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FINGRID

Grid and future winds
page 4

What will happen to winter?
page 14

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In this issue:

Editorial

System security ensured through preparations for the worst case scenario

The good system security of the Finnish electricity transmission grid is the result of efforts extending over decades. The technical solutions applied have been successful, and our grid is highly resistant to faults and weather phenomena. Of course, not all disturbance situations can be avoided. Disturbances in the transmission grid are caused by thunderstorms, technical faults, and sometimes human error.

Thanks to our looped grid, the disturbances are not usually reflected in the customers. Disturbances in the transmission grid have caused an average outage of only a couple of minutes per year to consumers.

Grid operation makes constant preparations for the worst single fault, which most usually means the sudden tripping of the largest power plant from the grid. The grid must withstand the consequences of the fault, and the grid must be restored in 15 minutes to withstand the next fault.

In practice, the Nordic grid forms a system which is operated together and whose regulating resources and reserves are utilised jointly. This brings benefits to all parties.

A power system always involves the risk of not only local disturbances but also a risk of a major disturbance, even one covering the entire country. There were several large-scale outages in the world in 2003, and a general blackout struck many countries in Continental Europe in 2006.

Preparations for a major disturbance include issues such as good advance planning, backing up of critical data systems, and exercises arranged in advance. Shared exercises, also arranged on a Nordic level, are an essential component of contingency planning. Fingrid's modern operation control simulator allows operating personnel to train the clearing of serious disturbance situations regularly, much in the same way as pilots train for emergencies.

The next decade will bring new challenges to grid operation in Finland. In line with the third nuclear power unit at Olkiluoto, the largest production unit in the Nordic countries will have a power of 1,600 megawatts. The larger the unit that can trip from the grid, the better the related preparations must also be. This is why Fingrid is adding the volume of reserves by constructing gas turbine power plants and by aiming to have a higher consumption volume as reserves.

Large-scale new wind power, in turn, will mean that the grid will be supplied with electricity whose power varies more than with other types of production. This will increase the need for regulating power. In the next 10 years, Fingrid will invest 1,600 million euros in the Finnish grid and reserve power. These capital investments will secure the connection of new electricity production to the grid and hence also elevate system security.

New cross-border transmission connections are being constructed as a result of the integration of the electricity market. Grids which are interconnected through reinforced transmission connections improve system security, because in critical operating situations there is a chance to get help from a neighbouring country. Trade in reserves between systems is also possible.

Will there be enough electricity in Finland next winter? Consumption will rise to peak figures during very cold weather, when electric heating is used extensively. It is possible that the milestone of 15,000 megawatts in Finland will be broken next winter. If the very cold period continues for a length of time, the structures and buildings cool down, people buy additional heaters, and consumption grows even further.

In the event that the wholesale price of electricity rises high, industrial consumption provides flexibility to alleviate the situation. In any case, domestic electricity production capacity is not sufficient to cover the consumption during peak demand, which is why electricity must also be imported from abroad. Calculations suggest that we can manage a situation of a very cold winter day encountered once in 10 years. Problems may occur if a cold front reaches Finland and its adjacent areas simultaneously, in which case imports from the neighbouring countries are reduced. Faults in electricity production in Finland may also complicate the situation.

Fingrid is responsible for the reliability of the Finnish power system and makes sure that even difficult operating situations are managed well. Fingrid's main duty is to keep the lights on in the whole of Finland – also when it is cold.

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

Fingrid making preparations for **Varying winds**

The plans of the Government of Finland concerning the multiplication of wind power generation will pose a challenge to the transmission grid. Fingrid is making investments worth 1,600 million euros in the grid and reserve power in the next 10 years. This will enable the connection of one large nuclear power unit and 2,000 megawatts of wind power capacity to the Finnish grid by 2020.

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

"2,000 megawatts of geographically decentralised wind power can be added to the Finnish power system," says Jussi Matilainen who has been responsible for the wind power analysis at Fingrid.

Fingrid has studied the impacts of additional wind power generation on the Finnish electricity transmission grid from three perspectives: from the aspects of system security, adequacy of transmission capacity, and the electricity market. **Jussi Matilainen**, specialist on transmission forecasts and models, has been responsible for the analysis at Fingrid.

New reserve power needed

The Nordic countries have a joint agreement on the principles of connecting wind power plants to the grid. "Nordel's connection code defines the technical minimum requirements which concern all wind power plants and turbines with a nominal power in excess of 10 megavolt amperes. National rules can be added to the code," says Jussi Matilainen.

According to him, wind power is a challenging form of electricity generation from the point of view of power system security. Its most critical issues are related to power balance management and availability of regulating power. Wind variation within one hour causes a power change which is estimated to represent one quarter of the nominal power of wind electricity. "Hence, 2,000 megawatts of wind power capacity calls for preparations for a power change of 500 megawatts," says Matilainen.

If wind power accounts for a large portion of the power system, the most challenging situation would be encountered when the wind turbines stop because of a storm. "However, the likelihood of all wind power units stopping at the same time is not very high, especially if the units are decentralised geographically."

"In 2020 we may be in a situation where the largest power plant which may trip from the grid is 1,600 megawatts, and it can be assumed that the largest power change in wind power is of the same magnitude."

In any case, Fingrid has to make preparations for sudden and comprehensive power changes in wind power generation. From the point of view of power system security, these changes are considered equal with other production disturbances, for which Fingrid has now more than 1,000 megawatts of fast-starting disturbance reserves. According to Jussi Matilainen, however, large-scale additional wind power capacity may require that the reserves be increased.

In assessing the need for disturbance reserves, Fingrid's starting point is that reserve power sources must be capable of replacing the power provided by the largest unit in the power system when such unit trips from the grid. "In 2020 we may be in a situation where the largest power plant which may trip from the grid is 1,600 megawatts, and it can be assumed that the largest power change in wind power is of the same magnitude," Jussi Matilainen estimates. This is why Fingrid is making preparations for constructing 100-400 megawatts of additional reserve power capacity. The company also has plans to utilise existing capacity through usage right contracts and by signing new contracts on disconnectable loads.

Need for regulating power on the increase

One of the major uncertainties involved in wind power is its availability during peak demand situations, which are critical in view of the reliability of the power system. You cannot control winds, so the availability forecasts must be based on estimates drawn up on the basis of long-term wind measurements.

Fingrid has calculated that 6 per cent of the installed wind power capacity is available during a peak load period. This estimate is based on a likelihood of 90 per cent.

"In other words, when assessing the adequacy of generation capacity, we can conclude that of the installed nominal total capacity of 2,000 megawatts, only 120 megawatts is available during a peak load period. This does not really improve the power balance in Finland during critical moments," Jussi Matilainen states.

According to him, increased wind power generation will inevitably raise the need for regulating power. New alternatives are needed alongside hydropower and condensing power plants, the conventional cornerstones of adjustable power generation. "Fingrid is involved in analysis work aiming to level out the electricity con-

Wind power was a topical theme in Fingrid's Grid Day arranged in early September. The audience were told that Fingrid is prepared for the changes and will contribute to protecting the climate by implementing an extensive capital expenditure programme of 1,600 million euros.

sumption peaks by using more flexible consumption patterns than now," Matilainen says. As an example, it is already technically possible to control direct electric heating on the basis of the price level of electricity.

Transmission grid needs reinforcements

Reliable power transmission is one of Fingrid's key duties. The company must attend to the adequacy of transmission capacity from the viewpoints of both system security and functioning of the electricity market. Jussi Matilainen's analysis concludes that increased wind power generation will raise the electricity transmission needs.

"Electricity transmissions will be increased by power transmissions from a wind turbine or plant into the grid and by the management of variation between wind power generation and other types of generation. Moreover, we need to be able to level out power variations between wind power units and between wind power generation and consumption," Matilainen says. In his analysis, he has examined the reinforcement needs of the grid from the viewpoint of Finland and also from the point of view of the entire inter-Nordic electricity market area.

The combined wind power capacity in the Nordic countries is now about 4,400 megawatts, but based on various scenarios, it is expected to rise up to 20,000 megawatts by 2020.

"New transmission lines need to be constructed. In Finland, the grid in Ostrobothnia in Western Finland needs to be upgraded to the 400 kilovolt voltage level. Moreover, a third alternating current overhead line is needed between Finland and Sweden to equalise generation variations and to utilise the regulating power and reserve capacity within the entire market area," Jussi Matilainen lists the upcoming grid investments.

According to him, Fingrid's objective continues to be to maintain the good system security of the Finnish grid also in the future. In practice, this has meant in recent years that outages caused by disturbance situations in the nationwide grid have been limited to less than 2 minutes per connection point.

Objective: impartiality

Fingrid has assumed impartiality as one of its foremost values. From the aspect of the electricity market, this means, among other things, equal treatment of various forms of electricity generation in grid connections, transmissions and their pricing.

"Wind power producers – like other electricity producers – must themselves pay the costs caused by their grid connection and take care of the sales of their electricity. And like other electricity producers, wind power producers must also take care of maintaining their production balance."

Jussi Matilainen emphasises that it is important that the costs of wind power generation are transparent and that the costs are allocated fairly. "There must be no hidden subsidies," he points out. When on the market, you need to play by the rules of the market.

According to Jussi Matilainen, one warning example in this respect is Germany, where wind power has been given exemptions for example from connection fees, and also other types of hidden subsidies. In the lack of business incentives, the solutions applied there – such as placing of wind power units in unfavourable areas – have been inefficient and unprofitable in view of the entire system.

Challenges under control

According to Jussi Matilainen, there are ongoing surveys concerning wind power projects for more than 4,000 megawatts in Finland. Considering land use restrictions (nature protection areas etc.) and referring to various analyses, he considers that Finland could have 5,000 to 9,500 megawatts of wind power potential. However, not all surveys lead to construction decisions; Fingrid's strategy is based on a growth estimate of 2,000 megawatts.

In addition to wind power, many other factors also impose new challenges on Fingrid. "Reinforcement of the grid is also required by the promotion of the functioning of the electricity market, ageing of the grid, and increased nuclear power generation," Jussi Matilainen lists the starting points of Fingrid's capital investment programme of 1,600 million euros.

He says that Fingrid has launched the preparations for the future changes and new situations in good time, and the challenges are under control. Despite its extensive capital expenditure programme, Fingrid intends to retain its internationally competitive transmission prices. ■

Director Mika Purhonen:

Higher domestic share of capacity and reserve power

Interrupted electricity supply will paralyse the modern society very quickly. Reserve power is needed in disturbance and extraordinary situations, but are there sufficient contingency plans for its production, and how can potential damage in the transmission grid be repaired?
Director Mika Purhonen of the National Emergency Supply Agency of Finland assures that the grid system in Finland works well. However, he says that the goal with production capacity and reserve power should be a higher degree of domestic origin.

Text by Pirjo Rautanen ■ **Photographs by** Juhani Eskelinen

Mika Purhonen says that from the viewpoint of the functioning of society, it would have been important to retain the former arrangement in Finland, where reserve power production was maintained by virtue of voluntary agreements.

The purpose of emergency supply is to secure the continuity of basic functions of society in crises and other extraordinary situations. The government and businesses contribute jointly to emergency supply, and this co-operation is coordinated by the National Emergency Supply Agency.

In the 1980s, when the cold war still reality, emergency supply was referred to as economic defence, and it focused on making preparations for military threats. This primarily meant ensuring that there were sufficient materials and logistics for them.

The threats have changed greatly over the past couple of decades as a result of technical developments and amended structures of society.

"The economy and society are now more versatile and the infrastructure has taken more forms than before, but we are more vulnerable than ever before. Security policy threats have been replaced by new risks, such as international terrorism as well as threats and interference concerning data systems. New means are needed to fight the new threats," Mika Purhonen says.

Emergency supply is secured through means such as contingency planning, structural solutions applied to infrastructure, and stockpiling which covers for example storage of fuels and medicine.

"Backing up and maintaining of technical systems aims at securing data communications networks and data systems and at the functioning of electricity production, transmission and distribution networks. Naturally, these are just one of the many sectors covered by emergency supply," Mika Purhonen says.

Number 1 challenge: secured basic infrastructure

Mika Purhonen says that electricity supply in all circumstances constitutes the foundation of securing the modern versatile infrastructure.

"In fact, almost everything is powered by electricity, and there must be a continuous supply of it. The most crucial thing for society is that the basic infrastructure must not collapse. For an individual consumer, the most important thing is that energy supply works – that there is light and heat."

"Before the liberalisation of the electricity market, electricity producers were obliged by contract to maintain reserve power. This was arranged

The career of Director Mika Purhonen of the National Emergency Supply Agency in emergency supply matters extends over a quarter of a century. He will retire at the end of this year.

within a specific electricity producers' delegation. In the system, power producers agreed to maintain a reserve power capacity of 10 per cent. The resulting costs were transferred to the prices paid by the consumers. When the Electricity Market Act came into force in Finland in 1995, it was considered that the system for maintaining reserve power contradicts competition legislation."

