about 100 metres. The new transmission line does not

merge into the surroundings equally as well as the old, narrower right-of-way. The wider right-of-way causes additional disadvantage to farming and forestry. Moreover, some summer houses are located in the immediate vicinity of the right-of-way.

"Fingrid understands very well that widening the right-of-way disturbs both the local residents and summer house owners. We have negotiated with both of these groups on how to mitigate the disadvantage caused by the new line. As part of the negotiations, we have offered to buy or transfer summer houses located right next to the line," Linna says. However, if no unanimity is reached in the negotiations, Fingrid has to expropriate the land area for the right-of-way.

The right-of-way is widened alternately on each side of the existing right-of-way. If the new line ran on one side only over the entire distance, it would make it even more difficult to adapt the widening of the right-of-way to the terrain. Some areas can be bypassed in this way.

"At crossing locations, the old line is connected to the new one. When shifting from one side to the other, electricity transmission has to be cut. In such cases, the line that is normally in operation is out of use for 2 to 4 weeks. There are more than a dozen such locations on the line. Since we need to decrease the electricity transmission capacity because of construction work at such locations, we have tried to minimise their number," Antti Linna says.

Response to criticism

The transmission line traverses the land of more than 500 landowners. Fingrid has been in contact with each of them in advance. Most of the landowners, some 70 per cent, have already signed an advance agreement with Fingrid.

Some landowners have wondered why the new transmission line cannot be built without widening the existing right-of-way. After all, in this project, too, tall self-supporting towers are used in places where the line crosses a waterway.

"Constructing the entire transmission line with self-supporting towers would mean that electricity transmission would have to be interrupted for two years in the entire connection."

"Constructing the entire transmission line with self-supporting towers would mean that electricity transmission would have to be interrupted for two years in the entire connection," Antti Linna explains. He also says that the self-supporting towers would be visible really far over the whole distance of the line. They are about 60 to 70 metres tall while guyed towers have a height of about 35 to 40 metres. Moreover, self-supporting towers are 3 to 4 times more expensive than guyed towers.

"The maintenance of the line is also facilitated if two parallel transmission lines are built on separate towers. When one line is being maintained or repaired, the other can be energised," Aki Laurila adds.

The environmental impact assessment of the project has also been updated in conjunction with the planning of the new right-of-way. Site cards have been drawn up of practically all nature areas for use by the contractors so that the contractors know what you can and cannot do in a given area. The environmental impact assessment also involves archaeological sites. The National Board of Antiquities has carried out excavations funded by Fingrid in the area so that appropriate locations for the transmission line towers can be found.

What if the line is not built?

What if this transmission line project was not carried out? After all, the existing line is still fully usable.

"The capacity of the present transmission grid is not sufficient for future electricity transmission needs. When the transmission needs increase, there is a risk that bottlenecks would emerge in electricity transmissions between South-Eastern Finland and the other parts of the grid. Such situations would raise the price of electricity when transmissions would have to be restricted. The system security of the power grid is also enhanced when there are two parallel lines available," Aki Laurila says. ■

Customer view:

Both parties benefit from the shared project

Lappeenrannan Energiaverkot Oy will have its own 110 kV transmission line on Fingrid's new transmission line towers over a distance of 17 kilometres from Yllikkälä to Huttula.

"For some years now, we have thought of ways how to increase the reliability of our network in the sparsely-populated areas within our network area. Now we were offered this excellent opportunity to realise our transmission line as part of Fingrid's project", says Managing Director **Arto Taipale** of Lappeenrannan Energiaverkot Oy.

The new transmission line improves the electricity supply reliability of the company. Fingrid was the building client in the project, so Lappeenrannan Energiaverkot only paid its part of the costs.

"It was more economical for us to take part in the shared project than to build the new transmission line on our own. This is a win-win situation both for Fingrid and us."

Towards smart consumption

Smart grids are an everyday challenge for an employee in an electricity grid company. Your telephone rings several times a day, and you are offered an excellent opportunity to participate in a SmartGrid seminar, where the leading minds in the industry think together how the entire business will change as a result of intelligent electricity grids.

You are told how your company just cannot afford to lag behind the developments, because the alternative is to make do with the present technology and face an eternal shame in the eyes of your stakeholders. Corresponding brochures fill up your e-mail and the trade journals. The question is whether we will actually see the smart grid itself as a result of all this fuss?

A smart grid refers to a decentralised power system, where electricity generation and consumption are kept in a balance by means of active load control. The term "smart grid" is in fact misleading, because the consumer end is the one that gets smarter. A smart consumer can independently – or even without knowing about it himself – control his own load and also feed electricity into the grid if necessary.

This resembles the FACTS (Flexible AC Transmission System) hype in the early 1990s, when the power system was being made more flexible. Adjustable FACTS devices have emerged in the networks in the past 20 years, but there has been no revolution. Maybe the reason for this is that the alternating current system is innately very flexible.

When you compare the FACTS hype in the 1990s with the present smart grid hype, this new wave highlights the controllability and two-way nature of distribution networks. What is emphasised now is the need to control the electricity load and balance it with the ever varying electricity generation which is based on renewable energy sources. This is about equalising generation and consumption, but also about securing the sufficiency of distribution networks. More and more small-scale generation capacity will be connected to distribution networks, too, but these networks were originally designed to take the electricity from the transmission grid to the end users.

The two-way approach and load control are already applied on the level of the high-voltage transmission grid. This is so because power transmissions vary continuously on the basis of the momentary availability and profitability of various forms of generation, in addition to which hundreds of megawatts worth of industrial loads which can be disconnected are utilised as disturbance reserves and for grid protection.

However, more comprehensive control of consumption will bring many additional opportunities to optimise the whole system to be increasingly cost-efficient. Mere effective load control on the basis of the price of electricity will considerably facilitate the maintaining of power balance. And if there is also a possibility to forced control of loads during various extraordinary situations, we are talking about a balancing reserve of thousands of megawatts.

