IEC TS 60364-8-3

Edition 1.0 2020-05

TECHNICAL SPECIFICATION

colour inside

Low-voltage electrical installations – Part 8-3: Functional aspects – Operation of prosumer's electrical installations

IEC TS 60364-8-3:2020-05(en)

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LOW-VOLTAGE ELECTRICAL INSTALLATIONS –

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FOREWORD

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- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical Specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 60364-8-3, which is a Technical Specification, has been prepared by IEC technical committee 64: Electrical installations and protection against electric shock.

The text of this Technical Specification is based on the following documents:

Draft TS	Report on voting
64/2400/DTS	64/2427/RVDTS

Full information on the voting for the approval of this Technical Specification can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60364 series, published under the general title *Low-voltage electrical installations*, can be found on the IEC website.

The reader's attention is drawn to the fact that Annex A lists all of the "in-some-country" clauses on differing practices of a less permanent nature relating to the subject of this document.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

There is a need for the development of new standards in smart grid that can apply to prosumers' electrical installations in low-voltage level. New standards relating to prosumers' low-voltage electrical installations that are different from existing facilities are needed in order to provide bidirectional power and information while being connected to upper smart grid systems, unlike other existing low-voltage electrical installations built in accordance with published standards, and in order to evaluate the power quality of electrical power supply.

The new standards should be able to verify the stability, interoperability, security which are characteristics of smart grid according to IEC TR 63097, published by IEC SyC Smart Energy. When a bidirectional power network is operating, it is very important to ensure the safety of homes and buildings and the protection of electrical installations in low-voltage against lightning and fault.

A new standard for the verification of the prosumer's electrical installations should in the first instance define the power system of low-voltage and require criteria for information exchange between the prosumer's electrical installations while connecting to other power systems.

This document is the first attempt in the development of a framework for low-voltage electrical installations. In order to match this overall framework, TC 64 made modifications to suit the needs of the prosumer's electrical installations in low-voltage, based on the framework and architecture that have already been developed by IEC, IEEE and ETSI. Up till now, no attempt to match the frame of other systems such as utilities, service providers, to other prosumers' electrical installation systems has been made and this new development will help in setting-up prosumers' electrical installations effectively.

As low-voltage to a prosumer's electrical installation is applied, the biggest change is the mode of the power supply. Direct feeding mode, reverse feeding mode and island mode are discussed in IEC 60364-8-2. The reliability of the system operation mode is important for the stability, safety, protection of the prosumer's low-voltage electrical installations, depending on the mode of the power supply.

In order to transfer the power consumption, failure and accident information to other systems or other prosumers' electrical installations, it is important to ensure the interoperability of the systems. This document defines the model of exchange information to facilitate the exchange of data between systems, defines a framework to ensure interoperability, but does not define how to secure communications for interoperability as communication type and methods.

In this document, a method of power supply and a data exchange model based on the framework are suggested and the role of a prosumer who can directly produce and distribute energy is defined.

LOW-VOLTAGE ELECTRICAL INSTALLATIONS –

Part 8-3: Functional aspects – Operation of prosumer's electrical installations

1 Scope

This part of IEC 60364 specifies requirements and recommendations for the safe and proper functioning of prosumers' electrical installations.

It is intended for use by contractors, users, facility managers and similar of electrical low-voltage installations.

This document also provides requirements and recommendations on technical parameters and their limiting values influencing:

a) safety:
   - protection;
   - alarm;
b) proper functioning:
   - stability (voltage, frequency, etc);
   - reliability (power quality, interoperability of communication, etc);
   - energy management (power, power factor, current, stored energy, etc);
   - ability to ensure correct operation of equipment.

This document also provides requirements and recommendations on data exchange models, and test procedures for the prosumer's electrical installations that could include the following applications:

- local generating sources (e.g. photovoltaic systems, rotating generators, wind turbines);
- energy storage units (e.g. stationary secondary batteries);
- electric vehicle charging and/or discharging;
- prosumer's energy measurement unit (PEMU);
- control and monitoring system;
- loads which can be controlled.

This part of IEC 60364 is intended to be applied in conjunction with the other parts of IEC 60364.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60364-8-1, *Low-voltage electrical installation – Part 8-1: Functional aspects – Energy efficiency*

IEC 62053 (all parts), *Electricity metering equipment*

IEC TS 62786, *Distributed energy resources connection with the grid*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
prosumer
entity or party who can be a producer and a consumer of electrical energy

[SOURCE: IEC60364-8-2:2018, 3.6]

3.2
prosumer's electrical installation
PEI
electrical installation connected or not to a public distribution network able to operate:

– local power supplies, and/or
– local storage units

[SOURCE: IEC 60364-8-2:2018, 3.2, modified – Deletion of the second part of the definition.]