Reserve power cannot be guaranteed through market forces alone

Mika Purhonen points out that as a result of the liberalisation of the electricity market, some production capacity was lost in Finland, and Finland has become increasingly dependent on imports of electricity.

"From the viewpoint of emergency supply, you absolutely need to have more own electricity production than now, and there must also be reserve power for covering the consumption peaks. At present, our dependence on imports is too high, 15 to 20 per cent of the annual total electricity consumption."

"The present-type electricity market has not produced enough reserve power, despite what the business itself says," Purhonen states and adds that additional reserve power has called for action by government. He points out that even the EU's directive for the electricity industry obliges all member states to provide for reserve capacity for the needs of their own country.

According to Purhonen, it is not possible to secure emergency supply of energy by means of domestic, renewable forms of energy alone. "They also need to be developed from the point of view of emergency supply, and especially the potential of hydropower, a zero-emission form of energy, should be utilised," he says.

"Wood, peat or wind do not provide a solution to the need for additional electricity production and they cannot respond to the electricity need existing in industries, because wind and biomass energy are not available continuously and in the sufficient volumes. What we need is competitive energy."

Finnish grid system works well

The main duty of Fingrid, which was established at around the liberalisation of the Finnish electricity market, is to take care of the Finnish power system. The functioning of the system is a critical factor, especially in the cold season of the year. Fingrid is prepared for disturbance situations through many ways, including disturbance reserves.

"In principle, the Finnish electricity transmission system is not subject to system-based threats, because our grid is backed up by means of a loop design, and the line and information systems have been secured. This means that potential malfunctions have been taken into account in the structure of the grid," Mika Purhonen says with satisfaction.

The reserve capacity of electricity is largely secured by the act which became effective in 2006, enabling the continued maintenance of condensing power capacity in starting readiness. Fingrid is to take care of this.

Shared rules for the European electricity market

The objective of the European Union is to have a single European electricity market. Mika Purhonen believes that integration will improve emergency supply, but it also involves some technical risks. He says that the management of disturbances, among others, will become more difficult when integration advances.

"The electricity transmission systems have mostly been constructed from national needs, which is why they differ from each other technically. When such systems are joined together, bottlenecks emerge. At present, Finland has some problems mainly re-

"From the viewpoint of emergency supply, you absolutely need to have more own electricity production than now, and there must also be reserve power for covering the consumption peaks."

lating to Nordic integration. As an example, there are not sufficient transmission connections in Sweden."

Mika Purhonen says that when aiming to reach the integration objectives, it is of utmost importance to consider the big picture.

"Integration calls for shared rules and transmission capacity which can be connected between the national markets. Major cross-border line systems are expensive, but adaptation is necessary. There is a need for co-operation between the public and private sectors, and for international co-operation mechanisms."

"The functioning of data exchange should be ensured in particular. The recent major power blackouts in Europe and USA have been the result of communications problems. It has not been possible to establish a realistic view of the situation when insufficient information has been available or when data systems have indicated erroneously that everything is alright. The EU is processing a directive proposal which aims to secure infrastructures which serve two or more member states," Purhonen says.

"The public sector ultimately has the responsibility and obligation to take care of electricity supply and sufficient reserve power capacity in extraordinary situations, but the desire and ability of businesses to contribute to our emergency supply also has a crucial role," Mika Purhonen summarises the situation. ■

Next spring will bring a new organisation for TSOs in the EU

ENTSO-E built through joint efforts

ENTSO-E, the new organisation of the European transmission system operators (TSOs) is gaining shape. The rules, procedures and plans of the organisation are being prepared in close co-operation between the various parties. The new organisation is due to be up and running next April.

The so-called third legislative package of the EU proposes that the TSOs should establish an organisation to draw up rules for an electricity transmission grid used for the single electricity market. The organisation would have an official status in the drawing up of rules, and it would work in co-operation with ACER (Agency for Cooperation of Energy Regulators) and the Commission of the EU. A corresponding organisation is being established for the gas market.

In their meeting in Prague on 27 June, the presidents of the TSOs made a unanimous decision to go forward with the establishment of ENTSO-E (European Network for Transmission System Operators - Electricity). The objective is to decide on the establishment of the organisation in December this year.

The work is supervised by a control group representing the European TSOs, and five task forces have been set up for the practical work. The task force which is to draw up the organisation's administrative model and rules, headed by Fingrid's Executive Vice President **Juha Kekkonen**, has made best progress. Several other Fingrid employees are also actively involved in the preparatory work.

Another task force is contemplating the internal processes. The three other task forces deal with the content of operations, i.e. co-operation in grid planning, system operation and electricity market development. These task forces are to draw up action plans for the new committees and to survey the functions and agreements to be transferred to ENTSO-E from the existing TSOs which will be wound down.

The work has progressed according to schedule, and the new organisation should be in operation next April. By that time, the present regional organisations and ETSO will merge into ENTSO-E.

ENTSO-E will initially be established from a voluntary basis, and once the third legislative package enters into force, it will obtain an official status.

The establishment of ENTSO-E will consolidate European and regional co-operation, resulting in improved market integration and supply security. At the same time, the rules of the market will be harmonised. ■

An increasingly difficult power situation can be anticipated on the basis of the available electricity production and transmission capacities and weather forecasts, and timely preparations can be made for it. But the situation may turn critical very quickly as a result of a sudden weather change or technical fault.

Good preparations for power shortage situations

A power shortage – imbalance between electricity production and consumption – cannot be forecasted. Moreover, such a situation is not likely only when the temperature goes down or at a particular time of the year. But no matter what the season of the year or time of the day, a potential power shortage is well under control.

Text by Kimmo Kuusinen ■ **Photograph by** Vastavalo

The cold and dark winter poses very different challenges on the Finnish power system than a warm summer, but the criteria of a power shortage may be fulfilled just as well during the heat of summer as in a freezing cold winter day. This is so because a power shortage is influenced by the available power production capacity and transmission capacity, which in turn depend highly on the prevailing market situation and various types of maintenance or construction work. However, precautions for a power shortage are primarily taken on cold winter days.

The Finnish electricity transmission system works mostly in a normal manner, without disturbance. However, we do not live in a perfect world, and outages potentially leading to a power shortage are unfortunately common occurrences in both electricity production and transmission.

Electricity consumption is not very flexible, either. Consumption may decrease somewhat among industries which use much electricity if the price of electricity rises high.

An increasingly difficult power situation can be anticipated on the basis of the available electricity production and transmission capacities and weather forecasts, and timely preparations can be made for it. But the situation may turn critical very quickly as a result of a sudden weather change or technical fault.

From strained power balance to power shortage

Fingrid uses a three-step procedure in the management of a power shortage situation:

- In a strained power balance electricity production and consumption forecasts show that electricity production and imports may not cover the consumption in the Finnish power system during the next few hours or in the next day. It may be necessary to start gas turbines used as fast disturbance reserves in order to manage the power balance.
- In a power shortage situation all available domestic electricity production capacity is in use and it is not possible to import more electricity into Finland from the neighbouring countries. Gas turbines used as fast disturbance reserves and disconnected loads are activated in order to manage the power balance.
- In a serious power shortage all available domestic electricity production capacity is in use and it is not possible to import more electricity into Finland from the neighbouring countries. Gas turbines used as fast disturbance reserves are in operation, and all contractual disconnected loads have been used. Fingrid restricts consumption in order to maintain the power balance.

Distribution operators kept up to date

Fingrid's Power System Control Centre co-ordinates and leads the management of power shortage situations in co-operation with Fingrid's Network Control Centre and network operators. All these parties must be prepared for power shortages by keeping up to date their instructions as well as technical and personnel resources. They must be prepared to the extent that in the most critical situation all necessary loads can be restricted quickly in remote control.

In a strained power balance Fingrid's Power System Control Centre informs network operators of the situation by e-mail. As far as possible, Fingrid's Network Control Centre also contacts network operators by telephone. Network operators must prepare themselves for an increasingly difficult situation and check their instructions for potential consumption restrictions.

If a network operator or a company belonging to the same group with it has available electricity production capacity at this point, this capacity should be offered to the regulating power market, because if the situation becomes even more critical, it cannot be used to compensate consumption restrictions.

The procedure in a power shortage situation is the same as in a strained power balance: Fingrid's Power System Control Centre sends the network operators the relevant notice by e-mail, and they must make sure they are prepared for an increasingly difficult situation.

Fingrid has reserved 600 megawatts of peak power capacity, some of which can be started in a power shortage as required by the operating situation. This capacity may have already been started in a strained power balance on the basis of market factors.

Consumption restricted in a serious power shortage

In a serious power shortage, it may be necessary to restrict electricity consumption in order to reach a pow-

er balance. Fingrid's Power System Control Centre informs the network operators by e-mail, and it also contacts the company's Network Control Centre and requests the launching of action to restrict consumption.

Small power volumes have no practical significance at the level of the entire power system. This is why Fingrid aims to restrict consumption by about 200 megawatts at a time. The company has formed groups of network operators, within which groups the sum power of consumption to be restricted is the said 200 megawatts.

In these situations, the Network Control Centre telephones a relevant network operator and asks it to restrict consumption. The Network Control Centre states the volume to be restricted by the network operator, and the starting and finishing time of the restriction. The Network Control Centre may request that the restriction begin immediately and request it to be in force until further notice, in which case the Centre states later when the network operator can connect consumption back to the grid.

The primary goal is to have staggered restrictions in consumption, 10 per cent at a time with respect to the peak consumption of the network operator in question. Based on the operating situation, other restriction volumes can also be applied. The actual restricted volume is stated to the network operator as an absolute power volume (MW).

If a serious power shortage continues for a long time, the restriction is circulated between the various groups in periods of about 2 hours. Correspondingly, the network operator may circulate the consumption restriction in the manner of its choice. The essential thing in consumption restrictions is that functions which are vital for society would not be subject to the restriction. This should be ensured in advance planning.

In extreme and most urgent situations, Fingrid's control centres can disconnect loads directly. Whenever possible, Fingrid aims to inform the relevant network operator of this beforehand.

Sufficiency of power makes the news each winter

Before winter comes, one of the repeating news items in media is whether there will be sufficient electricity in the coming cold days. Fingrid's task in this communications chain is to present the facts concerning the estimate of the coming winter. The estimate is based on information possessed by Fingrid on coming operating situations and on the shared annual analysis of the Nordic transmission system operators concerning the sufficiency of power and energy in the coming winter.

It is often asked why Fingrid does not give electricity conservation tips directly to consumers. This role does not actually belong to Fingrid, because it might influence crucially the functioning of the electricity market and topple the power balance to an undesirable direction in an extreme case. It has hence been agreed that information and advice aiming at electricity conservation is in the hands of the Ministry of Employment and the Economy.

Upon sending information to network operators in the various stages of a power shortage, Fingrid also informs many other parties such as authorities and electricity market parties. Other active communications channels include Fingrid's website as well as press releases drawn up by it in conjunction with a power shortage and serious power shortage. Network operators can use the information published by Fingrid as they provide information on the events to their own customers. ■

New guide gives

Enlightenment for power failures

Finnish electricity consumers have been prepared a new leaflet which provides a hefty information package on blackouts. The guide drawn up by the Ministry of Defence and its partners tells how long blackouts, which are rare occurrences but have serious consequences, affect everyday life and what preparations can be made for them. Fingrid has been one of the partners in the guide project, which also endeavours to augment people's knowledge about the electricity dependence of various functions of society.

The leaflet with 24 pages is a concrete reminder of how comprehensively electricity supply governs our daily life. The first consequences that come to mind of a blackout are related to the lights going out, television and radio turning off, and stopping of trains. A little longer outage causes concern over the deterioration of food stored in the freezer and refrigerator.

The guide also presents surprising consequences of a power failure. "I didn't come to think of that" is probably a common reaction aroused by the following consequences of a blackout:

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

N-1 ■ What does it mean?

The system security of the power system refers to the ability of the system to withstand faults without impacts on electricity consumption or production. The Nordic power system is so designed and operated that it can withstand the worst possible individual fault at any time without a wide-spread outage.

Preparations for the worst possible individual fault are generally made in large power systems, and this principle is called the (N-1) system security criterion, where "N" stands for the total number of components being used in the network at the moment of the fault and "1" stands for an individual fault which may occur in the network.

In accordance with the principle, individual faults may comprise faults in a large power plant, transmission line or substation, as a result of which protection disconnects the faulty unit from the network. The worst individual fault is referred to as a dimensioning fault, which determines the transmission capacity and necessary reserves of a power system.

