

FINGRID OYJ'S GENERAL CONNECTION TERMS YLE2013

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1 Introduction

The purpose of this document is to describe the general connection terms between Fingrid Oyj's (hereinafter Fingrid) electrical equipment and the electrical equipment owned or controlled by the other contracting party connected to Fingrid's grid (hereinafter the Connectee). The general connection terms are based on the *Nordic Grid Code*, which is part of European grid codes. The connection terms maintained by Fingrid ensure that the grids to be connected are technically compatible and define the rights, obligations and responsibilities concerning the connection. The Connectee and Fingrid agree on each connection in a separate connection agreement.

The use of the grid connection requires that an agreement between the Connectee and Fingrid has been drawn up of the transmission of electricity taking place at the connection point and of the management of the reactive power balance.

The Connectee shall agree with those connected to its grid directly or indirectly that their electricity networks and related electrical equipment also meet Fingrid's general connection terms as well as other guidelines and requirements related to the implementation of the connection.

Standby supply connections, which are in use only temporarily in disturbance or outage situations, are subject to these connection terms.

2 Connection to the grid

2.1 Connection solution and main principles

The Connectee's electrical equipment is connected to Fingrid's grid at a switch yard. The exception to this is a connection to Fingrid's 110 kV transmission line in accordance with item 2.3. The possibilities and solution of connection of cables are to be agreed separately taking into account the technical properties of the cables as well as the connection location and solution.

The issues to be taken into account when planning a connection to Fingrid's grid include the need for the connection, system security of the transmission grid, technical implementation options, and costs. In order to safeguard the reliability and efficiency of the main grid, low-power electrical equipment shall be connected to a distribution or regional grid unless such a connection is technically or commercially unreasonable to carry out.

The Connectee shall supply the implementation plans of the connection for Fingrid's review well before the starting of implementation so that the technical compatibility and electrical safety of the connection can be verified. The Connectee is responsible for the safe implementation of its electrical equipment in a manner which conforms to the provisions.

Overhead lines with a nominal voltage of 110 to 400 kV shall be equipped with shielding wires. The overhead lines shall be built and maintained so that trees cannot fall on the

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line, so as to prevent disturbance to the grid by nearby trees. The phases of overhead lines shall be transposed in accordance with Fingrid's guidelines. The Connectee shall ensure the compatibility of the technical implementation of transposition with Fingrid.

During the planning of the connection, the Connectee and Fingrid shall agree on the energy metering arrangements. Sufficient space shall be reserved for the necessary measuring instruments, auxiliary power supplies and instrument transformers with wirings, and connections for communications purposes.

When connecting to Fingrid's grid, the Connectee is responsible for the safe execution of the connection of its electrical equipment, for adherence to laws and decrees concerning the construction of electrical equipment, for the necessary contact voltage examinations and hazardous voltage examinations, and for measures required on the basis of these.

2.2 Switch yard connection

The Connectee's electrical equipment is connected to Fingrid's 400 kV, 220 kV and 110 kV switch yard bay. When connecting to a switch yard by a 110 kV overhead line, the ownership and management of the lines end to the U-bolts on the terminal support and the top connectors of the connecting jumpers. The U-bolts and connectors are owned by Fingrid. If dead-end tension joints are used for connecting the jumpers, they are owned by the Connectee.

When connecting by a cable, the ownership and management of the lines end at Fingrid's switch yard are the Connectee's cable terminal connectors in the cable rack. The cable, cable terminals with racks and foundations, their connectors and the overvoltage protectors of the cable are owned by the Connectee. Fingrid owns the other equipment and structures at its switch yard.

The Connectee and Fingrid have the right to place their transmission lines connected to the switch yard in the substation area without compensation.

