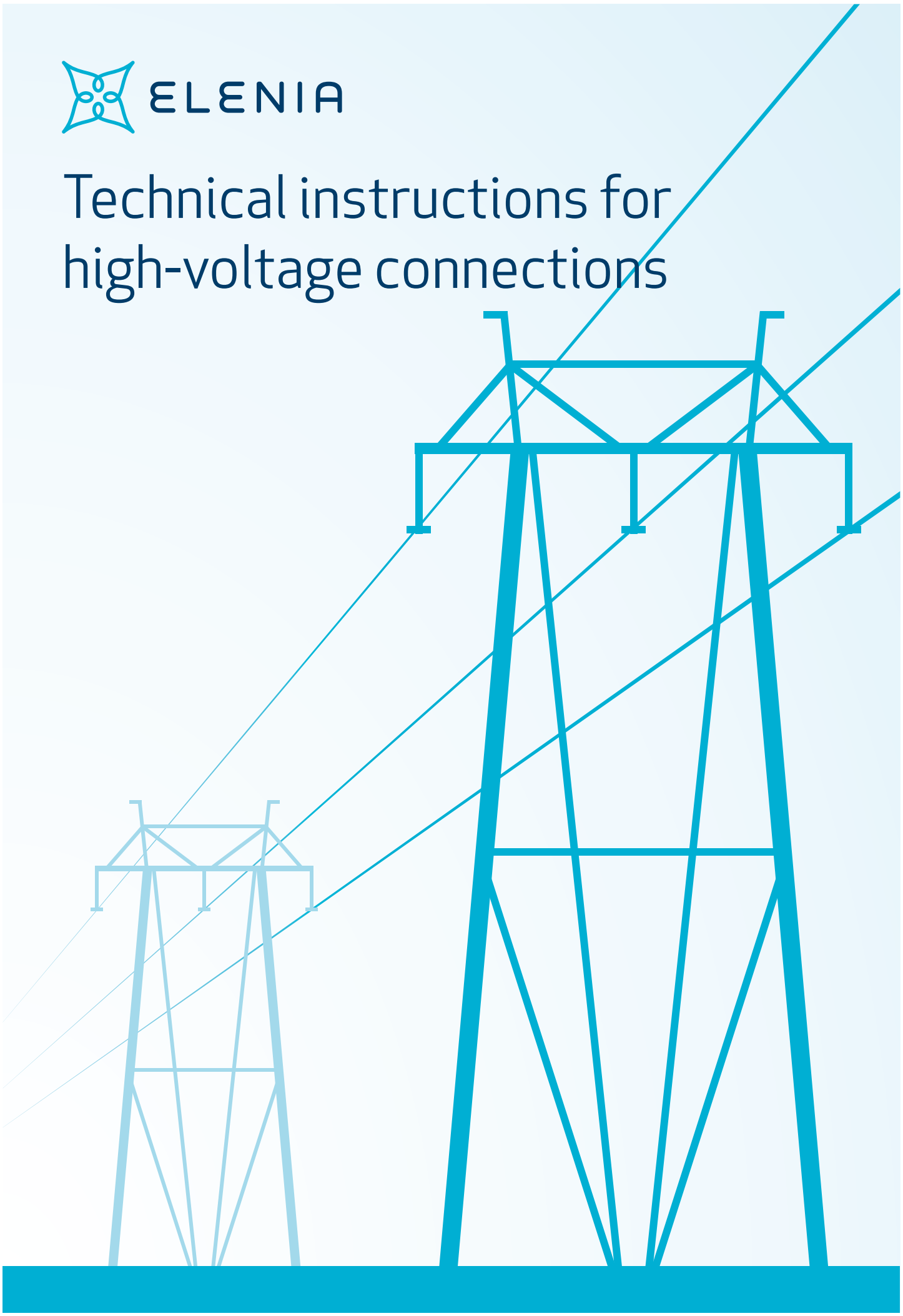
ELENIA

Technical instructions for high-voltage connections



Contents

1 General information

The purpose of these instructions is to describe the technical requirements and specifications for high-voltage connections to Elenia's network. The instructions are applied to new demand and production connections made to Elenia's high-voltage distribution network, together with the connection contract and the terms and conditions of Finnish Energy. The application of the principles to existing connections will always be agreed together with the customer. The design and construction of the connection must comply with the laws and regulations in force in Finland, orders by the authorities, the electrical standards of the EN-SFS 6000 series of standards and the current IEC norms and SFS standards regarding instruments and equipment.

The same guidelines used for the new network will always also be applied to existing sites. Deviations from the instructions must always be agreed in advance in writing. In addition to the above, the connection will comply with the current grid code specifications of the transmission system operator Fingrid for demand and production plants and electricity storage facilities.

The connection project can be divided into phases. During the connectivity assessment phase, Elenia and the customer will determine the best possible method to connect to Elenia's network.