This principle is also followed during maintenance and service work, when the network has been made weaker for example by disconnecting one or more lines from the network. As a result, the term "N" varies at different times, which is why it is not purposeful to give a numerical value for it.

Immediately after a line failure, transmissions continue along other parallel lines, and electricity users do not even notice the disturbance in many cases. Electric power which has tripped from the network in a power plant failure is mainly replaced by means of automatically activated reserves from hydropower plants. In both cases, transmissions on the available lines usually increase, so the network has to be "overdimensioned" to withstand this post-failure situation without excessive overloading.

Immediately after a fault the transmission situation may be such that the system would not necessarily withstand another dimensioning fault. In order to control system security, it has been agreed that within 15 minutes from a disturbance, the transmission situation must be brought back within the transmission limits so that the system can withstand another (N-1) fault. This is done by starting gas turbines or by activating regulation resources in the regulating power market.

Text by Timo Kaukonen

- Water supply is interrupted either immediately or in the next few hours. (Water supply is based on pumps operated by electricity.)
- Supply of warm water in most buildings ceases.
- Municipal and building sewers may overflow. (Pumps are needed in the sewer system to transfer waste water.)
- Most shops will close.
- Banks close their offices right away, and cash dispensers no longer work.
- You cannot normally use bank or credit cards because their payment terminals need electricity.
- No fuel is available at service stations, because the petrol meters, pumps and payment terminals use electricity.
- Home computers do not work. (A computer provided with a UPS device usually works for half an hour after the beginning of a power failure.)
- In the cold season of the year, heating of buildings becomes a problem; district heating also works on electricity.
- If the blackout continues to the next day, day care centres and schools cannot work, because the facilities no longer fulfil health and safety regulations.
- In buildings designed for domestic animals, interrupted ventilation and water supply and elevated indoor temperature cause major problems. Moreover, milking machines and cold storage of milk do not work without electricity.

These are just some of the problems that we have not had to think – and above all experience – thanks to the reliable Finnish power system. The list of everyday things not affected by a power failure would probably be very short.

People have become accustomed to trouble-free electricity supply especially in areas where electricity is transmitted in underground cables. Snow, storms and thunder occasionally put the transmission grid in sparsely-inhabited areas to the test, but the disturbances usually have a short duration. However, the foreword of the guide states that extreme weather phenomena are expected to become increasingly common. This renders the information and advice in the guide topical.

The data package has been compiled by interviewing hundreds of experts in government, businesses, research institutions and various organisations. The publication of the guide is related to the Government decision concerning the safeguarding of vital functions of society. The guide is distributed for example as an appendix to customer newsletters of electricity companies.

In the near future, there will be a broader guide on blackouts, intended for authorities and corporations. It will provide information on the impacts of power failures on basic infrastructure, needed in contingency planning.

The guide in Finnish is available at Fingrid's website at www.fingrid.fi/portal/suomeksi/uutiset/ajankohtaista/?id=1123

M. H.

Milder weather forecasted

Climate change will tame the coldest weather in the North of Europe. By the 2050s, winters in Northern Europe are expected to become 2 to 7 degrees Celsius milder than now. "The range depends largely on whether people will change their behaviour in the coming years," says Senior Meteorologist Sari Hartonen of the Finnish Meteorological Institute. According to her, very cold periods in the winter months will become rare in Southern and Western Finland.

Text by Maria Hallila ■ **Photograph by** Vastavalo

Finns still remember well the record-mild winter of 2007 to 2008. Last winter, the average temperature in most parts of Finland from December to February was about 6 degrees higher than on average.

"There was no actual permanent winter in some parts along the southern and western coast of Finland," Sari Hartonen says in referring to the definition of thermal season, according to which the average temperature is below zero degrees Celsius in the winter. There was no permanent snow cover, and most of the precipitation came down as water.

"Earlier, winters always contained a period when meteorologists in Finland did not have to think about the state of precipitation. Now we have to ponder on it throughout the winter," she describes the impacts of climate change on the work of meteorologists.

In fact, in the past couple of years the southern and western parts of Finland have had a foretaste of the weather conditions that can be expected in a few decades. Sari Hartonen says that the change is rapid and reflected in the winters in particular. "However, there will be many types of weather," she points out. "The winter weather in Finland will vary more from one year to another than the summer weather."

Photograph by Juhani Eskelinen

Sari Hartonen possesses more than ten years of experience in forecasting weather. "You can forecast temperature over a longer time span than for example winds," she says.

Increasingly accurate forecasts

Sari Hartonen possesses more than 10 years of experience in forecasting weather, but she does not wish to present an estimate of the weather in the coming winter. The chaotic nature of the atmosphere renders long-term forecasting difficult. "Relatively reliable forecasts can be given for about five days; any longer forecasts are merely suggestive," she says.

According to Hartonen, forecasts extending over an entire season of the year only work in the tropics, where the weather variations are slower than up in the north. "There are more long-term variations in the weather in the tropics, such as the El Niño-La Niña phenomenon, which can be forecasted using weather forecast models. There are no such phenomena in the north."

"However, weather forecasts have become much more accurate and reliable in the past decades thanks to advanced information technology. At present, a temperature and precipitation forecast extending over two days is as accurate as a one-day forecast ten years ago."

Local weather continues to be difficult to forecast, according to Sari Hartonen. "As an example, the constant weather variations last summer and the rapidly-moving low-pressure areas were problematic from a meteorologist's viewpoint, and the forecasts were not as reliable as on average."

Topic of conversation

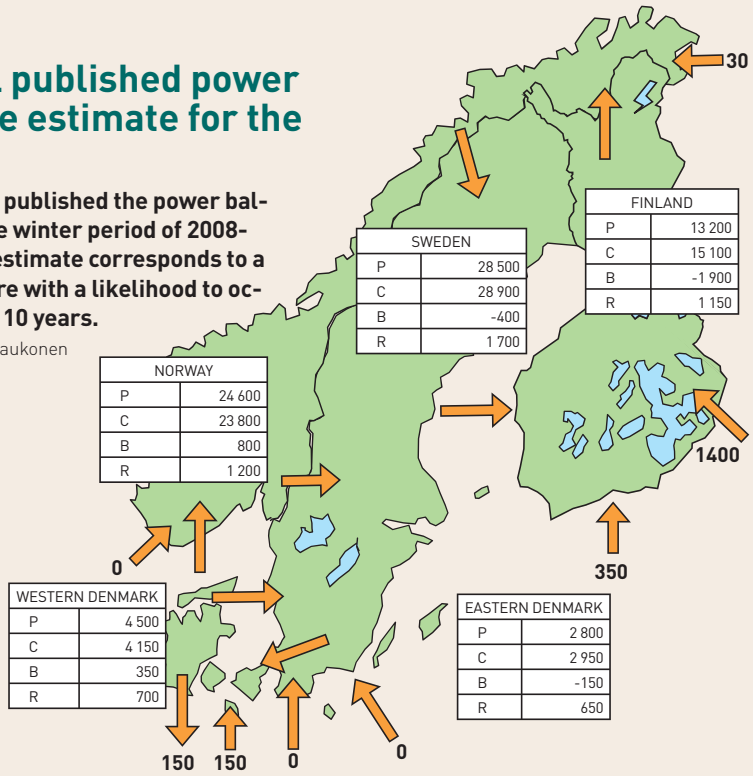
Weather is a common topic of conversation in Finland. Sari Hartonen says that this is no wonder, because weather gives much to talk about in the latitudes of varying weather conditions. "And not long ago, life here actually depended on the weather," she points out.

The weather service of the Finnish Meteorological Institute is one of the most popular websites in Finland. As an example, there were some days last summer in the Midsummer week when the website had as many as 300,000 different visitors in a single day.

Nordel published power balance estimate for the winter

Nordel has published the power balance for the winter period of 2008-2009. The estimate corresponds to a temperature with a likelihood to occur once in 10 years.

Text by Timo Kaukonen



NORDEL		Total
P =	Available production capacity, TSO reserves excluded	73,900
C =	Peak demand	73,400
B =	Balance without power exchange	500
NE =	Net power exchange to Nordel area	1,800
R =	Reserves available to the TSOs	5,400

The shared Nordic power balance is expected to show a narrow surplus at peak demand without imports from the neighbouring regions to the Nordic area. The power balances in Finland, Sweden and Eastern Denmark are in deficit without imports. The power balance is available on Nordel's website at www.nordel.org.

Total consumption in the Nordel area is estimated to be 2 per cent smaller than the sum of the national peaks due to the different periods of cold weather in the different countries.

The available production capacity has been estimated on the basis of the prevailing hydropower situation and experience. Wind power is estimated to be 0 per cent in each country, but 6 per cent (280 megawatts) in the entire Nordel area due to the different periods of calm weather. Nuclear power output is expected to be 100 per cent of the installed capacity based on statistics.

Peak demand in Finland is estimated to decrease by approximately 100 megawatts as compared to the past winter due to shutdowns made and planned in the Finnish paper industry.

The imports from Russia are expected to be 1,400 megawatts, although experience from previous years has shown that there are some restrictions during peak hours. The HVDC connection Estlink from Estonia is expected to give imports of 350 megawatts. These values are valid if the peak only lasts for a few days.

During high-price periods, the price elasticity of consumption will probably reduce the peak demand as compared to the presented values.

Finns have also become increasingly interested in weather in other countries as tourism, commerce and other interaction have brought us closer to our neighbours and more distant countries.

For example Fingrid, which is responsible for the electricity system in Finland, is interested in the winter weather not only in Finland but also in the adjacent St Petersburg area in Russia. The crucial question in terms of the sufficiency of electricity capacity in Finland is what happens to electricity deliveries from Russia if there is a very cold period simultaneously in Northwestern Russia and in Finland.

"St Petersburg represents a more continental climate area than Finland. It may happen that the cold high-pressure areas coming from the east extend to St Petersburg but never reach Finland. Last summer, it was correspondingly much warmer in the St Pe-

tersburg region than in Finland," Sari Hartonen says.

However, she adds that in terms of climate change, both areas represent Northern Europe, where the winters are becoming milder than before.

Tailored forecasts

For several decades now, the Finnish Meteorological Institute has offered tailored, real-time weather services to enterprises, organisations and authorities whose work depends on the weather conditions. Electricity companies are provided information on issues such as winds, storms and thunderstorms. In the winter, weather data is monitored for heavy crown snow loads which cause electricity distribution outages and even hazards.

"Crown snow loads are not a problem on the lines of electricity companies in the north alone, but there are also areas susceptible to this phenomenon in the south of Finland. It is very challenging to make forecasts concerning crown snow, because a difference of just one degree in the temperature may be decisive in its formation."

According to Sari Hartonen, climate change will bring many new consequences in the Finnish conditions, also concerning the electricity business. "What will happen to ground frost? Last winter, the ground did not freeze at all in the Helsinki region," she says.

"Ground frost protects trees against the impacts of wind. November and December may be very windy, and if the frozen ground does not support the roots, trees fall easily."

According to the statistics of the Finnish Meteorological Institute, the winds have not actually become more intense in recent years, even though this might be the conclusion from news headlines. However, Sari Hartonen says that climate change will increase the occurrence of heavy winds and other extreme weather phenomena in the future. ■

Recovery readiness in transmission grid is about

Shared preparations **for a bad day**

Fault repair readiness works like insurance: the more input in it, the smaller the risks. Alongside contingency plans for fault repairs in its own grid, Fingrid also contributes to shared preparations by the Nordic countries.

Text by Marcus Stenstrand ■ **Photographs by** Juhani Eskelinen

The transmission reliability of the Finnish power transmission grid represents international top standard, with major or large-scale disturbance situations being rare. However, Fingrid has drawn up contingency plans for faults in the transmission grid. This autumn, too, storms have caused regional outages, but such storms disturb the nationwide transmission grid more rarely. This is so because falling trees cannot usually reach the conductors on the transmission lines in the grid. Correspondingly, the Gudrun storm, which paralysed severely electricity distribution in Southern Sweden a few years ago, did not cause permanent damage to the transmission grid in Sweden, which has a structure resembling that of the Finnish grid.

Extensive collapse of transmission line towers as a result of weather phenomena constitutes the primary threat to the transmission ability of the Finnish grid. Such phenomena could include a hurricane or supercooled rain, which forms packed ice on the conductors and tower structures, causing them to collapse by the weight of the ice as happened in China in 2008 and in Canada in 1998. Another threatening phenomenon could be a tornado which hits a delicate location in the grid.

Personnel resources and tools provide the basis

When making preparations for both small and large faults, the most important thing is to ensure the manpower resources and the availability of tools and spare parts. Fingrid's own specialists co-ordinate the necessary resources in the event of faults, but

The lifting of an emergency tower is part of regular readiness exercises. Here, the lift is assisted by a helicopter of the Finnish Border Guard.

the actual repair resources are held by Fingrid's service providers. Fingrid has three-year maintenance contracts with these, stipulating that the service providers must have a certain number of personnel available continuously for switching work, fault patrolling and repairs at Fingrid's each work region.

