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Editorial staff
Telephone: +358 (0)30 395 5153,
Fax: +358 (0)30 395 5196
Postal address: P.O.Box 530,
FI-00101 Helsinki, Finland
Street address: Arkadiankatu 23 B, Helsinki
www.fingrid.fi
Editor-in-Chief:Tiina Miettinen
E-mail: tiina.miettinen@fingrid.fi
Editorial board: Eija Eskelinen, Mikko Jalonen, Reija Kuronen, Kaija Niskala, Arto Pahkin, Petri Parviainen, Tiina Seppänen
Design by bbo, Better Business Office Oy / Maria Hallila and Tuija Sorsa
Translation by Kielipaja Hannu Hakala

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Editorial

Working together for the market without boundaries

International co-operation between transmission system operators (TSOs) is now in focus in grid planning. There is nothing new in co-operation as such, and Finns also have long experience of Nordic grid planning. In addition to the Nordic countries, transmission links towards Russia and Estonia have been planned and constructed . What is new is that now the objective is to come up with pan-European grid plans drawn up using shared criteria.

Joint grid planning by Nordel is based on shared future scenarios and models which simulate the operation of the market. The first inter-Nordic grid plan was completed in 2002. The most recent plan was completed in the spring of 2008, after which eight prioritised projects have been named in the Nordic countries. These can be used for overcoming transmission congestions and improving the functioning of the electricity market.

From the point of view of Finland, the foremost project is Fenno-Skan 2, which, once ready in 2011, will increase the transmission capacity between Finland and Sweden by 800 megawatts. Moreover, the need for and viability of a third alternating current link between the two countries is being examined.

Nordel's most recent grid plan identifies a distinct need to make a closer study of electricity transmission interconnections across the Baltic Sea. This is why the Nordic TSOs together with corresponding organisations in the Baltic countries and Poland have used market simulation to assess the viability of the new interconnections between these areas in various production and consumption scenarios. The assumption was that the electricity market works openly also in the Baltic region and that the full capacity of the interconnections is made available to the market. The results show that the studied connections from the Baltic countries to Finland, Sweden and Poland give substantial market benefits and that it is sensible to carry them out over a long time span.

The second direct current link between Finland and Estonia, Estlink 2, is the quickest and most economical option to boost the integration between the Baltic and surrounding transmission grids. In its strategy, Fingrid is prepared to execute the project after 2015. However, the EU is ready to support the project by 100 million euros as part of its economy recovery package, if the project can be expedited. In addition to giving a stimulus to economy, the objective is to support the Baltic security of supply situation, which is deteriorating rapidly. Consequently, Fingrid is prepared to carry out the Estlink 2 project before 2015 just as long as it obtains sufficient guarantees that the Baltic electricity market will be liberalised gradually within an expedited schedule.

Ongoing shared grid planning within the area of the Baltic Sea and a pan-European aspect will continue and consolidate as the new co-operation organisation, ENTSO-E (European Network of Transmission System Operators – Electricity), is launching its work. After the summer, the duties of present organisations, such as Nordel, will shift to ENTSO, and the first trans-European grid plan will be ready in 2010. The present Nordel area will expand into the planning area of the Baltic Sea, also involving the Baltic countries, Germany and Poland. In other words, the work continues on the basis of the ongoing analysis for the Baltic Sea area. Norway and Denmark also belong to the planning area of the North Sea, where the crucial challenge is to plan grid connections for offshore wind power.

National aspects must be ignored in international grid planning, and the perspective must cover the entire Europe. Multinational market benefits will need to be highlighted in the evaluation of the benefits of the projects. TSOs in the area of the Baltic Sea must make a joint, transparent and genuine commitment to the development of the regional power system on the basis of shared scenarios. The planning process must also be transparent, and the scenarios need to be worked out in interaction with various stakeholders. All parties will benefit from such co-operation in the long term.

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

Minister Mauri Pekkarinen:

Total energy consumption must be turned to a decreasing track

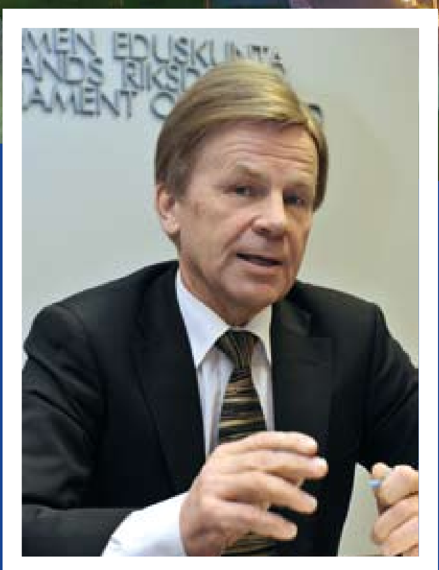
Electricity consumption continues to grow

According to the energy and climate policy report published by the Government of Finland in November 2008, total energy consumption in Finland must be turned to a declining track during the next decade. However, electricity consumption is expected to continue to grow, although at a decelerated pace.

"The goal is to restrain this growth through measures aiming at electricity savings and improved efficiency," says Mauri Pekkarinen, Finnish Minister of Economic Affairs.

Text by Tiina Miettinen and Maria Hallila

Photographs by Rodeo and Juhani Eskelinen



According to Minister Mauri Pekkarinen, impacts of savings and intensification measures can already be seen in the deceleration of electricity consumption growth. "There are many small brooks, and together they yield results."

Minister Pekkarinen estimates that without the savings and intensification programme, annual electricity consumption would grow in 10 years from the present 90 terawatt hours to 103 terawatt hours. According to him, various market-based and administrative measures can decelerate the growth rate to approximately 99 terawatt hours.

The Government of Finland thinks that turning the tide in the consumption of total energy will be reflected in the final consumption figures for 2020 as a 10 per cent reduction as compared to forecasted growth taking place on the basic track. The targeted consumption of 310 terawatt hours corresponds to the present level; without the change in the consumption trend, this would be 350 terawatt hours.

A work group appointed by Minister Pekkarinen is currently thinking of ways in which to improve energy efficiency. The work group is due to complete its work by the summer.

Electricity is taking over

Despite the savings and intensification programme, Finland will continue to need an abundance of energy also in the future. According to Minister Pekkarinen, the growth in electricity consumption is primarily based on the fact that the need for electricity by industries increases while some of the growth is due to many sectors of society shifting to the use of electricity from other forms of energy.

In the dimensioning of electricity supply, Pekkarinen stresses two significant strategic goals: elimination of dependence on imports, and gradual abandonment of electricity generation from coal.

"In order to achieve self-sufficiency, we will need a volume of domestic electricity generation capacity which corresponds to approximately 12 terawatt hours of consumption to replace present imports from Russia and Sweden," he says.

Based on the report published by the Government, domestic generation capacity must be able to cover not only imports but also the increase in consumption and the reduction of condensing power generation which causes CO_2 emissions.

"The objective conforming to the obligations of the EU is that 38 per cent of the energy used in Finland in 2020 would be produced from renewable energy sources."

Bioenergy in a key role

How will Finland generate electricity in the near future?

"The objective conforming to the obligations of the EU is that 38 per cent of the energy used in Finland in 2020 would be produced from renewable energy sources," Minister Pekkarinen says. "This is a tough target," he admits, but adds that the Government is committed to it. Approximately 90 million euros are available for increasing the share of renewable energy this year, while in the previous years the budget allocation for this purpose has been 25 to 30 million euros.

About half of the necessary renewable energy will be produced from mainly forest-based biomass energy. Minister Pekkarinen calculates that attaining the objective will require that the use of logging residues must be increased from the approximately 4 million cubic metres in recent years to almost 12 million cubic metres.

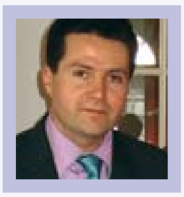
"We will probably not achieve this great an increase within the prescribed time frame, although much has already been done," he says and refers to the shortage of wood raw material by industries, which complicates the use of wood chips.

Opinions about feed-in tariffs?

The feed-in tariff work group appointed by the Finnish Ministry of Trade and Industry has been pondering on the structure and magnitude of the feed-in tariff for renewable energy since last December. The work group is to present its suggested principles for wind power in an intermediate report in April 2009. The final suggestion concerning all forms of renewable energy to be connected to the power system is due to be ready in June 2009. The objective is to introduce the feed-in tariffs as of the beginning of 2010.

The Fingrid magazine posed the following questions to energy professionals representing Fingrid's various types of customers:

1. What do you think about the feed-in tariffs of wind power and renewable energy in general?
2. How do feel that the feed-in tariffs should be implemented, or what issues should be taken into account when drawing up the tariff system?



Antti Koskelainen, Managing Director, Suomen ElFi Oy

1. Support systems are needed so as to achieve the challenging renewable energy obligations imposed by the EU. I believe that with proper details, a good and cost-efficient support system can be accomplished of the feed-in tariff in Finland.

2. Electricity generation capacity supported by Finnish electricity users must be built in Finland so that the benefits of increasing electricity supply will benefit the Finnish society. Subsidies paid to electricity generators must be linked to the market price of electricity in order to avoid oversupport or undersupport situations in the future. Moreover, a generator must take care of selling his electricity to the market, and the tariff must treat all generators impartially so that new and smaller producers can also access the electricity market in order to increase competition.

More wind power through tariff support

The energy strategy of the Government aims at a considerable increase in wind power capacity in Finland: the targeted power of 2,000 megawatts and a production volume of almost 6 terawatt hours are more than 20 times higher than the present wind power figures.

"This means that our goal is to have 670 wind turbines of 3 megawatts each in operation fairly soon," says Minister Pekkarinen in giving a concrete description the objective.

In order to achieve and expedite this extensive expansion in wind power generation, the Government intends to use more efficient support and control means than the ones in use at present. Many EU countries employ a feed-in tariff system for electricity generation based on renewable energy sources, and such a "guarantee price" to be paid to producers of wind power and bioenergy is now also being planned in Finland. Finland has been paying tariff support for electricity generated from fuel peat since the spring of 2007.

The structure and magnitude of the feed-in tariff for wind power is being contemplated by a work group appointed by the Ministry of Employment and the Economy. Minister Pekkarinen says that the law proposal concerning the tariff will be submitted to the Parliament in the early autumn, and the tariff system must be introduced at the beginning of 2010. He does not wish to make compromises about the schedule.

Encouragement to efficient solutions

Minister Pekkarinen has studied feed-in tariff systems used in other countries. "There are some bad models, ones that do not encourage cost efficiency," he says. In the approach to be adopted in Finland, he wants to combine market focus and an administrative role which is inherent of tariffs.

"The system must be able to reward for efficient solutions and encourage

Pekka Manninen, Director, Helsinki Energy

1. Electricity generation capacity should basically be built in Finland at market terms. However, the EU has now decided, on climate policy grounds, that electricity generation must be increased using generation methods which are not viable from a market point of view. This means that the market aspect is abandoned in this respect. The EU member states must then use their own control mechanisms to make sure that the obligation imposed by the EU on them to increase the use of renewable energy is fulfilled in each member state.

From the point of view of electricity generators, an investment subsidy is by far the best control mechanism. It provides the best foundation for assessing the profitability of projects, hence reducing the project risk and leading to a smaller need for subsidies.

However, the preparatory work for the control mechanisms in Finland is moving towards feed-in tariffs. It should be emphasised that the same control mechanism does not suit wind power and biomass-based electricity generation due to their different kind of cost structure and market impact.

The objective set by the Government of Finland to increase wind power generation cannot be attained by means of new wind power capacity installed on land alone. If the goal is to have offshore wind power, it requires different types of control mechanisms than wind power production built on land. A combination of a feed-in tariff for wind power and a separate investment subsidy might be a functioning approach for offshore wind power.

2. It is not really relevant whether the feed-in tariff is built on a "premium basis", "guarantee price basis" or some other principle. From an electricity generator's viewpoint, all principles can be used to accomplish both a good and a poor system.

What is essential for a generator and investor is that the control mechanism gives a sufficiently reliable view extending over the entire life span of the investment so that the viability of an investment project can be evaluated. The support decision concerning offshore wind power projects in particular needs to be made for the length of the entire project even though the implementation of a major project would be split into several stages over several years.

Another important consideration with offshore wind power projects is that the other uncertainties involved in the investment projects can be minimised. These uncertainties include unclear management and usage right procedure for areas, zoning process, permit process, and technical solutions used in the foundations of wind turbines.

Simo Nurmi, Director, Pori Energia Sähköverkot Oy

1. In many EU countries, feed-in tariff systems are currently in a central role among means that aim to guarantee

them. We must build a feed-in tariff structure where the tariff 'lives' with the market reality," Minister Pekkarinen describes.

According to him, fixed and strict tariffs do not lead to sustainable investments. They may also give undue benefits to investors.

The volume of wind power generation to be subsidised by means of feed-in tariffs had not yet been decided on the date of the interview (end of February).

"There can be a limit for a certain generation volume, or there can be a time limit. I believe that there will be some sort of a staggered system," Minister Pekkarinen thinks.

Vital duty of transmission grid

The transmission grid and its role in the power system has many links to the energy and climate strategy of the Government.

"The system will not work without a reliable and cost-efficient transmission grid," Minister Pekkarinen states.

According to him, the operating conditions of the transmission grid system need to be taken into account when making decisions about the placing of wind power production units. In the planning of the feed-in tariff system, the transmission grid operator has the role of an expert, but in the implementation of the system it has a crucial duty.