In the design phase, the customer and Elenia provide each other information, enabling the parties to draw up more detailed plans. During the design phase, Elenia will comment on the customer's plans. Elenia and the customer will also draw up a connection contract during the design phase. The connection contract details the connection method, delivery time and connection point. The connection point refers to the point where the limits of ownership of the various electricity system operators are located and where the customer's equipment is connected to Elenia's electricity network. The connection method is always agreed on a case-by-case basis with the customer.

During the implementation phase, the parties will build equipment in accordance with the plans and ensuring that the equipment can be connected to the network by conducting inspections. During the implementation phase, the customer and Elenia will draw up a contract on electricity network services. During the connecting phase, the customer's equipment will be connected to Elenia's network.

The various phases of connecting outlined above will proceed in parallel with the processes of verifying Fingrid's grid code specifications. This is described in Appendix 1. Connecting also includes various sector-specific processes, such as the process of commissioning of telecommunications and metering. Each step and process involves the provision of information between the parties, which requires particular attention in order for things to go smoothly. The customer must ensure that the information in chapter 7 is provided to Elenia in a timely manner along with the information regarding the verification process of Fingrid's grid code specifications.

2 Electrotechnical design

2.1 110 kV connections and connection methods

Connecting to Elenia's high-voltage distribution network shall happen in compliance with the relevant terms and conditions for connecting to the high-voltage distribution network. In addition, the current Fingrid requirements and guidelines apply to the extent that they concern connecting to the high-voltage distribution network. In addition, demand and power plants must meet Fingrid's current grid code specifications, or equivalent, for demand (KJV), production (VJV) or electricity storage (SJV). The requirements of European network codes must also be taken into account.

High-voltage distribution network connections shall be examined on a case-by-case basis and the method and location of the connection shall be determined on the basis of that examination, taking into account:

- Location, capacity and type of connection (demand/production)
- Impact on high-voltage distribution network, the environment and customers
- Technical implementation options and costs
- Primary substation connection or transmission line connection
- Protection and compatibility of electrical installations
- Energy metering and telecommunications
- Elenia's technical instructions for connecting

In the case of a production connection, the connection shall be designed in such a way that the connection capacity can be fed into Elenia's network under normal conditions. The main input direction is determined in cooperation with the customer. In the event of an anomalous switching situation, such as maintenance work or breakdowns in the main grid or Elenia's network, Elenia reserves the right to limit the customer's capacity. Limiting the capacity in deviating switching conditions is separately agreed with the customer.

2.1.1 Primary substation connection

Connection by a transmission line or cable to Elenia's 110 kV primary substation:

- The customer is responsible for the construction of their own connection line.
- The customer's line is connected to a 110 kV field owned by Elenia. Elenia owns the equipment for the connection field, with the separating switches of connection field as the boundary of ownership.
- The design and construction of the termination portal necessary for connecting the transmission line is the responsibility of the connecting party, unless otherwise agreed upon. The structure and placement of the termination portal must be approved by Elenia.
- When connecting with a cable, the connecting party owns the cable, the cable terminal, the cable terminal bracket and the overvoltage protectors as well as the lanyards with their connectors. Elenia owns the equipment for the connection field, with the separating switches of connection field on the side of the cable as the boundary of ownership.
- Elenia is responsible for the arrangements at its own switching substation.

Connecting via transformer field to Elenia's 110 kV primary substation:

- The customer is responsible for the construction of their own connection field, including the transformer foundation and the necessary primary and secondary equipment. The field shall be constructed in accordance with Elenia's instructions.
- The customer's field is connected to the 110 kV rail of the substation owned by Elenia, with the ownership limit being connectors of the pipe rail, which are the property of the customer. In connecting to a primary substation, the maximum permissible connected capacity as well as the transformer capacity and technical requirements of the transformer are examined on a case-by-case basis. The selected transformers must be approved by Elenia.
- 50 MVA and larger transformers shall be equipped with polarity synchronised circuit breakers
- Transformers over 25 MVA must be equipped with differential protection
- Elenia will arrange a place for the connection at its own switching substation.

The commissioning schedule of the connection is always agreed separately.

2.1.2 Transmission line connection

When connecting directly to Elenia's transmission line (transmission line connection), the following factors must be taken into account:

- The maximum distance of the farthest lanyard from the transmission line pylon is 25 metres. The lanyards shall be designed to permit variation in the height of the transmission line.