The requirements and number of personnel together with the response times have been laid down in the contracts, and their realisation is monitored by means of a shared quality register, audits as well as incentive and sanction clauses. The contracts also specify the vehicles, machinery and special tools which are available to the service providers, needed in potential fault repairs. The service providers must always have access to a so-called fault repair trailer. It contains tools needed in finding a line fault and in protecting the fault location safely.

The personnel resources for fault patrolling and repairs are increased whenever necessary at Fingrid's request, for instance when a storm is approaching. The service providers are also obliged to keep certain spare parts in their own stocks.

Critical components readily available

Fingrid has a stock of its own for components which are most critical from the viewpoint of the grid or in view of the age or condition of parts. The stock contains equipment from protection to entire components, such as 400 kilovolt circuit breakers. The equipment is recirculated in order to ensure its usability so that the components in stock are installed in the grid, and new components are purchased in their place.

Fingrid does not keep power transformers in stock although there are critical and less critical power transformers in the grid. If a critical power transformer is damaged, another transformer used at another substation can be transferred to replace the faulty unit. This brings the transmission reliability of the grid approximately to the previous level even though the transmission losses grow.

Transmission line towers are among the most critical components of the grid. The oldest lines in the Finnish grid were built in the 1920s, and there are many different tower models, which is why it would be impossible to keep all models in stock. Luckily, the replacing tower does not need to be exactly identical with the damaged one.

Fingrid can also use a so-called emergency tower. This is not actually a tower but an assortment of various steel sections, like a pile of Lego blocks, from which you can put together many different types of towers to replace a damaged 110, 220 or 400 kilovolt tower. An emergency tower is not intended for permanent use, but it is always replaced later by a new tower. The service providers have also developed their own emergency towers which are available to Fingrid whenever necessary.

Performance tested in exercises

In order to maintain recovery expertise, Fingrid arranges regular readiness exercises for the repairs of various types of major faults. The exercises are used to assess the service providers' and Fingrid's procedures and to optimise the volume of materials, tools and resources.

Fingrid's most recent own extensive exercise was arranged in the autumn of 2006, with 52 persons participating in it. The scenario in the exercise was an ice storm which hit Western Finland and made several towers collapse, causing disturbance situations in the remote operation and communications of substations. The next exercise with a similar scope will be arranged in the autumn of 2009.

In May, the Power and District Heat Pool, the contingency organisation in

Fingrid's reward system **encourages employee suggestions**

Marko Nauska, switchgear fitter working for a service provider of Fingrid, received 4,000 euros in reward for his suggestion concerning the elevation of transformation ratio of current transformers at the Keminmaa transformer substation.

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

In his work, Marko Nauska has noticed that maintenance is important for Fingrid. "Even though they build new substations, they also take good care of the existing stations." Also shown in the photograph are Fingrid's Executive Vice President Kari Kuusela (on the left) and Maintenance Manager Jari Helander (on the right).

the Finnish energy sector, arranged a readiness exercise for all electricity production and distribution enterprises operating in Northern Finland, focusing on an imaginary difficult weather situation in November. As a result of long-term rain, flooding and an autumn storm, the weather cooled down rapidly, coating the transmission line structures with ice, which resulted in blackouts, formation of problematic frazil ice at hydropower stations, and finally so-called island operation in the nation-wide grid. The exercise involved some 100 persons from 32 companies.

Increasingly better readiness through co-operation

For the past 10 years, Fingrid has participated in Nordic contingency planning in the electricity sector within the Nordic Forum for Emergency Matters (NordBer). Since 2000, a work group of NordBer has been developing inter-Nordic recovery readiness for major disturbances in the high-voltage grid.

The work group has had members from the transmission system operators of each Nordic country and representatives of primary service providers. It has arranged workshops and exercises on the topic and developed procedures and processes which facilitate the utilisation of resources and materials in another Nordic country in conjunction with a potential major disturbance. The participants in the workshops and exercises have comprised representatives of the TSOs and also a high number of participants from regional network companies and service provider enterprises.

All information on materials, resources and their usability in the various countries together with glossaries and occupational safety instructions have been compiled in a manual which facilitates the giving and receiving of help from one country to another. The manual contains, among other things, the high-voltage spare parts, special tools and personnel resources for high-voltage work in all Nordic countries.

There is a high-level letter of intent of Nordic recovery co-operation, and the intention is to specify this further in the near future. The objective is that the resources in each country would be available to another country also in the event of smaller faults. Co-operation enables much better contingency planning for fault repairs without significant additional costs. ■

Switchgear fitter Marko Nauska of Kempele received some pleasant news in the spring: his suggestion which he had made to Fingrid in the previous year had been carried out, as a result of which he received a reward of 4,000 euros from Fingrid.

Nauska's suggestion concerns changing the transformation ratio of the 400 kilovolt current transformers at the Keminmaa substation from 1,500 A/1A to 3,000 A/1A. As a result of the change, the transmission capacity between Finland and Sweden remains at the normal level even though there is a fault in some piece of switchgear at the 400 kilovolt bay of the transformer substation.

Active suggestion maker

From 2001, Fingrid has encouraged contractual service providers working at substations to make observations and suggestions concerning deficiencies and improvement needs detected in maintenance management for the transmission grid. Marko Nauska was aware of the reward system, and he had made some suggestions earlier. This time the suggestion was considered so important that in addition to an item reward, a nice sum of money was also deposited to his bank account.

"It all occurred to me when I was repairing a fault," he reminisces the situation which gave rise to the suggestion. "I mentioned about my idea to the substation manager, who encouraged me to write down the suggestion and send it forward."

Experience also of control room work

Marko Nauska, who works for Fingrid's service provider Finnish Substation Service Oy, also has experience of the control of the transmission grid. From 1998 to 2001 he worked at the control room of Fingrid's area centre for Northern Finland. He believes that this gave him a broader view of situations which surface in his present work.

Most of Nauska's work is still with Fingrid even though his employer changed in 2001 as Fingrid centralised its regional operation control in Hämeenlinna and outsourced local operation and maintenance for substations.

Reward money for paving

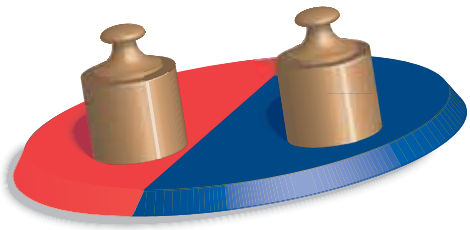
Marko Nauska says that the reward will motivate him to think about emerging problems more deeply. "You never know, maybe something similar comes to my mind again," he says and thinks that the reward will also motivate his colleagues.

According to Marko Nauska, the reward is a welcome addition to the income of a family with children. However, the money was not spent entirely on running expenses, but the suggestion also provides concrete daily delight for the family: most of the sum was used on paving the yard of their single-family house.

More than 500 observations and suggestions

To date, the reward system introduced in 2001 has yielded more than 500 observations and suggestions, of which Fingrid has given rewards for 120 significant observations, 28 accepted suggestions, and 12 implemented suggestions.

Significant observations are rewarded once a year by a small monetary reward. Accepted suggestions are rewarded in two stages: first with a small monetary or item reward, and later, after Fingrid has decided to carry out an accepted suggestion, with a personal suggestion reward. The amount of the reward is proportioned to the financial gain obtained by Fingrid from the suggestion. ■



New balance service model

paves the way for a shared consumer market in the Nordic countries

Electricity has a peculiar feature: you cannot store it. This is why each party operating on the electricity market must take continuous care of its electricity balance. In other words, the production and consumption or procurement and sales of electricity must be in balance during each hour. In practice, transmission system operator Fingrid takes care of this work in Finland as so-called balance service. The terms and conditions of balance service will change at the beginning of 2009.

Text by Tiina Miettinen ■ **Photograph by** Juhani Eskelinen

Balance service will be revised at the beginning of next year when all Nordic countries will introduce a new balance service model. Balance service harmonisation is related to market integration.

"National rules will give way to Nordic rules. The pieces of the jigsaw puzzle will fall into place, and we will accomplish something important," is how Fingrid's Balance Service Manager **Pasi Aho** characterised the reform in Fingrid's balance service event.

The present national balance model has been in use for about 10 years, and even though the model has worked well, harmonisation efforts have been going on at the background for quite some time. Since the early part of this decade, Nordel, the co-operation organisation of the Nordic transmission system operators, has drawn up several reports of the similarities and differences of balance service in the various Nordic countries.

Moving over to shared balance service brings several benefits.

"Harmonisation paves the way towards a Nordic end consumer market. It facilitates the access of new players to the market and the expansion of existing players to the other Nordic countries. Impartial treatment of balance providers and electricity market parties in different countries is also an important consideration," Pasi Aho says in listing the reasons for the reform.

Harmonisation now only covers the main principles, and the reform does not bring a shared balance settlement or balance service agreement for all Nordic countries.

"We are now implementing the short-term objective, in other words agreeing on the principles of how close to a specific hour electricity transactions can be concluded, how to harmonise the number of balances and how to agree on the pricing of balance power in the two balances. It can be assumed that over the long term, the objective is to provide balance providers in the Nordic countries with 'one stop service': one balance service agreement, shared balance settlement, and a Nordic balance."

"The balance service model has held its ground very well," said Reima Päivinen, Fingrid's Senior Vice President responsible for power system operation, in his opening words in the balance service event.

Three major changes

The three main points in the reform are the harmonisation of costs involved in balance service (mainly reserve costs), introduction of two balances, and harmonisation of rules for electricity trade close to gate closure.

The biggest cost item in balance service is made up of the reserve costs of the transmission system operator (TSO), i.e. reserves required by the frequency of the grid and maintenance of system security. In the new model, various reserve types are allocated both to balance service and other TSO services applying the causing principle. In practice, the new division model will raise the costs of balance service in Finland.

The second reform is that the balance is divided into two parts: production balance and consumption balance. Production is handled in one balance, and purchases, sales and consumption in another. Moreover, a separate price is applied to the balance power existing in the production and consumption balances.

A two-price model is calculated for the balance deviation in the production balance, and a one-price model is calculated for the balance deviation in the consumption balance; in other words, there is the same price for the purchase and sales of balance power. Over the long term, the one-price system is more inexpensive for the balance provider, and it is expected to in-

Balance service fees as of 1 January 2009

- fixed monthly fee 200 €/month
- production fee 0.035 €/MWh (actual production)
- consumption fee 0.075 €/MWh (actual consumption)
- volume fee for balance deviation in the consumption balance 0.5 €/MWh
- energy fees for balance power in each balance in accordance with an agreed model
- if necessary, the fees are adjusted semiannually

crease the volume of balance power. The new system is also believed to encourage small players to become balance providers.

One of the cornerstones of the new model is reporting close to gate closure. This means that the electricity market parties have an opportunity to electricity trade up to one hour before the specific hour, for example on the Elbas market. Moreover, the production plans and regulating power bids must be delivered to the TSO 45 minutes before the hour. In this way, the TSOs will have sufficient time to forecast the power and operating situation during the commencing hour and to carry out potential adjustments before the beginning of the hour and during it.

Towards European balance management

The harmonisation of Nordic rules and practices will continue in small steps. The focus in the implementation and rules of the regulating power market will shift to the European level. The 15-minute handling of the production balance will probably be a topic of discussion soon.

In Fingrid's balance service event, it was thought that European integration will change balance management and balance service shortly. "This new model will probably not be in force for 10 years like its predecessor," Pasi Aho stated. ■

Example calculation:

Initial information: A balance provider whose total production plan for a specific hour is 55 MWh, actual production 60 MWh, actual consumption (load) -40 MWh, and sales to Elspot -30 MWh.

Old model:

Actual consumption and production, total +20 MWh
Sales to Elspot total -30 MWh
The balance deviation is a deficit of -10 MWh. In order to cover this, Fingrid will sell the balance provider balance power at the sales price of balance power, with the volume fee for balance power added to the price.

New model:

a) Production balance:
Actual production total 60 MWh
Total production plan -55 MWh
The balance deviation in the production balance is a surplus of 5 MWh, which is purchased by Fingrid from the balance provider at the purchase price of balance power.

b) Consumption balance:
Total production plan 55 MWh
Sales to Elspot total -30 MWh
Actual consumption total -40 MWh
The balance deviation in the consumption balance is a deficit of -15 MWh. In order to cover this, Fingrid will sell the balance provider balance power, with the volume fee for balance power added to the price.
The fee for actual production is 0.035 x 60 = 2.1 €, and the fee for actual consumption is 0.075 x 40 = 3 €. The total fees are hence 5.1 €.