2.3 Connection to a 110 kV transmission line

Because of the long geographical transmission distances in Finland, the transmission lines in the main grid are long and the substations are far apart. This is why connection to Fingrid's 110 kV transmission line is permitted, taking into account the available transmission capacity of the transmission line and the below technical conditions:

- The maximum permitted unit size of a transformer to be connected to a 110 kV transmission line is 25 MVA, which may consist of more than one transformer machine. If the Connectee's transformation need is greater than 25 MVA, another transformer of a maximum of 25 MVA can be added to the same connection, provided that this is permitted by system security and the transmission capacity on Fingrid's transmission line. The 25 MVA transformers connected to a transmission line must not be connected in parallel.
- When connecting to a transmission line more than 100 km in length, the connectivity of the transformer size shall be checked separately.

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- The length of a transmission line to be connected can be at the most half of the distance of the connection from the closest protective circuit breaker in the main grid.
- It must be possible to disconnect a connecting line in excess of 2 km from the main grid as a normal operation measure while the connecting line is live.
- If the connection of a connecting transmission line contains a circuit breaker equipped with protection relays, the length of the connecting transmission line may be equal to the distance of the connection from the nearest protective circuit breaker in the trunk line.
- Transmission line connections are not allowed near a substation or on 110 kV loop lines which serve as replacing links in the main transmission grid.
- The Connectee shall make sure that the connection point can be earthed on the side of the transmission line in the main grid, with the earthing having short circuit strength. When connecting to a double circuit line, the connection disconnectors shall have earthing switches on the side of the transmission line in the main grid in order to ensure occupational safety.

When the Connectee's line or substation is connected to Fingrid's transmission line, the ownership limits are the connectors of the connecting jumpers, owned by the Connectee, on Fingrid's line. The disconnectors possibly located at the connection point on Fingrid's line are owned by Fingrid. The disconnectors on the connecting line are owned by the Connectee.

2.4 Connection of DC link

The connection of a DC connection to the main grid shall be separately agreed with Fingrid.

2.5 Connection of power plant

A power plant which is to be connected to the Finnish power system is required to fulfil Fingrid's valid specifications for the operational performance of power plants.

A power plant in excess of 250 MVA is primarily connected to the 400 kV grid. The connection of large power plant units shall be agreed well in advance with Fingrid so that the connectivity of the power plant to the power system can be determined. The connectivity of a power plant depends on the trend in the electricity production architecture of the Nordic power system and on the ability of the power system to withstand rapid power changes. In 2013, the biggest permitted stepped power change in the connection of a power plant to the Finnish power system is 900 MW. Based on the estimated trend of the power system, the biggest permitted stepped power change in the connection of a power plant can grow to a maximum of 1,650 MW. Fingrid monitors the trend of the Nordic power system. If necessary, updates are made to the power change limit so that system security is not compromised.

The Connectee's power plant or electrical equipment, to which a power plant is connected, shall be connected to the main grid at the switch yard through a circuit breaker bay. Exception to this are small power plants of less than 5 MVA, which are to

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be agreed separately, and power plants of a maximum of 25 MVA, which feed to the main grid a short circuit current no more than 1.2 times the rated current of the power plant.

The holder of the power plant, the Connectee and Fingrid shall separately agree on voltage regulation, production of reactive power and maintaining of reactive power reserves.

A power plant which is connected to a transmission line shall be equipped with disconnecting relays. A power plant in excess of 5 MVA connected to a transmission line connection shall be equipped with a telecommunications connection to enable high-speed automatic reclosing in the main grid.

2.6 Parallel operation of grids

If the Connectee's grid or the Connectee's grid together with a grid of other parties constitutes a parallel operational grid with the main grid, the Connectee shall agree on their parallel operation and potential action and costs caused by it with Fingrid in advance, before starting parallel operation.

2.7 Supply of information

For the design of the connection, Fingrid shall submit to the Connectee a proposal concerning the location of the connection, information about short circuit currents and earth fault currents and information about the basic protection requirements. In transmission line connections, Fingrid also submits requirements concerning the distances of structures from Fingrid's transmission lines and towers. When the Connectee is dimensioning its electrical equipment, the Connectee shall take into account the basic design values and their forecasts given by Fingrid.