- The minimum distance from connecting structures and fences from the above-ground structures of the transmission line pylons is 3 metres and minimum distance from the point where the branch enters into the ground is 3 meters to fences and 4.4 meters to other structures.
- The distance of the transformer from the nearest phase conductor must be at least 10 metres.
- The distance of the building from the innermost phase conductor must be at least 23 metres.
- No structures other than the support insulators of the lanyards and pipe rails are permitted under the transmission line.
- The connection shall be de-energised by means of a remote-controlled switching device.
- The connection point separating switch must be equipped with short-circuit earthing switches to ensure occupational safety. Earthing switches must be installed on the connecting party's side of the field and on the side of Elenia's transmission line.
- The same principle applies to earthing switches when connecting to a double circuit line. Location of the earthing switches are determined in cooperation with the connecting party and Elenia.
- When connecting to a double circuit line, it shall also be ensured that the capacity of the rail and field ropes of the connection station equal that of the transmission line.
- Transmission line connections with a capacity of 60 MW/63 MVA or less, the maximum allowed transformer capacity for transmission line connections is 25 MVA. If the transformer is equipped with forced ventilation (ONAF), the transformer can be loaded up to 31.5 MVA. The technical requirements of the transformer are always examined on a case-by-case basis.
- Certain Elenia transmission lines may also allow larger transformer capacities provided that:
  - Connection capacity is greater than 63 MVA
  - A transformer of capacity over 25/31.5 ONAN/ONAF MVA may be permitted based on a case-by-case examination
  - 50 MVA and larger transformers shall be equipped with polarity synchronised circuit breakers
  - Transformers of over 25 MVA must be equipped with differential protection
  - The technical requirements of the transformer are always examined on a case-by-case basis and the chosen transformer must be approved by Elenia.
- The connecting party's substation can also be designed in cooperation with the connecting party in a way that allows freely choosing the number of transformers. However, the low-voltage sides of the transformers may not be connected together.
- The connection point, or ownership limit for the transmission line, is the top connectors of the lanyards, which are the customer's property.
- When connecting by cable, the technical implementation of the connection shall be agreed separately, taking into account the technical characteristics of the cables and the connection location.
- It is important to take the above into account, for example, when purchasing real estate for connection equipment.

2.2 Electrical rated values

2.2.1 Electrical rated values of 110 kV equipment

- Nominal voltage 118 kV
- Maximum continuous operating voltage 123 kV
- Surge resistance 1.2 / 50 µs
- Against the ground and with a phase interval of 550 kV
- Isolation voltage 50 Hz 1 min
- Against the ground and in a phase interval of 230 kV
- Nominal frequency 50 Hz
- Thermal short-circuit resistance 1 s 31.5 kA
- Behind the connecting party's own circuit breaker, the thermal rating can be chosen to be smaller according to the operating speed of the protection.
- Dynamic short-circuit resistance 80 kA
- Behind the connecting party's own circuit breaker, the dynamic rating can be chosen to be smaller according to the operating speed of the protection.
- Earth fault resistance 1 s 6 kA

2.2.2 Rated values of 110 kV overvoltage protectors

The minimum rated values of 110 kV overvoltage protectors for network voltages must always be at least as follows: Other rated values of overvoltage protectors are available for the connecting party to choose according to the protection coordination of their own equipment.

Phase overvoltage protectors

- Maximum network operating voltage 123 kV
- Maximum continuous operating voltage (Uc) min. 78 kV
- 10 s. Operating frequency overvoltage (TOV) min. 130 kV

Star point overvoltage protection

- Maximum network operating voltage 72 kV
- Maximum continuous operating voltage (Uc) min. 58 kV
- 10s. Operating frequency overvoltage (TOV) min. 78 kV
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2.3 Other issues to consider regarding connecting

2.3.1 Transmission line connections on the main grid

Elenia's lines or substations that connect to the mains of the main grid (main grid transmission line connection) are accepted with a maximum conversion capacity of 2x25 MVA. The low-voltage sides of the transformers may not be connected together.
A maximum of 5 MVA synchronous generator or 30 MW converter-connected power plant may be connected to cables or substations connected to the mains of the main grid when the fault current supplied by the power plant is no more than 1.2 times the rated capacity of the power plant. The rated capacity of power plants connected to Elenia's transmission lines is always examined on a case-by-case basis.

2.3.2 110 kV network earthing method

The 110 kV network earthing is managed by Fingrid. The 110 kV star point of the transformer is earthed only at the selected stations using a earthing inductor in order to ensure the functionality of earth fault protection and to maintain earth fault current at a reasonable level. Elenia, the connecting party and Fingrid in cooperation will agree, on a case-by-case basis, on the method with which the star points of the transformers shall be earthed, as well as on the responsibilities and obligations between the connecting party and Fingrid. Bypassing the earthing inductor, for example by means of an earthing isolator, must be agreed separately with Fingrid. To protect the transformer from overvoltage, it is recommended that the unearthed star point be equipped with an overvoltage protector. Overvoltage protection of other devices is also recommended in case of overvoltage cased by switching and lightning overvoltage.

The earthing of the equipment to be connected must be connected with two 50 mm^2 Cu earthing lines to the earthing at the connection point, to either the shielding wires or the earthing system of the substation. In addition, the shielding wires of the transmission line to be connected must be connected to the earthing system at the connection point, either to the shielding wires or the earthing system of the substation.

2.3.3 110 kV network voltage

In Elenia's 110 kV network, the voltage range is based on the voltage and voltage fluctuation of the main grid. The network voltage is 105–123 kV under normal conditions and 100–123 kV in during deviations and exceptional situations. In principle, the voltage at the connection point can be considered to be 118 kV for design purposes, but it is recommended for Elenia's contact person to verify the voltage at the connection point during the design phase.