Price table for balance power €/MWh	Production balance 2-price			Consumption balance 1-price		
	Up-regulation hour	No regulations	Down-regulation hour	Up-regulation hour	No regulations	Down-regulation hour
Up-regulation price	**100**	50	50	**100**	50	50
Spot price	50	50	50	50	50	50
Down-regulation price	50	50	**20**	50	50	**20**
Fingrid's sales price for balance power	**100**	50	50	**100**	50	**20**
Fingrid's purchase price for balance power	50	50	**20**	**100**	50	**20**

Comparison table	up-regulation hour	no regulations in the hour	down-regulation hour
old model	1,007 €	507 €	507 €
new model	1,262.6 €	512.6 €	212.6 €

Terms

Electricity market party
An electricity trading party with fixed electricity deliveries or measured deliveries in the nation-wide grid, regional network or more than one distribution network.

Power balance
Total electricity production, procurement, consumption and sales of a party.

Regulating power
Electric energy related to an electricity delivery between Fingrid and a party carrying out the adjustment as a result of a regulating request made by Fingrid. The volume of regulating energy is calculated as the product of regulating power and time of use.

Regulating power market
The Nordic regulating power market is a "tool" needed to maintain the Nordic power balance. Holders of capacity which can be adjusted can make bids of their regulating capacity to the regulating power market. The Nordic TSOs order adjustments from the regulating power market for the needs of balance management in the Nordic system, i.e. for the needs of frequency or of an individual subsystem. The regulating power market in Finland is part of the Nordic regulating power market.

Balance management
Balance management refers to the maintenance of power balance between electricity generation and consumption in the entire Finland or by an individual electricity market party.

Balance service
A service provided by Fingrid where the main duties are national balance management and drawing up of national balance settlement. ■

Interaction is an asset

in the development of the grid and electricity market

The customers' ideas, experiences, needs and wishes provide a crucial guideline when Fingrid is making decisions concerning transmission system development. The company has provided room for interaction by establishing committees and co-operation forums which involve more than 60 representatives of Fingrid's customers and other stakeholders.

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

"We have wanted to give our customers and other stakeholders an opportunity to review our performance in procedures related to grid plans, transmission line routes, substation contracts, clearance of disturbance situations, and many more," says **Matti Tähtinen**, Fingrid's Senior Vice President responsible for stakeholder relations.

Advisory Committee as the pioneer

Fingrid has heard the voice of customers and market players since its establishment. As early as when Fingrid was being founded in the spring of 1997, an Advisory Committee was set up to promote two-way interaction between the customers and the company. The Advisory Committee is to serve as a consultative body contributing to the transmission business in accordance with the principles laid down in the Finnish Electricity Market Act.

"The Advisory Committee has been a pioneer in promoting dialogue. Its opinions and views have given us important guidelines when making decisions in matters which are crucial to us," Matti Tähtinen says.

Three new channels

The desire and need to increase interaction has led to the establishment of three new customer forums within Fingrid. The Grid Committee, Operations Committee and Market Committee, which were launched in the autumn, focus on topical issues and operative practices in each of the above areas.

THE GRID COMMITTEE serves as a co-operation organ in grid development and maintenance. The customers' views and needs constitute the foundation of grid planning. The Committee aims to improve and advance this interaction process even further. "The Grid Committee also provides an opportunity to express opinions about Fingrid's capital expenditure, maintenance and environmental policies, specification of the grid, tariff formation, and various procedures in the process of ensuring sufficient transmission capacity," says the chairman of the Committee, Fingrid's Executive Vice President **Kari Kuusela**.

THE OPERATIONS COMMITTEE discusses and expresses opinions pertaining to the development of procedures used in the operation of the power system and maintenance of system security. The topics discussed concern issues such as power system operation, maintenance of power balance, acquisition of reserves, outage planning, and disturbance clear-

◂ The themes discussed in Fingrid's regular customer events comprise topical matters in the industry. The Grid Day in September attracted some 150 representatives of customers and stakeholders from different parts of Finland.

ance. "Power system operation represents day-to-day co-operation between various parties. It is important that the procedures have been thought out beforehand so that action in disturbance situations, for example, is swift. The Operations Committee provides a good forum for this discussion," says **Reima Päivinen**, chairman of the Committee and Fingrid's Senior Vice President responsible for power system operation.

THE MARKET COMMITTEE serves as a link between Fingrid and electricity market parties operating in Finland. Being an advisory discussion forum, the Market Committee assists Fingrid in the development of the Nordic and European electricity markets. Fingrid informs the Market Committee and obtains feedback from it concerning topical development plans. Fingrid's Executive Vice President **Juha Kekkonen** serves as the chairman of the Committee. "As the market expands, the negotiation processes become increasingly complex, and it is important to keep the Finnish market players involved. By the way, in market issues our customers comprise all parties irrespective of whether they have a contractual relationship with Fingrid or not," he points out.

The new committee architecture gives the customers and other market players better facilities to contribute to the development and implementation of Fingrid's main duties. Fingrid's customers are its practical regulator, and the overall interests of the Finnish society in the evolving electricity market can be secured through the customers' views.

Comprehensive co-operation

Interaction with not just customers but other stakeholders, too, is a vital precondition for the successful management of corporate social responsibility by Fingrid. For this purpose, Fingrid established three stakeholder forums three years ago, focusing on technology co-operation and expertise, environmental matters, and co-operation with authorities.

"The technology forum and the forum on transmission lines and the natural environment support our own R&D. We can hear the ideas of top-ranking experts, and we can also test our own ideas. The essential thing is that we get a broader perspective to our business than if we were just looking at things from our own viewpoint," says **Jussi Jyrinsalo**, Senior Vice President responsible for system development.

According to Jyrinsalo, the forum focusing on transmission lines and environmental legislation has turned out to be a well-functioning channel of information, with authorities being supplied with information on Fingrid's ongoing and future projects. This creates the foundation for increasingly good co-operation and promotes the fluency of matters. ■

New committees are looking forward to

Open discussion on topical issues

Fingrid's three new committees which started their work in the autumn intensify interaction on topical matters between Fingrid and its customers. We asked one representative from the Grid Committee, Operations Committee and Market Committee to answer the following questions:

1. What topical matters should your committee discuss?
2. What expectations do you have for the work of your committee?
3. What kinds of challenges do you see in the sector where your committee works?

GRID COMMITTEE

Esa Kalla
Energy and Electricity Distribution Manager
Outokumpu Stainless Oy

1. The Grid Committee should discuss grid development as an entity which serves all parties in an equal manner. The grid must provide its customers, both consumers and producers, with an opportunity to connect to the grid without unreasonable difficulties or costs.

2. I look forward to transparency, efficiency and practicality in the efforts of the Committee. What we need is co-operation, not pushing your own agenda, to make things happen.

3. There will be considerable capital expenditure in the Finnish grid over the next 15 years, while at the same time we will likely have much new wind and nuclear power, which imposes specific demands on the grid and its operation.

The challenge, and also my expectation, is to improve the system security and transmission capacity of the grid so that the needs of the whole of Finland are taken into account equally.

From the point of view of my company – and Finnish industries in general – it is

naturally very important that the growing energy need resulting from increased production capacity can be catered for reliably from the aspect of a manufacturing unit.

"Production of electric energy there, loads here" is one way we could put it as a significant individual electricity user. The price of electric energy, reliability of its transmission and a reasonable transmission price are the key factors for securing our production in Tornio in Northern Finland. In other words, we have every reason to expect that the grid operator would take an impartial stand on grid development and on making the costs equitable in view of electricity transmission needs in the entire Finland.

OPERATIONS COMMITTEE

Jukka Rajala
Managing Director
Etelä-Pohjanmaan Alueverkko Oy

1. The Operations Committee should highlight in advance specific issues related to each season of the year, such as the power situation in the winter period, sufficiency of transmission capacity, and related guidelines. Attention should also be paid to arranging some of the frequent outages in the summer at other seasons of the year and to the consequent system security considerations in a parallel regional network.

Co-operation with various authorities should be developed further, and the goal should be to create a uniform communications model for various types of extraordinary situations.

2. It would be good if the Committee could work to continue the well-started harmonisation of procedures applied by the market players and the development of well-functioning practices.

I am looking forward to an ability to react to needs to change outage planning and various work methods, and to build flexible procedures without forgetting the equal treatment of various energy sectors.

I especially consider continued reliability and safety of network operation as important. All input in safety is important, because just a single electric accident is too many.

3. In my view the challenges include maintenance of power balance and especially the sufficiency or transmission connections and reserve capacity in extreme situations, for example during very cold weather in the winter, but also during unexpected disturbance situations in the grid or in power plants. It would be important to make sufficient preparations and give instructions for these eventualities, and all parties should have a desire to jointly develop contingency planning so that impartiality and equality are not compromised.

Network operators must accept the challenge of assessing the impacts of renewable, decentralised electricity production plants and different power plant solutions and of making advance preparations for network development.

Another major challenge is to improve the public image of the energy sector and increase awareness of its crucial role as one of the most important cornerstones of society. Without an electricity infrastructure, many activities become paralysed in a matter of a few hours.

Political decision-makers and market authorities should not control the electricity business too much, because this business works over a long time perspective with the shareholders carrying the financial risks.

MARKET COMMITTEE

Vesa Mäkilä
Senior Vice President, Electricity Sales Business
Oy Turku Energia

1. The topical issues for the Market Committee naturally include functioning of the electricity market and the role of transmission system operators in it. It is also important to discuss the outlook of the market as well as the transmission congestions and their impact on the electricity market in different situations.

Moreover, the Market Committee should monitor the Nordic and European integration developments and the position of Finnish players and consumers now and in the future from the viewpoints of transmission connections, price formation, and market risks. Area pricing in the electricity market and the functioning of this type of pricing is another topical issue.

2. I look forward to an open discussion on the above topics, and distinct views of the present situation and future objectives.

3. I think that it is a challenge how the potential conflicts of interest of various parties can be eliminated from open discussion and examination of various viewpoints.
It is also a major challenge to defend the interests of Finnish players and end customers in the integrating market; Finns must not be ignored between the east and west. Inexpensive electricity must not depend on transmission connections. It is important to think how we can influence the improvement of transmission connections in the entire Northern Europe. ■

Pearl-bordered fritillary.

Photographs by Jussi Murtosaari and Risto Jutila

Cranberry fritillary.

Freyja's fritillary.

Open transmission line areas in bogs
are an important habitat for butterflies

Bogs provide butterflies with a significant habitat. Butterflies thrive if the bog remains open and has but few trees. The number of butterflies can be influenced by clearing transmission line areas in bogs as frequently as such areas in forest land. This is revealed by an extensive research study carried out by the University of Jyväskylä, concerning transmission line areas as habitats which can replace natural bogs. The research material was gathered between 2004 and 2008.

The study financed by Fingrid and Finnish Energy Industries examined the significance of transmission line areas in bogs as butterfly habitats which can replace natural bogs. The study indicated clearly that transmission line areas have importance both for bog butterflies and daytime butterflies as habitats which replace natural bogs and other open areas.

Corresponding results have also been obtained in earlier studies. A study published by the Finnish Environment Centre in 2003 concluded that transmission line areas have great importance for butterflies which suffer from the disappearance of natural meadows. According to that study, frequent clearing of transmission line areas increases the number of butterflies.

Based on research results by the Finnish Environment Centre and other factors favouring shorter clearing intervals, such as system security and smaller amount of clearing waste, Fingrid decided to shorten the clearing interval in forest areas. The clearing interval was shorted from 6-7 years to 5 years in Southern Finland and from 6-9 years to 5-7 years in other parts of Finland.

The height growth of coppice in bogs is slower than in mineral soil areas, which is why bogs could be subject to a longer clearing interval than forest areas, without compromising system security. However, Fingrid wanted to find out first how the number of trees in bogs affects butterflies and what would hence be the optimum clearing interval. Finding out this called for field work extending over several years, examining the number of butterflies in the various stages of the clearing cycle.

The field work is now complete and the analyses show that the growth of thickets on bogs towards the end of the clearing cycle reduces the number of butterflies. The results suggest that from the point of view of butterflies, the optimum clearing interval would be as short as 3 to 4 years. This is why Fingrid will primarily use the same clearing cycle of 5 to 7 years in bogs as in forest areas. ■

10 to 20 new connections to Fingrid's 110 kV network annually

Shared rules guarantee system security

Constructing a power network and adding new parts to it is about integrating technical systems. When the connection principles are followed, it can be ensured that the system security of the power system is retained even though the structure of the network becomes more complicated over time.

