



Jari Siltala

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Network code on emergency and restoration – requirements and implementation in Finland

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Contact persons

Jari Siltala
Fingrid Oyj
jari.siltala(at)fingrid.fi

NC ER implementation
24 h capability

Harri Kuisti
Fingrid Oyj
harri.kuisti(at)fingrid.fi

The automatic under
frequency load shedding
system

Tiia Renlund
Suomen Erillisverkot Oy
tiia.renlund
(at)@erillisverkot.fi

KoVa services

Juha Korpio
juha.korpio(at)fingrid.fi

Implementation of KoVa
information exchange with
Fingrid

Erno Paananen
erno.paananen(at)fingrid.fi



General

Network Code on Electricity Emergency and Restoration (NC ER)

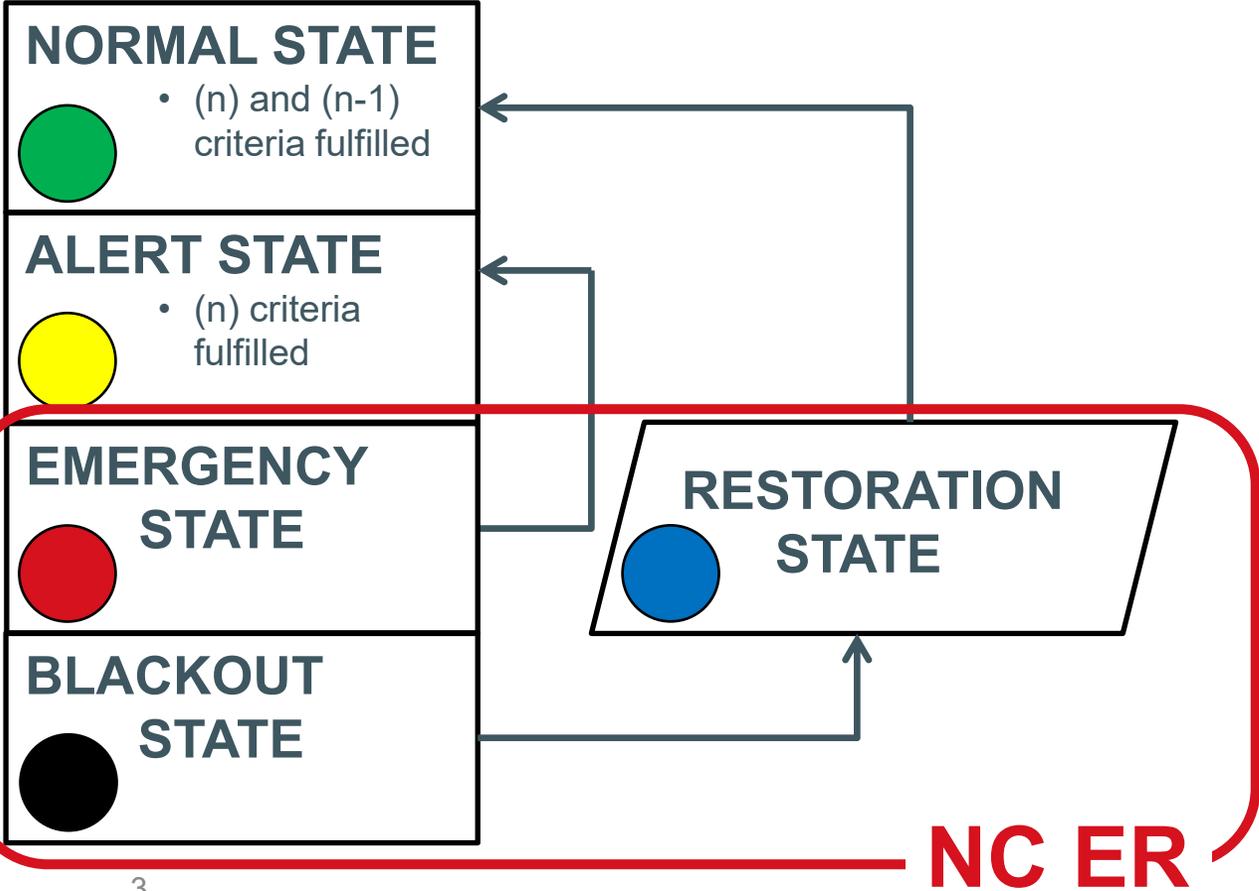
Defines common requirements and goals for managing the Emergency, Blackout and Restoration states of the electricity system:

- to prevent the escalation of an emergency situation and to prevent blackout and
- to enable efficient and fast restoration after a blackout.