With all this, will there be a need for a high-voltage transmission system in the future? The answer is yes, because otherwise generation and consumption should be balanced on a continuous basis at a local level. In such a case, the constructed generation capacity would be running at reduced output for much of the time, in addition to which much of it would be standing as reserve power. Strong high-voltage transmission systems enable national and pan-European energy solutions with superior cost efficiency and climate impacts. This is why we intend to continue to develop our grid and cross-border connections without a bad conscience of this being somehow old-fashioned. ■

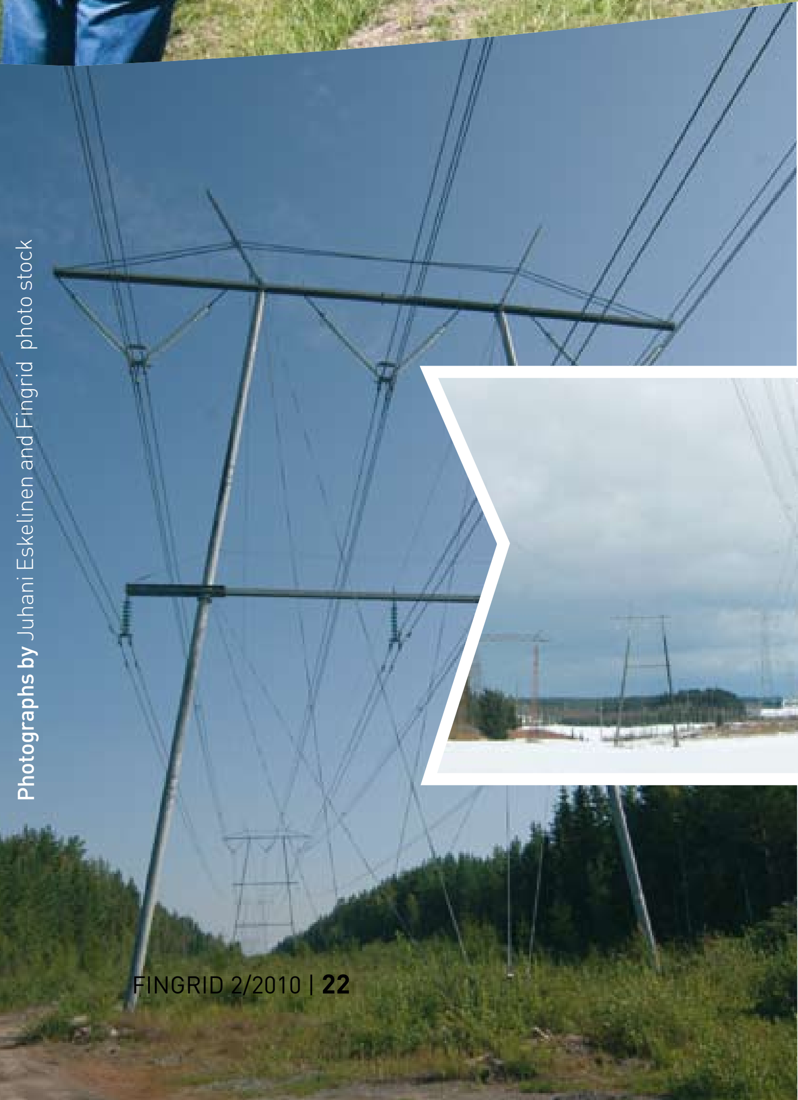
Jussi Jyrinsalo
The author is Fingrid's Senior Vice President responsible for system development.

The environmental impacts of transmission lines are assessed in various statutory proceedings and permitting processes. This also involves site visits to evaluate the impacts of the entire project.

Why can't a new line be installed on existing towers?

Frequently asked questions about high-voltage transmission lines

The total length of Fingrid's transmission lines is approx. 14,000 kilometres. There are about 48,000 towers in the grid. New lines will be built and existing lines will be renewed extensively in the coming years. How, why and by what technical solutions? Fingrid's specialists Sami Kuitunen, Kimmo Kuusinen and Ritva Laine shed light on the most common questions concerning the transmission lines in the nation-wide grid.



Tower types used in the Finnish grid: on the left a guyed 400+110 kilovolt (kV) tower, in the middle a guyed 110 kV tower and 2x400 kV Tannenbaum tower, on the right 2x110 kV Tannenbaum tower and guyed 110 kV tower.
On the far right for comparison, there is a typical 20 kV tower in a distribution network used for supplying electricity from substations to consumers; these types of towers are not included in Fingrid's transmission grid.

Photographs by Juhani Eskelinen and Fingrid photo stock

Nearly all new transmission lines in the grid will be installed in existing rights-of-ways.

How is a line route determined and on what grounds are the technical solutions devised?

The planning of transmission lines is based on the national land use objectives conforming to the Finnish Land Use and Building Act. As a rule, these require that existing rights-of-ways be employed. The present right-of-way or structure is utilised in almost all (85 to 90 per cent) new transmission lines in the high-voltage system.

When new transmission lines are constructed in conjunction with existing lines, the environmental impacts of the lines are concentrated. On the other hand, this eliminates the need to open new rights-of-ways.

Environmental drawbacks are mitigated by using technical solutions, such as lateral shifts, careful selection of tower locations, and double circuit towers. However, it is impossible to completely avoid situations where a new transmission line constructed in conjunction with an existing line is located close to housing. Fingrid conducts interaction with landowners to come up with an acceptable solution.

Tower types which fulfil the standards concerning transmission line structures are used in the construction of transmission lines in Finland. Technical engineering is based on electrical safety, environmental conditions, terrain contours, swaying of conductors, strength of tower structures, and foundation conditions of the towers. Attention must also be paid to the possibility to construct and maintain the transmission line without interrupting electricity transmission. In other words, it is also assessed how the specific tower type influences electricity transmission management over its entire life cycle of decades.

Guyed 110 kV and 400 kV portal towers represent the basic types of towers in Fingrid's grid. Guyed tower types are highly suited to the Finnish conditions and also inexpensive. The total height of a guyed portal tower at the voltage level of 110 kV is on average 25 metres, and at the voltage level of 400 kV on average 35 metres.

The photograph shows a guyed 400+110 kV double circuit tower, with a 110 kV transmission line on the lower crossarm and a 400 kV transmission line on the upper crossarm.

Why can new 400 kV transmission lines not be installed on the same towers with existing lines, but new towers need to be erected for the new line?