"The model to be adopted is likely one where the transmission system operator charges the costs of the feed-in tariff system from the market players and distribution network operators."

Nuclear power for own needs only

Olkiluoto 3, the world's largest nuclear power unit which is under construction in Finland, will generate electricity for an annual consumption of almost 13 terawatt hours once ready in 2012. The energy strategy of the Government states that preparations must be made in the present legislative period to construct additional nuclear power so that the additional capacity would be available before 2020.

Does Fingrid need to make preparations for connecting even more nuclear power capacity to its grid?

"The decision on additional nuclear power capacity is based on the overall interests of society," Minister Pekkarinen points out. He does not wish to speculate on the number of new nuclear facilities.

However, one thing is for certain according to the Government strategy: permanent exports of nuclear electricity will not be used as a design criterion for nuclear power generation.

"We will only construct nuclear power capacity for our own needs and the needs of the Nordic market," Minister Pekkarinen points out. ■

that such forms of energy production which are deemed to be worthy of receiving public subsidies evolve into practical projects. On the flip side, feed-in tariffs are new types of taxation imposed on electricity users, with network operators serving as the tax collector.

The architecture of feed-in tariff systems must be transparent and simple, their objectives must be generally acceptable and impartial, and the roles of various parties in the maintaining of the system must be unambiguous. In this case they can contribute to the attainment of sustainable development objectives – hopefully even cost-efficiently.

2. It is important that the structures, unit prices and other terms of the feed-in tariffs are completely unambiguous and standardised in advance so that network operators, among others, can allocate the resulting costs to the electricity users transparently and predictably. Moreover, the impacts of feed-in tariffs on the performance of network operators must be neutralised in the supervision model adopted by the Energy Market Authority. The role of the network operator must also be limited to the collection of tariff fees so that for example the funding of the systems takes place completely by means of fees collected from the electricity users. Electricity generators must also pay the costs caused by the connection of generation plants to the grid and take care of the sales of the electricity generated to the electricity market in the normal manner.

Mikko Rintamäki,
Vice President, Energy, Outokumpu Oyj

1. I think that the construction of wind power capacity and other forms of renewable energy generation within the scope conforming to the commitments made by Finland calls for correctly planned and comprehensive support. With proper design, the feed-in tariff is in my opinion the best option presented to date. It is not realistic to build capacity for renewable energy production on the basis of the price of electricity alone, and this would become much too expensive for society and electricity users.

2. A feed-in tariff, implemented for example as a fixed-period guarantee price tariff, is in my opinion a practical and efficient way to secure the access of renewable energy to the market. It is clearly better than the green certificates used for example in Sweden.

Because of marginal pricing used in the electricity market, it is important that the subsidy system ensures the access of additional energy to the market so that the limit price in the electricity market does not rise – in other words, the consumers' electricity cost must not rise more than by the amount of the subsidy.

I think that the subsidy should secure the realisation of renewable energy projects in profitability order so that the government imposes a minimum of detailed regulation or control between the forms of energy production subsidised. ■

AT THE LEADING EDGE
to the direction shown by the energy strategy of the EU

Transmission system operators are in a key role when the EU's energy and climate strategy is being put into practice. Only a reliable transmission grid can support the strict objectives aiming at reduced emissions from electricity generation, increased use of renewable energy, and enhanced efficiency.

Grid reinforcement by Fingrid is already in full progress. The company's most extensive capital expenditure programme to date is also prompted by another major goal: integration of the electricity market within the EU.

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

According to Fingrid's President and CEO **Jukka Ruusunen**, the views expressed in the energy and climate policy of the Government of Finland, which is based on the obligations specified by the EU, have a greater impact on Fingrid's action programme in the near future than any other intentions or trends.

"Finland is contributing seriously to climate protection, and the transmission grid is one of the foremost instruments for attaining the objectives," Jukka Ruusunen says.

Towards carbon-neutral Finland

"The electricity generation architecture will change considerably by 2020, and we must work so that the electricity transmission infrastructure does not retard the progress towards the objective of carbon-neutral Finland. It must be possible to connect one large nuclear power unit and 2,000 megawatts of wind power to the Finnish grid in the near future," Jukka Ruusunen says.

The grid reinforcements included in Fingrid's capital expenditure programme of 1,600 million euros also make preparations for a considerable growth in wind power production in the entire Nordic electricity market area.

"As an example, the grid in Ostrobothnia in Western Finland will be upgraded to a voltage level of 400 kilovolts so that we can receive the generation of large wind power units. Small-scale decentralised power generation is not a problem for us."

The decision on whether or not more nuclear power capacity will be built in Finland will be made within a year, but based on present knowledge, Fingrid must be prepared for connecting yet another large generation unit to the grid in 2018.

"In line with the Olkiluoto 3 nuclear power unit due to start in 2012, we have learnt in recent years how to connect an extraordinarily large generation unit to the power system," Jukka Ruusunen says.

Steady course of progress

Struck by the economic recession, many enterprises have had to revise their project plans. However, the gloomy outlook on economy does not undermine the implementation of Fingrid's capital expenditure programme.

"We work in quarters of 25 years. Recessions come and go – economic fluctuations are a part of life," Jukka Ruusunen philosophises.

He adds that from the point of view of society, it would be good if enterprises responsible for infrastructure carried out their capital expenditure projects specifically during a recession. When the prices of supplies decrease, the projects can be executed more economically than during an economic boom.

"We should not press the break now," Ruusunen points out. He feels that the declining electricity consumption trend in Finland does not give a reason for this, either.

"It may be that consumption continues to decrease this year. However, we must not let short-term fluctuations influence the way in which we

"The electricity generation architecture will change considerably by 2020, and we must work so that the electricity transmission infrastructure does not retard the progress towards the objective of carbon-neutral Finland."

take care of our long-term responsibility."

Jukka Ruusunen thinks that the focal points in Fingrid's strategy are not threatened even in the eventuality that the directive proposal included in the EU's single electricity market package, concerning the ownership structure of TSOs, would be accepted and Fingrid would have to revise its ownership. The proposal that would deny

Jukka Ruusunen feels that energy and climate objectives have raised the transmission system operator to the centre of public debate in Finland. "Ordinary people understand nowadays that the company responsible for nation-wide electricity transmission has an important role."

electricity producers ownership of the nation-wide transmission grid is being favoured within the EU, and Jukka Ruusunen thinks that the matter will be decided during the Czech presidency.

"Our capital expenditure programme serves the basic needs of the Finnish society. I believe firmly that the potential new owners also want to be committed to this and to our goal of continuing to be one of the technically best TSOs in the world with one of the lowest transmission prices."

Single market contributing to climate protection

In addition to the domestic front, the Finnish TSO is also working on the international arena. Fingrid has an active role in EU co-operation, where the goals include a flexible and efficient pan-European electricity market.

"The integration trend is favoured by commercial factors and also by the ambitious climate objectives of the EU. If the electricity market was not opened, it would be much more difficult to carry out plans to increase renewable energy, for example," Jukka Ruusunen says.

"The market and climate objectives are often perceived opposite factors, but in this context they support each other," he points out.

A long leap in trans-European market developments was taken in December 2008. It was then that 42 TSOs from 34 countries signed the charter of ENTSO-E (European Network of Transmission System Operators – Electricity). In early April, this organisation assumed responsibility for the development of the European transmission grid: grid planning, system security, and measures aiming at promoting the integration of the electricity market.

The earlier co-operation organisations in the transmission grid business, such as Nordel in the Nordic countries, ETSO which has facilitated the European electricity market, and the traditional UCTE in Continental Europe, will merge into ENTSO-E.

Recirculation of good experiences

Jukka Ruusunen thinks that the pace of integration of the European electricity market and the progress achieved in TSO co-operation have exceeded the expectations.

"If someone had said a couple of years ago that the old TSO organisations will merge into one in 2009, nobody would have believed that."

Fingrid has succeeded in building EU co-operation and attained the trust of its European partners. Fingrid's employees have been entrusted two top positions in ENTSO-E. Jukka Ruusunen serves as the Vice President of ENTSO-E, and Fingrid's Executive Vice President **Juha Kekkonen** heads the strategically important Market Committee.

"Moreover, our top-ranking experts participate in the work of all committees of ENTSO-E," Jukka Ruusunen adds.

He is very pleased by the strong Finnish representation in the new organisation. Finns have a higher share of the top positions than what the minor weight of Finland – representing 3 per cent of the total volume of electricity use in Europe – would suggest.

"We wish to introduce the proven Nordic co-operation procedures in ENTSO-E, and correspondingly launch the European approaches here," says Ruusunen, who served as Nordel's Chairman in 2007-2008.

In European TSO co-operation, he emphasises the importance of work methods and attitudes which have traditionally been characteristic of Finns: moderation, transparency and a long-term approach. "Pursuing your own interests is not part of good co-operation nor part of Fingrid's culture," he stresses.

Economies of scale

However, the outlook on the pan-European electricity market is not quite without problems despite the good start. Jukka Ruusunen considers that there are two major threats which have arisen as a result of the financial crisis: nationalism and protectionism.

"However, we Finns only have to look at the Nordic countries to see the benefits of a shared market. For decades, we have drawn undisputed advantages from the Nordic electricity market both in terms of the price of electricity and its sufficiency. If we had only worked relying on our own resources, it would have been quite dark here at times," Jukka Ruusunen states. He regrets that an unfortunately small portion of Finns are aware of the benefits of market co-operation.

"Even fewer know that the majority of the adjustments in our power system are carried out within the inter-Nordic grid using hydropower in Sweden and Norway." According to Jukka Ruusunen, the objective to increase wind power generation in the entire EU also calls for large-scale systems and a well-functioning electricity market.

The challenges of European market developments now also come from the Baltic direction. In terms of Finland and Fingrid, the concrete response to these challenges is the construction of Estlink 2 transmission connection between Estonia and Finland. This project, which would primarily serve Estonia and the other Baltic states, is receiving 100 million euros in support from the EU. However, the condition is that the schedule of liberalising the Estonian electricity market has to be expedited.

"The TSOs are ready to start the construction work right now just as long as there is political will required by integration in Estonia," Jukka Ruusunen assures. A closed market not only blocks the flow of electricity but also investment opportunities.

"It is the price that moves electricity in an open market. If there is no price, there is no movement in the cable, either," he summarises the idea of an open market, one of the cornerstones of Fingrid. ■

Photograph by FutureImageBank

Directive on the promotion of renewable energy

The directive of the European Union on the promotion of renewable energy was accepted in December 2008. The directive sets national targets for renewable energy.

In order to achieve the objectives, the member states must draw up national action plans, whose implementation is monitored. The plan must be submitted to the Commission of the EU no later than 30 June 2010. Many renewable energy sources must be subsidised in order to achieve the objectives so that these energy sources would be competitive. The member states can also devise shared projects between themselves or with third countries so as to attain the objectives.

The member states can give renewable energy fed into a power network either a guaranteed or priority access to the grid. Guaranteed access means that the sold and subsidised electricity has access to the grid, but it does not mean that a member state should subsidise or purchase renewable energy. Guaranteed access to the grid is fulfilled if the member state has a spot market for electricity, into which market all types of electricity have access at equal terms and conditions. The directive hence does not pose a need to change the present Nordic procedure. However, the member states of the EU can give priority access to renewable energy if they so wish. In most cases, priority access means in practice an obligation to purchase subsidised renewable energy, and a fixed price.

Integrating wind power to the power system may require great capital investments. It will be especially challenging to connect offshore wind power generated on the North Sea and the Baltic Sea to the grid. The importance of the transmission grid is also highlighted because preparations must be made to transmit electricity from replacing power plants due to the fact that wind power features greater variation than other forms of electricity generation. So that the development of the transmission grid for renewable electricity generation would be easier, the member states need to streamline their transmission line permit processes. If the member states wish, they can oblige grid operators to carry responsibility for the costs of connecting renewable energy to the grid, but the directive does not contain requirements which would cause changes to the present procedures in Finland.

Because of the greater variation of wind power generation, the adjustment needs of the power system will also grow. The new directive also favours heat pumps and electric cars, which change the demand curve for electricity. The significance of the intra-day Elbas market and the regulating power market will increase in the balancing of generation and consumption. In the future, consumption must also react more flexibly so as to retain power balance.