Transparency
Impartiality
Efficiency

Co-ordinates and harmonizes operation of the electricity system in Emergency, Blackout and Restoration states inside the EU and with third countries.

States of the electricity system



EMERGENCY STATE

At least one of the following is fulfilled:

- main grid power flows outside security limits even after remedial actions
- frequency outside 50 ± 0.5 Hz for more than 15 min
- frequency outside 50 ± 1.0
- complete loss of SCADA or another critical tool for more than 30 min (in essence, loss of Fingrid's control center functionalities)
- load shedding takes place
- electricity shortage in Finland

BLACKOUT STATE

At least one of the following is fulfilled:

- loss of more than 50 % of consumption in Finland
- total absence of voltage in the main grid for more than 3 min

RESTORATION STATE

- restoration process after blackout has been initiated **and**
- the TSO has started to activate measures to restore consumption and production.

Network code is the law!

- NC ER is applied to
 - transmission system operators (TSO),
 - distribution system operators (DSO),
 - grid users significant to the System Defence plan and the Restoration plan
 - defence service providers,
 - restoration service providers,
 - balance responsible parties,
 - balancing service providers,
 - nominated electricity market operators (NEMO).
- **Fingrid** is responsible for defining the practical measures required by NC ER monitoring their implementation.
- **The Energy Authority** monitors the appropriate implementation of NC ER.
- **Each party** is responsible for implementing the required measures.



What and where?

- NC ER can be found
 - in English on ENTSO-E's web site: https://www.entsoe.eu/network_codes/er/
 - in all EU languages on the European Union's web site:
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2017.312.01.0054.01.ENG
- Some public material is available on Fingrid's web site:
<https://www.fingrid.fi/en/electricity-market/market-integration/network-codes/operating-codes/>
- Detailed material, incl. webinar presentations, will be delivered separately to those concerned.

**The System defence plan,
the Restoration plan
and the significant grid users**

NC ER obliged the TSOs to create two plans:

System defence plan

- The scenario:
 - the situation is severe, but the lights are still on in the nation
 - the "normal" actions have been taken (the automatic and manual reserves have been activated, Fingrid's reserve power plants are running etc.)
 - ...and this might not be enough.
- What further actions need to be taken and which tools are needed in order to avoid blackout? And with whom shall these actions be taken?

Restoration plan

- The System Defence plan was not sufficient or fast enough to prevent blackout.
- What actions and tools are needed to do the restoration? And who else do we need?

...and to nominate the grid users which are significant for the implementation of these plans.

Grid users significant for the **System defence plan**

- **All** distribution system operators and operators of high voltage distribution systems (DSOs).
- Electricity consumption sites directly connected to the main grid.
- Existing and new power plants of > 10 MW and their owners.
- Existing and new electricity storage units of > 10 MW and their owners.

Responsibilities for the grid users significant for the System defence plan

- Obligation to participate in the implementation of the automatic low frequency demand disconnection system
- Obligation to participate in the implementation of an automatic high frequency production disconnection system (in case such a system will be implemented in the Nordic synchronous area and in Finland)
- Obligation to obey the TSO's instructions regarding active and reactive power, voltage control and demand and production disconnection
- Obligation to relay the TSO's requirements to the nominated significant grid users which are connected to its grid
- Obligation to follow the test requirements regarding the automatic systems

Grid users significant to the **Restoration plan**

- All distribution system owners and owners of high voltage distribution systems (DSOs) connected directly to the main grid.
- DSOs who have substations named as significant for the restoration plan.
- Existing and new power plants of > 30 MW and their owners.
- Existing and new electricity storage units of > 30 MW and their owners.
- Main grid connected consumption sites with average > 30 MW.