Text by Petri Parviainen ■ **Photograph by** Mika Kuivalainen

Since a new connection becomes an integral part of the nation-wide grid, the technical implementation method of the connecting network – meaning issues such as right-of-way widths, ground wires and earthing systems – must be at least of the same standard as those used in the nation-wide grid.

The basic requirement is that a new connection must fulfil the valid acts, decrees and standards governing electrical equipment as well as **General Connection Terms of Fingrid Oyj's Grid (YLE 2007)**. It must also be ensured that the structure of the connections enables sufficiently fast disconnection from the grid in the event of faults and that normal operation and maintenance work at a substation does not cause unnecessary outages for the other customers in the area.

If one or more power plants in excess of 10 MVA are connected to the new connection, they must fulfil Fingrid's **Specifications for the Operational Performance of Power Plants (VJV 2007)**.

The connecting party should contact Fingrid at an early stage in order to determine the connection options and technical requirements of a new substation.

The issues to be considered in the preliminary engineering phase for a new substation include stand-by supply options for the substation in service and fault situations, and preparations for disturbances in the supplying network, such as voltage dips and no-voltage situations. Statistics show that there are some 300 momentary disturbance situations in the nation-wide grid annually, with the protective relay system of the grid managing these automatically. The number of disturbances requiring operation measures is on average 2 to 4 per year.

In addition to disturbances, the substations and transmission lines in the grid are subject to maintenance work by Fingrid and other connecting parties, requiring outages. A party connecting to the grid is responsible for making preparations for grid outages and, if necessary, for informing other parties connected to its network.

Connection to a substation in the nation-wide grid

The method of connection to the grid is determined by the power need and location of the connecting substation. Transformers in excess of 25 MVA must primarily be connected to a switching station by means of a circuit breaker bay. If there is no switching station nearby, it may be more viable to construct a new switching station to a transmission line in the nation-wide grid closer to the location in question.

Based on prevailing practice, Fingrid constructs a 110 kV circuit breaker bay at its substation for the connecting party and charges the resulting costs from the connecting party. The circuit breaker bay remains property of Fingrid. The connecting party obtains a right of use to the bay and to the shared equipment, structures and ground at the substation. Upon paying the construction costs of the circuit breaker bay, the connecting party contributes to the purchase of Fingrid's fixed assets and can process its portion of the costs in accordance with the Finnish act on business income taxation.

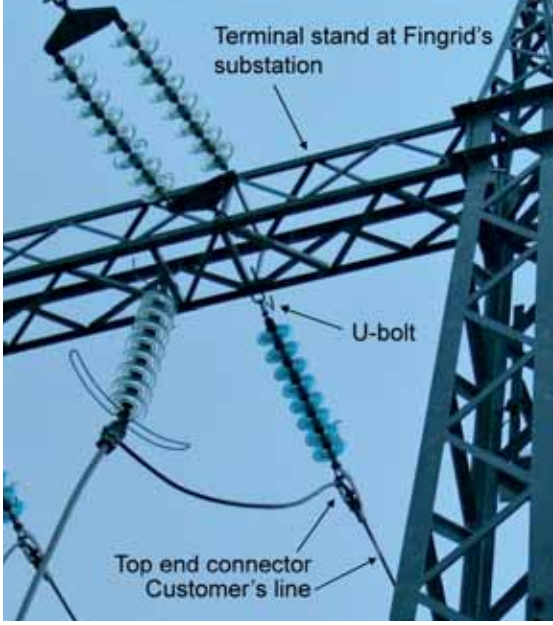
A connection agreement is always drawn up between the connecting party (owner) and Fingrid of a new connection, specifying the ownership limits, responsibilities and obligations concerning the connection. Moreover, a construction agreement is drawn up whenever necessary of the construction of the circuit breaker bay. In it, the technical details are specified more accurately than in the connection agreement, and issues such as schedule, co-operation during the construction period, and payment arrangements are also agreed in it. Because of the busy construction situation in the business and the competitive bidding process, the connecting party must be prepared for a construction period of at least 24 months.

Connection to a transmission line

In order to ensure the functioning of line protection in the nation-wide grid, it is not possible to connect to a transmission line which is in looped operation in the immediate vicinity of a switching station. The maximum permitted transformer size connected to a tapped line is 25 MVA. Two transformers of a maximum of 25 MVA can be connected to the same connection just as long as the transformers are not connected in parallel at the low-voltage side.

In an individual case a transformer of a maximum of 31.5 MVA can be allowed, but in this case it must be ensured together with Fingrid that the protection in the first zone in the tapped line does not extend to the secondary side of the transformer, in other words faults in the medium-voltage network must not trigger circuit breakers in the tapped line. As a rule, medium-voltage protection must work within 0.2 milliseconds in a fault situation. If the main protection does not work for some reason, back-up protection must trigger the fault within 0.5 milliseconds. The said times include the activation times of circuit breakers.

It is not technically possible to use grid protection as a protection of long branch lines. This is why the maximum permitted length of branch lines connected to a tapped line is half of the



Connection and ownership limits of customer's transmission line at Fingrid's substation: the U-bolt and the top end connector of the down rope constitute the ownership limit.

distance between the planned connection point and the closest circuit breaker protecting the tapped line.

In special cases a branch line which is connected with a circuit breaker having line protection can be connected to the tapped line when the length of the branch line is at the most the same as the distance between the connection point and the closest circuit breaker protecting the tapped line. Second zones of protective relays of a tapped line in the grid serve as back-up protection for these branch circuit breakers, with the second zones breaking the entire tapped line to prevent the fault from spreading to the surrounding network. These cases are always decided individually in each case taking into account impacts on the system security of the other surrounding network, compatibility of protection, inconvenience caused by increased outages and disturbances on electricity production and consumption in the area, alternative costs, and environmental impacts. The high-speed automatic reclosing function must not be used in a branch circuit breaker which protects a said exceptionally long branch line.

As a new issue, Fingrid will require that it must be possible to disconnect new branch lines with a length of more than 2 kilometres connected to a tapped line as live work. In practice, this means that branch lines more than 2 kilometres but less than 7 kilometres must be equipped with at least disconnectors, and any longer lines with either power disconnectors or circuit breakers. These switching devices must always be provided with earthing switches, and the devices must be located as close to the connection point as possible.

Connection of power plants

Power plants of less than 5 MVA can be connected directly to a transmission line. In these cases, the connection must be equipped with disconnection relays, and the tapped line must be equipped with synchrocheck relays. These ensure that the power plant is disconnected in the event of a fault in the tapped line before autoreclosing relays attempt to reclose the line, and that the power plant does not keep on feeding the fault location.

Power plants of more than 5 MVA must always be connected to a switching station. If there is no switching station close to the power plant, one must be constructed with at least three circuit breaker bays, for example to the closest transmission line in the nation-wide grid. For the above reasons, the power plant bay must also be equipped with disconnection relays.

Power plants of more than 10 MVA must fulfil Fingrid's Specifications for the Operational Performance of Power Plants (VJV 2007). This must be indicated by means of network tests of the power plant, used for testing the ability of the plant to cope a potential fault situation occurring in the network. From the point of view of the power system, it is of utmost importance that power plants can support the system as long as possible also during disturbance situations in the grid.

Impacts of connections on the grid

In accordance with the Electricity Market Act, Fingrid is responsible for the sufficiency of transmission capacity in the nation-wide grid. In other words, Fingrid is obliged to reinforce the grid – for example transmission lines, switching devices and transformer capacity – if the connecting party's power need calls for it.

The connecting party is responsible for the changes at the actual connection point. As an example, if connection to the grid requires changes to the line structure or the construction of new switching stations, they can be carried out either by the connecting party or Fingrid, as determined individually in each case. The connecting party is ultimately responsible for the costs resulting from the change.

If a customer connecting to the grid wishes to improve the availability of his own connection for example by adding disconnectors on the tapped line close to his connection, the details relating to their construction is agreed between the connecting party and Fingrid. In accordance with the causing principle, the party who needs new switching devices pays the related costs.

Switching devices built as part of a tapped line circuit are owned and maintained by Fingrid until their technical age is fulfilled or until the properties of the devices are no longer sufficient as the surrounding grid evolves. In this case, the need for such devices is decided again in the same manner as in the initial situation. This individual deliberation and procedure will also be followed when paying compensations for existing switching devices in the nation-wide grid.

Co-operation in grid operation and maintenance

In accordance with the connection agreements, both the parties connected to the grid and Fingrid are responsible for the operation and maintenance of the part of the network owned and administered by them respectively. This calls for constant contacts and negotiations between the parties.

In order to match up maintenance work and transmission outages in the grid, Fingrid's regional operation and maintenance specialists have regular contacts with their contact persons.

One new matter that will puzzle grid operation and maintenance is that blow opening of 110 kV disconnectors will finish for safety reasons as of the beginning of 2011. This will cause a need to change the switching devices and also the switching philosophy in some places.

Fingrid maintains and develops technical terms and guidelines aiming to facilitate the planning of new connections. The up-to-date documents can be found for example at: www.fingrid.fi > Services > Grid service > Grid connection.

Fingrid's contact persons in matters pertaining to connection to the grid:
Petri Parviainen, tel. +358 30 395 5282 and Heikki Ruhanen, tel. +358 30 395 5166.

EIA process for additional reserve power capacity in progress

Six location options presented

Reserve power plants are needed as fast disturbance reserves for the management of disturbance situations in the Finnish power system. Fingrid has launched the environmental impact assessment (EIA) procedure for the construction of additional reserve power plant capacity. The project and the environmental impact assessment programme were presented to the general public in six target locations in November.

Text by Satu Vuorikoski ■ **Photographs by** Juhani Eskelinen

The need for additional reserve power capacity required for emergency purposes in the management of serious disturbance situations in the nation-wide power system is at the most 400 megawatts of total electric power. In practice, capacity can be added by placing new units in conjunction with an existing reserve power plant or by constructing new reserve power plants.

Construction is planned to take place in units of at least about 100 megawatts. When a new reserve power plant is built, it is also taken into account that the plant can be doubled in power if the reserve needs rise.

The examined potential locations of reserve power capacity are Forssa, Inkoo, Joroinen, Jyväskylä, Kangasala and Seinäjoki. The first phase of construction, encompassing at least 100 megawatts, is expected to be ready in 2013. The total additional capacity of a maximum of 400 megawatts is estimated to be needed by 2020.

The need for additional reserve power capacity is influenced by the trend in the total need for disturbance reserves, availability of alternative reserves, and usability of existing reserves.

Based on statutory obligations

The reserve power capacity is needed for the management of statutory reserve obligations imposed on Fingrid, in other words for securing the technical functioning and system security of the nation-wide power system. The reserve power plants are not used for commercial electricity production, but they are only started when serious disturbance situations occur in the power system.

The increased need for fast disturbance reserves is crucially influenced by larger unit sizes of new power plants, i.e. introduction of new, large nuclear power units. If there is a failure in the operation of a large electricity production unit, it must be possible to replace its production quickly and temporarily by the production of reserve power plants in order to restore the normal state in the power system. Over a longer perspective, plans for large-scale power production which cannot be adjusted also increase the need for reserves when preparations for sudden production variations need to be made. The project also ensures the sufficiency of reserve capacity during the service of reserve power plants.

Most recently, a reserve power plant was completed in Olkiluoto at the end of 2007. The rest of Fingrid's present reserve power capacity was constructed in the 1970s, and its availability is maintained by extensive refurbishment programmes.

The most recent reserve power plant in Finland was completed in the Olkiluoto power plant area at the end of 2007 (2 x 50 MW gas turbine plant).

Short operating time of reserve power plants

The reserve power plants are unmanned, and they are started in remote control from Fingrid's Power System Control Centre when necessary. The buildings in the plant area comprise the actual power plant, fuel tanks and fuel pumping station. Moreover, a receiving point for fuel is needed in the plant area. The fuel used is low-sulphur light fuel oil.

The short operating time of the plants reduces their environmental impacts. In a normal situation, reserve power plants are only operated for approx. 10 hours per unit per year. This consists of monthly trial operation and of actual use for random reserve power needs. The trial operation for testing the plant is carried out in the daytime, and it lasts for about 1 hour per unit.

Serious disturbances of the power system leading to the starting of a reserve power plant are rare occurrences (about once a year), and the reserve power plants are usually operated for only a few hours in conjunction with such disturbances.

EIA procedure progressing rapidly

The EIA procedure for additional reserve power capacity examines six alternative locations. Two different technical options, i.e. a gas turbine plant and a diesel engine plant, are also examined at each location.

The EIA programme was drawn up in the first phase of the procedure. This was completed in October. The programme describes what impacts will be assessed in conjunction with the EIA procedure and how the assessments will be carried out. The results of the work will be compiled in an assessment report, which will be ready in the spring of 2009.

The contact authority in the EIA procedure is the Central Finland Regional Environment Centre, which will announce the public display of both the completed assessment programme and assessment report in the relevant locations. Citizens can express their opinions to the contact authority during the display period.