3.3
prosumer's energy measurement unit
PEMU
equipment used for measuring the electrical energy used or produced by the PEI or part of it,

– to collect and analyse data for an efficient usage of the electricity, and
– to inform the control and monitoring system for management of the electricity

3.4
grid connected PEI
PEI connected to the distribution network, where local sources operate in parallel to the grid

Note 1 to entry: In case of power outage, the electrical installation cannot be supplied by the local supplies.

3.5
stand-alone PEI
PEI designed for being never connected to a distribution network, supplied by its own local sources only

3.6
islandable PEI
PEI connected to the distribution network, able to operate in island mode in case of distribution network outage

3.7
operating mode
operation of an installation with respect to the different sources of electrical energy and to energy flow

[SOURCE: IEC 60364-8-2:2018, 3.11]

3.8
electrical energy storage
EES
system for storing and releasing electrical energy based on the needs of the connected installation

4 General

4.1 PEI architecture

As shown in Figure 1, it can be considered that PEI architecture is composed of the following layers:

- protection and metering: equipment and devices in the installation for the purpose of safety, reliability, power and energy management;
- power supplies: includes the connection to the distribution network and local power supplies such as PV system, wind turbines, electrical energy storage;
- control system to ensure the proper functioning of the PEI;
- monitoring system;
- analytics and services for optimization of the power supplies usage.

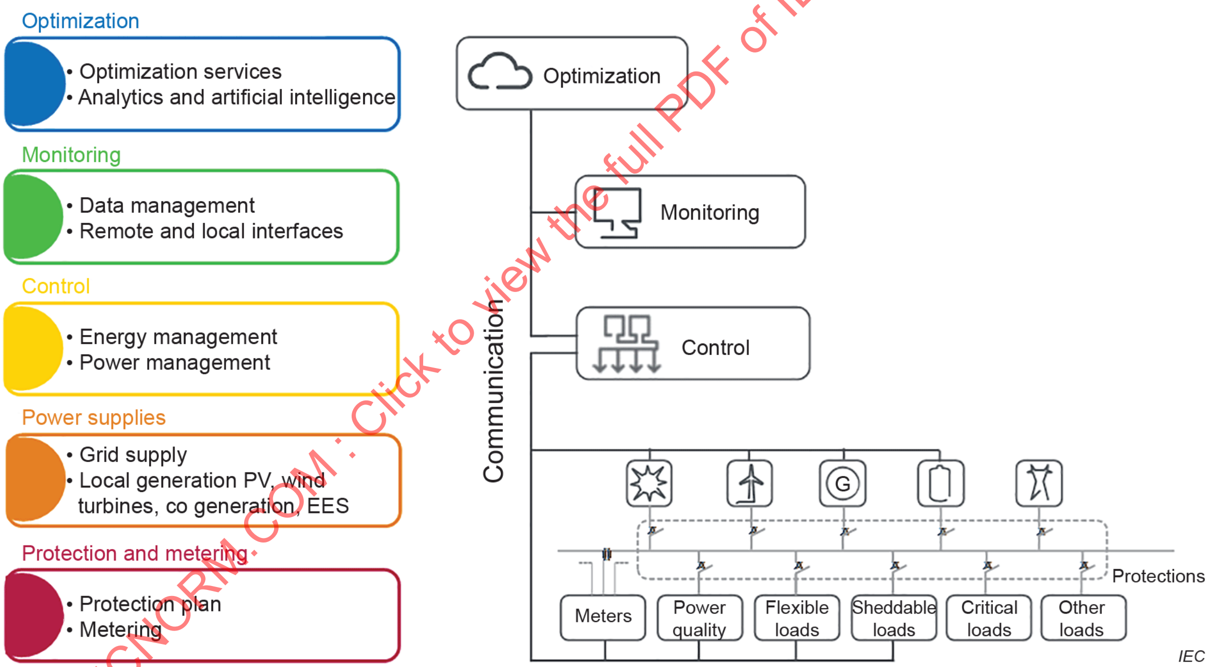
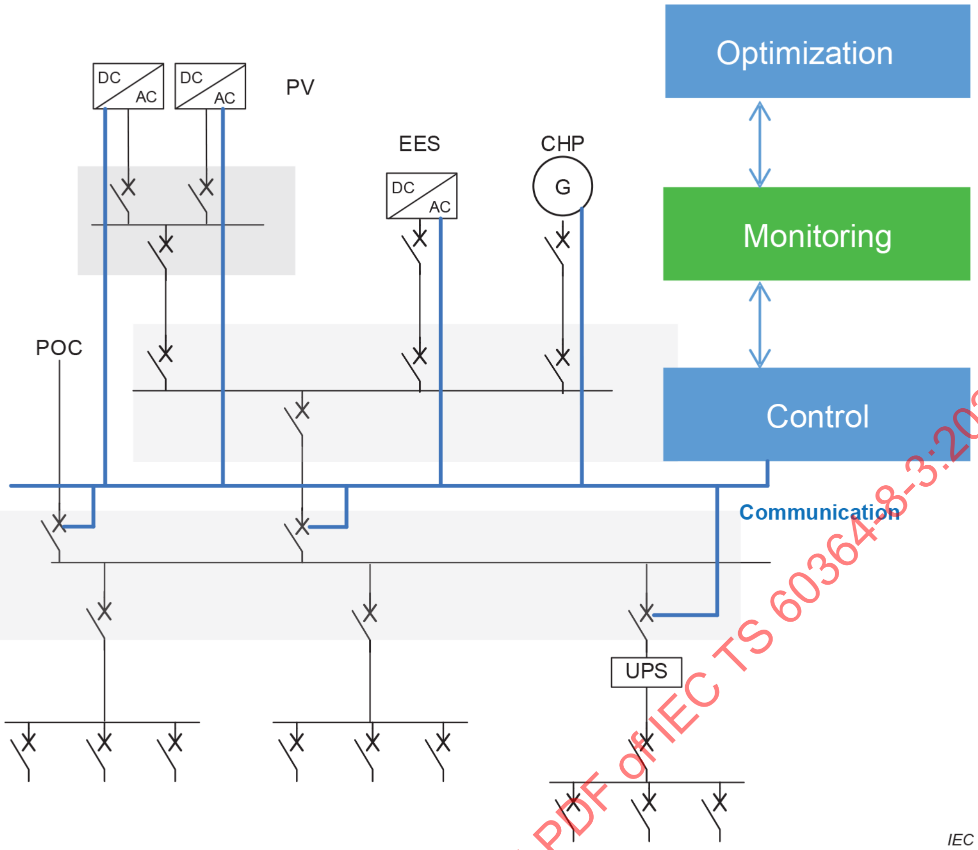