Responsibilities for the grid users significant for the Restoration plan

In addition to the requirements related to the System defence plan:

- Requirement 24 h capability regarding critical tools and facilities, including
 - control center,
 - substations significant to the Restoration plan,
 - SCADA and the systems necessary for its operation, incl. telecommunications to the significant substations and power plants and
 - voice communication towards Fingrid.
- Implementation of the voice communication in such a way that the calls coming from the TSO can be prioritized
- Krivat situational awareness system.
- Real time measurements of the electricity consumption included in the automatic low frequency demand disconnection system: this applies to those grid users for which the KoVa FEN real time information exchange is a requirement.
- Testing and monitoring requirements regarding the 24 h capability, automatic systems and voice communication

Reasoning

System defence plan significant grid users:

- a longer list: the parties that
 - are needed in the implementation of the automatic under frequency load shedding
 - are able to provide assistance in the emergency state to avoid blackout
- compatibility with the power plant classification in NC RfG (Network code on requirements for grid connection of generators) and VJV (Fingrid's requirements for generators)

Restoration plan significant grid users:

- a shorter list:
 - the bigger parties together with whom the restoration process after blackout is in practice carried out
- compatibility with Fingrid's existing procedures for managing serious disturbances
 - regarding both the DSOs and power plants
- regarding power plants, compatibility also with the power plant classification in NC RfG (Network code on requirements for grid connection of generators) and VJV (Fingrid's requirements for generators)

Naming of significant grid users is based on the Energy Authority's information:

- Electricity grid operation technical data (Sähköverkkotoiminnan tekniset tunnusluvut)
 - Energy transmitted to grid service customers and yearly avg. power calculated from this (Verkkopalveluasiakkaille siirretty sähköenergia)
- Power plant registry (Voimalaitosrekisteri)
 - the column Max total MW (Maksimi yhteensä MW)

Substations significant to the **Restoration plan**

- All substations in the main grid which are classified as transformer stations or switching stations and which contain remote controlled switching equipment.
- Those substations owned by DSOs or other significant grid users
 - which are on the path from a distribution grid connected significant power plant or electricity storage unit to the main grid or
 - through which a main grid power line passes and
 - and which contain remote controlled switching equipment.

24 h capability requirements for the substations significant for the restoration plan

In case of loss of external power supply:

- the significant grid users own voice communication shall remain operational for at least 24 hours,
- the measurement and status data from the substation remain available in the SCADA system of the party responsible for the operation of the substation, for at least 24 hours,
- it shall be possible to remotely switch the equipment necessary for restoration after blackout, for at least 24 hours and
- the standby power supply shall be capable of covering the substation's house load for at least 24 hours, taking into account that
 - it shall be possible to open and close each of the above specified equipment at least 6 times.

The naming of main grid connected consumption sites as grid users significant to the restoration plan:

Applies to a consumption site:

- which is connected directly to the main grid (ie. there is no distribution grid between the installation and the main grid),
- which has one connection point to the main grid and
- which has an average consumption of more than 30 MW.

The requirements:

- the capability of the control center to operate for at least 24 h during the loss of external electricity supply,
- implementation of the KoVa Puhe and KoVa FEN services,
- implementation of the Krivat situational awareness system,
- regular testing of the 24 h capability and
- providing to Fingrid real time measurements of the consumption included in the automatic low frequency demand disconnection system (UFLS).

In case the party has more than one main grid connected consumption site and one centralized control center:

- Regarding control center, it is sufficient to implement the 24 h capability of the centralized control center. In this case Fingrid will communicate with the centralized control centers instead of the different sites.
- Regarding the real time measurements of the LFDD consumption, the connection from the site to the centralized control center does not need to be 24 h secure, **unless** there are power plants at the site which are significant to the restoration plan.