The member states must report no later than 31 December 2011 on their progress in increasing the use of renewable energy, and thereafter at intervals of two years. ■

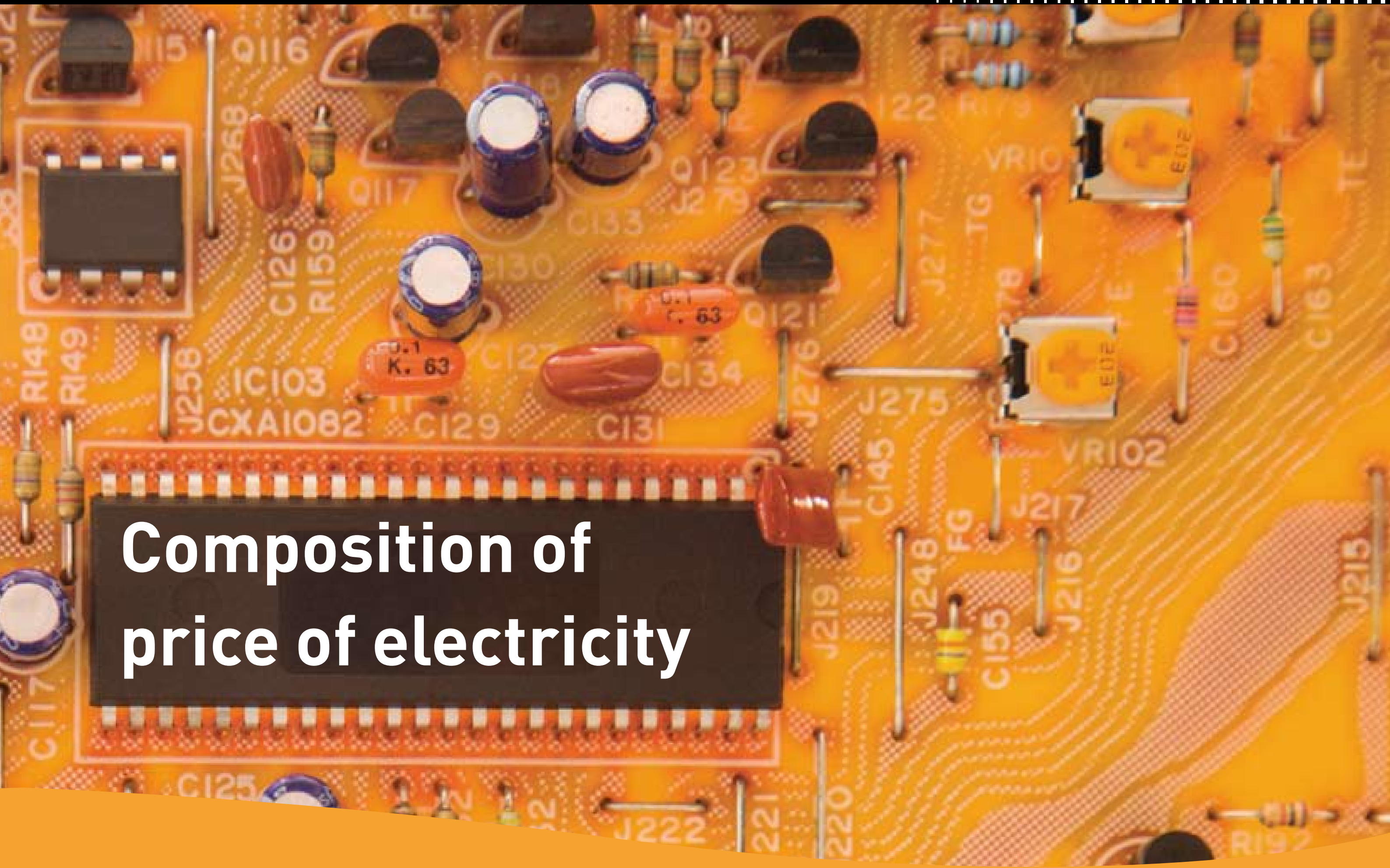
Risto Lindroos

Consumption peak in the winter 13,000 megawatt hours

The electricity consumption peak in this winter period in Finland was reached on 16 January at 8 to 9, when the average hourly power rose to 13,008 megawatts (MW). This was 755 MW less than the peak figure in the previous winter (13,763 MW) and as much as 1,906 MW less than the record power of 14,914 MW attained two years ago.

According to the statistics of the Finnish Energy Industries, electricity consumption in Finland reduced in January 2009 by almost 9 per cent from January 2008. With temperature and calendar correction, the reduction was more than 11 per cent. The reduction was due to the recession in economy, which cut electricity consumption by industries by almost 17 per cent. Other electricity consumption decreased by 2 per cent.

During the 12-month period of February 2008–January 2009, electricity consumption in Finland was 86.1 terawatt hours (TWh), under 5 per cent less than during the previous corresponding 12 month period. With temperature and calendar correction, industrial electricity consumption has decreased by 9 per cent in a year, while other electricity consumption has remained at the same level as in 2008. ■



Composition of price of electricity

As the electricity market in Finland has become available to free competition, it has been possible to utilise the benefits brought by a large market in the price of electricity. In the wholesale market, electricity is primarily traded in the electricity exchange, and market mechanisms guide the prices. Anyone estimating the trend in the price of electricity should study not only supply and demand but also the prices of fuels and the water reservoir situation.

Text by Maarit Kauniskangas ▪ **Photograph by** Rodeo

The Nordic power spot exchange Nord Pool Spot is the trading place for about 70 per cent of the electricity used in the Nordic countries. Other electricity trade takes place bilaterally between electricity companies and consumers. Some of the major users of electricity produce their own electricity.

The Nordic power exchange was established after the liberalisation of the electricity market, first in Norway in 1993. The exchange expanded gradually, and since 2002 Nord Pool Spot has also been operating in Finland, Sweden and Denmark. Nord Pool Spot is owned by the Nordic transmission system operators.

Electricity from the exchange

The electricity exchange serves as a middleman in the electricity market in the same way as the stock exchange does in the stock market. When electricity is bought and sold in electricity exchanges, the wholesale price of electricity varies from one hour to another, just like prices in the stock market. The exchange determines the wholesale price of electricity to be delivered in the next day. Nord Pool Spot establishes the price for each hour in four currencies.

However, there are congestions, or bottlenecks, in the transmission grid, which means that electricity in different areas has a different price. Finland and Sweden each have a single price area only. On the other hand, both Norway and Denmark are divided into two areas at present. This is why there is a different price for electricity in at least one area for about two thirds of the hours of a year. Congestions between Finland and Sweden are very rare, only accounting for a few per cent of the hours of a year. Instead, congestions are quite common in Southern Scandinavia.

"Congestions are troublesome from the point of view of the functioning of the electricity market. However, it takes considerable capital investments to eliminate them, which makes the elimination process very slow. Once the many development projects for developing the Nordic grid will be ready by the mid-2010s, the situation will be much better," says Fingrid's Executive Vice President **Juha Kekkonen**.

"The Nordic TSOs have agreed that they use the auctioning income, or the congestion income they receive because of the insufficiency of transmission capacity, as investments in the transmission grid."

However, the Nordic electricity market can be regarded as a good example and forerunner if it is compared to the market in other parts of Europe, for example. The Commission of the European Union has raised the Nordic electricity market as a model for the development of the electricity market for the EU. In other parts of Europe, the transmission grid infrastructure is insufficient so that the electricity market would work equally as well. The grids have usually been built for the internal use of a country, not for the comprehensive transmission of electricity from one country to another. Moreover, factors such as increasing wind power generation in various parts of Europe add to the challenges imposed on transmission grids.

How is electricity procured from the exchange?

"Most of the electricity traded in Nord Pool Spot consists of Elspot trade. In it, a specific price is determined for electricity to be sold in the next day for each hour, at the intersection of supply by electricity sellers and demand by electricity buyers," describes **Karri Mäkelä**, Director of Operations of Nord Pool Spot.

Both industrial enterprises and dealers buy electricity in the exchange. Major power companies also circulate more and more of their electricity through the exchange; in other words, the production sector sells electricity to the exchange and the sales sector buys it there to be delivered further to the consumers. In this way, the production and sales of these companies is separated into different businesses by means of the exchange.

In addition to the Elspot market, Nord Pool Spot also provides an opportunity to trading in the Elbas market (Elbas = Electricity Balance Adjustment Service). If a customer has reserved too little electricity or if an electricity producer's plant goes out of order, they can procure the missing volume of electricity from the Elbas market. In this case, however, the price is typically slightly higher than in Elspot trade.

Actual physical power transactions take place at a short time span of one day, while in derivative contracts the price can be agreed for several years. The buyer in a contract can be for example an industrial plant, and the seller can be an electricity producer. An electricity market player can use the derivative contract to secure the future price of his electricity, but it does not guarantee that the price is more affordable than the actual market price in the future.

"If an electricity buyer signs the derivative contract when the price of electricity is high and the buyer does this because he fears that the price may rise even more, and then the prices come down and the buyer does not react by signing new contracts, the buyer has to pay the difference between the actual price and the contract price to the seller in the contract. Correspondingly, if an electricity producer has signed a contract when the prices are low, and then the prices rise, the producer has to pay the difference between the prices while at the same time the buyer of electricity obtains electricity at a price which is below the market price," Karri Mäkelä explains.

The composition of the wholesale price of electricity in the power exchange is the sum of many factors. The above congestion situations and derivatives trading have some impact on the price, but the form of generation of electricity is the most decisive factor.

Hydropower is cheapest

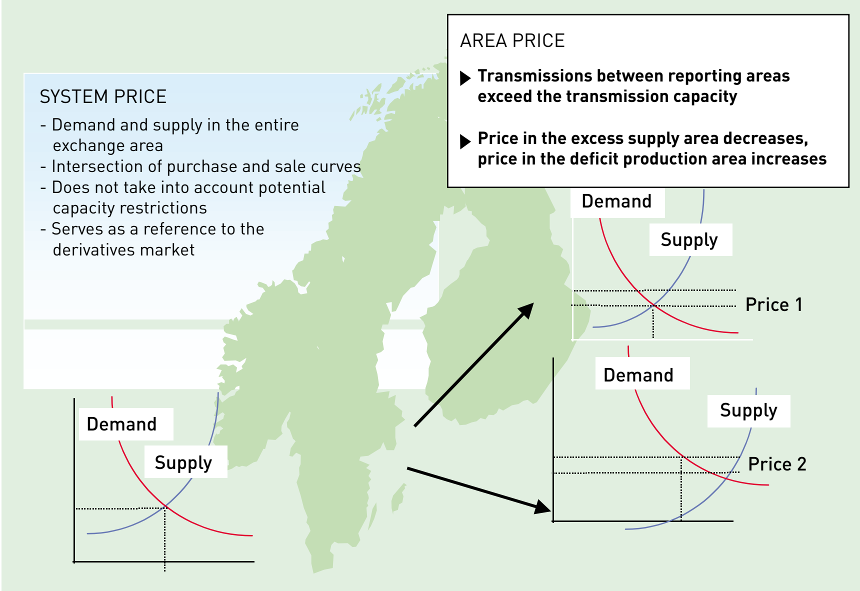
The variable costs of hydropower render it the most economical way of generating electricity. Its availability depends on the prevailing level of water reservoirs. The Meteorological Institute of Finland, among others, estimates the water levels. Data is compiled from physical water measurement points, satellite images, precipitation, and water content of ice and snow. Electricity producers also use this data as they draw up their sales bids.

Hydropower has a much greater role in the Nordic countries than elsewhere in Europe, because about one half of all electricity is produced from hydropower in the north. However, the differences between the various Nordic countries are very great. Almost all electricity in Norway is produced from hydropower, in Sweden about half, and about one fifth in Finland.

Water reservoirs in a rainy year enable a higher volume of hydropower generation than in a dry year. Abundant use of hydropower decreases the wholesale price of electricity, but not in an as straightforward manner as one could imagine. In fact, it is the most expensive form of electricity generation available at any given moment that controls the price of electricity. In electricity sales bids, volume correlates with price: the higher the price in the sales bid, the greater the volume of electricity sold. In other words, the producer offers its production capacity for sales in an order where the most inexpensive price is offered first.

The methods of electricity generation in the Nordic countries are, from the most inexpensive to the most expensive: hydropower, nuclear power,

System price vs. area price

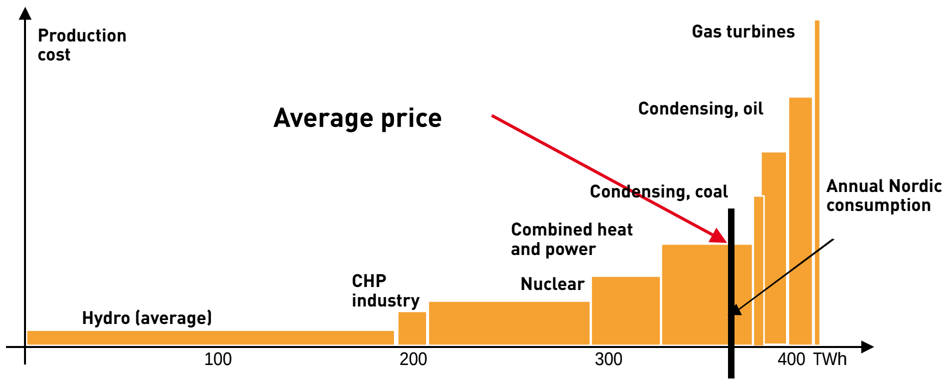


combined heat and power production (CHP) by industries and municipalities, and separate electricity production using coal, gas or oil. The capital and operating costs of generation plants have an impact on the price of electricity produced. On average, the lowest price of Nordic wholesale electricity is at a level of the price of combined heat and power production, and the highest price is the price of electricity produced in a coal-fired power plant.

Renewable energy sources solar power and wind power are considerably more expensive than the above forms of production. Even though the raw materials themselves do not cost anything, the construction costs of wind power and solar power units are high. However, consumers wishing to have "green electricity" are willing to pay more for their electricity, and hence they support indirectly the building of wind turbines, for example. Only 0.3 per cent of the electricity used in Finland in 2008 was generated by wind turbines, but the growth rate from the previous year was 40 per cent.

The ultimate objective of carbon dioxide emissions trading within the European Union was that industries and energy producers would reduce their carbon dioxide emissions, for example by shifting to production methods which result in less emissions. The emission rights were allocated to industrial plants before the world economy slid into recession. Now that industrial production has reduced rapidly, many companies have sold their excess emission rights, and their price has come down to one third of the price they had when they were allocated.