The project for additional reserve power plant capacity and the EIA programme were presented in public events in all six locations in November. The public events were open to all those interested in the matter, and the events mainly provided information. Fingrid's representatives, representatives of the consultant drawing up the assessment report and the contact authority were present in the event to discuss the project and answer questions. ■

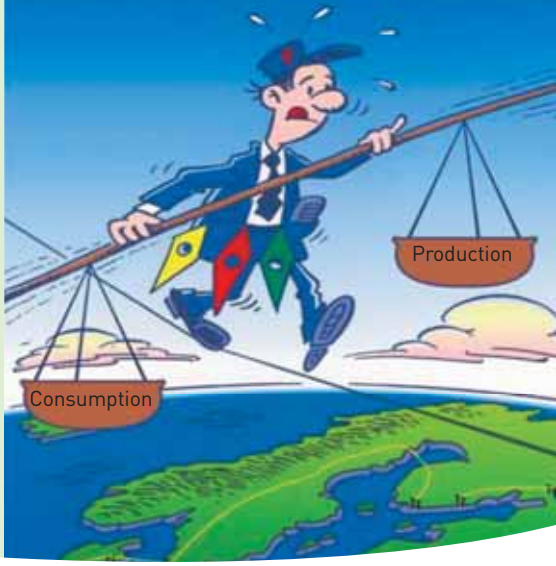
Alternative locations of reserve power plant capacity.

More information (in Finnish):
www.fingrid.fi > Ympäristö > YVA-menettelyt > varavoimalaitoskapasiteetin lisääminen.

The environmental impact assessment (EIA) procedure is a statutory process aiming to "promote the assessment of environmental impacts and uniform consideration of the impacts in planning and decision-making, and to improve citizen's information supply and contribution opportunities".
The EIA procedure is not a permit procedure, but it provides information for decision-making.

Grid ABC

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



Maintaining of frequency **in the power system**

Through the transmission grid, the Nordic power system has been integrated into a single system encompassing Finland, Sweden, Norway and Eastern Denmark. In this inter-Nordic system, the power balance between electricity production and consumption is maintained continuously both during normal and disturbance situations in accordance with principles agreed between the Nordic transmission system operators (TSOs).

Text by Jarno Sederlund ■ **Illustration by** Heimo Suomalainen

Fingrid is responsible for maintaining the continuous power balance between electricity production and consumption, i.e. for balance management. Monitoring pertaining to balance management takes place 24 hours a day, 7 days a week at Fingrid's Power System Control Centre in Helsinki.

The primary objective in balance management in the inter-Nordic system is to maintain the power system frequency, which describes the balance between electricity production and consumption. The better the balance, the smaller the variation in frequency and the better the quality of electricity.

In a normal situation, the frequency can vary between 49.9 and 50.1 hertz (Hz). If the frequency of the grid is below 50 Hz, consumption exceeds production. Correspondingly, when the frequency is above 50 Hz, production is greater than consumption.

Power balance is maintained by means of frequency-controlled reserves and manual adjustments.

Frequency control tools: reserve bank and regulating power market

The objective is to keep the power system used for electricity transmission in balance at all times. In this case, production and consumption are almost equal, but in practice there is often a small difference between them. This constantly varying difference in the power balance manifests itself as variations in frequency. Since consumption varies with time and since this variation cannot be predicted fully, there is a need for reserves in the power network for maintaining the power balance.

The power system has access to two types of reserves, normal operation reserves and disturbance reserves. Both of these can be divided further into frequency-controlled and manually-started reserves on the basis of the activation time. Terms primary and secondary regulation are also used on the Nordic level.

Owners of reserve capacity participate in frequency maintenance on a voluntary basis. Fingrid has established a so-called reserve bank, into which companies with capacity that can be regulated can report their resources. Against a compensation paid by Fingrid, the resource owners maintain the measured regulation properties at their power plants at the agreed terms.

Moreover, Fingrid maintains a regulating power market, into which possessors of capacity which can be adjusted can make bids of their available capacity. The enclosed table contains a

Reserve	Contractual capacity	Obligation
Frequency-controlled normal operation reserve (50.1–49.9 Hz)	- Power plants 144 MW - Vyborg DC link max. 100 MW - Vyborg DC link max. 35 MW	143 MW *)
Frequency-controlled disturbance reserve (49.9–49.5 Hz)	- Power plants 520 MW - Loads which can be disconnected 90 MW	240 MW **)
Fast disturbance reserve (activated manually)	- Fingrid's own reserve power plants 615 MW - Plants subject to right of use contracts 164 MW - Loads which can be disconnected 425 MW	865 MW ***)

*) The obligation is divided between the subsystems annually in proportion to the annual energies used by them.
**) The obligation is divided between the subsystems weekly in proportion to the dimensioning faults.
***) Volume corresponding to a dimensioning fault.

summary of the maintenance agreements and obligations for Fingrid's reserves for 2008.

Frequency-controlled reserves

Frequency-controlled reserves refer to reserves which are activated quickly (in seconds and minutes) and automatically by frequency changes.

For frequency maintenance, the power system must have a sufficient volume of so-called spinning reserves, which react automatically to frequency changes. The frequency-controlled normal operation reserve and frequency-controlled disturbance reserve are active power reserves which are activated automatically by frequency changes.

■ Frequency-controlled normal operation reserve

The Nordic TSOs have agreed that a total of 600 megawatts (MW) of frequency-controlled normal operation reserve is maintained continuously in the inter-Nordic system for normal-state (49.9–50.1 Hz) frequency adjustment. The reserve maintained jointly is distributed annually between the countries included in the inter-Nordic system in proportion to the annual energies used by them respectively. Of this, Finland's share was 143 MW in 2008.

The frequency-controlled normal operation reserves used in Finland are active power reserves in power plants as well as the direct current links to Russia and Estonia.

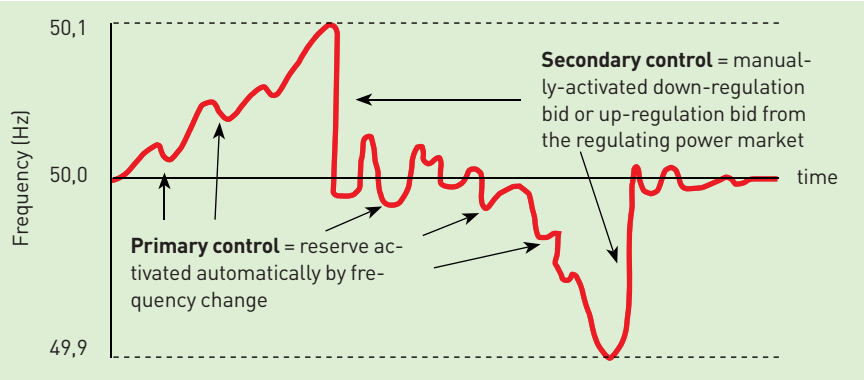
■ Frequency-controlled disturbance reserve

When the frequency goes below 49.9 Hz, the frequency-controlled disturbance reserve begins to activate. If the frequency stays below 49.5 Hz for more than 30 seconds, the reserve must have been activated fully.

This reserve consists of contractual power plants in Finland and of industrial loads which can be disconnected. The frequency-controlled disturbance reserve works as primary adjustment in terms of time, but it is not used for balance management in a normal situation of the power network.

The need for inter-Nordic frequency-controlled disturbance reserve is determined weekly on the basis of the largest dimensioning fault, from which 200 MW is deducted because of the frequency dependence of loads. Dimensioning fault refers to the largest individual fault which can occur in the grid (such as the largest production unit that may disconnect in a disturbance situation).

In a normal operating situation, the frequency-controlled disturbance reserve power required in the Inter-Nordic system is typically 1,000 MW, of which the obligation for Finland is approx. 240 MW.



Manually-started regulation capacity

If it is not possible to keep the frequency within the permitted limits using frequency-controlled reserves alone, manual adjustments must be carried out. The manually-activated reserves can be deemed to include adjustments activated within no more than 15 minutes in the regulating power market as well as fast disturbance reserve.

■ Regulating power market

Fingrid maintains a regulating power market because it does not have regulating capacity of its own for maintaining the power balance. Holders of production and loads can give bids to the regulating power market of their capacity which can be adjusted.

Regulating bids can be given of all resources which can carry out a power change of 10 MW within 15 minutes.

Regulating bids

Up-regulating bid	Down-regulating bid
- increase in production	- decrease in production
- decrease in consumption	- increase in consumption
- resource holder sells electricity to Fingrid	- resource holder buys electricity from Fingrid

The bids must be submitted to Fingrid before the beginning of the hour.

The regulating power market in Finland maintained by Fingrid is part of the Nordic regulating power market. A Nordic regulating bid list is drawn up of all regulating bids by placing the bids in a price order.

The regulating bids are used in the price order as well as possible considering the operating situation of the power system. The cheapest up-regulation bid is used first, and correspondingly the most expensive down-regulation bid is used first.

■ Fast disturbance reserve

The fast disturbance reserve is manually-activated power which is available in Finland at reserve power plants (gas turbine plants) and as industrial loads which can be disconnected manually by virtue of contracts. The reserve can be made available in 15 minutes, after which the power system can withstand another disturbance.

There is no inter-Nordic requirement for the volume of fast disturbance reserve. Each TSO specifies itself the volume of necessary fast disturbance reserve, with which the system can be restored to a normal state after a disturbance.

In 2008, the volume of fast disturbance reserve maintained by Fingrid was 865 MW, which corresponds to a dimensioning fault in the Finnish grid.■

Fingrid involved in examining the services of intelligent electricity network

The Finnish Electricity Research Pool and numerous energy companies have launched a long-term research project for examining the opportunities provided by smart electricity metering as part of an intelligent electricity network. The objective is to study how functions related to new measurements can be utilised in the management of electricity networks, increasingly efficient fault services, intensifying the functioning of the electricity market, and in services encouraging energy efficiency.

The research project is carried out by the research teams of the Tampere University of Technology, Lappeenranta University of Technology, and VTT Technical Research Centre of Finland. The total costs of the project are approx. 1.3 million euros.

The main financier of the project is Tekes (Finnish Funding Agency for Technology and Innovation). In addition to the Electricity Research Pool, the other contributors to the project are, among others: ABB Oy, Aidon Oy, Empower Oy, Enease Oy, Energiakolmio Oy, Fingrid Oyj, Fortum Sähkönsiirto Oy, MX Electrix Oy, Nokia-Siemens Networks Oy, Oy Nykarleby Kraftverk Ab, PowerQ Oy, Siemens Oy, Tammerkosken Energia Oy and Telia-Sonera Oyj.

Increasingly decentralised electricity production and requirements concerning demand response call for new, intelligent functions from electricity networks and customers' electricity metering. The intelligent electricity networks of the future will enable features such as connection of decentralised electricity production to the network, its management, load control, demand response, and increasingly efficient automatic control of networks. Improved customer metering is in a central role in the study.

Electricity meters have been developed into smart meters for quite some time. The data provided by such meters can be used in the future comprehensively not only in conventional energy metering but also for developing the entire electricity distribution system. Intelligent electricity networks are subject to active research and development also through various research projects of the EU.

The objective of the Finnish research project is to specify and demonstrate technical solutions for new generation energy meters, functions relating to the customer interface, utilisation of various technological solutions, and various business models for network management and electricity market functions. The research project will concentrate on a number of areas.

The project will examine issues such as improved reliability of electricity distribution and intensified fault service, functions pertaining to smart metering of electricity, and network connections of decentralised production capacity. Other matters studied include network and electricity market impacts of rechargeable hybrid and electric cars, customer's load control, and technological solutions for demand response.

Business models for market-based load control as well as functions and services which support energy conservation and efficiency will be surveyed, too. The project will also provide information on the utilisation of metering data and functions at the customer interface in distribution network management, planning and network asset management.

The new services will give customers new opportunities, for example to participate actively in the intensification of the electricity market, improve energy use efficiency, and also to shift over to the use of rechargeable hybrid cars.

Electricity companies will have new opportunities to develop for instance real-time electricity pricing and new products based on demand response. For industrial players, such as equipment manufacturers, data communications and data systems suppliers and service providers, smart automated metering opens new perspectives for business development. ■

Route options of Tahkoluoto-Kristiinankaupunki line project examined

In early 2008, Fingrid launched an environmental impact assessment (EIA) procedure for the 400 kilovolt transmission line between Tahkoluoto in Pori and Kristiinankaupunki in Western Finland. Based on the statements received of the assessment programme, Fingrid is examining new alternative line routes in Pori, Noormarkku and Pomarkku.