Figure 1 – PEI architecture: functional layers

An example of physical PEI architecture is presented in Figure 2.



Key

EES: electrical energy system

CHP: combined heat and Power

POC: point of connection

UPS: uninterruptible power supply

Figure 2 – PEI architecture: example of physical layout

4.2 Operating modes

4.2.1 General

Each operating mode is a unique configuration of local energy supplies, supplied loads, EES and electric vehicle charging or discharging state.

4.2.2 Grid connected PEI

The operating modes in a grid-connected PEI are as follows:

- the PEI is supplied by the distribution network;
- the PEI is supplied by the distribution network and local energy supplies. The EES operates as load or as energy supply. Each operating mode is defined by the available local energy sources and supplied loads.

4.2.3 Stand-alone PEI

A stand-alone PEI is energized by local power supplies without any supply from the grid. The voltage and the frequency reference are fixed by one of the local power supplies.

4.2.4 Islandable PEI

The operating modes in an islandable PEI are as follows:

- the PEI is supplied by the distribution network;
- the PEI is supplied by the distribution network and local power supplies;
- the PEI is supplied by local power supplies only.

5 Local power supplies

5.1 General

Local power supplies may include:

- energy sources (e.g. PV, wind turbines),
- electrical energy storage (EES) units,
- electric vehicle charging stations (EVCSs).

When required, the local power supplies shall be erected in such a way that it should be able to disconnect from the installation, in accordance with the requirements of the distribution system operator (DSO).

5.2 Renewable energy sources

Energy sources may include PV inverters, wind turbine inverters or co-generation units.

Renewable energy sources shall correctly transfer information to the control and monitoring system on power measurements and inverter status. They shall be able to receive set points for operation or control orders from the control system.

Renewable energy sources may be temporarily, automatically disconnected from the PEI in order to avoid damage resulting from voltage fluctuation.