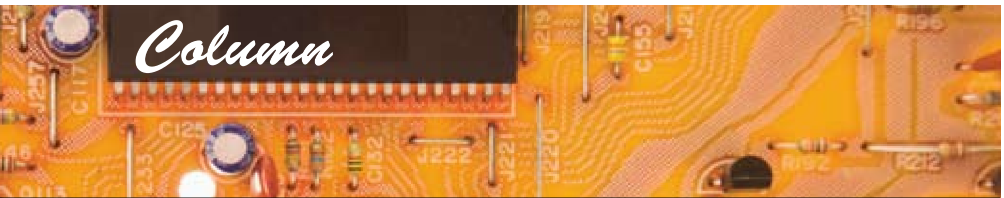
Price determination



In electricity production, the price of emission rights is included in the wholesale price. If the emission right costs 20 euros per carbon dioxide tonne, it increases the production costs of a coal-fired power plant by approx. 15 euros per megawatt hour. The higher the price of emission rights, the more it also raises the price of electricity.

Decreasing electricity consumption

The wholesale price of electricity is naturally also influenced by the demand for electricity. In 2008, electricity consumption in Finland totalled 86.9 thousand million kilowatt hours. Con-



CONGESTION IN THE MARKET

Last year 2008 was the worst ever in terms of the coherence of the Nordic electricity market. This is the case at least if we measure it by the coherence of area prices in the spot market. Only 9 per cent of the hours in 2008 were ones when there was an identical price within the entire market area. At other times, the market was split into at least two, often into more price areas.

This was because of congestions, or bottlenecks, in the electricity transmission grid. Congestions tend to disturb electricity trade especially in Southern Scandinavia. Last year, additional problems were caused by a transformer fault which continued in the Skagerrak connection between Southern Norway and Jutland. One of the three HVDC cables there was out of order for about 1 year. This period was extended because there was no backup transformer, but one had to be ordered separately.

Another problem was the failure of the two cable links running at the bottom of the Oslo fjord. Each link holds a total of six cables, with oil leaks appearing in many of them. Statnett, the Norwegian TSO, has been criticised for poor material and other contingency planning for such a fault and for its slow repair. It seems that the repair will last until the summer, when more than one year will have elapsed from the detection of the fault. On the other hand, the circumstances for locating and repairing the fault have been extremely difficult. It is also very rare that this many cables fail simultaneously, and no contingency plans are usually made for such an eventuality.

TSOs normally maintain a high degree of readiness to respond to faults which can occur in parts of the grid which are critical in view of system security. The risk assessments take into account not only the magnitude of the potential disadvantage but also the likelihood of the fault.

But is this technical viewpoint sufsumption decreased last year as major industrial enterprises, especially in the pulp and paper industry, curtailed their production. The relative reduction in electricity use in Finland in 2008 was the greatest since the Second World War. Industrial electricity consumption decreased by 7 per cent, but industries continued to use more than half of all electricity. Electricity consumption by households remained at the earlier level. The weather last year was 1 to 2 degrees milder than average. With temperature correction, electricity consumption in Finland decreased by 3 per cent last year.

Factors such as decreasing demand have brought down the wholesale price of electricity since last autumn. However, in the early part of the year and in the summer the price was rising steadily. Market electricity was on average 70 per cent more expensive in 2008 than in 2007. As the market mechanisms work, the consumer prices of electricity will also come down, albeit with a delay and not in direct correlation to the wholesale prices.

Measured with purchasing power, the consumer prices of electricity in Finland are the most inexpensive in the EU. According to Eurostat statistics, the price of electricity in Finland is about two thirds of the average price in the EU countries.

"The wholesale price of electricity should control the formation of consumer price of electricity much in the same way as for example the Euribor interest rate controls the interest rate level, or like the price of orange juice in the juice exchanges of Florida guides the price of orange juice in our shops," Karri Mäkelä says.

The consumer price of electricity is made up of the price of the actual energy and also of energy taxes and price of electricity transmission. The latter accounts for about one third of the price, and most of this consists of the distribution network costs. Fingrid's transmission fee accounts for about 3 per cent of the consumer price of electricity. ■

ficient? It may not pay enough attention to the market impacts of grid failures. In disturbances of the above type, the lights have stayed on, but significant disadvantage has been inflicted on the market. The price of electricity in Finland and Sweden was tens of euros higher per megawatt hour than what it would have been without the cable faults. As this situation continued for months on end, consumers in these countries had to pay almost one thousand million euros more. The disadvantages are not measured in monetary terms only. Situations such as this may even undermine confidence in the entire market.

There have also been some doubts concerning the eagerness of TSOs to repair faults. This has been suspected because a shortage of capacity increases the congestion income received by the TSOs. However, at least Fingrid employees do not love this income, because the performance bonus paid to the personnel depends partly on the congestion income: the smaller the transmission congestions on the border of Finland, the bigger the bonus.

But the disturbances of last year also provide an opportunity to learn something. The Nordic TSOs have consequently launched an analysis within Nordel concerning parts of the grid which are critical for market functioning. The analysis focuses on those line connections and other grid elements which, in the event of failure, could cause significant market disturbances. These may be partly the same parts as those critical in view of system security, but there can also be others. TSOs, including Fingrid, need to review their grid from the market aspect and make sure that their contingency plans are up to date.

It should be stated here that Statnett is not just waiting for the completion of Nordel's analysis: it has already placed an order for a spare cable in case bottlenecks ever re-emerge in the Oslo fjord. ■

Juha Kekkonen

Terms:

Nord Pool Spot power exchange: Nord Pool Spot AS is the leading power exchange in Europe, trading in physical electricity. The company is owned by the Nordic transmission system operators, and it provides a market place for large-scale consumers, dealers and producers of electricity.

Elspot: The Elspot market is for daily electricity trading for the hours of the next day in all Nordic countries and Germany. As a result of this trading, the exchange publishes a price for electricity and optimises electricity transmissions in the Nordic countries between various areas on the basis of bids made and the transmission capacity of the grid.

Elbas: The Elbas market serves as an intra-day market which opens after the publication of Elspot prices. The customers can trade in this market up to one hour before the consumption of electricity.

System price: An electricity price index covering all Nordic countries, established in the Elspot market.

Area price: Price of electricity established in the Elspot market, also covering the transmission congestions of the grid between various areas.

Derivatives: Through derivatives, an electricity buyer and seller agree on a certain future price for electricity for a certain period of time, with the intention of hedging the price of electricity against major fluctuations. The derivatives contract does not contain physical delivery of electricity.

Emission right: "Currency" used in the EU's emissions trading, in other words emission rights that can be bought and sold within the EU. One emission right corresponds to one carbon dioxide tonne released into the atmosphere.

Factors influencing the price of electricity:

- demand
- supply
- form of production
- water reservoir situation
- volume of derivatives contracts
- congestions in transmission grids
- prices of raw materials
- cost level (salaries etc.).

Juha Hiekkala, Jyrki Uusitalo and Katja Lipponen, members of Fingrid's analysis group, show where the potential area division in Finland would be.

New price areas
– solution to the Nordic congestion problems?

Fingrid is examining the division of Finland into two price areas for electricity

At the request of the Ministry of Employment and the Economy, Fingrid is examining the possibility of dividing Finland into two price or bidding areas for electricity. This was prompted by inefficiency resulting from transmission congestions within the price areas of the Nordic electricity exchange. "Even though the problem does not yet concern Finland to a great extent, it is also in our interests that we are aware of potential future challenges and that Nordic co-operation works well," says Fingrid's Development Manager Juha Hiekkala, who belongs to Fingrid's work group.

Text by Suvi Artti ■ **Photograph by** Juhani Eskelinen

In September 2008, the Nordic energy ministers requested the Nordic transmission system operators (TSOs) to examine the division of the inter-Nordic electricity exchange area into more numerous price or bidding areas than at present. In practice, this examination concerns Finland and Sweden more than the other Nordic countries; Finland and Sweden now make up one price area each.

Fingrid's analysis is due to be ready by the end of October. The initial results will be heard in Fingrid's Electricity Market Day in April, when the work group will publicise an interim report.

Deteriorated transmission capacity in Sweden

The energy ministers requested the analysis because of the problem of occasional inefficiency in the Nordic electricity market. This problem has prevailed throughout this decade, but it has become more pronounced over the years. Congestions emerge between the price areas when internal restrictions are transferred to the borders of the submarkets. This problem concerns in particular Sweden, which is located in the middle of the Nordic electricity exchange area.

"The Swedish electricity system has evolved over the years so that Svenska Kraftnät has great challenges to maintain one price area without shifting internal transmission restrictions to the outer borders," says Fingrid's Development Manager **Jyrki Uusitalo**, who is a member of the work group.

He says that one individual reason why the transmission capacity between Northern and Southern Sweden has declined is that the Barsebäck nuclear power plant was shut down in two stages in 1999 and 2005.

According to Uusitalo, the grid reinforcements planned by the Swedish TSO will alleviate the situation over a long term, but there is no certainty whether they will eliminate the problem completely.

One solution would be that Sweden takes care of the transmission restrictions by means of counter trading. However, this seems unlikely, because there is no unanimity of the division of the costs of counter trading. "Based on information received from Sweden, splitting Sweden into two or three submarkets is a serious option so as to solve the problem."

Costs from remaining as a single submarket

The electricity transmission grid in Finland is stronger than that in Sweden, and the shifting of internal restrictions to the border is not a similar problem in Finland as in Sweden.

"In the south-to-north direction of the transmission grid in Finland, the so-called P1 section south of Oulu may pose a problem in some situations," Jyrki Uusitalo says. "To date, it has been possible to limit the transmission capacity to Sweden in these situations. However, this has not increased significantly the number of hours with different area prices between Finland and Sweden except for years with low water reservoirs."

The transfer of transmission restrictions to borders impairs the efficiency of the Nordic electricity market. The analyses made by Fingrid's work group suggest that removing the restrictions by means of counter trading in dry years may become very expensive.

"From the competition point of view, division into more price areas than now would not be an ideal solution, because competition does not work as well in a small market as in a large market," Juha Hiekkala says. He adds that the analysis group is to weigh the disadvantages caused by dividing Finland, and compare these disadvantages to the costs resulting from keeping Finland as a single submarket. Juha Hiekkala points out that since the costs must be paid by Fingrid's customers, their opinions carry much weight.

Splitting into price or bidding areas examined

The work group is examining two options: price area or bidding area division. Of these, division into price areas seems more viable.

Division into bidding areas would mean that Finland would be split into two submarkets, but Fingrid would use counter trading based on Elspot bids to make sure that both areas always have the same wholesale price in the Elspot market. In intra-day trade and in regulating power and balance power trade, however, the prices could differ from each other, if P1 turned out to be a constraint.

"However, there are fears that the bidding area division may change the bidding behaviour of the market players and potentially distort the wholesale market prices," Juha Hiekkala says.

Concern over the centralisation of market

If area division is adopted in Finland, the biggest practical change will be that separate sales and purchase bids would be submitted for each area. Balance settlement would also be drawn up separately for each submarket.

"There would be administrative extra work for the market players as a result of the division, because they would have to renew their data systems if they operated in both submarkets," says Planning Engineer **Katja Lipponen**, who is also a member of Fingrid's analysis group. "However, in view of the competitive situation, it would be important that small electricity producers are also present in both submarkets."

It is likely that even after the division, Finland would in practice make up a uniform wholesale market area for electricity together with Central and Northern Sweden. In other words, the situation would be very much the same as now; in 2008 there was an identical spot price in Finland and Sweden for 98 per cent of the time. In addition to national area division aspects, the work group is also examining the possibility to establish price areas beyond national borders (for example between Northern Finland and Northern Sweden).

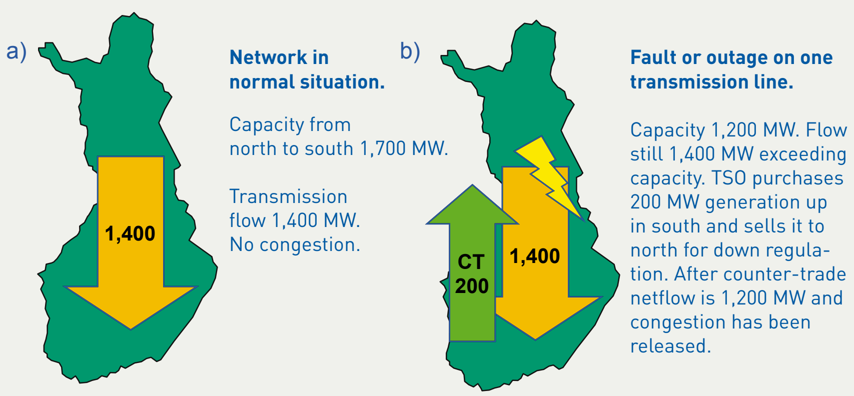
Eyes on the future

To date, the constraints of P1 transmission capacity have concerned Finland only when the Nordic water reservoirs have been scant. However, the experts preparing the analysis emphasise that the future challenges must also be taken into account when making the decision.

"The situation may be different in a few years as the new nuclear power unit in Finland and the Fenno-Skan 2 link between Finland and Sweden are ready. Moreover, additional wind power capacity changes the operation of the physical power system," Jyrki Uusitalo says.

He also points out that Finland has heavy-duty connections to the power systems in the neighbouring countries, and any changes in the neighbouring countries may be reflected considerably in electricity transmissions in Finland, too. ■

Counter-trade example



MARKET DESIGN
for a low-carbon future

The functioning of the electricity market is a current topic not only among energy professionals but economists, too. Fingrid invited Professor Richard Green, Professor of Energy Economics and Director of the Institute for Energy Research and Policy at the University of Birmingham, to give a presentation in its Electricity Market Day. Here is a summary of his presentation.