2.3.4 Voltage changes

Rapid voltage changes are mainly related to switching situations. Connecting demand or a power plant either starting or suddenly disconnecting from the network can cause significant and rapid voltage changes.

Connecting demand or power plants to the electrical system may not cause changes of more than 3 % in the voltage at the connection point of the plant. The need to limit the rate of increase of active power demand or production during plant start-up shall be agreed separately with Elenia. Disconnecting demand or power plants from the electrical system may not cause changes of more than 4 % in the voltage at the connection point of the plant.

On the other hand, if a substation is connected to customers who are particularly sensitive to rapid voltage changes and disconnection of the demand or production connection is considered likely, more stringent limits for rapid voltage changes may have to be applied.

2.3.5 Flicker

Upon request, the connecting party must provide calculations of the flicker emission caused by their connection. Elenia shall provide the initial data necessary for calculating the flicker emissions. The disturbance indices must be calculated for both the flicker caused by starting and the flicker caused by continuous operation. The full calculations must be submitted to Elenia.

2.3.6 Harmonic current

The harmonics and the total voltage distortion caused by a demand or production plant shall not exceed the limit values specified in the standard SFS-EN 50160.

2.4 Crossing statements

Crossing refers to any activity or event in the vicinity of a transmission line. For example, a crossing statement is always required for the construction of an electricity network or other infrastructure. Elenia delivers crossing statements to customers who submit a crossing statement request to Elenia's contact person. The crossing statement request must be submitted well in advance during the connection design phase. The statement does not concern approving or rejecting the design, but provides the framework of conditions for the construction.

The crossing statement request must include information regarding the responsible party and as well as the activity to be undertaken near the transmission line. The request must be include by the necessary map sections and information about the location, including the cable ID and pylon number. Elenia's maximum processing time for crossing statements is 4 weeks. A crossing statement is required in order to safely implement the planned project in the area.

3 Compensation of reactive power and designing control

3.1 Capacity and compensation of reactive power

In the case of a demand connection, compensation of reactive power shall be dimensioned in such a way that no significant amount of reactive power is produced or consumed at the connection point under any circumstances.

A connected power plant must meet the currently valid and applicable grid code specifications (VJV) or another corresponding document for the reactive power capacity of power plants. If no reactive power requirements are set in the power plant's grid code specifications, the reactive power capacity shall be measured in such a way that the power plant is able to operate at the connection point with a power factor of 1.0 under all conditions.

The power factor requirement also applies to idling, when the power plant does not produce any active power. Therefore, even in an idle condition, the plant must be able to operate in the normal reactive power range.

3.2 Connection point and power plant control

At the connection point, the customer's equipment will be connected to the equipment owned by Elenia. The electrical values and adjustment parameters are always given at the connection point. If the connection point is located at a distance from the actual power plant, but the intermediate network does not significantly affect the reactive power capacity of the power plant, the measurements required by the regulator can be placed at the same point as the power plant itself and the power plant controller. In this case, the adjustment parameters can be given for that point.

3.3 Choice of power plant control method

In this context, “control method” refers to controlling the reactive power produced or consumed by the production plant. Any power plant to be connected must allow selecting either fixed voltage, fixed reactive power or fixed power factor as its control method.

For a power plant connected to the high-voltage distribution network, fixed voltage shall be the primary control method, meaning the power plant shall aim to generate or consume reactive power in order to maintain the voltage level at the connection point at a set level.

In addition to the above, the requirements for production plant control set out in the grid code specifications for power plants must be taken into account when designing power plant control.

4 Protection design

Connecting to Elenia's high-voltage distribution network is subject to the applicable connection terms and conditions. In addition, the connecting party must comply with the current Fingrid requirements and guidelines to the extent that they concern connecting to the high-voltage distribution network.

In addition, demand connections and power plants must comply with Fingrid's current grid code specifications for demand (KJV) and/or production (VJV), including electricity storage (SJV). The requirements of European network codes must also be taken into account.

Equipment associated with Elenia's high-voltage distribution network must meet the protection requirements specified in the Fingrid guideline "Relay protection of the main grid and customer connections" or another equivalent document.

This guidance also defines requirements for the protection of generation and consumption from the point of view of Elenia's electricity network, in order to enable Elenia, as distribution network operator, to ensure an adequate level of safety of its electricity network and, on the other hand, to ensure the appropriate functioning of other forms of protection of the electricity network.

If there is a need to deviate from the general requirements set out here, the matter must be agreed with Elenia in writing.

4.1 Customer responsibilities in electronic protection

The customer's electrical equipment (power plant, substation or similar) must be equipped with suitable protective devices. The customer is responsible for the appropriate protection of their electrical equipment. The protection of electrical equipment shall be such that it can withstand, without breaking, normal network failures, such as short circuits, earth faults and reconnections these may cause. In addition, the electrical equipment must withstand unexpected interruptions in distribution, for example in the case of a breakdown in the distribution network or in the overhead network, as well as momentary disturbances and changes in the voltages, currents and frequency of the network caused by faults.