5.3 Electric vehicle charging system

The electric vehicle charging station shall correctly transfer the following information to the control and monitoring of the PEI, if relevant:

- verification of the correct connection of the electric vehicle to the PEI;
- activation or not of the charge or the discharge of the electric vehicle;
- setting of charging and/or discharging rate and charging and/or discharging time;
- keeping and releasing connection of the charging interface equipment;
- user recognition;
- measurement or calculation of used energy;
- calculation and payment of charge or discharge;
- charging status of the electric vehicle.

Minimum specifications of the electric vehicle shall be transferred as follows to ensure safety and interoperability of the PEI out of information required for the control and operation of the electric vehicle charging equipment:

- specification of the electric vehicle for detection and adjustment of allowable load current of the power supply equipment;
- specification for measurement or calculation of used energy of the electric vehicle;

- continuous detection and adjustment of allowable load current of the power supply equipment.

The control system can start, stop the charging or the discharging, if relevant, of the electric vehicle according to power supply status and user commands.

When the PEI is operated in island mode, it is required to control whether or not the electric vehicles can be charged or discharged considering availability of the electrical power from the local power supplies of the PEI.

5.4 Electrical energy storage

Electrical energy storage (EES) units shall complement unstable output of the distributed generation or be used as a main local power.

EES shall provide instantaneously any power fluctuation occurring from the difference between power generation and current-using equipment consumption in the island mode.

- Local power generation and local power consumption shall be measured and compared.
- The control system shall analyse the above information to control the power generation and the local consumption.

In case of sudden disconnection of the PEI from the public distribution network, the PEI shall instantaneously change from the connected mode to the island mode. In this case the EES shall complement the distributed power supplies for supplying the current-using equipment.

When connected to the public distribution network and using the reverse feeding mode, the control system shall manage output power and current-using equipment consumption and power feedback to the public distribution network to improve power quality and supply stable power.

After supplying power to the current-using equipment from a distributed generation in the local system, the surplus power shall be stored in the EES unit, or the power supplied from the system shall be stored in the EES unit for demand management and preparation for a situation of power supply in an island mode.

6 Power measurement

Power measurement equipment shall provide current, voltage, power, frequency and power quality information.

Power measurement equipment shall measure power usage in a certain time interval.

Power measurement equipment shall integrate a remote measurement function.

Power measurement equipment shall provide information on power generation and load consumption to the control, monitoring and optimization systems.

Accuracy of the measuring instrument allows correct information for PEI operation. Accuracy of the measuring equipment shall have the relevant class according to IEC 62053 (all parts) so as to allow correct PEI operation.

The smart meter and measuring equipment shall be installed on such locations that allow information required for each equipment according to conditions of operation and system connection.

7 Control

7.1 General

The implementation of control functions is required to guarantee the PEI reliability, stability and proper operation.

Control functions are integrated to a PEI controller equipment.

The control system shall improve energy efficiency.

7.2 Grid connected PEI

When connected to the public distribution network, the control system shall manage output power to avoid power feedback to the public distribution network isolated PEI.

The control system may be required to provide a control to stabilize power factor or manage loads to improve local power supplies usage.

It is recommended to implement a load control for lighting and a standby power control for demand response, allowing communication and control with other equipment (e.g. outlet).

7.3 Stand-alone PEI

Imbalance between local energy supplies and local power consumption in island mode may result in frequency or voltage fluctuation.

For stable PEI operation, the control system shall ensure the balance between electrical consumption and local electrical energy production.

The control system shall:

- monitor the local power generation and consumption;
- calculate set points for the local power supplies and set points or states for the local loads;
- communicate and control the local power supplies and loads.

7.4 Islandable PEI

An islandable PEI shall integrate control functions required for both grid-connected and island mode. The control system of an islandable PEI shall manage in addition the disconnection and the reconnection to the grid.

When the PEI is disconnected from the public distribution network, voltage and/or frequency fluctuation may occur. To mitigate these fluctuations, the control system shall monitor fluctuation and determine which local energy sources shall be connected or disconnected. Actions could include the following:

- electrical energy storage (EES) units can be used for reducing instability of the PEI voltage;
- renewable energy sources may be temporarily automatically disconnected from the PEI in order to avoid damage resulting from voltage fluctuation.

In case of sudden disconnection of the PEI from the public distribution network, the PEI shall instantaneously change from the connected mode to the island mode.

In island mode, the control and monitoring system shall manage the quality of the power supply so that there is no damage on the power supply equipment, distribution equipment, current-using equipment, or equipment connecting them.

When reconnecting to the grid, the control system shall ensure the voltage and frequency synchronization of the local power supplies to the distribution network.