Markets are the best way we know of sending signals about what something costs to produce. In most markets, such as the oil market, people observe the market price and decide whether or not to buy and sell, basing this decision on their own private information on (for example) their production costs. In most electricity markets, by contrast, while there is still a lot of bilateral trading through which two counter-parties discover a price at which they are willing to trade, an auction is used to trade power and schedule production. In this auction, in contrast to the normal market situation, participants give out their private information in the form of bids and offers, and the market operator uses this to calculate a price.

This market price will usually be much higher than some of the offers to generate, since some power stations have very low variable costs and may even find it difficult to *stop* generating for short periods. This means that these stations are being paid a lot more than they need – in the short term – to be willing to operate. If the payments are not needed to cover their fixed costs of building the plant and making it available (and in particular, if the fixed costs of a hydro plant have now been paid off), then we would describe them as economic rents. An economic rent is any payment that someone receives, over and above what they could get from the next best option available to them. Most of the money received by highly-paid footballers, for example, is an economic rent.

Since economic rents are in some sense unnecessary, could we get rid of them in an electricity market? What about paying each generator the amount it offered to sell its power for, rather than the (higher) market price? This idea is attractive for the amount of time it takes to realise that the generators would quickly change their price offers if the auction rules changed.

In the oil market, producers with low costs trade at the going rate in the market, not at a price linked to their costs. Similarly, if an electricity market changed to a "pay-as-bid"* rule, then the generators selling through it would attempt to estimate what the market price would be, and set their offer very close to this level. If their estimates are accurate and the market is sufficiently competitive, there should be no difference in outcomes. If the market is less competitive, a pay-as-bid rule might reduce average prices, but does so at the cost of blurring the signals of what each station's costs are. There is a risk that more expensive stations end up producing power, because they set their offers slightly below those of stations that were in fact cheaper and should have been running instead.

Rather than trying to change the market rules to get rid of economic rents – a task which is likely to be possible only at the cost of a less efficient outcome, if at all – it would be better to deal with them outside the market. Economic rents are an excellent source of tax revenue. Normally, taxing something (such as work) persuades people to do (or buy) less of it, which creates an economic loss. An economic rent is the amount of money that someone did not need in order to persuade them to do something, and so taxing it should not affect what they do. If the government were to tax the profits from written-down hydro plants, for example, it could use the money to reduce some other tax. The tax law would need to be carefully written to ensure that it was just the economic rents that were taxed, of course.

There are even better means

While taxes on economic rents – if they can be made practical – are an excellent source of government revenue, there is one even better source. That is to tax something that is undesirable, such as pollution, since if the tax then reduces the amount of it, we will be better off. Taxing emissions of carbon dioxide is therefore one way of persuading people and companies to reduce those emissions.

Another method, equivalent in many ways, is to use a trading scheme such as the EU Emissions Trading Scheme. Companies must surrender a permit for each tonne of CO_2 that they emit. Some permits are allocated to companies without charge, some are auctioned, and some are traded between firms. In an efficient market, the electricity price will rise by the value of the permits needed by the power station which is setting the price. Even if those permits were allocated without charge, the station is giving up the chance to sell them to someone else when it generates.

While the ETS can send an efficient signal, it will also create rents in the market. Companies with low-carbon generation, or those allocated a lot of permits without paying for them, will gain, while those who needed to buy more permits than the marginal generator will lose. Once again, it is usually better to acknowledge this, and think about redistributing the rents in other ways, than to create an artificially inefficient system in the hope of avoiding rents.

Sometimes, however, it is possible to make a market more efficient without creating (or destroying) rents. In the United States, several electricity markets use a system of nodal pricing, which sets a separate price for every point on the grid. Generators submit offers which include their location and technical abilities as well as the prices they would like to sell at, and the transmission system operator uses these to design the operating schedule – something that has to happen, even in countries with only one price. The system operator calculates the cost of providing slightly more power to each point on the network, and sets it as the price at that point.

This kind of market gives more information on the state of the electricity system than a market with a single price covering an entire country. As the amount of renewable generation, subject to the weather, and distributed generation controlled by consumers increases, the amount of power required from traditional stations will vary much more, and there will be times when some of them are in the wrong place to provide it. Nodal pricing ensures that stations which are able to assist the system operator are given a strong economic signal to do so, whereas stations in an area with surplus power see a low price and have an incentive to generate less. The signals for investment will be more accurate, and so there is less risk that money will be wasted by building in the wrong place.

The potential problem is that nodal pricing will tend to raise prices in some areas, and reduce those in others, creating and destroying rents. Fortunately, there is an efficient way to protect the interests of existing system users. A financial transmission right is a contract that hedges the difference between the market price at one node and a system-wide price, for a fixed amount of power. This reduces the financial risks for all involved, as a generator (for example) will get the same revenue as the system price, provided that it generates the predicted amount of electricity. However, it still faces the nodal price for its actual decisions (the transmission right is for a fixed quantity of power) and so the generator may be able to make more money by changing its output in response to that nodal price.

Normally, the security provided by a financial transmission right comes at a price, so that a generator in a low-price region would have to pay the expected difference between the (higher) system price and its own local price up front, getting back the actual difference later. To ease the task of introducing nodal pricing, however, we could give incumbent generators and customers long-term financial transmission rights, without payment. This would "lock in" their existing financial position, so that they would neither win nor lose from the new market system – unless they change their behaviour in response to the new, more accurate, price signals. By doing so, they can only win.

Markets are the best means we have of discovering what it costs to produce electricity, and hence where we should get our power from. They work because profits depend on the prices that they set, and so companies have an incentive to send accurate signals. They can also create rents, but it is better to accept the existence of these rents – and deal with them in other ways – than to try to distort the way the market works in an attempt – often in vain – to eliminate them. ■

"Markets are the best means we have of discovering what it costs to produce electricity, and hence where we should get our power from."

* In the pay-as-bid model, the bidder is paid the accepted bid price, not the market price, which is determined as the balance price between supply and demand.

Photograph by Rodeo

Impartially to all

The apple did not fall far from the tree even though Petri Parviainen, descendant of a merchant family, chose to study engineering in the past. As a customership manager in Fingrid's grid service, he also needs the skills of a salesman in his work on a daily basis. Ensuring the impartiality of the service requires not only technical expertise but also negotiating skills and an ability to get along well with the most varied people.

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

In Fingrid's grid and transmission service, impartiality is a principle where no compromises are made. "The grid contracts are signed for four years at a time, and they are exactly identical for all parties connected to the grid," Petri Parviainen says.

The signing of the contracts is preceded by a round of negotiations of approximately two years, during which period all customers are heard. Together with his colleague **Heikki Ruhanen** (from 1 July 2009 with **Jarno Sederlund**), Petri Parviainen has been involved closely in this process repeated every four years, from tariff planning to the signing of the contracts.

Optimum solutions

In addition to the electricity transmission contracts, the customership managers are responsible for changes made in the grid. The solutions required by these changes must be agreed with the customers affected by the relevant change. Petri Parviainen says that this area calls for more work than the others, because solutions and contracts which satisfy all parties do not come about easily or quickly.

"It is our crucial duty to acquire information from the customers on how they will use electricity in the future; in other words what kinds of needs they have," Parviainen says.

A change in production by an industrial plant may require considerable capital investments in the transmission grid so that a transmission capacity conforming to the greater electricity need is secured. If Fingrid builds a new substation, for example, the impacts and responsibilities of the project must be ascertained and the contracts must be negotiated with all those parties connected to the grid who are affected by the change.

"The customers think that Fingrid has evolved towards a more negotiating direction."

"First of all, we need to come up with an optimum solution in terms of technology and finances. This is followed by negotiations on the schedule and cost limits; in other words, we find an understanding of the division of the costs between each party involved," Petri Parviainen describes the process.

According to him, the negotiations are demanding because the customers' views concerning the scope of their own responsibility may sometimes differ quite much from each other.

Principles weighed

Petri Parviainen says that in the solutions applied to changes to be made in the transmission grid, the principle of impartial service is weighed especially carefully. Retaining the present excellent system security and transmission capacity in the Finnish transmission grid are among Fingrid's key objectives, and the company must therefore adhere to its main principles – sometimes very strictly.

"It is Fingrid's duty to take care of the functioning of the entire power system in Finland. We cannot promise a customer that the solution adopted is favourable to him, if a solution preferred by the customer translates into deteriorated system security. All our contracts must be open to scrutiny," Petri Parviainen points out.

He adds that the stringent approach may sometimes even be interpreted as one-sided decision-making, but for the most part Fingrid currently receives positive feedback from its customers.

"The customers think that Fingrid has evolved towards a more negotiating direction. They feel that we now seek solutions to problems more openly than before."

Petri Parviainen says that these types of opinions indicate that Fingrid has succeeded in its objective to promote discussion and lower the threshold of contacts.

"We have recently also brought to the discussion table matters that we have not yet thought out thoroughly ourselves. We wish to use an open discussion to expand our view and enhance the contribution of customers."

Impartiality is a principle of Fingrid's where no compromises are made. "Our solutions must be generally accepted and technically of a high quality," Petri Parviainen says.

Discussion on the topical matters relating to the development and maintenance of the grid is conducted for example in Fingrid's Grid Committee, which started its work last autumn and where Petri Parviainen serves as the secretary.

Customership manager is a contact person

Fingrid measures its customers' satisfaction towards its performance and service on an annual basis. On a scale from 4 to 10, the score received by Fingrid from its customers has repeatedly been between good and excellent; the score for grid service in 2008 was 8.8. Fingrid's operations have been considered to be responsible, transparent and cost-effective.

Petri Parviainen thinks that the satisfaction comes from two basic reasons: system security of the grid and price level of transmission service. "These things are alright in Fingrid, no matter what the indicators used are. The technical functioning of the grid is very good, and our transmission tariff is the cheapest in Europe."

He adds that customers also seem to appreciate the fact that Fingrid sticks to its values while managing its basic duties.

Petri Parviainen knows the people in his own customer group over a period of almost 20 years, and he regards functioning personal contacts as a prime requirement for the success of his work.

He feels that he is primarily a contact person in customer co-operation. "I need to know something of each and every ongoing or planned project so that I can engage our proper specialists to the projects at the correct stage."

An important new role in Petri Parviainen's job description is that he is responsible for the customer team which co-ordinates and develops Fingrid's customer service. The team is to make sure for its part that Fingrid's service in transmission and electricity market issues matches the customers' needs.

The composition of the team is "multidisciplinary", crossing organisational boundaries. In addition to the customership managers, the team comprises communications and balance service personnel.

Sensible engineer's work

Petri Parviainen feels that he is "doing the most sensible work that you can with an engineering background". "If I had the skills it takes, I would like to share a workplace with **Tiger Woods**," he says with a smile. He likes working with people and large entities.

"As early as during my studies, I was more interested in power technology than electronics," Petri Parviainen says and reminisces that the large transmission line towers made a great impact on the power fitter trainee who was gazing the towers wearing climbing irons.

"This job gives me a buzz," he summarises his experience of almost 20 years at the customer interface.

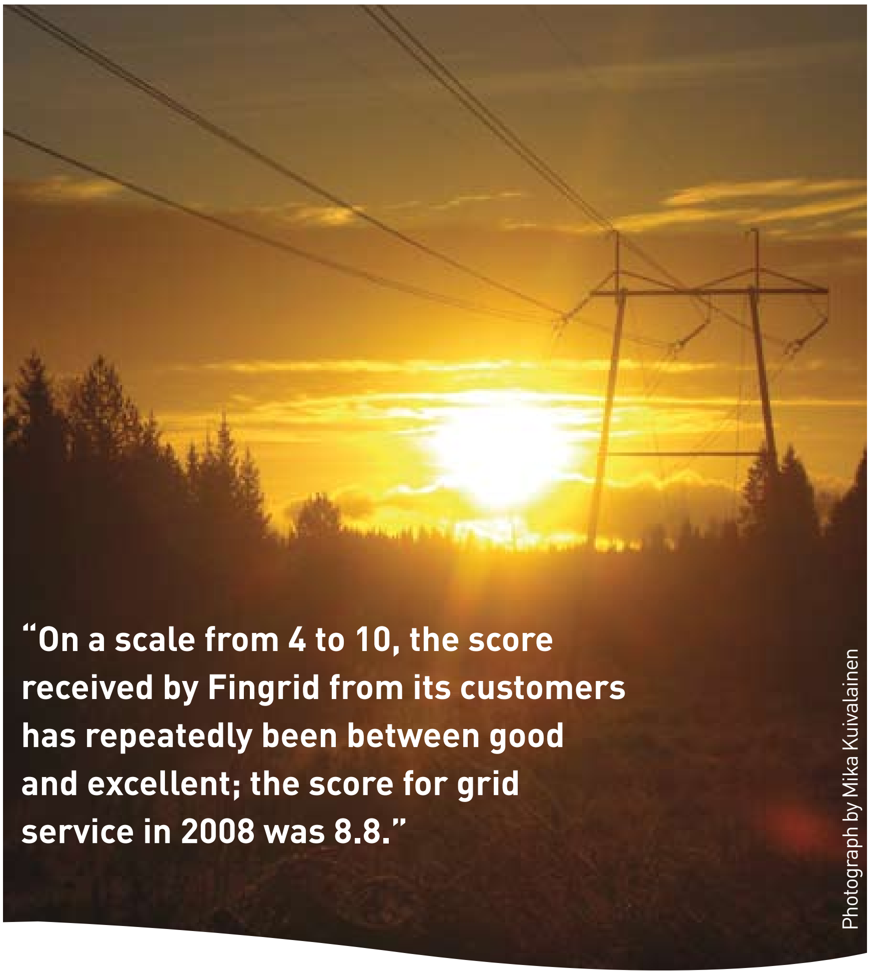
If he had to find a suitable person to replace himself, he would emphasise knowledge of the power system and transmission grid, and also perception and response ability.