The Connectee shall submit to Fingrid the necessary information about the electrical equipment to be connected and about related devices and systems. Information is required on issues such as lines, transformers, generators and compensation equipment, and on the method of grid operation, method of preventing trees from falling on the lines, and ownership changes. Before commissioning the connection, the Connectee shall deliver to Fingrid the area map of the connection, location co-ordinates, layout and sectional drawings, main circuit diagram, energy metering implementation details, earthing plan, relay protection information, and communications information. The updated final documents shall be delivered to Fingrid no later than two months after the commissioning of the connection. The measurement record of the earthing impedance shall be submitted to Fingrid after the measurements, no later than one year after commissioning.

2.8 Modification of grid

If the Connectee intends to make additions or modifications to the Connectee's own electrical equipment or to electrical equipment connected directly or indirectly to the Connectee's grid, the Connectee shall contact Fingrid well in advance so as to clarify the effects on the main grid and to implement any modifications or additions possibly required in the main grid. These types of changes by the Connectee include a new line of at least

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110 kV, a new transformer or change of transformers, a new power plant, power operation of a reserve power plant, and changes in the technical system properties of an existing power plant or grid. Any grid modifications shall fulfil the valid connection terms.

3 Operational requirements of electrical equipment

3.1 Laws and regulations

The Connectee and Fingrid are responsible for their electrical equipment meeting the requirements of valid laws and official regulations.

3.2 Quality and requirements of electrical equipment

In order to guarantee the quality of electricity and system security, the Connectee's and Fingrid's electrical equipment shall fulfil the applicable standards and the requirements of system responsibility. This also applies to the electrical equipment of other parties connected to the Connectee's and Fingrid's grids directly or indirectly.

3.3 Monitoring the fulfilment of the connection terms

Fingrid has the right to inspect the connection and any subsequent amendments made to it, and, if necessary, to request further clarifications. As far as the connection is concerned, the Connectee has a reciprocal right to inspect Fingrid's electrical equipment.

If it turns out that the connection does not fulfil the connection terms, the Connectee shall submit to Fingrid an account of the impact of the shortcomings on the operation of the connection plus a plan concerning the measures for the correction of the shortcomings and the correction schedule. After the completion of the modifications, the Connectee and Fingrid shall jointly verify that the connection fulfils the connection terms. The Connectee is responsible for the verification and for the related and possibly resulting measures both technically and economically.

If the shortcomings of the connection impact the operation of the power system, Fingrid as the transmission system operator has the right to interrupt or restrict the operation of the connection or impose obligations pertaining to the operation of the connection until the shortcomings have been corrected.

4 Engineering, operation and maintenance

4.1 Main principles

The Connectee and Fingrid are responsible for the electrical safety, functioning, condition and operation of the electrical equipment in their control respectively. The technical level of the new connection must not differ from the general technical level in the main grid.

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The Connectee and Fingrid shall operate and take care of their electrical equipment so that the transmission of electricity or the operation of the power system are not unnecessarily disturbed. No inconvenience or disturbance exceeding the limits specified in standards or recommendations must be caused to other parties connected to the grid. In order to ensure maintained system security The Connectee and Fingrid shall supply each other with operation and maintenance information.

The Connectee and Fingrid have the right to connect those bays, to which the Connectee or Fingrid have usage right, to their own operation control system at their own cost. The exchange of information concerning the connection is defined in the main grid agreement and in the connection agreement.

4.2 Frequency and voltage variation in main grid

The standard value for grid frequency in the Nordic power system is 49.9 to 50.1 Hz. In a disturbance-free operation situation of the grid, the frequency can vary between 49.5 and 50.5 Hz and in exceptional situations between 47.5 and 53 Hz.

The nominal voltage levels in the Finnish main grid are 110 kV, 220 kV and 400 kV.

Correspondingly, the design of the connection shall be based on the normal connection point voltages of 118 kV, 233 kV and 410 kV respectively.

The normal voltage range of a grid with a nominal voltage of 400 kV is 395 - 420 kV, and in exceptional and disturbance situations the voltage range is 360 - 420 kV.