8 Monitoring

The monitoring system shall provide information for energy usage.

The monitoring system shall be able to monitor equipment and device status.

The monitoring system shall provide power quality information.

Information on power quality, protection, proper functioning required for the connection with the public distribution network and low-voltage electrical equipment shall be verified through the monitoring system for the proper functioning and the operation of the PEI.

The PEI operator and/or manager may check and manage the electric power of the PEI and quality of the power supplied to the PEI, and operate the PEI by using appropriate filters, capacitors, reactors to improve quality of power, if necessary.

The monitoring operation shall be as follows:

- acquisition of energy data through communication;
- recording energy data in database;
- software operation with process management interface;
- software operation using database with data logged to clock time.

The user interface of the monitoring shall include:

- a display to identify and to control the software functions;
- a user database;
- communication means for the users to communicate through a portable computer or mobile device (e.g. remote control) and to provide information by SMS to cell phones, or dedicated display.

The monitoring system shall manage equipment data and energy usage target, check and monitor the power usage, in accordance with IEC 60364-8-1.

It may be required to install interfaces between the control and monitoring system and various kinds of equipment and facilities within the PEI.

It may also be required to install interfaces between the control and monitoring system and its equivalent inside the public distribution network called higher level control for correct interoperation.

Bidirectional communication, to transfer usage information at regular intervals of time, measured by the control and monitoring system and tariff information from the utility company or other service provider to the users, is important for PEI operation.

9 Optimization

The utilization of the local sources may be optimized through the exchange of information and controlling signal with other systems such as weather forecasts, demand response, tariffs.

Configuration of the control and monitoring system for predicting power usage is based on power information for efficient use of power load in the installation.

10 Communication

10.1 General requirements

For effective operation, communication between components within a PEI is required.

Exchange of information between different prosumer's electrical installation components in the grid environment for controlling the operation of equipment within the PEI is implemented by erecting a communication network using hardware, software and network infrastructure communication equipment.

A communication network shall be erected so that power information exchange, equipment status and other information shall be accurately exchanged.

Communication networks shall be installed to enable information exchange between the components of the PEI.

Communication networks shall be installed in compliance with the communication protocol used within the PEI.

10.2 Information exchange within PEI

The PEI provides stability, interoperability and security. Interoperability addresses the effective exchange of information and operation between the PEI and supplies to the PEI.

Interoperability shall be provided by checking the definition of the information to be exchanged with the connected communication networks, protocols to be used, communication channels. Data mapping and information exchange between communication networks using different protocols shall not affect the correct operation of the PEI.

The distribution equipment, the PEMU, and current-using equipment shall transfer required information on power usage and PEI management to the monitoring, control and optimization system.

The monitoring, control and optimization systems analyse the information and transmits control commands for stability and safety of the PEI to each equipment. It also transmits the commands required for efficient energy use.

Table 1 provides examples of information exchange within the PEI.

Table 1 – Examples of information exchange

From	To	Contents of information
Local power supply	Control, monitoring, optimization system	Electrical power (active, reactive), voltage, current, frequency
EES	Control, monitoring, optimization system	Charge volume, charging time, electrical power (active, reactive), voltage, current, frequency, direction of power flow
PEMU	Control, monitoring, optimization system	Quantity of electrical power (active, reactive), voltage, current, frequency, direction of power flow, alarm of outage/image, remote load on/off, load limitation order, energy price information, power quality
Electric vehicle	Control, monitoring, optimization system	Charge and/or discharge volume, charging and/or discharge time, electrical power (active, reactive), voltage, current, frequency, direction of power flow
Current-using equipment	Control, monitoring, optimization system	Quantity of load (active/reactive power), voltage, current
Control, monitoring, optimization	Local power supply, EES, electric vehicle	System control and management order, setting point
Control, monitoring, optimization	User Interface system	Interface of each system information
Control, monitoring, optimization	Current-using equipment	Lighting, control and management order, energy efficiency management, load control operation order based on demand response

10.3 Interaction between PEI and other systems

10.3.1 General

In its design and operation, a PEI may be requested to interact with other systems.

Typically:

- it may be requested to be compliant with defined network/grid codes and associated exchange information with other systems, such as utilities, distribution system operators;
- to perform a real optimization of energy usage and associated costs, it may also need to interact with the revenue metering system;
- it may also be requested to interact with third party service providers, typically aggregators, energy retailers, service providers.