"In most cases, you have to grasp things right there and then, and you sometimes have to devise some sort of a solution to problems off hand."

Petri Parviainen thinks that a good customership manager can also be characterised by words such as extrovert and creative.

"You have to be able to negotiate with people without making anyone angry, and you must get along with different types of people."

Despite the challenges of his duties, he is not stressed by work. As counterbalance to the daily grind, he can be found on the golf course in the summer and on the skiing track in the winter. This winter he has also done tour skating, with distances up to 60 kilometres in a single weekend. And when you are skating fast, any problems are sure to shake off. ■



"On a scale from 4 to 10, the score received by Fingrid from its customers has repeatedly been between good and excellent; the score for grid service in 2008 was 8.8."

Photograph by Mika Kuivalainen

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.

Supergrid in Europe?

Text by Matti Lahtinen ■ **Photographs by** Päivi Bourdon and Eija Eskelinen

It has been required that a new supergrid based on direct current technology be constructed in Europe. Electricity can be transmitted using direct current or alternating current. Fingrid has used both of these depending on which method is best suited for a particular need.

The electricity generation units and almost all consumption devices use alternating current (AC). When these are connected together by means of AC lines, the entire system is self-adjusting, in other words changes in consumption immediately cause a corresponding change in the generated and transmitted power. On the other hand, the power of a high-voltage direct current (HVDC) connection must be adjusted separately to correspond to the changed situation, which renders the control of a large system much more difficult.

However, HVDC connections have certain benefits which is why they are already used, and new HVDC connections are also constructed continuously. Long cable links, for example between Finland and Sweden and between Finland and Estonia, have been carried out using HVDC connections. This is also the method for connecting large unsynchronised power systems, for example between the Nordic countries and Russia. Transmitting a very large power from a distant generation area to a consumption area may be advantageous at direct current.

The present Finnish electricity transmission system based on AC works well and it can be expanded flexibly, also for the needs of renewable energy sources. New consumption and generation can be connected to the existing grid by making the necessary additions only, such as connections from the sea to the land. HVDC can also be employed at sea. The normal procedure is that the grid is planned and constructed in stages as new needs emerge to connect new generation units or consumption points to the grid. It is not technically or economically sensible to renew the entire power system in one go.

Differences between AC and DC

The AC transmission grid is meshed in order to improve system security. In a meshed grid, the impacts of a fault can be minimised. A single fault does not usually cause an interruption for the end user.

An HVDC link is typically connected to the AC grid at its both ends, and it consists of a rectifier, HVDC line, and inverter. Conventional HVDC transmission connections have been built using line-commutated converter technology (LCC). This technology is well suited for power transmission between two points, but poorly so for power transmission between several points simultaneously, which is why a transmission grid may not be constructed using this technology.

The newer technology based on voltage source converters (VSC) enables the construction of a high-voltage direct current connection for power transmission between several points; in other words, an HVDC grid is possible. There is not yet a single network of this type in use, so there are no experiences of it. The challenges may include faults in the HVDC grid, and management of load flow in the power system (AC and DC grid together). If the grid is not equipped with HVDC circuit breakers, a single fault will switch off the entire HVDC transmission grid. HVDC circuit breaker technology is expensive and underdeveloped. Management of the entire power system refers to maintaining a balance between generation and consumption both in the entire system and regionally.

The management of transmission powers in an HVDC network can be illustrated by a simple example shown in Figure 1.

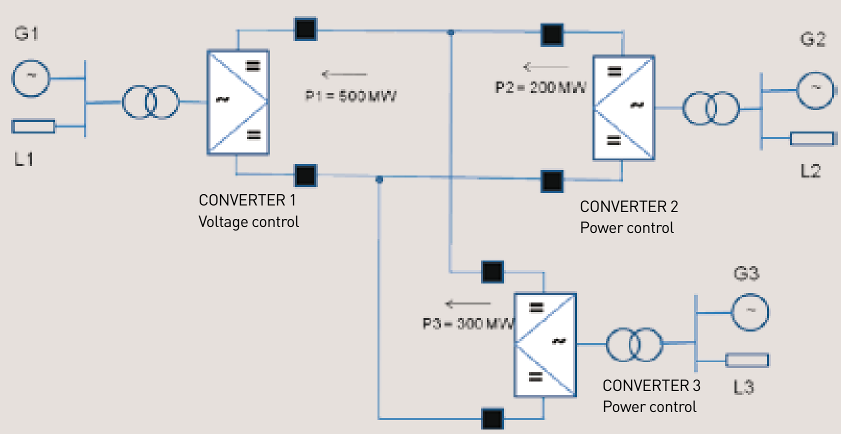


Figure 1. A high-voltage direct current network carried out using three voltage source converters (VSC). Converter 1 takes care of the level of direct voltage, and converters 2 and 3 take care of power control.

In a connection between two points, one converter controls the magnitude of the direct voltage, in other words attempts to keep it constant, and another converter controls the power of the connection. From the point of view of an HVDC network, the converter controlling voltage can be regarded as an ideal voltage source, and the converter controlling power can be regarded as an ideal current source. With this configuration, the power remains constant until the power set value, power of the current source, is changed. In this case, both converters are dimensioned for the same nominal power, so the converters cannot be overloaded.

In the example of three points shown in Figure 1, each of the voltage source converters could be dimensioned for a power of for example 500 megawatts (MW). In this network, one converter must control the direct voltage while the other two can control their own power within their capacity, i.e. ±500 MW. Converter 1, which controls voltage, always receives the sum of power fed into the network by the other two converters (considering the direction of power) within its capacity. If the power sum exceeds the capacity of converter 1, it can no longer maintain the constant voltage.

When adjusting the transmission powers, co-ordination between converter substations is needed. There would be no overloading if converter 1 was dimensioned for a power of 1,000 MW, which is a sensible option, if and only if the prevailing transmission need is from converter substations 2 and 3 to substation 1. In the example network, power transmission can be adjusted to 500 MW in pairs between all converter substations in both directions.

If a supergrid was constructed using VSC technology, it can be expected that the above control method (one converter controls voltage and the others control power) can be applied up to a certain size of the grid, but as the distances increase, several voltage-controlling converters may be needed, in which case the power flow control between these could become challenging.

Impact of technology on the costs

The capital investment costs can be compared for example by dimensioning an AC line so that its costs over a selected transmission distance (for example 800 km) are the same as the costs of an LCC connection at a transmission power of 2,000 MW. With this line dimensioning, an AC line is always the most economical option at transmission distances below the above 800 km. Based on present prices, a connection employing VSC technology is slightly more expensive than an AC line.

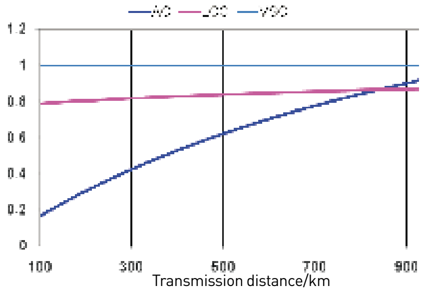


Figure 2. Comparison of investment costs of transmission connections carried out using various technologies as a function of transmission distance with respect to the costs of a VSC connection.

The fact that a converter substation has a shorter economic lifetime than an AC substation also needs to be taken into account in the calculations. Converter substations also need more maintenance than AC substations. These factors have not been taken into account in the comparison of Figure 2.

Differences also in losses

Transmission losses are another crucial consideration. To serve as an example, we can use a transmission connection between two points, having a capacity of 2,000 MW. In a direct current connection, there are two conductors, plus and minus, while three conductors are needed in alternating current. The lines between substations can be dimensioned using various principles, and the comparisons end up in considerably different conclusions. The losses of an LCC converter substation are in the range of 0.7 per cent, and the losses of present VSC substations in the range of 1.7 per cent of nominal power.

1. The cross-sectional areas of the phase conductors are the same, in which case an HVDC line is less expensive, because two conductors are needed in DC and three conductors in AC.

2. The AC line is dimensioned more heavy-duty so that the capital investment costs of the transmission connection are the same in accordance with the above principle at a transmission distance of 800 km.

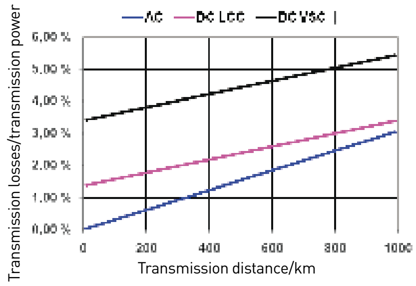


Figure 3. Comparison of relative losses of transmission connections carried out with various technologies at a nominal transmission power of 2,000 MW as a function of transmission distance.

In option 1, the transmission losses of the AC line are the smallest up to a transmission distance of approx. 450 km. At distances above this, the losses of an LCC-type HVDC connection are the smallest. The losses of a VSC connection are always the greatest up to a distance of 1,000 km.

In option 2, the AC connection is always the best option in terms of losses up to a distance of 1,000 km, and because it has the lowest capital investment costs up to 800 km, it is hence the option with the best overall benefits up to that transmission distance.

Controllability of power flows in a transmission system

In an AC system, the structure of the network determines the power flows between the lines automatically, and there is usually no need to interfere with the power flows. The system is also self-controlling, because when a consumer switches on for example an electric stove, electricity generation increases correspondingly; in other words, consumption and generation are always in a balance. In some cases

there may be a need to control power flows, which can be done within a limited range using various instruments such as phase shift transformers.

HVDC connections are equipped with power control. The power of the connection hence remains constant until its set value is changed. The power is therefore independent of power transmissions on other transmission connections. This can be regarded as an advantage in a single connection, but it may be a burden in a network.

The supergrid presumably refers to an electricity highway to be built in addition to the existing alternating current grid, with power being fed from generation into the supergrid and with electricity being distributed to the AC network from the supergrid. In this case, the problem of storage of electricity in a large scale needs to be remembered. It is not sufficient that generation and consumption in the entire power system are in a balance; sufficient regional balance must also be ensured by adjusting the powers of each converter. There must be sufficient electricity generation capacity in regional AC networks so that the generation is able to balance out any power variations of loads.

In the simple system of Figure 1, the power of G1 is controlled as load L1 varies while the power of converter 1 remains constant. So that the system could manage a fault in the HVDC system in the transmission situation of the example, G1 must have an opportunity to raise generation quickly by 500 MW.

If the suggested supergrid was built on top of the existing AC network, areas 1, 2 and 3 in Figure 1 would probably be connected to each other via the AC network, and transmission management would hence be much more challenging than now. The comprehensive control of such a power system requires enormous data communications capacity to relay the measurement and control data, and massive amounts of real-time computing capacity are also needed. These are also required great reliability in order to secure disturbance-free electricity transmission.

Supergrid will probably remain a dream

The technology used must be selected on the basis of technical and commercial factors considering the suitability of the technology for the application, costs of the investment, technical lifetime, and operating costs. The AC network is the best solution for many transmission needs, but HVDC connections are also needed. Also in the connection of renewable energy sources to the grid, the best solution is obtained by combining the most suitable technologies for each application.

In order to control the system security of the power system, heavy-duty and self-adjusting AC trunk networks with high fault resistance will also be needed in the future. HVDC technology can be added flexibly between these trunk networks or as part of them. However, since it is not possible to store electricity in great volumes, sufficient regional generation capacity is also needed to balance load variations.

Responsible and long-term planning is always based on the full utilisation of the existing transmission system before any new connections are constructed. The implementation of new transmission connections does not require new technology, but anticipating grid planning and a flexible permit process. The proposed low-loss HVDC supergrid which would be constructed on top of the present transmission grid and which would solve all transmission needs is primarily a dream and may probably remain one. ■

Old aluminium transmission line towers replaced with new

Photograph by Heikki Puustinen

The last aluminium tower was changed in Sukeva. In the photograph from the left: Fingrid's Project Manager Antti Linna, Eltel Networks' Project Manager Erkki Vaittinen and Site Manager Erkki Kettunen.

Fingrid has completed its major project of several years: replacing 400 kilovolt aluminium towers. A total of 1,300 aluminium towers were changed with steel towers over a distance of 750 kilometres.

The project started south of Oulu in 2000, when thirty 400 kV towers at intersections of the line and other transmission lines, roads or railways were replaced on the Pyhäselkä-Alapitkä-Huutokoski line. The last part of the project concerned the line Vuolijoki-Huutokoski. The project was due to be ready a couple of years ago, but mild winters prolonged the work. The replacement work calls for ground frost so that machinery can access the difficult terrain.

The towers dating from the 1970s had to be changed because of aluminium corrosion. The first signs of corrosion emerged in the early 1980s, when about 100 towers were strengthened or changed. Based on later analyses, Fingrid decided to change all aluminium towers.