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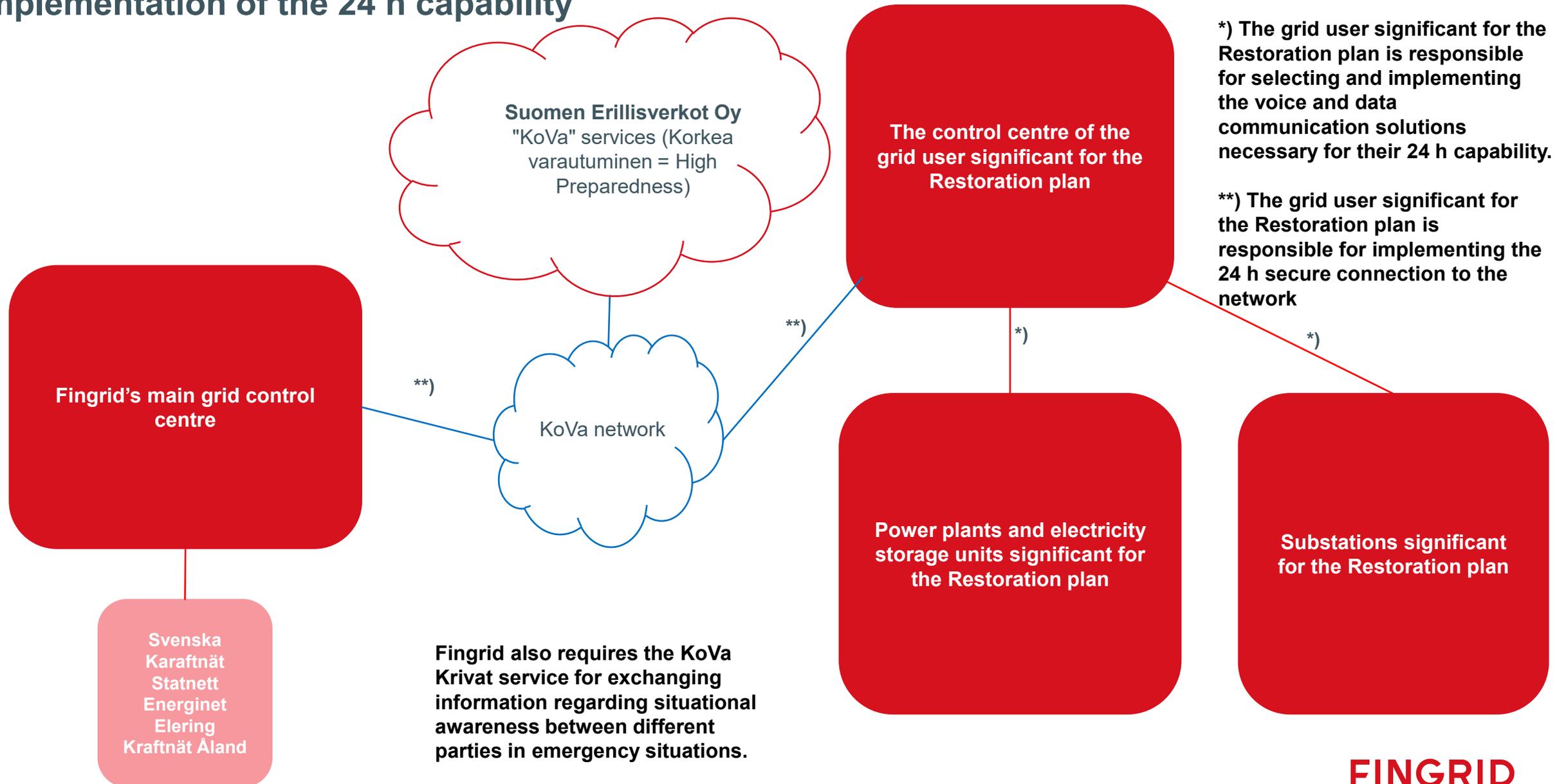
**The 24 h capability of the grid users
significant for the Restoration plan**

24 h capability in general

Grid users significant to the Restoration plan shall, for the critical tools and facilities listed below, have a capability to operate for at least 24 h in case of loss of external electricity supply:

- control room (in case control room services are outsourced, this applies also to the service provider's control room),
- control and monitoring functions of the SCADA system regarding the substations and power plants which are significant for the Restoration plan,
- 24 h capability of its substations, power plants and electricity storage units which are significant to the Restoration plan and control of the equipment which are significant to the Restoration plan,
- LFC controller and telecommunications for the major parties,
- real time data exchange with Fingrid and
- voice communication between its control center and Fingrid's main grid control center and voice communication to its substations and power plants which are significant for the Restoration plan.