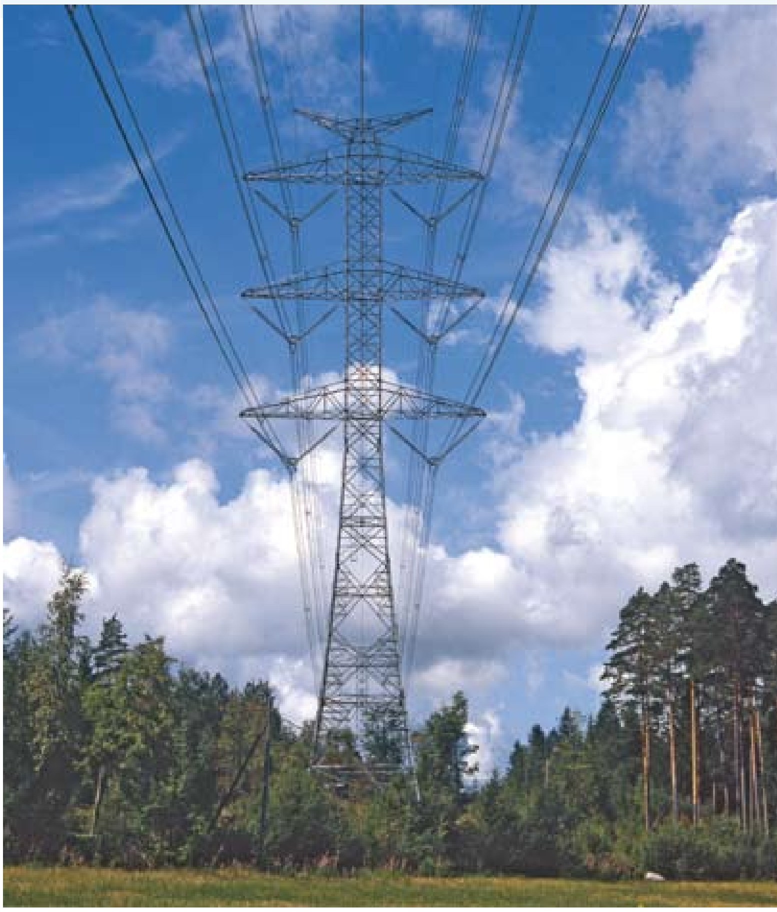
People often hope that 400 kV double circuit towers be used on the lines. Such a double circuit tower used on 400 kV transmission lines is always self-supported, unguyed, so-called Tannenbaum tower. An unguyed 400 kV tower is on average 25 to 30 metres taller than a guyed tower. On the other hand, the land area needed by the transmission line can often be kept unchanged by using double circuit towers.

A 400 kV double circuit tower accommodates two 400 kV circuits (transmission lines). In Finland, the 400 kV transmission lines are the main electricity transmission links in the nation-wide grid. The construction of double circuit towers causes long-term electricity transmission interruptions on existing transmission lines, because construction is a lengthy and multi-stage process: first, the foundations need to be built for the new tower, then the existing transmission lines must be dismantled, followed by the erection of the new tower.

The various work stages require multiple transmission outages during the construction period, sometimes totalling several years. During this time, the system security and safety of the high-voltage transmission system would be compromised crucially, and electricity transmissions would be subject to major restrictions.

A double circuit tower for a 400 kV line requires a relatively large foundation. The goal is to build the foundations and erect the towers when the ground is frozen.

A double circuit tower for two 400 kV circuits, typical height 55 to 60 metres.



A double circuit tower is very difficult and expensive to build in varying terrain. This is so because of the size of the towers and the massiveness of the foundations in particular. A guyed 400 kV transmission line tower weighs on average 7 tonnes, while a 400 kV double circuit tower is on average five times as heavy.

The electricity transmission grid is also susceptible to failures caused by many external factors. A failure in a 400 kV double circuit tower structure is always a significant risk factor, because its correction requires that two 400 kV transmission lines which serve as the backbone of electricity transmission are de-energised for the duration of the repair work.

Cable solutions are also suggested frequently. At the 400 kV voltage level, their construction costs soar as compared to overhead lines; the cable solution is 15 to 20 times more expensive. Failures occurring in cables are also of a significantly longer duration than failures in overhead lines, thus causing a considerable system security risk for the transmission system.

What aspects are related to the placing of lower-voltage 110 kV transmission lines on the same towers with higher-voltage lines?

In the 1990s, a 400+110 kV guyed double circuit tower was introduced in the Finnish grid, with the circuits located on top of each other horizontally. At present, this type of a structure is always an alternative technical application when it is feasible in terms of the system security of electricity transmission. The solution saves about 20 metres of the width of the land area required as compared to a situation where the two transmission lines would be built on separate towers.

However, in this solution, too, the double circuit towers complicate the maintenance and service work on the transmission lines, because in most cases maintaining the tower requires that both of the circuits are de-energised.

It is slightly easier to arrange outages in electricity transmission during the construction of the transmission line and repair of failures in a 110 kV network than in a 400 kV network, so building 400+110 kV double circuit towers in the place of a 110 kV line can be implemented a little more easily.

How are the towers erected, and how is an electricity transmission outage arranged?

The goal is to build the foundations of transmission line towers and to erect the towers when the ground is frozen so as to minimise the disadvantage caused and to facilitate moving in the terrain. Foundation work for the towers in the vicinity of a transmission line often calls for an outage because of occupational and electrical work safety.

Especially if the tower foundations need to be reinforced by pile driving, the distances to live conductors may be too

Erection of 400+110 kV double circuit tower.

Assembly of a new 400+110 kV tower in progress under the existing 110 kV transmission line.

Protective row covers on fields need to be fastened firmly so that they cannot fly on a transmission line. For safety reasons, only professionals must remove row covers which may have become entangled in the conductors, because covers which are just a little moist or dirty conduct electricity.

short, and an outage needs to be arranged on the line for the duration of the pile driving work.

When the foundations are ready, it takes some weeks to assemble the transmission line towers at the tower sites. The actual erection of the new tower is preceded by the dismantling of the old conductors and felling of the old tower. After this, the new tower is raised and the guys are tightened. About five guyed 400 kV transmission line towers per day can be erected when the ground is frozen, and about two per day when the ground is not frozen.

The last work stage in the construction of a transmission line is to draw the conductors and to install the additional earthing.

Timing of the various work stages calls for careful advance planning between the grid customers requiring electricity, Fingrid's control room operations and the site resources of the construction project. Careful planning helps to stick to the agreed schedules, maintain a high level of occupational safety, and reduce the risk of disturbance. If good planning is neglected, the result may be a disturbance causing losses of up to hundreds of thousands of euros to the national economy because of electricity not supplied.

The planning of electricity transmission outages begins in the early stages of a transmission line project so that the different work stages can be managed as well as possible. The schedules become increasingly precise as the projects progress. On the other hand, you may come across surprising factors resulting from ambient conditions. However, good co-operation between professionals helps to overcome the surprising challenges.

Transmission line projects consist of dozens, even hundreds of towers, which is why flexible and fluent scheduling during the entire construction work and hence ensuring the cost-efficiency of the project are important issues.

What kinds of failures occur in the transmission lines and what measures are taken to prevent failures?

Most of the operating disturbances in the high-voltage transmission system are line failures. These include temporary overvoltage caused by thunder (strokes of lightning) even though the transmission lines are mostly protected by the overhead ground wires located highest in a transmission line tower.