The new transmission line towers were erected as close to the old towers as possible. The total costs of the project were approx. 32 million euros. The work was mainly carried out by Eltel Networks, with Empower working on the line between Alajärvi and Seinäjoki. ■

KNOW THE TERMS

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

Transmission capacity ■ What does it mean?

A limited volume of electricity conforming to the system security criteria can be transmitted in a power grid. This is referred to as the transmission capacity of the grid.

The inter-Nordic principles for determining transmission capacity have been recorded in the System Operation Agreement signed by the Nordic transmission system operators. The definitions used in the Nordic countries are consistent with those of ETSO.

The total transfer capacity is the maximum transmission at an intersection (one or more parallel lines) of the grid, at which maximum transmission the safety and system security criteria are fulfilled. The criteria are fulfilled when the grid components are not overloaded and when voltage and frequency remain within the accepted limits. The criteria must also be fulfilled during potential faults in the grid or in electricity generation. In fault situations, it is also required that the fault does not escalate to the other parts of the grid.

The transmission capacity varies as the consumption and generation situation changes. The transmission capacity is calculated using specific computing programs, which include models of the transmission grid as well as of power plants and consumption connected to the grid.

Total Transfer Capacity – TTC

Not all of the total transfer capacity is made available to the electricity market, but some of it is reserved as a transmission reliability margin. The transmission reliability margin is needed so that reserves activated automatically during frequency changes do not result in exceeding the total transfer capacity. The transmission reliability margin also covers the potential inaccuracy of measurements in the real-time operation monitoring of the grid.

Transmission Reliability Margin - TRM

The commercial transmission capacity made available to the electricity market is obtained by deducting the transmission reliability margin from the total transfer capacity.

Net Transfer Capacity – NTC

The capacity made available to the Elspot market between Finland and Sweden differs slightly from the difference between the total transfer capacity and transmission reliability margin. This is so because electricity in Northern Norway and in the Kalix area in Sweden is transmitted via the Finnish grid, and these transmissions are taken into account in the capacity made available to the electricity exchange.

Text by Jyrki Uusitalo

Contracts secure good maintenance management

During the next three years, maintenance management for Fingrid's substations is in the hands of Empower Oy, Infratek Finland Oy, Kemijoki Oy, and Voimatel Oy. The new contracts came into force at the beginning of 2009.

Text by Timo Heiskanen

Fingrid has signed contracts on the maintenance management of substations for the period of 2009 to 2011 with four service providers. The value of the contracts during the contract period is approx. 10 million euros, and they cover basic maintenance, local operation and stand-by services including materials, spare parts and subcontracting services for substations owned by Fingrid. Moreover, the contracts cover the basic maintenance services for substation components at Fingrid's reserve power stations.

Fingrid's maintenance management responsibility covers more than 100 transformer and switching substations, some 150 disconnector stations, and 9 gas turbine power plants.

The process was carried out as a public procurement, and the negotiation procedure was applied to it. The procurement was divided into eight geographical work areas, with a supplier chosen for each of these using uniform economic criteria.

In the selection criteria, costs had a weighting of 75 per cent and operational quality 25 per cent. The costs are composed of stand-by service, work carried out at unit prices, performance work, remote expenses, and subcontracted work.

Because of the nature of transmission system operation, the remote costs are a significant portion of the total costs. Stand-by service represents fixed-price services. Maintenance of equipment is typical work carried out at unit prices. Issues such as local operation and fault repairs of substations as well as materials procurement represent performance work. Subcontracting includes services related to real estate technology, for example. The quality of the operations was evaluated using criteria such as availability of service, its quality, and references.

The foremost changes as compared to the previous contract period were that one work area, South-Eastern Finland, was added, and that the amount of work carried out at unit prices was increased.

Special maintenance management services for substations, such as equipment modifications, overhaul of circuit breakers, or maintenance of on-load tap changers, is procured through site-specific or fixed-period contracts. Maintenance management for protection relays is procured through fixed-period maintenance management contracts for secondary devices.

Maintenance always subjected to competitive bidding

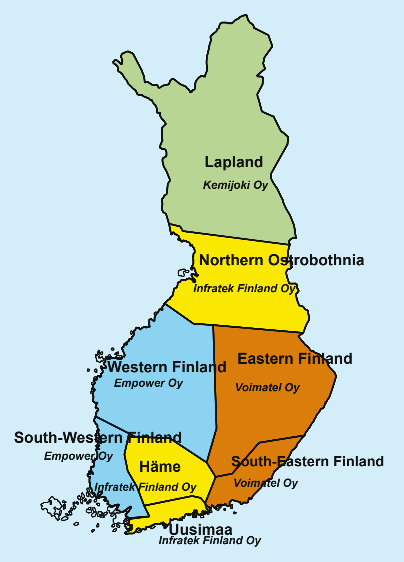
Basic maintenance for Fingrid's substations has been covered by competitive bidding since 1997. The service procured was expanded in 2001, when local operation for substations was first ordered completely from service providers.

The main principles – competitive bidding, specification of the procured service using in-house technical specifications, and division of the procurement into work areas – have remained the same. The number of work areas has varied, and at present there are eight work areas. The number and quality of the technical specifications has increased considerably over the years. The most recent procurement relied on a total of some 60 technical specifications, guidelines and purchasing conditions. Operators of regional networks have also acquired these technical specifications from Fingrid. The goal has been that as many network operators as possible would use the same documents in the procurement of services and that they would develop the documents jointly.

Operational quality has gained more and more focus in the selection criteria of suppliers. Related supplier feedback has been compiled systematically since 1997. The compilation of feedback concerning Fingrid from the suppliers was also launched in 2008. The compilation and analysis of feedback are enhanced further.

One indicator of a supplier's quality is the annual amount of bonus paid to suppliers for successful performance. This amount is influenced by factors such as execution of work on schedule, documentation, disturbances caused by personnel, taking care of environmental matters etc.

Audits of service suppliers were launched in 2003. Relating to substation maintenance, about a dozen different work performances by various suppliers have been audited in the various work areas; in other words a total of more than 50 work performances. The material accumulated of the audits is reviewed with the suppliers, and the development needs by both the client and supplier are recorded. ■



Maintenance of Fingrid's substations is divided into eight work areas.

Electricity museum Elektra

10 years of electric history

Text by Kimmo Kyllönen and Pekka Niemi

Photographs by Juhani Eskelinen

The establishment of electricity museum Elektra in Hämeenlinna at the end of the 1990s coincided with the period of great changes in the Finnish power system. Many renowned energy companies, such as Imatran Voima Oy, Hämeen Sähkö Oy and Hämeenlinnan Energia, were reaching their final stages as businesses.

The idea to establish a museum presenting electrification combined the heritage project ideas which had arisen within nation-wide transmission operation and in the area of the Vanaja power plant in Hämeenlinna. The electricity museum was founded on the Vanaja power museum established by the Vanaja power plant and **Matti Niinivaara**, head of the operation district. It was built in Kivikamari, which currently serves as Fingrid's conference room, at the end of the 1970s. Another prominent pioneer was **Paavo Luoko**, who worked as a superintendent at the Virkkala transformer substation. He compiled photographs, items and documents from power stations, line areas and substations in the early 1970s.

However, the actual museum project was prompted by coincidence: the alternating current model of the nation-wide transmission grid purchased jointly by the Helsinki University of Technology and Imatran Voima Oy in 1957 became under a threat of being scrapped.

The grid model represents the history of the construction of the Finnish transmission grid in a special and significant manner. The decision to engineer the Finnish grid through Finns' own expertise and tools describes the Finnish approach very well. Students of electric power engineering at the Helsinki University of Technology and Technical College of Helsinki used the grid model for years to do their exercises.

The decision concerning the establishment of a museum and the procurement of the grid model was made by the Board of Directors of IVO Voimansiirto Oy towards the end of 1996. The changes in the corporate environment in those days were swift, so Suomen Kantaverkko Oyj, later known as Fingrid Oyj, became the owner of the museum, and Fortum Oyj became the landlord for the museum facilities.

The basic exhibition of the museum was set up in 1998. The exhibition team wanted to use everyday surroundings to tell about the change and development brought by electrification.

Elektra's initial exhibition represented a very modern way to build museum exhibitions. The items were embedded in sceneries of their respective eras, and the overall picture is still quite fresh.

However, a good museum also entails living action and new exhibitions. Elektra has consequently changed its appearance many times over the past 10 years. The revision of the basic exhibitions began in the summer of 2004, and this work is still continuing. Feedback compiled in 2004–2006 gave the

idea to erect an experimental department for children. The museum was also made more interactive by acquiring a functioning Tesla transformer. At around the same time the museum was also given its own mascot, Voltti the electric rabbit.

Exhibitions presenting special topics have been included in the museum at intervals of approx. 2 to 3 years. The present one, "From amber to technology" continuing until the end of this year, is the fifth such special exhibition. The exhibition presents the early stages of electrical research from the ancient Greece to the early 20th century. The earlier themes have included the nation-wide transmission grid, control room work, Gottfrid Strömberg, and electrotherapy. The next theme exhibition will be opened in the spring of 2010.

Elektra has also created contacts with educational establishments; of all visitors in 2008, almost half came from schools. Moreover, the museum has arranged teaching in themes relating to the history of electrification in two schools in the Hämeenlinna area. The objective is to increase this type of co-operation in the future.

Elektra's exhibitions offer history, technology, insight, experiences, and things to experiment with all senses. The various departments shed light on the history of electrification from the 19th century to the 1980s. The more than 50 centimetres long arc discharges from the Tesla transformer have been the highlight of the museum tour for almost 2 ½ years. The museum also presents the development and construction history of the Finnish transmission grid, and the experimental department offers an opportunity to examine the basic phenomena of electricity in a safe and illustrative manner under the instruction of Voltti the electric rabbit.

In the first years, the museum was only open in the summer, and the number of visitors was fairly low. Since 2005, the number of visitors has increased by some 400 every year. The museum is not yet open throughout the year, but thanks to permanent personnel, groups making an appointment in advance have access to the museum around the year. In 2008 the number of visitors grew to 2,300; most of the visitors came in a group.

The year 2009 will bring considerable changes to the work of the museum. Instead of the earlier annual sponsorship contracts, there is now more long-term funding, which will stabilise and facilitate the operations. Elektra aims to be not only a good museum recording the history of electrification and the nation-wide transmission grid, but it intends to be the best electricity museum in Finland. The development of the museum will continue on a steady course towards the future years. ■

Photograph by archives of electricity museum Elektra

80 years since the first steps of the Finnish transmission grid

The construction of the backbone of the Finnish electricity transmission system was launched 80 years ago. The first 110 kilovolt line between Imatra in Eastern Finland and Turku in Western Finland was taken into use on 16 January 1929. Since then, the transmission grid has expanded to the whole of Finland, now conveying most of the electricity consumed in Finland.

The introduction of the first high-voltage line from the Imatra power plant to Turku is one of the primary milestones in the history of electricity transmission in Finland. This was also the first major nation-wide project carried out by Finland. It launched the development of the nation-wide grid, which is now one of the best electricity transmission systems in the world.

The transmission grid was initially constructed by various industrial players. The industrialisation of Finland absolutely called for an electricity transmission infrastructure. After decades of various construction phases, the ownership of the Finnish grid shifted to the nation-wide transmission system operator in 1997. At present, transmission system operator Fingrid owns the Finnish grid and all significant cross-border connections. There are approximately 14,000 kilometres of transmission lines and 106 substations

The idea to transmit electricity over longer distances first emerged in Continental Europe at the end of the 19th century. Over time, the idea also adopted in Finland made grid builders and decision-makers understand the true significance of electrification for society. Electricity and its transmission have become an indispensable infrastructure.

The Finnish transmission grid administered by Fingrid consists of 400, 220 and 110 kilovolt transmission lines. High voltage levels are used in the grid over long transmission distances and at high transmission powers so as to reduce the losses inevitably arising in electricity transmission. ■

Agreements for electricity transmission from Russia to Finland for 2009

Photograph by FutureImageBank

Fingrid has concluded agreements with three electricity importers on electricity transmissions from Russia to Finland in 2009. The commercial capacity of the Russian cross-border connections totals 1,300 megawatts (MW).

The following enterprises will import electricity on Fingrid Oyj's cross-border connections from Russia: Fortum Power and Heat Oy (405 MW), RAO Nordic Oy (645 MW) and Scaent AB (250 MW). In accordance with a report submitted by Federal Grid Company (FGC "FGC UES"), the Russian TSO, the Russian electricity seller INTER RAO UES has agreed on electricity supply from Russia to Finland with the said enterprises. Fingrid's transmission agreements with the electricity importers have a duration of one year.

In Fingrid's new transmission service agreements for 2009, the 100-minute guarantee (so-called priming) will be abolished from imports in disturbance situations, and the pan-European trading day (CET) used by the Nordic electricity exchange Nord Pool Spot will be applied to electricity imports from Russia. There is ongoing development work with the Russian parties to amend the transmission conditions for imports of electricity from Russia so that the electricity market could be served better. The objective is to introduce the new, increasingly market-focused import conditions during 2009. ■

Grid Quiz

Competition to the readers of Fingrid Magazine

Answer the below questions and send your reply by fax (number +358 (0)30 395 5196) or mail to Fingrid no later than 31 May 2009. Address: Fingrid Oyj, PL 530, FI-00101 HELSINKI, FINLAND. Mark the envelope with "Verkkovisa".

Among all those who have given right answers, we give 5 Sagaform's grill skewers with handle 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.