The customer is responsible for the design of the protection layouts of their electrical equipment so that the safety of persons and equipment is not compromised, and damage to the equipment is avoided. The protection settings must be designed so that they do not conflict with the grid code specifications.

The customer is responsible for the settings of the protective equipment under their control and the suitability of the settings for the protection of the electrical equipment in question, as well as for the proper maintenance of the protective equipment.

The design of the operating values of the protective devices is always carried out in cooperation with Elenia's protection designer. The test protocols for essential protection devices, both for the commissioning of the equipment and for subsequent maintenance tests, must be submitted to Elenia in order for Elenia to continue to ensure the selectivity of the protection and to ensure the proper functioning of the protection.

4.2 General principles for protection of high-voltage connections

For transformers above 25 MVA, differential protection should be used as the primary protection for the main transformer field.

Elenia also recommends protecting 25 MVA and smaller main transformers with differential protection. However, if differential protection is not used in these cases, the main transformer field protection must meet Fingrid's requirements for relay protection of customer connections. In addition, Elenia may, on a case-by-case basis, require differential protection for the primary protection of main transformers of 25 MVA or smaller, if the selectivity in relation to the protection of the supply network so requires.

For transformers of 25 MVA and above, to ensure selectivity of the protection, the rail and proximal short-circuit faults on the medium-voltage side must be rectified in a maximum of 0.2 second (200 ms). Even for smaller main transformers, Elenia recommends rapid firing times in case of rail and proximal short-circuits on the medium-voltage side, but in regards to the selectivity the firing time is limited to 1.0 seconds.

The primary and backup protection of the connection field must have a separate, secured DC auxiliary voltage supply.

4.3 Production connections and demand connections with production

The purpose of the protection requirements is primarily to guarantee the safety of the electricity network, and to ensure that the protection of the electricity network functions as intended, including successful reconnections. This requires that the production equipment not remain energised in the event that the circuit breakers in the supply network have been opened, for example in the event of a failure of the electricity network. The formation of such an unintended island must be prevented by the protections of power plants (over-frequency, under-frequency, over-current, under-current and island protection). For this part, the protection must be complemented with over and undervoltage as well as over and underfrequency protection for the primary and backup protection of the main transformer field.

The protection settings must be designed so that they do not conflict with the grid code specifications. However, the technical control requirements contained in the grid code specifications are of secondary importance in a situation where there is a risk to personal safety. In such a case, electrical protection and safety take precedence over control of the power plant.

The capacity limits defined in the protection requirements refer to the total combined power output, which may consist of one or more production installations. Here, production installation refers to any unit of electricity production, including electricity storage.

4.3.1 110 kV zero-voltage protection

The transformer, through which production is connected to the network must be equipped with 110 kV zero-voltage protection.

Zero-voltage protection is not required if both of the following conditions are met:

- (each) individual piece of production equipment has a production capacity of less than 1 MW, and
- the gross production capacity within the supply area of the main transformer is less than 50 % of the power consumed in the supply area of the main transformer

If the zero-voltage protection is omitted on this basis, Elenia has the right to require the connecting party to supplement the protection of the main transformer field with zero-voltage protection at a later time in the event that the gross production capacity exceeds 50 % of the consumed power limit, or a single production installation of 1 MW or more is connected to the supply area of the main transformer field.

It is up to the customer to decide whether the 110 kV zero-voltage protection will trigger the circuit breaker on the high- or low-voltage side of the main transformer field, or the outputs on the medium-voltage side to which the production is connected.

4.3.2 Production disconnection

Production disconnection shall be built for each production connection. In the case of a demand connection behind which production is or has been connected, the disconnection requirements shall apply within the limits defined below.

Production disconnection is not required if both of the following conditions are met:

- (each) individual piece of production equipment has a production capacity of less than 1 MW, and
- the gross production capacity within the supply area of the main transformer is less than 50 % of the power consumed in the supply area of the main transformer

If the disconnection protection is omitted on this basis, Elenia has the right to require the connecting party to supplement the protection of the main transformer field with disconnection protection at a later time in the event that the gross production capacity exceeds 50 % of the consumed power limit, or a single production installation of 1 MW or more is connected to the supply area of the main transformer field.

The implementation of disconnection depends on the production capacity according to the following options.

Option A: Production disconnection (1–5MW)

Local disconnection relays shall be built for 1–5 MW production. The local disconnection relay protection shall meet the requirements of Fingrid's current guidelines "Relay protection of the main grid and customer connections", or any guidelines replacing this document.

It is up to the customer to decide whether the disconnection protection relays will trigger the circuit breaker on the high- or low-voltage side of the main transformer field, or the outputs on the medium-voltage side to which the production is connected. Elenia recommends locating the disconnection trigger to the medium-voltage outputs to which the production is connected.