Longer-term disturbances include the breaking of insulation in a transmission line or a foreign object in the air gap of the circuit, such as an object flown by wind or a tree which has fallen on the conductors.

Thanks to regular inspections and maintenance, line faults are rare, but they cannot be avoided completely.

Instructions on how to work safely close to transmission lines are available for example on Fingrid's website at www.fingrid.fi and in the brochures published by the company. These can be requested through our website or from corporate communications, tel. 030 308 5128. ■

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.

Transmission grid withstands geomagnetic storms

Text by Matti Lahtinen & Jarmo Elovaara ■ **Photograph by** FutureImageBank

Geomagnetic storms are created by violent plasma flows from the Sun during periods when the Sun is most restless. This happens at about the time when the number of sunspots is peaking. Geomagnetic storms and the electrical interference caused by them are a frequent topic of discussion globally. Now the related speculations have been boosted by the fact that in 2012 the levels of our solar system and the Milky Way will coincide in an extraordinary manner. Moreover, a long era in the Mayan calendar will finish in December 2012, and large-scale events and upheavals comparable to the end of the world have been associated with this.

Therefore, the interrelation between the maximum occurrence of sunspots and disturbances in power systems is not a fully fictional issue. During the sunspot maximums, major disturbances and especially failures in transformers have occurred in the United States and Canada, among other places. Undue tripping of individual protective relays or regional disturbances have been experienced in Sweden, and the Sun has been claimed as their ultimate cause.

Both Finland and Sweden are located in a region which, due to both its location and soil conditions, is especially susceptible to disturbances attributable to solar activity. However, no significant event related to the exceptional behaviour of the Sun has ever occurred in Finland.

Geomagnetic storms

Our Sun is a relatively unsettled celestial body as compared to the planets which orbit it. The fusion reactions in the Sun generate not only heat and electromagnetic radiation such as light, but also particle radiation, whose density and number of particles vary in different times. This particle radiation is referred to as solar wind. It is very hot plasma and mainly consists of electrons and positrons so that the particle flow has a weak charge. The solar wind carries with it a so-called interplanetary magnetic field. When the solar wind meets the Earth, various interaction phenomena occur, because the Earth also has a magnetic field of its own.

A geomagnetic storm is a powerful transition concerning the entire magnetosphere, the bowl-like layer around the Earth protecting it from the particle bombardment from the space. A geomagnetic storm is typically caused for example by a coronal mass ejection from the Sun to the Earth (corona is the outer gas atmosphere of the Sun). The number of particles released from the Sun depends on solar activity. This, in turn, is manifested in the number of sunspots, which varies in cycles of approximately 11 years.

It is not yet known what kinds of changes actually take place in the Sun during the sunspot maximum and why the period is as long as it is. However, it is known that the sunspots are points colder than the rest of the "surface" of the Sun, and that their occurrence is influenced by the Sun's own magnetic field and rotating motion.

The Sun is highly active during a sunspot maximum. During those periods, a much greater amount of charged particles than normally is ejected from the Sun into the space. Mass ejections are also likely. In such a period, the Sun radiates more intensely than normally. During a geomagnetic storm experienced on the Earth, the Earth's magnetic field may change about 10 per cent from its minimum state value, and even the compass needle may fluctuate a few degrees on the Earth's surface. A geomagnetic storm typically lasts from a few hours to a few days, but those effects on the surface of the Earth, which can affect man-made constructions and systems (i.e. the largest amplitudes), typically only last a few minutes. Magnetic storms may disturb man-made systems on the Earth and in its immediate surrounding space. The next sunspot maximum with the resulting geomagnetic storms is expected in the early part of the 2010s.

Fingrid studies geomagnetically-induced currents

Great changes take place in the current systems in our immediate surrounding space when solar wind and especially a transient disturbance in it hit the magnetosphere. If the rates of change of the phenomena are described with frequency, the typical frequency is in the range of 0.015 to 0.020 Hz. In other words, the phenomena resemble direct current by nature.

Rapid changes in the currents induced in the ionosphere and magnetosphere are manifested as a geomagnetic disturbance on the surface of the Earth. On the Earth, this disturbance is seen as changes in the magnetic field and further as an electric field in the direction of the Earth's surface. In Fin-

No significant event related to the exceptional behaviour of the Sun has ever occurred in Finland.

land, the longitudinal magnitude of the electric field created on the Earth's surface during a heavy geomagnetic storm has been up to approx. 7 volts per kilometre. However, the value is so small that the alleged power surges of thousands of amperes cannot be created in the power grid in Finland as a result of a geomagnetic storm, and the current conductors do not heat up and melt here as purported in sensation-seeking articles.

If two points on the surface of the Earth are connected together by a conductor, an electric current may start travelling in it during a geomagnetic storm. This current is referred to as a geomagnetically-induced current, GIC. Naturally, the GIC is at its maximum if the intensity of the electric field is great, if it has the same direction as the line, and if the line is long (hundreds of kilometres). A GIC also comes about in the connecting lines (phases) between star-connected three-phase windings which are connected to the earth from their neutral points.

As far as the Finnish transmission grid is concerned, there has been research co-operation regarding GICs with the Department of Geophysics of the Finnish Meteorological Institute since the late 1970s. Within our studies, GICs have been measured in the Finnish grid and the behaviour of Finnish transformers as a result of these currents has been analysed. Moreover, the Meteorological Institute has modelled the changes in the Earth's magnetic field as a result of solar wind in Scandinavia, and developed for us a calculation model so that we can simulate the distributions of currents induced by a current travelling in the ionosphere to a transmission grid located on the Earth's surface.

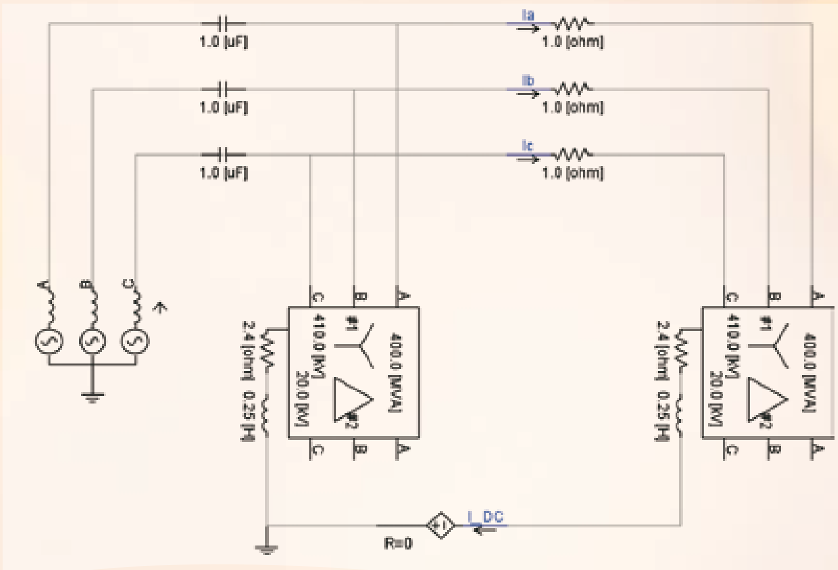
The basic reason for problems caused by geomagnetic storms in power grids is that they induce currents, which resemble direct current by nature, on the ionosphere above the surface of the Earth. These currents result in a difference in potential of a few volts per kilometre between points on the Earth's surface. If the electricity grid has long (at least in the range of 100 kilometres) overhead lines which are in contact with the ground through the neutral points of power transformers, a current which resembles direct current by nature may start to travel through the conductors of the overhead line, and this current influences the functioning of the grid.