10.3.2 Specific functional constraints related to grid codes requirements

Typical functional constraints which PEIs shall comply with, are described in IEC TS 62786. This may include requirements for:

- active exported power constrained by frequency for frequency stability and regulation purposes (frequency sensitive mode);
- reactive power capability, during grid faults or permanently;
- post fault power recovery capability;
- stability in case of power oscillations;
- voltage or frequency fault ride through capability;
- cease to energize/return to service functions and associated state machine behaviour;
- automatic connection, disconnection, re-connection to the network;
- system restoration and reconnection after an incidental disconnection;
- status information (such as active/reactive power, voltage, current) exchange capability;

- forecast information (power, site availability) exchange;
- logic interface to receive a remote instruction;
- certification, testing and simulation;
- cybersecurity related requirements.

10.3.3 Interaction with utilities or distribution system operator

The PEI shall comply with requirements identified by the DSO or utilities.

In case requirements from grid codes apply, these are usually included within the DSO/utilities requirements, i.e DSO/utilities requirements have to be considered as a superset of grid codes requirements described in 10.3.2.

The PEI may be required to guarantee the local power supplies disconnection in case of power supply loss from the public distribution network.

The PEI may be required to limit the reverse power injected to the grid.

10.3.4 Interactions with revenue metering systems

The PEI may interact with the revenue metering system, typically to retrieve energy metered data information from revenue meters either through a direct link to the smart meter(s), or by connecting to revenue meter data collectors through a specific communication link (typically the internet), with the purpose of performing energy usage and cost optimization.

The revenue metering system may also be used for conveying demand-response related information.

10.3.5 Interactions with energy-related service providers (including energy retailers)

This subclause deals with interactions with energy retailers and/or energy-related service providers, including aggregation, demand-response, energy efficiency, ancillary services (typically congestion, voltage and frequency support). Such service providers may in their turn interact with energy markets, balance responsible parties, utilities.

Thus the PEI may be requested to support the sending of information to these service providers related to its energy resources such as embedded generation, storage, flexible loads resources. Such information may include sending installed energy-related capabilities, forecast, flexibility capabilities. The PEI may also be requested to support the receipt of incentives/constraints/controls from these service providers.

Such data exchange should be performed in a cyber-secured way.

Such interactions would mean that the PEI has the ability to adapt its energy behaviour on demand, i.e. control in some ways its energy resources such as generation, storage and flexible loads.

10.3.6 Peer to peer interactions with other prosumers or distributed energy resources

The PEI may also interact with other PEIs or just distributed energy resources, to optimize the global energy usage and/or energy costs and/or produce services to the grid, typically under a contractual format.

To enable this, the PEI may have to exchange information (possibly in real-time), with these other stakeholders, and perform as expected.

Such data exchange should also be performed in a cyber-secured way.

11 Power quality

11.1 General

The power quality of the PEI to be supplied to the public distribution network shall be monitored (e.g. harmonic content, voltage fluctuation) and improved if needed. Installation and operation of filters, capacitor banks, reactors can be used for improving the quality of power when necessary.

Power quality of the PEI (harmonic wave, voltage fluctuation, etc.) shall refer to the appropriate standards or requirements set by the public distribution network company/DSO.

If quality of the power supplied to the PEI exceeds thresholds for over voltage, flicker, frequency, harmonic wave and power factor criteria, disconnection or control of the PEI may be required.

11.2 Voltage regulation

The voltage shall be within the specified limit value for proper operation of loads.

Since the voltage at the point of connection could increase and exceed the operation limit due to power flow to the grid, voltage increase shall be prevented using an automatic voltage control function.

11.3 Flicker

The local power supplies shall not generate voltage flicker exceeding the allowable value for the PEI.

11.4 Superimposed DC component

Local power supplies may inject DC current components to the electrical installation.

Where the DC component of the current exceeds the threshold defined by the DSO at the point of connection, no injection to the public distribution network shall be applied.

11.5 Frequency

Local power supplies shall operate under the frequency of the public distribution network in connected mode.

In island mode, frequency shall be controlled in order to remain within the specified limits. When connecting the PEI back to the public distribution network, the PEI should be the one that synchronizes the frequency with the public distribution network.

11.6 Power factor

It is recommended to operate the PEI to a power factor equal or exceeding a present threshold (e.g. 0,85) at rated load in all operating modes.

12 Maintenance

The control and monitoring system shall analyse and store a certain number of logs for analysing causes of failures and post-management.

The control and monitoring system shall provide alarms in case of an abnormal situation or misoperating equipment.