Option B: Production disconnection (above 5MW)

Elenia determines on a case-by-case basis whether local disconnection relays or a communications link for disconnection (EVY) should be built for production capacity of 5 MW and above. However, the primary method of implementation is local disconnection. Nonetheless, Elenia has the right to require the construction of a communications link for disconnection at a later time in locations with local disconnection relays.

The local disconnection relay is implemented with a relay that is separate from the other 110 kV protection, and which is acquired by the customer and remains their property. Configuration shall take into account the possibility of adding a communications link for disconnection (EVY) by configuring such option for the relay (incl. SCADA signals). During the design phase the possibility of adding a communications link for disconnection must be taken into account by reserving space for the telecommunications and IO equipment.

No disconnection based on real-time data shall be built to complement local disconnection relays in Elenia's network. However, Elenia has the right to require a disconnection based on real-time data at a later date in accordance with Fingrid's valid guidelines.

If a communications link for disconnection (EVY) is defined for the site, it shall be built only in the specified main supply direction. For stand-by supply situations, production associated with Elenia's high-voltage distribution network shall always be equipped with local disconnection relays in addition to the communications link for disconnection (EVY). This ensures that production also has disconnection protection in stand-by supply situations, in case the EVY built into the main supply direction malfunctions.

The communications link for disconnection shall meet the requirements of Fingrid's current guidelines "Relay protection of the main grid and customer connections", or any guidelines replacing this document. It is up to the customer to decide whether the disconnection protection will trigger the circuit breaker on the high- or low-voltage side of the main transformer field, or the outputs on the medium-voltage side to which the production is connected. Elenia recommends locating the disconnection trigger to the medium-voltage outputs to which the production is connected.

The remote trigger signal passes through a reception condition, which is described in more detail in the Fingrid manual. When connecting to Elenia's high-voltage distribution network, the local disconnection relay is implemented with a relay that is separate from the other 110 kV protection, and which is acquired by the customer and remains their property.

5 Real-time data exchange

The connecting party provides the necessary information to Elenia and Elenia forwards it to Fingrid. The requirements for real-time data exchange are based on Fingrid's current grid code specifications and, where applicable, Fingrid's current guidelines for real-time data exchange.

Real-time metering and status information must be available in Elenia's operation and control information system when a new power plant or substation is connected to the electricity network.

5.1 Technical implementation of data exchange

The real-time data exchange between Elenia and the customer is carried out between the operation and control information systems. Telecommunications between the operation and control information system is implemented using the FEN network (FIN Elcom Network). The IEC 60870-5-104 protocol is used for real-time data exchange.

If the customer or their control room operator does not already have access to the FEN network, it must be obtained during the project. The customer agrees on joining and using the FEN network directly with its manager, Empower. Up to approximately three months should be allowed for the implementation of the connection.

The customer and Elenia's contact person will agree on the test time well in advance before the planned commissioning. The customer must provide Elenia's contact person with a test plan and a signal list of the transferred data by e-mail no later than 4 weeks before the testing and commissioning of real-time data exchange.

The update interval for real-time data exchange may not exceed 60 seconds. Detailed data communication specifications are agreed on a per-project basis with the customer. The communications shall comply with Elenia's valid information security guidelines.

5.2 Real-time data required from the customer

Elenia requires the following information regarding the maintenance of network security of supply:

- Measurements of active and reactive power by type of production (P, Q)
- Connection-level current and voltage measurements (I, U)
- Switchgear up to circuit breaker, including earthing isolators
- Information on the position of the on-load tap-changer of the connection-level main transformer
- Self-monitoring, awakening and triggering information of connection-level protection
- If the disconnection fuses do not trigger the connection circuit breaker, unambiguous information is required about the production disconnection from the network
- Power plant control mode and information on reactive power control status
- Reactive power control, On/Off
- Mode of reactive power control
- Active power control, On/Off
- Mode of active power control
- Active power limitation, On/Off
- Active power limitation power limit

In addition, other separately requested information as agreed.

5.3 Operation in case of maintenance, faults and security incidents

The customer must inform Elenia of any service interruptions. The notification must include the start and end time of the service interruption, as well as the possible effects on Elenia's systems and equipment.

In the event of a prolonged (6h) fault, the customer must notify Elenia by e-mail of the estimated end time of the fault. After recovery from the fault, the customer must inform Elenia of the impact on Elenia's systems and equipment.

6 Energy metering

Elenia installs, maintains and owns the meters used for energy invoicing. Elenia must have unrestricted access to the metering panel, for example by means of a key placed in a key deposit cylinder.

The plan for implementing energy metering (e.g. a main circuit diagram of the equipment, measurement circuit diagram, nominal values of the instrument transformers) must be submitted to Elenia's contact person via email and approved by Elenia no less than one month in advance of the desired start of metering. If necessary, Elenia's contact person will provide the customer with an example circuit diagram for the planning and implementation of metering.