We have used measurements to verify that the highest geomagnetically-induced direct current recorded in the neutral point of a 400 kilovolt transformer in the Finnish transmission grid has been approx. 200 amperes. This value is high on an international scale, but nothing out of the ordinary has taken place in Fingrid's grid as a result of it. The reason why a d.c. (direct current) voltage of just a few hundred volts is enough to generate significant currents is that only the resistance of the grid restricts the magnitude of the current created in the alternating current grid by d.c. voltage. Normally, the goal is to keep the resistance at a minimum to minimise the losses in the grid.

Studies have shown that the highest GICs in the conditions prevailing in Finland tend to be created in the corner points of the grid. This is why for example Huutokoski and later Pirttikoski were selected as some of the measuring points. The quantity registered has been the direct current travelling through the current limiting coil connected to the neutral point (i.e. star point) of the 400 kilovolt winding. As the structure of the grid has changed, the measurement locations have been changed, and at present there are five measurement locations. The 400 kilovolt series capacitors installed in Fingrid's grid at the beginning of this millennium have considerably reduced the likelihood of large geomagnetic fluxes to occur in Finland, and it is probable that neutral point currents in the range of 200 amperes can no longer be attained here.

Structure of transformers matters

Since there have been no significant disturbances caused by geomagnetic storms in Finland despite its poten-



The route of direct current between substations during a geomagnetic storm. The d.c. voltage source describes the difference in potential between the substations, caused by the geomagnetic storm.

tially risky location in the auroral zone, one can ask how the situation here differs from that in for example Sweden or Canada.

Most of the longest 400 kilovolt transmission lines in Finland have been provided with series capacitors during the past decade. The purpose of the series capacitors has been to increase the transmission capacity of the grid, but the series capacitors also prevent the flow of direct current on the lines equipped with the capacitors. The result of this is that the magnitude of the currents created in the Finnish transmission grid by geomagnetic phenomena has decreased in the past 10 years.

Other explaining factors include the method of earthing used for the transformers in the Finnish grid, with this method differing from that applied in many other countries, and the structure of Finnish power transformers. The goal in Finland has been to restrict the earth fault currents by raising the impedance of the zero sequence circuit of the grid. This is why inductor coils have been installed between the ground and the neutral points of 400 kilovolt windings in power transformers. The resistance of the inductor coils is considerably higher than the resistance of overhead lines.

Damage reported abroad or at least cases with unclear causes have primarily concerned transformers. There are considerable differences between Finland and other countries in the structures of transformers used. So-called auto-transformers, which are less expensive than the full-wound transformers used in Finland, are utilised commonly in other countries. Auto-transformers do not have a separate low-voltage winding, but the low-voltage winding is composed of a part shared with high-voltage winding. Moreover, in many cases the transformers are composed of single-phase units to limit the transport weight. The short-circuit impedance of an auto-transformer is very small, and there has been no need to pay special attention to stray field phenomena when designing such transformers.

In full-wound transformers, the GICs or the fault currents cannot flow directly from one voltage level to another. In a full-wound transformer, the short-circuit impedance, which describes the magnitude of the stray flux, can be designed to have a desired magnitude by selecting a purposeful distance between the different windings of a phase. This naturally affects the size of the transformer. Because of the high specific resistance of the Finnish ground, a high short-circuit impedance is applied in Finland. In this way, it is possible to restrict the fault currents as well as dangerous and disturbance voltages during failure situations. Naturally, the GICs flowing through the transformers are also hence reduced.

Moreover, Finnish transformers have a five-limb or three-limb core, while auto-transformers are usually single-phase shell-type transformers. Literary sources generally state that a three-limb structure endures direct current magnetisation very well, because the zero-sequence flux can only shut off from the iron core via a large oil gap to the tank. The reluctance is very great in such a case, and very high currents are required to saturate the transformer. According to the same literary sources, a five-limb structure does not endure direct current quite as well as the three-limb structure. The two extreme limbs of such a transformer have no windings, and the total cross-sectional area of the extreme limbs is usually slightly smaller than the cross-sectional area of a single wound limb. Only the extreme limbs apparently become saturated first with just direct current magnetisation, after which the transformer starts to operate with direct current magnetisation, just like a three-limb transformer. However, the alternating current flux occurring simultaneously with the zero-sequence flux complicates the situation.

The peak values of the phase voltages in the wound limbs of a three-limb transformer occur at different moments, which is why the maximum effect of the direct flux and alternating flux takes place at different times in the different limbs of three-limb transformers. This is why also the possible saturation of the wound limbs takes place at different times and only occurs at one wound limb at a time, and a significant portion of the magnetic flux does not need to flow along routes outside the iron core of the transformer. On the other hand, single-phase shell-type transformers, typically auto-transformer units, only have a single magnetic circuit, which is saturated completely with direct current magnetisation. In a normal state, the flux emerges inside the magnetising winding, circulates along the iron circuit, and returns inside the magnetising winding. After the state of saturation is reached, however, the flux begins to flow outside the iron circuit and only returns to the iron at a point which is no longer saturated. In this case, the flux is a stray flux by nature. When the entire magnetic circuit becomes saturated, large stray fluxes are created.