The new 400 kilovolt transmission line makes preparations for a future shift-over from a voltage level of 220 kilovolts to 400 kilovolts in the transmission network in the coastal regions of Ostrobothnia. The higher voltage will be introduced in the next 10 to 20 years.

The new transmission line will also improve the system security of the power plants in Tahkoluoto by joining them to the looped transmission grid. Moreover, the transmission line will enable the addition of power plant capacity in Tahkoluoto.

In January 2008, Fingrid delivered the assessment programme in accordance with the EIA procedure to the Southwestern Finland Regional Environment Centre, which serves as the contact authority. The Regional Environment Centre submitted its statement of the assessment programme on 18 April 2008.

As a result of opinions and statements expressed of the EIA programme and based on the meeting of the control group, the EIA procedure is examining the earlier route options and also the northern Meri-Pori route between Tahkoluoto and Lampaluoto, the southern and northern Poikeljärvi routes, an alternative route at Järvikylä, and the northern Poosjärvi route.

The location of the examined route options can be viewed on the Internet site of the project (in Finnish) at www.fingrid.fi under "Ympäristö" and "YVA-menettelyt". The results of the assessment work were also presented in public events in the autumn.

The transmission line is expected to be built in 2014 and 2015. ■

Extracts from Fingrid Group's interim report

Fingrid published its interim report for period 1 January - 30 September 2008 at the end of October. Here are some details of the report:

• The Group's revenue was 87 million euros from July to September 2008 (73 million euros during the corresponding period in 2007). The sales volume of balance power was 27 million euros (14 million euros) and purchases of balance power 19 million euros (12 million euros). The IFRS profit before taxes was 9 million euros (7 million euros).

• The Group's revenue from January to September was 280 million euros (234 million euros). Transmission revenues grew slightly to 136 million euros (135 million euros). The sales volume of balance power was 76 million euros (41 million euros) and purchases of balance power 68 million euros (37 million euros). Fingrid's share of the inter-Nordic bottleneck revenues grew because of capacity restrictions between Norway, Sweden and Denmark to 21 million euros (19 million euros). The cross-border transmission revenues on the Russian and Estonian connections totalled 16 million euros (14 million euros).

• Operating profit between January and September without the change in the fair value of derivatives was 63 million euros (56 million euros). The compensations for the European market place had a positive impact of 7 million euros on the operating profit. Operating profit was decreased by items such as higher depreciations.

• Between January and September, the operating profit in accordance with IFRS was 61 million euros (68 million euros), which contains 2 million euros (+13 million euros) of negative change in the fair value of electricity derivatives. The IFRS profit before taxes was 28 million euros (30 million euros). The equity ratio was 29 (27) per cent at the end of the review period.

• The Group's income flow is characterised by seasonal fluctuations, which is why the financial result for the entire year cannot be directly estimated on the basis of the nine-month result. ■

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 9 January 2009. Address: Fingrid Oyj, PL 530, 00101 HELSINKI, FINLAND. Mark the envelope with "Verkkovisa".

We give five distance meters (value 50 euros) as prizes. The winners are decided by drawing lots among all those who have given the right answers. We will inform the winners in person. The answers to the questions can be found in the articles of this magazine.

Fingrid has calculated that if the nominal power of wind electricity generation to be potentially constructed in the future is 2,000 megawatts, its volume available in a peak demand situation would be:
- ◯ 300 megawatts
- ◯ 250 megawatts
- ◯ 120 megawatts.

In a serious power shortage, electricity consumption has to be restricted in order to reach power balance. Fingrid aims to restrict consumption by the following volume at a time:
- ◯ 100 megawatts
- ◯ 200 megawatts
- ◯ 400 megawatts.

In order to control system security, it has been agreed that the transmission situation must be brought back within the transmission limits within the following time from a disturbance so that the system can withstand another (N-1) fault:
- ◯ 15 minutes
- ◯ 20 minutes
- ◯ 25 minutes.

El Niño-La Niña is:
- ◯ a South-American salsa band
- ◯ a weather phenomenon occurring in the tropics
- ◯ a group of butterfly species favouring bogs.

If the winter is so mild that the ground does not freeze:
- ◯ trees will fall easier than if the ground is frozen
- ◯ trees are more likely to stay up than if the ground is frozen.
- ◯ Ground frost has no impact on the susceptibility of trees to fall.

The annual operating time of Fingrid's reserve power plants per unit in a normal situation is:
- ◯ 10 hours
- ◯ 18 hours
- ◯ 30 hours.

In recent years, the average outage experienced by customers because of disturbance situations in the Finnish transmission grid has been:
- ◯ about 10 minutes
- ◯ a couple of minutes
- ◯ half an hour.

In 2008, the volume of fast disturbance reserve maintained by Fingrid is:
- ◯ 650 megawatts
- ◯ 748 megawatts
- ◯ 865 megawatts.

Name _____

Address _____

Post office _____

E-mail address _____

Telephone number _____

Winners of prizes of the Grid Quiz in the previous Fingrid magazine (2/2008): Tuula Huiko, Valkeakoski; Tarja Janatuinen, Kotka; Esko Kuljukka, Leppiniemi; Arto Köykkä, Muhos; Jatta Leppänen, Harjavalta; Mirella-Katriina Levomäki, Punkalaidun; Seija Lohikoski, Espoo; Satu Sallinen, Salo; Martti Uppala, Rovaniemi; Mikko Vehniäinen, Vaala.

Photograph by Sami Kuitunen

Fingrid specifies transmission line project from Yllikkälä to Huutokoski

Fingrid will continue the implementation of a 400 kilovolt (kV) line project, which has been planned since the 1990s, from Lappeenranta to Joroinen in Eastern Finland. The implementation plans of the line have been specified on the basis of amended environmental legislation, land uses, and feedback provided by authorities and landowners.

Landowners in particular have suggested that the entire line be constructed using double circuit towers in order to save forest land. Consequently, the new 400 kV transmission line will be installed on double circuit towers with a 110 kV line over a total distance of 79 kilometres. The right-of-way will become wider also on the section with double circuit towers, but only to 9 metres instead of the 30 metres which would be required by a parallel line.

From Lemi to Heinälahti in Mikkeli, however, there will be no double circuit towers, but the new line will be placed parallel with the existing 400 kV line. The main reason for this is that the existing transmission line cannot be made dead for the duration of the construction of a new double circuit tower line without compromising system security in the region of Savo-Karjala and in the entire transmission grid.

The present Yllikkälä–Huutokoski 400 kV transmission line is very loaded, which is why there is a need for a new parallel line.

The line route has been examined in view of some 80 different nature areas, such as the habitat of the endangered Russian flying squirrel. According to the updated assessment report, the line project imposes a relatively small burden on the natural environment if the line is placed in the existing right-of-way or in the place of the existing 110 kV line. The Kuolimo, Konijärvi and Iso-Huppio nature protection and Natura areas are located along the line route.

The scenic disadvantages concern the same locations as the existing transmission line, with the new line naturally accentuating the scenic disadvantages. As an example, the line route crosses a waterway at 24 locations. At Visulahti in the Lampila area, the existing 400 kV line will also be moved to a new route in order to mitigate scenic disadvantages and ones inflicted on the cultural environment.

Ways to reduce the scenic and land use disadvantages was examined with almost 90 buildings. In many places, it has been possible to alleviate the disadvantages by the relocation of the line. The disadvantages of the line project on livelihoods and land use are considered to be relatively small. The line area will cover a total of 280 hectares of forest land and 20 hectares of fields.

During the updating of the project, an idea emerged to combine Lappeenrannan Energiaverkot Oy's 110 kV line project on the double circuit towers of Fingrid's new 400 kV line. As a result of this solution, the 110 kV line from Yllikkälä to Huttula in Lemi will not need a transmission line area of its own. The new parallel line will improve electricity supply reliability in the Lemi-Savitaipale-Taipalsaari area.

The general planning for the transmission line is already in progress, and the related field work will commence next spring.

Construction work will begin in 2010, and the line is due to be ready in the spring of 2013. The cost estimate for the project is 40-50 million euros. ■

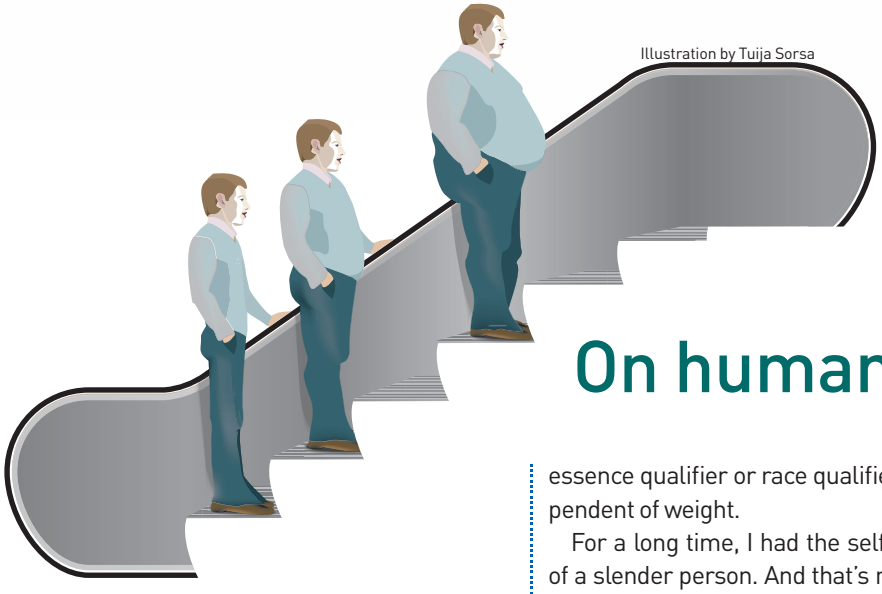


Illustration by Tuija Sorsa

On human growth

One way to conserve energy is to save it in your body. Electricity is energy-saving in this sense. To put it simply: electricity makes you fat. Refrigerators, elevators, escalators, microwave oven, computer work... Electricity offers ample opportunities for both quick and easy meals and less exercise.

The modern electric life has also put up my weight, by more than 30 kilos in this millennium alone.

According to the right-wing extremist logic, there is a pseudobiological barrier between criminals and decent citizens. Just like a white man cannot become black even though he smudges his face with shoe polish, a decent citizen will not become a "criminal" even though he commits a crime. No: he is essentially a decent citizen with one misdemeanour in his record. Similarly, an impoverished businessman does not think that he is a loser – no, he is a winner who just happens to be out of money right now because of bad luck.

It is easy to say that this mindset is incorrect and racist. But a person who has put on weight easily thinks in just the same way: he feels that he is still the same slender me, who has just caught on some loose kilos. As if fatness was an essence qualifier or race qualifier independent of weight.

For a long time, I had the self-image of a slender person. And that's no wonder, because it was true for long. When I was studying, I was at my thinnest; I was a downright stick insect. A lunch at the university cafeteria was a sufficient day's rations. I did not eat anything in the evening! Long-distance runner Ron Clarke once stated that he had to practice five years before he could train like top athletes. The journey from Laurel to Hardy requires the same in eating.

Gaining weight causes electric reactions in people. Many noisy old friends do not even greet you, they just start right off: "My God, you've put on a lot of weight. I never thought that of you!" As if I didn't know that already! Gesture language is another common reaction. Neo-fat people have to get used to the harassment code no longer applying to them: it is not uncommon that people poke their finger into the protruding belly.

As the hug touch changes, activities of another kind may emerge: tickling of double chin, bouncing of pot belly, trying the size of the side python. The scientifically uncivilised question is usually: "Well, what do we have here!"

By far the most people are polite and say nothing. However, most have to struggle at that.

In traditional societies, the shift-over from a social category to another required some sort of an initiation rite. In modern societies, sorting based on social classes and professions is not only more mobile but also prohibited grounds of referral from the point of view of the equality ideal. This is why the modern world tends to replace socio-symbolic classifications with categories relating to the body. The attitude towards someone who has put on weight is like he would have changed his status in his own right.

"I have reached the weight of 100 kilos now. Welcome to celebrate this with me at my house..."

However, our culture does not have an event where you could invite your friends to verify and celebrate a shift-over to another size caste. I have been to a divorce party (not a bad idea, either), but I have not come across a rite for transferring into fatness: "I have reached the weight of 100 kilos now. Welcome to celebrate this with me at my house..."

It should be possible to take a matter-of-fact attitude towards fatness. Why should this lardy by-product of electricity involve unnecessary social and psychological pressures? The above celebration institution would solve all other problems relating to fatness except health considerations. The cure for them is exercise – and it helps even if you do not lose weight. ■

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).

Merry Christmas and a Happy New Year

This year we donate the sum reserved for our Christmas greetings to the Hyvä joulumieli charity campaign arranged by the Finnish Red Cross and the Mannerheim League for Child Welfare.

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