The normal voltage range of a grid with a nominal voltage of 220 kV is 215 - 245 kV, and in exceptional and disturbance situations the voltage range is 210 - 245 kV.

The normal voltage range of a grid with a nominal voltage of 110 kV is 105 - 123 kV, and in exceptional and disturbance situations the voltage range is 100 - 123 kV.

The Connectee's electrical equipment and electrical equipment connected to it directly or indirectly shall be able to operate within the presented voltage and frequency ranges so that the equipment meets the requirements set by the power system. The electrical equipment shall be protected so that it will not be damaged even by voltage or frequency changes greater than those mentioned above.

4.3 Transmission outages

If the Connectee's or Fingrid's electrical equipment needs to be temporarily disconnected from the grid because of service, repair, modification, inspection or other similar measures, and these have an effect on the other contracting party's operation, the Connectee and Fingrid shall negotiate about the outage in advance.

The Connectee and Fingrid shall plan their arrangements, schedules and measures concerning the outages so that the duration of the outage is not unnecessarily prolonged. Each party is responsible for its own costs unless otherwise agreed between the Connectee and Fingrid.

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4.4 Island operation

The Connectee has the right to disconnect its electrical equipment from the electricity grid or to disconnect itself from the main grid to island operation without advance warning so as to prevent a disturbance or hazard or in the event of faults or disturbance situations in the grid. Island operation refers to a situation where one or more power plants feed a part of a grid which is separated from the main grid. The shift-over to island operation must not disturb the opportunities of other parties to use their connections to the main grid nor interrupt transmission connections in the main grid.

The Connectee and Fingrid shall agree in advance on the arrangements relating to island operation. The Connectee shall be responsible for the implementation costs of island operation.

4.5 Grid disturbances and faults

In the design and operation of the Connectee's electrical equipment, the Connectee shall take into account the short-term voltage dips and dead state caused by grid faults as well as the effects of high-speed and delayed automatic reclosing generally used in restoring normal operation. The Connectee shall take into account the effects of disturbances on the electrical equipment of other parties connected to the main grid through the Connectee's grid.

The Connectee and Fingrid shall agree in advance on the principles concerning the clearing of disturbances and on the related division of costs. If a fault or disturbance occurs in the grid, Fingrid has the right to disconnect the Connectee's electrical equipment from its grid without advance warning, if this is essential because of disturbance clearance or repairs. Fingrid shall take immediate action so as to remove the disturbance from its grid.

If electrical safety or the system security of the main grid so require, Fingrid has the right to request a power plant connected directly or indirectly to the Connectee's grid to adjust the electrical equipment, and in extreme cases to disconnect the electrical equipment from the grid.

The Connectee and Fingrid shall immediately inform each other of faults which have an effect on the other contracting party's grid operation.

If faults or shortcomings, which disturb the operation of the power system by the Connectee or a third party (electrical safety) and which cause electricity quality deviations exceeding normally acceptable limits, are detected in electrical equipment connected to the Connectee's and Fingrid's electricity grids, the contracting party causing the disturbance shall immediately correct the faults and shortcomings.

4.6 Earthing method of grid

In Finland, the 400 kV and 220 kV grids are effectively earthed; the earth fault factor is 1.4 or less. The 110 kV grid is partially earthed, and its earth fault factor is 1.8 or less. The earth fault factor means the ratio between the voltage occurring in a sound phase during an earth fault and the normal phase voltage.

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The 400 kV or 220 kV neutral of a transformer included in the Connectee's electrical equipment shall be earthed by means of a current limiting earthing coil unless the operation of the power system requires otherwise. The 110 kV neutral of a transformer is only earthed at selected substations by means of an earthing coil to enable earth fault protection and to maintain a reasonable level of earth fault current. The Connectee and Fingrid shall agree on how to earth the neutrals of transformers. There shall also be a separate agreement with Fingrid on bypassing the earthing coil for example by means of an earthing switch. It is recommended to equip an unearthed neutral with an overvoltage protector to protect the transformer against overvoltage.