When single-phase shell-type auto-transformers have been designed, the possibility of large stray fluxes has apparently not received attention. If the routes of stray fluxes have not been taken into account in the design, stray fluxes may cause significant point-specific heating in various structural parts and windings, and the heating may even lead to the burning of the insulation material. In fact, the cases of reported transformer damage abroad as a result of geomagnetically-induced currents have taken place exclusively in single-phase auto-transformer units. The likelihood of such an event in the transformers used in the Finnish grid is small also because Fingrid's transformers are subject to a testing in overmagnetisation conditions, outside the testing required by standards. This testing reveals hot spots created in the iron core and windings as a result of stray fluxes. ■

The text is based on article "Geomagneettisen myrskyn vaikutukset kantaverkkoon" (Impacts of geomagnetic storm on the transmission grid) by Fingrid's corporate advisors Matti Lahtinen and Professor Jarmo Elovaara. Further information is available from jarmo.elovaara@fingrid.fi.

Capital investment decision on EstLink 2 submarine cable

Fingrid has made a capital investment decision on the construction of EstLink 2, the second direct current transmission link between Estonia and Finland. The capacity of the planned transmission link is 650 megawatts and the costs of the project total approx. 320 million euros.

The submarine cable will be built in co-operation with the Estonian transmission system operator Elering. The execution of the project still requires that the recently-opened electricity market in Estonia starts off favourably and that the project receives an investment subsidy of 100 million euros from the European Union.

At present, there is one 350 megawatt direct current connection between Finland and Estonia. The new transmission link will raise the total electricity transmission capacity between the countries to approx. 1,000 megawatts, therefore integrating the Baltic electricity market closer to the Nordic market. The new connection will also increase the supply security of electricity in the Baltic Sea region. The goal is that the new link will be brought to commercial operation at the beginning of 2014.

Fingrid and Elering have been drawing up preliminary plans for the new submarine cable for about three years. EstLink 2 is one of the foremost reinforcements in the electricity transmission grid in the Baltic Sea region. The permit applications were delivered to the authorities during the spring of 2010, and bids for the converter stations, cable, power line and substations are under way. Contracts with the suppliers are to be signed within the current year. Forest and earthwork at the Anttila substation will begin in the autumn of 2010 in order to keep to the target schedule.

The Commission of the European Union also considers the transmission connection between Finland and Estonia as very important, which is why it has proposed an EU subsidy of 100 million euros for the EstLink 2 connection. The potential subsidy is part of a broader recovery package of the EU, aiming to stimulate economic activity in the Union and also support the strategic energy policy objectives. The EU's final subsidy decision is expected in the coming weeks.

Promising launch of Estonian wholesale market

Fingrid's capital investment decision requires that the Estonian wholesale market for electricity functions well. The Nordic electricity exchange Nord Pool Spot opened the new Estlink price area in early April. Fingrid and its Estonian counterpart Elering rented approx. 250 megawatts of transmission capacity from the owners of the present Estlink connection for use by Nord Pool Spot. The total capacity of the link is 350 MW.

The early stages of the market have been positive. Elspot electricity already accounts for over 20 per cent of the electricity consumption in Estonia. The market has utilised almost the full Estlink transmission capacity made available to Elspot trading. The demand for the capacity has exceeded the supply, and the transmission link between Estonia and Finland has been the most congested cross-border connection within the Nordic electricity exchange area. The prices in Estonia and Finland have been different from each other for approx. 80 per cent of the time, which shows that the ongoing EstLink 2 cable is really needed. ■

Fingrid received an international certificate for good asset management

Fingrid is the first enterprise in the Nordic countries to be awarded an internationally recognised certificate for good asset management by Lloyd's Register.

As a company specialised in safety and risk management of companies, Lloyd's Register reviewed last spring Fingrid's asset management operations by comparing Fingrid's performance with the best practices in the sector. The reference was PAS 55 (Publicly Available Specification 55) developed by the British Standard Institution (BSI). It is applicable to the assessment of operations in asset-intensive sectors.

According to Lloyd's Register, Fingrid's performance exceeds the requirements determined in the specification.

"The certificate granted to Fingrid indicates that outsiders also regard our asset management as excellent. Not only do we transmit electricity in a reliable manner but also make every effort to ensure that the operations are safe and secure and to keep the substations and transmission lines in a good condition. We also require top-grade and responsible operation in line with our operating mode from all our service providers and suppliers," says Fingrid's Executive Vice President **Kari Kuusela**, who is responsible for the company's asset management.

The certificate was handed over on 6 June by Peter Glaholm (on the right), Utilities Manager at Lloyd's Register, to Fingrid's team consisting of President and CEO Jukka Ruusunen (middle) and Executive Vice President Kari Kuusela.

The certificate has also been granted to some other energy companies such as National Grid in Great Britain and ESB in Ireland. ■

Kimmo Kyllönen, Director of Electricity Museum Elektra, concludes that the attraction of the games rests on the fact that playing enables such tasks and adventures that are not possible in everyday life.

Electronic games available for playing in

Electricity Museum Elektra

Text by Reija Kuronen ■ **Photographs by** Eija Eskelinen

This summer's special exhibition called "From Electra to Pong – from Pong to Playstation" sheds light on the history of electronic games all the way from former electromechanical board games to present and future spectacle games that resemble a real film. The short history of electronic games is surprisingly long.

Games and playing have always inspired people to compete and spend their time with congenial people, or to relax all alone by playing. The history of games is long and the success story still continues in the electronic games of today. Playing the games has at present a major role in our digital culture.

This special exhibition was opened in the spring at Electricity Museum Elektra in Hämeenlinna. It sheds light on the game culture and on the usage and cultural history of the equipment from many different aspects. For a playing enthusiast, now visiting the museum, the exhibition will bring back nostalgic memories from times of some twenty or thirty years ago. For a younger player, it will remind of times before and after the turn of the millennium.

History and future

The visitor will detect concretely how electronic games got out of date and went out of use surprisingly fast, thereby making way for new applications. Taking into consideration that Pong games played in the 1970s and 1980s were true wonders of that time, we may only imagine what kind of electronic games there will be in years to come: 3D versions of games in which the player is an active participant in a virtual world, practically speaking in the midst of the game, together with other participants of the network society.

The exhibition will offer the visitors some amusing details of their own playing history. The formerly used Commodore 64 home computer will evoke memories from once so ultramodern 8-bit device. It was the first real PC used for both playing and for example word-processing. The cassette drive right beside the computer will bring back to mind how the games were downloaded from C-cassettes. During loading, you had to keep your fingers crossed that the adjustment of playback heads is OK

The visitors may brush up their playing skills with many different games or slot machines originating from the 1970s, 1980s and 1990s – and all playing is free of charge.

and that the device won't get stuck in the middle of loading.

The games have over time become a lot more interactive and packed with magnificent graphics and sounds. As a result of the developing 3D graphics, one-level game patterns have been upgraded into complex presentations that resemble a real film.