6.1 General requirements for metering

Metering equipment and connections must be carried out in accordance with the standards in force at the time, such as SFS 3381 Measuring equipment and SFS 2529 Energy meter chassis.

For an individual meter that is the responsibility of Elenia, one standard M2 meter grid is required for the meter. Metering circuits shall be wired from the grid and their conductors numbered at the instrument transformers in advance. The metering circuits must have interruptible so-called metering terminal blocks. The conductors shall be labelled with the number of the instrument or terminal block. The metering conductors (current and voltage circuits) must have a cross-section of at least 2.5 mm^2.

The customer's switchgear must allow for sealing the parts containing unmetered electricity and the wiring of the metering equipment.

An auxiliary voltage of 100-240VAC/DC must be wired to the energy meter to ensure that the meter can be remotely read. For auxiliary voltage wiring, a 1.5 mm^2 conductor must be used. If arranging auxiliary voltage is not possible, the voltage drop of the measuring cable must be verified by calculation and it may not exceed 0.05 %.

6.2 Current and voltage transformers

The customer shall dimension and procure for their switchgear or metering panel the instrument transformers required for metering electrical energy. For high-voltage measurements, three current transformers and three unipolarly insulated single-phase voltage transformers shall be used in accordance with the standard. It is recommended to place the voltage transformers before the current transformers in the main direction of the energy.

No devices other than the energy meter used for invoicing shall be connected to the same voltage or current metering circuit. The metering voltage circuit is protected by its own 3x10 A circuit breaker.

Current transformers must be installed in such a way that their shield values are visible when the equipment is energised or the values can otherwise be reliably verified.

The recommended secondary current for current transformers is 5A. All phases must have their own return current conductors. Current transformers must have an accuracy class of at least 0.2 s and the accuracy class required for voltage transformers is 0.2.

In order for the current transformers to remain within their accuracy class requires the selection and dimensioning of current transformers and conductors to form a load of between 25 % and 100 % of the nominal load of the current transformers. If necessary, additional resistors shall be used to achieve an adequate load. The load calculation and any necessary additional resistors are acquired and installed by the customer. The load calculation shall be submitted to Elenia on request.

The nominal values of the instrument transformers and any possible primary current range allowed by the current transformers must be documented in e.g. the main circuit diagram and reported to Elenia in no less than one month before the start of metering.

If the electricity consumption changes significantly, the transformation ratio of current transformers must be changed to correspond to the increased primary current. The change and its schedule must be notified in advance to the contact person of Elenia via e-mail.

6.3 Production connections and their metering

Elenia carries out a separate inspection for the metering equipment of production connections to verify the correctness of the measurements after the VJV tests of the power plant and any other inspection and maintenance activities that may affect the metering equipment have been completed. Changes to the energy metering circuits must be notified to Elenia before the change is made.

For production connections, the customer must take into account the requirements and implementation of possible metering of internal consumption.

Elenia offers, as a separate service, meters, meter installations and the delivery of metering data for metering required by the legislation concerning subvention of production. The metering must meet the above requirements.

Elenia delivers the measurement data of the aforementioned metering to the customer or to the entity authorised by the customer by sending a time series of the output and input of active power and reactive power as MSCONS messages.

Elenia charges the customer for the cost of the metering device, installation and inspection, as well as reading maintenance fees for each metering. If the meter is damaged or has to be replaced for any other reason, the cost of the metering device and its installation will be charged again.

7 Information and documents required from the customer

The content of the designs, reports and tests, as well as the schedule of the documents to be submitted, are specified in Fingrid's grid code specifications. In addition to these, other network access information, documents and plans specified in this section must also be provided to Elenia.

7.1 Information to be provided in the connectivity assessment phase

- Customer contact information
- Basic connection information and preliminary location
- Transformer and branch line information
- Connection location and method
- Background network information (Elenia delivers to customer)

A careful preliminary study prepares for the design phase and ensures a good starting points for the design. Elenia shall ensure connectivity and manages cooperation with the network operator.

7.2 Information to be provided in the design phase

- Customer and project information for drawing up the connection contract
- Precise location information
- Layout and cross-section drawings
- Site map
- Main circuit diagram
- Earthing
- Location coordinates
- Branch line details
- Messaging contact details
- Dangerous voltage clarification of the associated 110 kV substation and transmission line
- Crossing statement request and crossing statement (Elenia delivers to customer)
- Report on flicker, upon request
- Supplementary and protection-related documents (also applies to type A production equipment as defined in the VJV in cases where the production capacity is 100kVA or more)
  - Protection diagram
  - Planned protection settings and possible security reports
  - Information on the operating principle of island protection (production sites)
  - Report on possible EVY implementation (production sites above 5 MW)
- Telecommunications implementation (no later than four weeks before the test):
  - Test plan and contact details of the control room operator*
  - Signal list
- Implementation of energy metering (no later than four weeks before the start of metering):
  - Metering circuit diagrams
  - Nominal values of the instrument transformers used for energy metering
  - Load calculations
  - Contact details and interface point identification of the balance responsible party for the conclusion of the electricity network services contract

* if the customer or the customer's control room operator does not already have access to the FEN network, up to 3 months of processing time must be reserved for related preparations

The customer must submit the design data and documents for comment to Elenia. Elenia will reserves a two-week comment period for the plans.