In accordance with the obligations imposed by the EU, the portion of renewable energy sources of all energy used in Finland in 2020 should be
- ○ 17%
- ○ 38%
- ○ 49%.

The objective of the Government of Finland concerning the wind power generation capacity of 2,000 megawatts means that the present wind power capacity will have to grow
- ○ 6-fold
- ○ more than 13-fold
- ○ more than 20-fold.

The charter of ENTSO-E (European Network of Transmission System Operators – Electricity) was signed by
- ○ 18
- ○ 35
- ○ 42 transmission system operators.

The first pan-European grid plan drawn up by ENTSO-E is due to be ready in
- ○ 2009
- ○ 2010
- ○ 2020.

The grid plan shared by the Nordic countries and the Baltic region concludes that the quickest, most economical, and in terms of market benefits, the most viable option is to construct a transmission connection
- ○ between Sweden and the Baltic countries
- ○ between Finland and Estonia (Estlink 2)
- ○ between Lithuania and Poland.

The portion of Fingrid's transmission fee of the consumer price of electricity is about
- ○ 3%
- ○ 7%
- ○ 11%.

The first line in the Finnish transmission grid was completed 80 years ago. The line extended from the Imatra power plant to
- ○ Turku
- ○ Tampere
- ○ Helsinki.

The Nordic electricity exchange Nord Pool Spot accounts for approximately what percentage of the trading concerning electricity consumed in the Nordic countries?
- ○ 20%
- ○ 70%
- ○ 80%.

Name ____________________

Address ____________________

Post office ____________________

E-mail address ____________________

Telephone number ____________________

Winners of prizes of the Grid Quiz in the previous Fingrid magazine (3/2008): Tuomo Humina, Kokkola; Arto Köykkä, Muhos; Timo Routanen, Kärkölä; Kauko Vierimaa, Oulunsalo and Veli Wirkkala, Porvoo.

Illustration by Tuija Sorsa

On the different aspects of positive energy

A female friend of mine is walking to the corner store in Hyde Park in Chicago. She is stopped a couple of times, and even more people comment on her appearance.

Why? Has she left the fly of her jeans open? Is she comically ugly? Or extraordinarily sexy? Or is it all about a hold-up? I guess that a Finnish reader who has never visited the United States cannot answer this question correctly.

Well...? The people who stopped my friend and talked to her were naturally women who praised her hairdo, colour of her coat, or the trendiness of her shoes!

We all know that. Americans have always been characterised with positive terms such as energetic, happy and friendly. Or criticised: when a Finnish-Lutheran comes across such a string of adjectives, his eyes narrow instantly. "It's all so artificial and shallow..."

Even though I prefer a happy grin over a sour face and consider myself to be quite extrovert, before leaving for Chicago I also contemplated the possibility that the American positiveness might go to the extremes.

First of all, my suspicions had a political dimension: Do they all really favour positive thinking in the lines of: "There are no social structures, politics or power; it's all up to you! Just put on a smile, and your worries will soon be a thing of the past!"

Secondly, it is a fact that over-vivacity is hideous, especially before noon. Besides, it often entails a treacherous, compelling side meaning: "Oh, if you don't want to join the silly dance or hug the nearest tree, you grouch, you'll be sorry!"

The type of energising of people known as "positive thinking" is not really that common as a philosophy pontificated to others here in the United States.

Of course, you can see success guides written by white people. They always carry the same advertising slogan: "If I can do it, you can do it, too!" Anyone saying this admits that he is a fool, which is sympathetic. But the idea that the success of some people might sometimes require unsuccess by others is not presented even as a distant alternative.

Books on "how did I do it" are written by those who have found the formula to success. Even though this may appear to substantiate the validity of this positive message, it is actually quite the opposite. It would be much more convincing if someone publicised his success strategy as a hypothesis before his own success – and only then achieved the success. But who would buy a book that would end like this: "By the way, make sure to read part 2 to see how I did..."

The United States oozes with another type of positiveness, everyday exuberant kindness. In a store, a total stranger may receive a smile which in Finland is not bestowed even upon a loved one returning from a long journey. A neighbour is delighted by my negligible fortune in the same way that the early Christians must have been overjoyed by the miracle of sacrament. And everyone wishes you a pleasant day so frequently it disturbs your own thinking.

And how does all this make a laconic Finn feel like? Just good. Not at all unnatural or superficial – only pleasant. That surprised me. Maybe I have become old, but I fail to see anything negative in all this.

Well, maybe the small talk rituals are a bit too elaborate for a Finn. You have to slow down your walking pace just to be able to go through the entire litany within a hearing distance. But you can only blame yourself for this moderate awkwardness.

Where is the power plant from which Americans draw all this? God forbid, it cannot be the legacy of Puritanism! I think that ultimately the American energy wells from the Black Deep South, its dark and tested depths.

Even though the Black Deep South has had to endure many hardships, it has only given the world positive things, no matter whether we are talking about music, food or joy of life. ■

Tuomas Nevanlinna is a writer, columnist, debater and translator as well as a member of co-op Lektio, living in Helsinki. He has written books such as "Antero joutuu luontoon" (Teos 2004), "Nurin oikein" (Teos 2006), and "Kuninkaista ja narreista" (Kirjapaja 2006).

The writer is living in Chicago, USA, until next summer.


Photograph by Juhani Eskelinen

Contracts on continued maintaining of power reserve capacity

Based on inquiries for quotations concerning new power reserve capacity, Fingrid has concluded contracts on the maintaining of peak load power with the producers for the remaining period of the relevant act, 1 March 2009 to 28 February 2011.

The second contract period covers the same power plants as the previous period: Mussalo 2 owned by Nokian Lämpövoima Oy, Vaskiluoto 3 owned by PVO Huippuvoima Oy and Kristiina 1 owned by PVO Lämpövoima Oy. The total capacity of the power plants is 600 MW.

The annual costs for maintaining the power reserves increase to 13 million euros as a result of the new contracts. The increased costs are based on the need for servicing the power plants during the contract period, necessary alteration work, and a general rise in the cost level.

Based on the costs caused by the new contract period and estimated electricity consumption in Finland, the power reserve fee will increase from 0.15 EUR/MWh to 0.18 EUR/MWh from 1 April 2009. The fee will be revised when needed to correspond to the actual costs and electricity consumption. ■

Dimensioning fault in the Finnish power system temporarily to 1,300 megawatts

The electrotechnical protection changes at the Olkiluoto nuclear power plants have raised the dimensioning fault in the Finnish power system from 865 megawatts to 1,300 megawatts.

The power system makes constant preparations for the most serious individual fault, known as a dimensioning fault. In the Finnish power system the dimensioning fault has been 865 megawatts (MW) corresponding to a situation where one nuclear power unit at Olkiluoto trips from the grid.

Electrotechnical protection changes have been made at the Olkiluoto nuclear power plants in order to secure nuclear safety. These changes influence the behaviour of the plants during grid faults. The Olkiluoto plants decrease their power on a short-term basis in the event of short circuit in the nationwide transmission grid in the adjacent area. In about one minute, the power of the plants is restored to almost normal. This results in the increase of the dimensioning fault in the Finnish power system to 1,110-1,300 MW depending on the operating situation of the power plants on the west coast.

In order to control the situation, the import capacity from Sweden has been reduced by 100-300 MW, and the present maximum import capacity is hence 1,750-1,950 MW. The protection changes at Olkiluoto have no impact on the export capacity.

The import capacity into Finland for the next day is defined on the basis of the forecasted operating situation, and it is published on Nord Pool Spot's website daily. TVO, the owner of the Olkiluoto nuclear power plants, together with Fingrid is examining measures which enable returning to the former dimensioning fault. ■

Photograph by Kuvaliiteri

European TSOs established new organisation ENTSO-E

The European transmission system operators (TSOs) established a new organisation ENTSO-E in December 2008. A total of 42 TSOs from 34 countries signed the charters of the organisation. The new organisation comprises TSOs from Iceland to Cyprus and from Finland to Portugal. ENTSO-E commenced operations in early April 2009.

The European TSOs established the new organisation so as to develop the electricity market within the European Union and to intensify TSO co-operation. The establishment is related to the third legislative package on the energy market in the EU and to the EU's energy and climate package, which require active co-operation from TSOs. All TSOs in the EU countries and in countries which have signed an agreement on the single electricity market with the EU can join the organisation.

The organisation aims to promote electricity market integration within the EU and create market and security of supply rules related to transmission grids in co-operation with the Commission of the EU and with ACER (Agency for Cooperation of Energy Regulators). ENTSO-E is also to draw up ten-year plans for grid development, monitor the trend in security of supply, and prepare shared procedures to support grid operation.

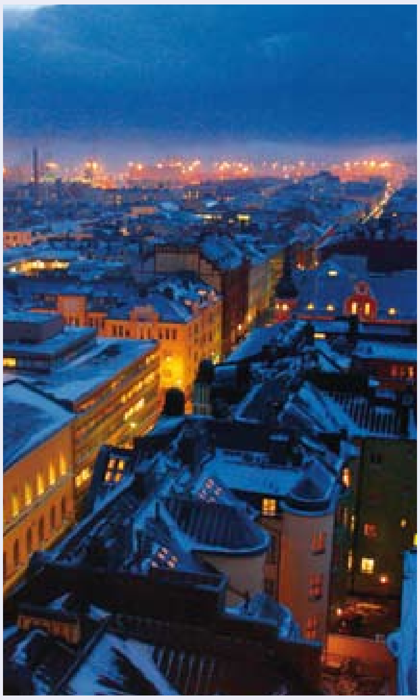
The supreme decision-making body of the organisation is the general assembly where all the members are represented. ENTSO-E is headed by a Board with 10 members, representing the various regions of Europe. Subject to the Board, there is a Market Committee, System Development Committee and Operations Committee as well as a group for legal affairs, with all members having an opportunity to name their representatives to these. Functional and regional groups work under the committees.

The practical efforts are in the hands of a co-ordinating secretariat in Brussels, consisting of 10 to 20 persons. The objective is that ENTSO-E makes decisions unanimously, but ultimately decision-making follows the same patterns as that in the Council of the European Union.

The President of ENTSO-E is **Daniel Dobbeni** from Belgium, and the Vice President is Fingrid's President and CEO **Jukka Ruusunen**. **Graeme Steele** of Great Britain serves as the Chairman of the Board. The actual work in ENTSO-E is carried out in the three committees, with Fingrid's Executive Vice President **Juha Kekkonen** serving as the Chairman of the Market Committee.

Konstantin Staschus started as the Secretary General of ENTSO-E in March 2009. He is originally from Berlin, but he has studied and worked for a length of time in the United States for example at Pacific Gas and Electric, and in German trade organisations, most recently as the Managing Director of VDN, the Association of German Electricity Network Operators. ■

Fingrid Group's annual report and financial statements published on the Internet


Photograph by Vastavalo

The financial statements of the Fingrid Group for 2008 were published in February. The annual review, report of the Board of Directors and financial statements have been published on the Internet at www.fingrid.fi/portal/in_english (under Investors). The publications have also been printed, and the printed versions can be ordered from Fingrid's communications.

Revenue of the Fingrid Group in 2008 was 382 million euros (335 million euros in 2007). Grid revenue decreased slightly despite the 4.5 per cent tariff increase carried out at the beginning of the financial year. This was mainly due to the rapid decline in global economy, which is why electricity consumption by Finnish industries went down quickly towards the end of the year.

The IFRS operating profit of the Group was 68 (91) million euros. Fingrid introduced hedge accounting in Group reporting for electricity derivatives as of 1 July 2007. The Group's profit for the year was 28 (42) million euros. The return on investment was 5.8 (7.3) per cent and the return on equity 6.6 (10.3) per cent. The equity ratio was 26.7 (27.5) per cent at the end of the review period.

As a result of the recession in economy, electricity consumption in Finland in 2009 is expected to decrease further. Despite this, Fingrid will continue the implementation of its extensive capital expenditure programme. The major capital investments have a negative impact on the cash flow, and they will require further borrowing. ■

New balance service model introduced

A new Nordic balance service model was introduced at the beginning of 2009 in Finland, Sweden and Denmark. This reform will harmonise the rules of balance power trade in the Nordic countries.

The main changes include the handling of electricity balances in two different balances – production and consumption balance – and the harmonisation of costs included in balance service. A so-called two-price model is applied to the balance deviation in the production balance, and a single-price model is applied to the balance deviation in the consumption balance. Another major change was that production plans and regulating power bids must now be submitted 45 minutes before the beginning of each hour.

The introduction of the new model involved considerable information system changes for nation-wide balance settlement in Finland, for example the launching of a new Extranet service for the balance providers.

Fingrid and the balance providers have signed balance service agreements for 2009 and 2010. The number of balance providers operating in Finland grew by one, with the total number now being 25.

"The new model has been in use for a couple of months now, and the final balance settlement for January is being completed on schedule. Of course, there have been many things to examine in balance settlement and human errors have occurred, but everything has been solved in good co-operation with the balance providers. Considering the magnitude of the change, we have managed this job well," says Fingrid's Balance Service Manager **Pasi Aho.** ■

Photograph by FutureImageBank

Photograph by Rodeo

FINGRID OYJ

Arkadiankatu 23 B, P.O.Box 530, FI-00101 Helsinki • Tel +358 30 395 5000 • Fax +358 30 395 5196 • www.fingrid.fi

Helsinki
P.O.Box 530
FI-00101 Helsinki
Finland
Tel. +358 30 395 5000
Fax +358 30 395 5196

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

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

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

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