In addition to old game computers, the exhibition reveals interesting development stories of game computers and their software. For instance, Nintendo, now the leading global brand, started in Japan in the late 19th century as a playing card making company. The exhibition will also widen the outlooks beyond the electronic game world: technology behind game applications is applied to practical use in simulations that belong to devices used every day in different schools and research centres.

Insights for people of all ages

The visitors have an opportunity to play the games by themselves at the museum. The games range from the most recent Pajatso version made available by the Finland's Slot Machine Association (RAY) to old slot machine games from the past decades. The visitors may brush up their playing skills with many different games or slot machines originating from the 1970s, 1980s and 1990s – and all playing is free of charge. Available are such jewels of their era as Space Invaders, Pac Man, Commando, Bubble Bobble and many other.

The special exhibition gives an insight into the recent history of the electronic world of games up to its outlooks. It is an enjoyable experience for both children and adults. To sum up the attraction of games over time, it could be said that playing enables such tasks that couldn't be performed in reality. The electronic world of games has made it possible to add adventurous and imaginary features in the games. ■

The exhibition theme is discussed in a publication with a wide description of the game culture and its subareas. The publication is issued by Society for Electrotechnical Heritage Elektra and Media Museum Rupriikki and available at Elektra at a price of 2 euros.

Electricity Museum Elektra with its special exhibitions is open to the public in August 2010, Tue-Fri at 11-18 and Sat 10-17. At other times, the museum is open by appointment. Address of museum: Valvomotie 11, 13110 Hämeenlinna.

Please find more info about the Elektra's special exhibition and other offerings at: www.elektra.fi

Small wonders

Very early one summer morning, my eyes caught a group of lesser butterfly orchids growing in our yard. There was something strange in one of the flowers. On closer examination, I saw a flower spider with a large pine hawk moth in its jaws. I sat down to look at them. The night was turning into morning and it was completely calm; only the sound of a corn crake came from a nearby field. The intoxicating scent of the lesser butterfly orchids filled the air and brought to my mind the exciting summer nights of my childhood.

As I was sitting there I realised what small wonders lay before me. The incomprehensible versatility and subtlety of the co-existence of organisms that has come about over millions of years. They call it evolution – the origin and constant development and specialisation of species.

The lesser butterfly orchid is especially renowned for its fine scent. However, many people have been disappointed upon sniffing at the flower in the daytime, which is dispensable idle time for this orchid. It is only when the night falls that the flower starts to disseminate it tempting scent, which intends to attract nocturnal hawk moths, like the pine hawk moth captured by the spider.

The system is downright ingenious. The nectar of the flowers glowing in the dim is at the bottom of a long and curved calcar, where only large hawk moths with their long probosces can reach. While sucking the nectar, the hawk moths usually hover in place in front of a flower, but when they come across a lesser butterfly orchid, they need to fly quite close to the plant and stick their head into the flower. At that time, a lump of sticky pollen is attached on the forehead of the moth, which in the next flower coincides with the stigma of the carpel. That is how the lesser butterfly orchid is pollinated.

In other words, the lesser butterfly orchid has reserved its sweet nectar exclusively for the hawk moths; its flower has evolved into a perfect structure for this co-operation. The hawk moths are an excellent investment, because, being superb flyers, they can easily move from one population to another. In this way, pollination does not only take place between individual plants located close to each other, but the genotype is spread over a larger area.

If, when surrounded by the natural environment, you look around through the curious eyes of a child and understand things with the knowledge of an adult, you get to see many small wonders.

In this particular case, an outside disturbance in the form of the spider had emerged in the set-up. This small event, too, is one of nature's amazing wonders, when you come to think of it closer. The flower spider lurking in the inflorescence of the lesser butterfly orchid is white, which is why it assimilates well in the flowers of the same colour. However, it can change its colour into bright yellow, and does so when it lives for example in a dandelion.

The small spider is about one centimetre long while the plump body of the pine hawk moth is about four centimetres long. Measured in weight, the difference is even greater. The predator grabbed the hawk moth which was buzzing in place, squirted a portion of venom from its jaws, and kept its grip until the venom paralysed the moth. It clenched the flower, exerted itself and came out as the winner. Then it squirted digestive enzymes into its prey, and was sucking the dissolved insides of the hawk moth as its nutrition when I noticed it. That is a brilliant system for a small animal feeding on hard-shelled insects.

The lesser butterfly orchids in the midsummer night offer much to admire. I can appreciate the scene offered to me because I know of the subtle co-existence of the flower and hawk moth, and the abilities and hunting methods of the spider. Knowledge is an asset and often opens the gate to magnificent experiences. On the other hand, the scent of the orchid takes me back to my childhood summers. I did not have a clue of all this then, but the evening invitation of the orchid, its flowers glowing in the dusk, the sound of the large moths flying by and their buzzing in front of the flowers were like a mysterious fairytale.

Over the years, I have accumulated a vast amount of knowledge of nature; small things and details which enable me to understand the big picture. The curiosity of the child is now in the background, but I try to tempt it out every now and then. If, when surrounded by the natural environment, you look around through the curious eyes of a child and understand things with the knowledge of an adult, you get to see many small wonders. ■

Heikki Willamo, columnist of the Fingrid magazine, is a photographer, author and journalist from Karjalohja. He has published several nature books for both children and adults; most recently "Hirven klaani" (Otava 2005), "Pyhät kuvat kalliossa" (together with Timo Miettinen, Otava 2007) and "Huuhkajavuorella" (together with Leo Vuorinen, Maahenki 2008). Heikki Willamo's special objects of interest include forest nature in Southern Finland, Northern rock art, and myths related to animals.

Small-scale consumption provides flexibility in power balance management

E.ON Kainuun Sähköverkko and Fingrid used a joint project to experiment with the control of small-scale electricity consumption as part of maintaining the power balance in the whole of Finland. The project revealed that small-scale load control has significance for the national economy in levelling out the consumption peaks of electricity.

The project involved some 4,000 consumers, and it was mainly carried out in February 2010. The objective was to find out about the technology, operating time and reliability of the methods used for controlling various small-scale loads and their utilisation in the management of extraordinary situations in the power system.

The project showed that it is quite difficult to forecast the volume of disconnectable loads. According to the experts involved in the project, attention must be paid to making the forecasts increasingly accurate. Another thing requiring further consideration are the effects of the so-called reconnecting power, which can be reduced for example by circulating the disconnectable loads.

The project period coincided with the coldest month of an extraordinarily severe winter, which was also reflected in the results. Despite the cold weather, the customers were positive about the project and understood why their consumption was shed temporarily.