4.7 Protection of electrical equipment

The protection of the Connectee's electrical equipment and the protection of electrical equipment connected to it directly or indirectly as well as the protection of the main grid shall uniformly and selectively operate in order to maintain system security in the grid. The Connectee and Fingrid are responsible for the proper operating condition of protection equipment in the circuit breaker bays owned by them respectively. The usage right holder is responsible for the suitability of protection and for specifying the adjustments. If needed, Fingrid will give technical information and instructions for co-ordinating the protection of the connection and the main grid.

The Connectee's 400 kV grid protection shall operate so rapidly that the fault tripping time is 0.1 seconds or less in all faults with the exception of high-resistance earth faults. The main protection in 400 kV lines shall be doubled and supplemented by communications. Moreover, 400 kV lines shall have protection against high-resistance earth faults.

The Connectee shall agree with Fingrid on the co-ordination of the operation of 110 kV or 220 kV protection if the activation time of protection in the Connectee's grid at the connection point is more than 0.1 seconds. The basis of design of protection is that the activation time of main protection in the Connectee's 110 kV electricity grid is at the most 0.1 seconds and the activation time of backup protection is at the most 0.5 seconds with the exception of the following cases:

- At substations where the protection of another electricity grid or some other reason does not necessarily require busbar protection, the activation time of protection in a busbar fault may be at the most 0.5 seconds and the activation time of backup protection at the most 0.8 seconds including circuit breaker faults and current transformer faults. In the Connectee's looped 110 kV grids and in the construction and renovations of such grids the target shall be an activation time of no more than 0.1 seconds.
- High-resistance earth faults with a staggered activation time of protection from 1 to 4 seconds where the activation times are adapted to the protection of the main grid. However, an as short activation time as possible should be used in radial lines.

If cable sections are connected to a grid or if the connection is to a resonant earthed 110 kV grid, the protection of the electrical equipment shall be agreed separately.

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Line protection in the main grid is designed to primarily operate in the case of line faults in the main grid. In practice, protection for the main grid can mostly be adjusted so that it reliably operates also in the case of faults in transmission line connections. However, the Connectee shall assure the operation of protection in its transmission line connection together with Fingrid. It is not technically possible to use line protection in the main grid as a protection of a transformer of a transmission line connection or as a protection of a long radial transmission line. If a radial transmission line is connected to a transmission line of the main grid by a circuit breaker equipped with protection, the co-ordination and settings of the protection shall be agreed with Fingrid in advance.

The Connectee shall ensure that an exceptional voltage or frequency or a loss of voltage does not damage the Connectee's or other parties' electrical equipment. This can be achieved, for example, by equipping its electrical equipment with overvoltage and undervoltage protection and, if so required by the electrical equipment, also with frequency protection. The specifications for the operational performance of power plants possibly concerning the connection shall be taken into account when adjusting the protections.

5 Agreements and fees

The connection to the main grid is agreed in a connection agreement signed between the Connectee and Fingrid. Fingrid's general connection terms constitute an integral part of the connection agreement. The connection agreement determines the ownership and liability limits, usage rights, responsibilities concerning operation and maintenance, and the connection fee. The connection fees are adjusted annually and published on Fingrid's website.

Fingrid determines the solution and location of connection to the main grid, whereby the changes caused by the connection in the existing main grid are covered by the connection fee. If the Connectee's own needs require additional structures or equipment in the main grid, Fingrid takes care of their implementation and the Connectee carries the resulting costs. Once completed, the switching devices built in a transmission line of the main grid are property of Fingrid, and Fingrid is responsible for their operation, maintenance and replacement investments until a need for the device no longer exists.

The Connectee is responsible for the modification costs in the Connectee's electrical equipment, caused by an increase in fault currents in the main grid. The Connectee is responsible for measures required in the grids of other parties connected to the Connectee's grid directly or indirectly and shall reach an agreement on such measures.

Fingrid constantly monitors the developments both in solutions applied to the grid and in technical issues. Additionally, Fingrid keeps the valid connection terms and its other guidelines, requirements and pricing principles relating to the implementation of the connection publicly available.