Requirements for the grid users significant to the Restoration plan regarding the implementation of the 24 h capability



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The automatic low frequency demand disconnection system (LFDD)

What is the LFDD and why do we need it?

- The LFDD automatically disconnects a part of the electricity demand when the frequency is exceptionally low (48.8 Hz or lower).
- 30% of the Finnish electricity consumption is included in the LFDD.
- In an event like this, the LFDD is the last straw. By disconnecting demand we try to stop the decrease of the frequency and to prevent a blackout.
- Frequency is the same in the entire synchronous area
=> the Nordic TSOs will implement the system according to common principles.
- The LFDD is in Finland implemented by the grid users significant to the system defence plan, ie:
 - all distribution system operators and owners of high voltage distribution systems (DSOs) and
 - all main grid connected electricity consumption sites.
- By taking the LFDD from the main grid to the distribution grids and to the main grid consumption sites
 - the critical loads can be secured and
 - the amount of production which is lost when the LFDD is activated, can be minimized.

	f (Hz)	Viive(s)	%
Porras		Nopea	kuormasta
1	48.8	0.15	5
2	48.6	0.15	5
3	48.4	0.15	5
4	48.2	0.15	5
5	48	0.15	10

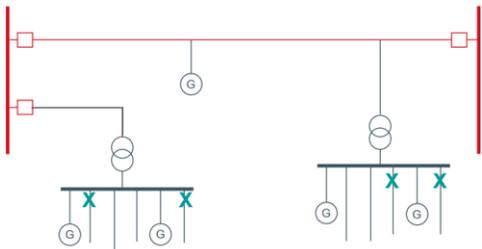
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Implementation guide

- A working group consisting of the Finnish Industry, DSOs and, Fingrid) has created an implementation guide (in Finnish):
<https://www.fingrid.fi/globalassets/dokumentit/fi/yhtio/tki-toiminta/raportit/frequency-based-emergency-disconnection-policy-review-for-the-nordic-region-v1.0.pdf>
- **The DSOs and the main grid connected consumers shall select the implementation method best suited for their needs.**
- **Alternatives:**

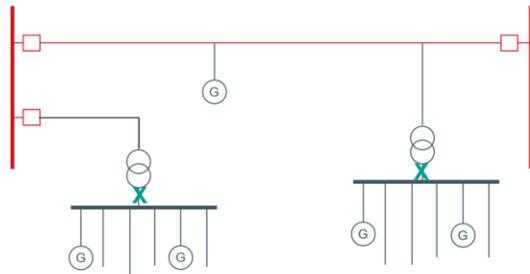
Alternative 1 **RECOMMENDED**

- LFDD implemented at the medium voltage level (or lower)



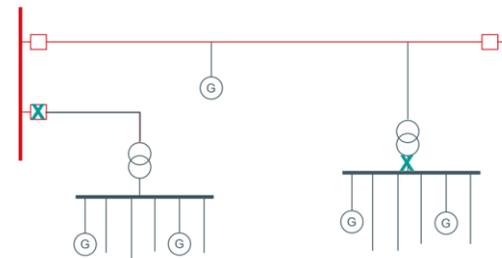
Alternative 2 **ACCEPTABLE**

- LFDD implemented entirely or in part in the distribution grid at the substation level



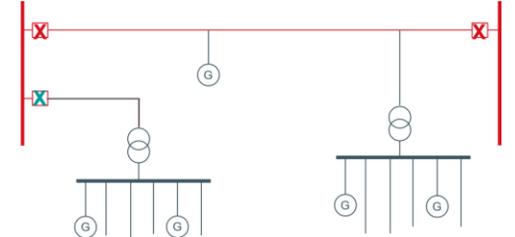
Alternative 3 **ACCEPTABLE**

- LFDD implemented entirely or in part in the main grid radial lines



Alternative 4 **NOT ACCEPTABLE**

- LFDD implemented on the main trunk lines



Testing of the NC ER requirements

The implementation of 24 h capability and LFDD shall be tested regularly

- The requirements for testing are specified in the NC ER test plan.
- Test results shall be reported in Oma Fingrid.