According to the final report of the project, small-scale consumption can serve as demand response and reserve in the electricity market. "If consumption has already been elastic earlier, there is no more enough consumption in the specific hour to serve as reserve, not at least to the full volume. On the other hand, demand response potentially carried out guides the power system to the correct direction and prevents eventual problems in the specific hour. The role of small-scale consumption in this sense is not quite clear at this point," says Fingrid's Senior Adviser **Jonne Jäppinen**.


Photograph from the archives of E.ON Kainuun Sähköverkko

According to him, the project also provided practicable information for making preparations for potential power shortage situations. ■

Survey among users:

More information needed on transmission line maintenance and EIA procedures

The results of a user survey concerning Fingrid's website are ready. There were 445 respondents in the survey carried out by Suomen Online Tutkimus Oy. The survey was available on the website from 12 February to 15 March 2010, and it aimed to compile the views of customers and stakeholders for the revision of the website.

Most (44%) of the respondents were electricity consumers, service providers (10%), grid customers (8%) and market players (6%). Respondents outside Finland accounted for 5% of all respondents.

Most respondents were using the website to seek information on the state of the power system (58%) and electricity market information (14%). When asked to express an opinion on the sufficiency of information available on the site, the respondents stated that they were most satisfied with the information on the state of the power system. The lowest level of satisfaction concerned information on transmission line maintenance and environmental impact assessment (EIA) procedures.

The respondents wished more general information on the transmission business and graphic presentations to clarify statistics and other information shown on the website. The users also look forward to information on grid disturbances in as real time as possible, on the progress of transmission line projects, topical news related to the energy industry, and information on the market prices of electricity and generation data on power plants.

Many users were satisfied with the present website and hoped that new data contents and features are added without affecting the good functionality of the present site. ■

Numerous responses to slogan competition

Fingrid has been looking for a new slogan through a competition. Personnel and customers were asked to come up with slogans that would describe Fingrid's operations today and well into the future. There were very many suggestions, more than 200, and some people submitted several alternatives.

The communications team, which served as the jury in the slogan competition, reviewed the suggestions and concluded that an actual winner could not be found this time. This is why it was decided that the first prize (a gift voucher of 500 euros to Stockmann) be divided between the two best suggestions.

The communications team thought that the two best suggestions were **Pasi Aho's** "Vaiheen verran edellä" (One phase ahead) and **Hannu Matila's** "Kohti valoisaa tulevaisuutta" (Towards a bright future).

Among all those who participated in the competition, three cast iron pots designed by **Timo Sarpaneva** were given as prizes by drawing lots. The lucky winners were: **Ella Käck**, Fingrid, **Visa Myllyntaus**, Fingrid and **Esa Kalla**, Outokumpu Oy. ■

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 1 September 2010. Address: Fingrid Oyj, PL 530, 00101 HELSINKI, FINLAND. Mark the envelope with "Verkkovisa".

Among all those who have given right answers, we give 5 shoe care sets as prizes by drawing lots. We will inform the winners in person. The answers to the questions can be found in the articles of this magazine.

1. According to the vision for 2050 of Finnish Energy Industries, what will the portion of imports be of electricity supply in Finland in 40 years' time?

○ 10 per cent
○ 18 per cent
○ 0 per cent.

2. The worst enemy of guy structures in transmission line towers is

○ vandalism
○ corrosion
○ fatigue of metal.

3. Kainuunharmas is

○ a Finnish sheep variety
○ a Finnish rock type
○ a colour tone of transmission line towers made of steel.

4. An unguyed 400 kV transmission line tower is higher than a guyed tower. The difference in height is

○ 10 to 15 metres
○ 20 to 25 metres
○ 25 to 30 metres.

5. The number of transmission line towers in the Finnish grid is approximately

○ 28,000
○ 48,000
○ 55,000.

6. The Talvivaara nickel mine is located in

○ Eastern Finland
○ Lapland
○ Pirkanmaa.

7. Which party decides on the land expropriation compensations related to the construction of transmission lines?

○ Fingrid
○ an impartial expropriation committee
○ Ministry of Employment and the Economy.

Name ________________

Address ________________

Post office ________________

E-mail address ________________

Telephone number ________________

Winners of prizes of the Grid Quiz in the previous Fingrid magazine (1/2010):
Anneli Fagerlund, Espoo; Lauri Kumpulainen, Vaasa; Seija Lohikoski, Espoo; Hannu Matila, Oulunsalo; Liisa Sormunen, Niittylahti.

Fingrid once again to participate in major exhibitions

Fingrid will be present at two major exhibitions, Farmari 2010 and FinnMETKO 2010, due to be held this summer and early autumn, in order to meet important interest groups, for instance landowners.

The Farmari 2010 exhibition to be held at the Mikkeli race track from 29 July to 1 August is arranged by ProAgria, South Savo. It is expected to attract 80,000 visitors. Fingrid has participated in the event in many past summers. The company is this year again present as one of the exhibitors in the "A" hall.

The key significance of the event is the opportunity to meet face to face landowners and other interest groups and to discuss for instance the versatile use of transmission line areas and the building projects. Additional info available at: http://www.farmari.net/

METKO due in early autumn

FinnMETKO 2010 will be the biggest forestry equipment sector's professional and sales exhibition held in Finland. The exhibition will attract nearly 300 exhibitors of the sector to display their products. One of them is Fingrid. The exhibition to be held in Jämsä on 2-4 September is expected to attract around 35,000 visitors.

Fingrid's special theme for METKO is the safety of work done with the forest equipment close to transmission lines and the appropriate treatment of border zone trees. The company has a 30 sqm stand in the FinnMETKO exhibition hall. Additional info available at: www.metko.fi ■

Taking care of the lines

Fingrid is responsible for the nation-wide electricity transmission grid in Finland. About 75 per cent of all electricity used in Finland is transmitted through Fingrid's grid.

Fingrid maintains the grid in good condition and constructs the grid in view of the customers' future needs. The official objective of Finland to reduce the carbon dioxide emissions and to increase the portion of renewable energy sources in electricity generation also call for reinforcements in the transmission capacity of the grid.

In the next few years, Fingrid will construct almost 3,000 kilometres of new transmission lines and about 30 substations in different parts of Finland.

Fingrid makes sure that Finland obtains electricity without disturbance also in the future. Our main projects include for example the construction of a new 400 kilovolt transmission line between the Yllikkälä and Huutokoski substations in Eastern Finland.

Welcome to our stand in hall A in the Farmari 2010 exhibition to find information on transmission lines, their significance, and the impact of present and new lines on your environment. Our specialists are at the stand to answer your questions.

Farmari 2010 exhibition in Mikkeli 29 July – 1 August 2010.

www.fingrid.fi

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