The comments do not remove the customer's responsibility for fulfilling the safety, functionality and quality requirements set for the plans.

Plans and signal lists for data exchange must be submitted four weeks before the test to Elenia's contact person. A binding test schedule shall be agreed two weeks before the test date. Signal testing is carried out during normal working hours. Similarly, the information related to the implementation of the energy metering must be submitted to Elenia four weeks before the desired metering date.

Updated final version of the above documents are required after implementation. The final documents shall be delivered to Elenia's contact person.

7.3 Information to be provided during the implementation and connecting phases

- Schedule and connection initiation form (28 days before commissioning)
- Commissioning inspection report (on the day of connection before connecting)
- Protection-related and supplementary documents
  - Final main circuit diagram
  - Final protection diagram
  - Final protection settings
  - Relay test protocols (at least one week before commissioning)
- Final metering circuit diagram as well as nominal loads and load calculations for instrument transformers
- Contact details of the operation manager and of the control room or operation personnel responsible for controlling the operation of the connection
- Information on the location of keys and access tags required to access the location. A key deposit cylinder to which Elenia delivers the lock.
- Final documents and electronic values

The customer shall submit a connection initiative form for the connection switchgear to Elenia no later than 28 days before the switching on of the high-voltage equipment. If requested, Elenia's contact person will provide the customer with a template for the connection initiation form. The connection initiation form provides instructions on how to complete it and return it to Elenia. When planning and scheduling the connection, it must be taken into account that, at the time of connection, the equipment must have a connection permit in accordance with the requirements detailed in Fingrid's compliance process issued.

Before switching on the power, a commissioning inspection report must be drawn up for the equipment, which shall be delivered to Elenia's network control centre and contact person on the day of connection. The network connection relay test must be completed for the part to be commissioned, and the relay test protocols delivered to Elenia's contact person no later than the week prior to connecting.

The electricity network services provided and use of network after the connection comply with the electricity network services contract and Finnish Energy's contract terms SJVPE 2019. The electricity network services contract between Elenia and the customer must be concluded and signed well in advance before the connection is commissioned.

8 Operation

Operational use and communication related to connecting are carried out in Finnish with Elenia's network control centre. The contact information for Elenia's network control centre for the implementation and management of connections is available from Elenia's contact person.

Upon request, the customer must provide Elenia with the design information regarding the use of the connection equipment in accordance with the applicable connection terms and conditions. For work requiring transmission line interruption (e.g. connection point separating switch maintenance), the customer must agree with Elenia's contact person well in advance. In addition, for transmission line interruptions, a connection initiation form must be filled in and submitted to Elenia no later than 28 days before the interruption. The connection initiative form and instructions on how to submit it can be obtained from Elenia's contact person.

Before commissioning the equipment, all documents and records required by Elenia must be checked and approved by Elenia. Prior to commissioning, the customer must also provide Elenia's contact person the contact details of the operations manager of the connection, as well as the contact details of the operation manager and of the control room or operation personnel responsible for controlling the operation of the connection for the use of Elenia's network control centre. The control room or operating personnel must be available for contact 24/7. The customer is responsible for the operation of its own electrical equipment, the safety of operation and managing the connection.

8.1 Access rights and access to connection point equipment

The connection point shall be equipped with a remote-controlled separating switch that allows it to be separated from Elenia's network. The customer must have 24/7 readiness to separate the equipment from Elenia's network at the request of Elenia's network control centre in case of faults, or similar situations. In principle, the customer will handle the separation of the equipment from Elenia's network in all situations at the request of Elenia's network control centre. In addition, in order to ensure a sufficiently rapid separation in emergency and exceptional situations, Elenia must have access to the connection point separating switch which must be lockable in order to guarantee the safety of network operations. If in the event of an emergency or other exceptional situation, Elenia has to separate the customer's equipment for the customer, this must be agreed separately between Elenia's network control centre and the customer's operating personnel.

The site must have a key deposit cylinder to which Elenia will deliver the lock part. A customer key shall be placed in the cylinder to allow control of the separating switch and access to any equipment premises assigned to Elenia. The customer shall familiarise Elenia representatives with the use of the equipment to the extent necessary.

Elenia's representatives shall have access to network components Elenia owns on a 24/7 basis for repair and maintenance purposes. A similar requirement also applies to switchgear that Elenia has the right to use. This must be taken into account, in particular, in the case of equipment located inside buildings or fenced areas, in which case keys or access tags necessary for accessing the site must also be added to the site's key deposit cylinder.

Appendix 1: Connection process - Production - SJLE2019 / VJV2018