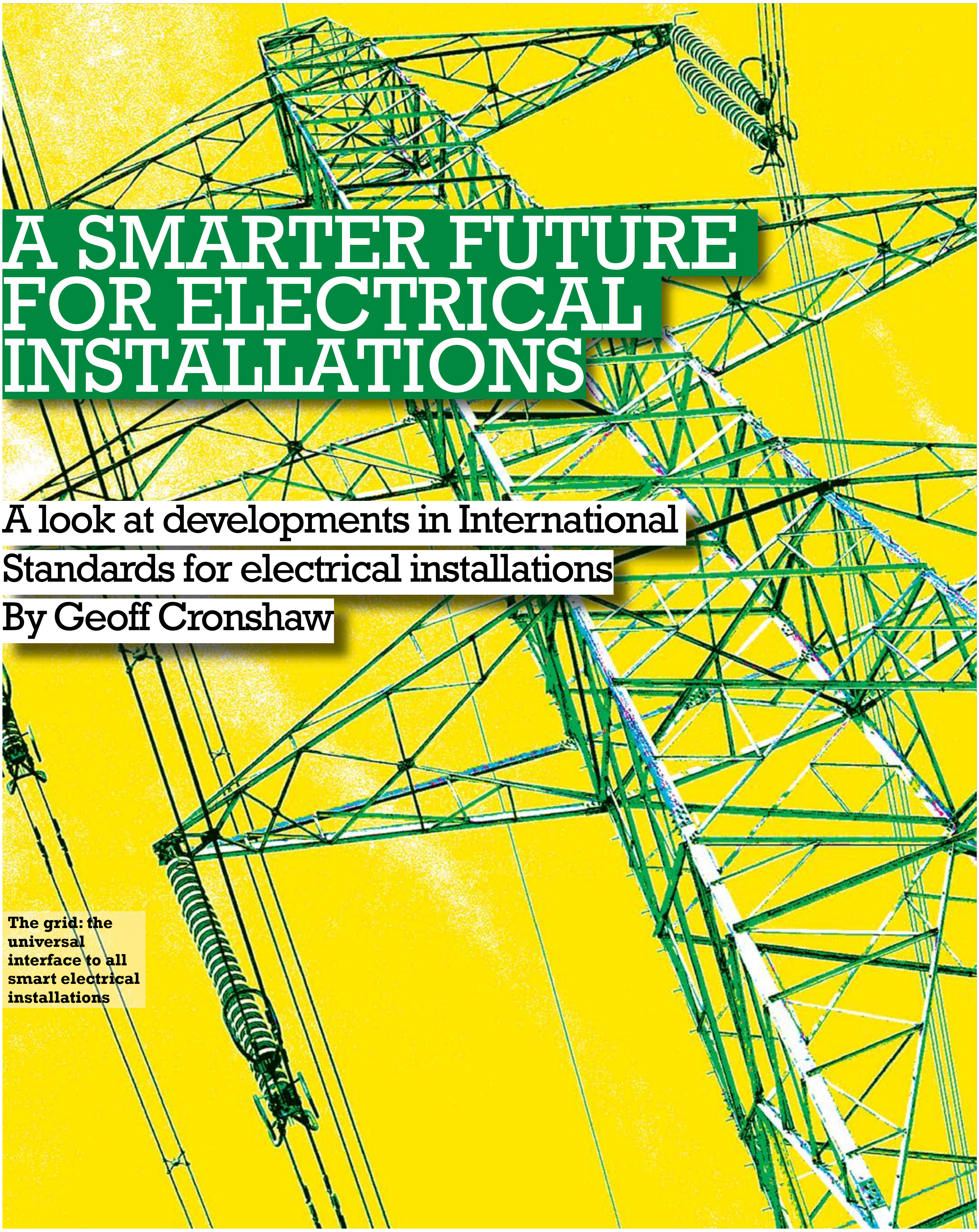

A SMARTER FUTURE FOR ELECTRICAL INSTALLATIONS

A look at developments in International Standards for electrical installations

By Geoff Cronshaw

The grid: the universal interface to all smart electrical installations

THE IET WIRING Regulations (BS 7671) are based on European Standards, which in turn are usually based on International standards. One new area of possible development within International Standards is a new section proposed within IEC 60364 covering smart electrical installations (SEIs) to incorporate energy-efficiency measures, interface with the smart grid and manage renewable sources of electricity.

The proposals look at the possibility of Individual Smart Electrical Installations, Collective Smart Electrical Installations and Shared Smart Electrical Installations.

Individual Smart Electrical Installations are considered to be an electrical installation (for example a private house or workshop) that can either produce or consume electrical energy. Three operating modes are considered for the Individual Smart Electrical Installation. These are: direct-feeding mode (where the installation is supplied from the grid/supply network); autonomous mode (where the installation is supplied from its own generator); and reverse-feeding mode (where the installation supplies electricity back to the grid/supply network).

Collective Smart Electrical Installations are considered to be a group of SEIs (for example, private houses, private flats in a building, and small shops in a mall) that have a common electrical power supply from one separate unit producing energy and from the grid/supply network. Three operating modes are considered for the Collective Smart Installation. These are: direct-feeding mode (where the installation is supplied from the grid/supply network), autonomous mode (where the installation is supplied from its own generator), and reverse-feeding mode (where the installation supplies electricity back to the grid/supply network).

Shared Smart Electrical Installations are considered to be, for example, where a group of individual houses may pool their interests in accepting to share their supply with their neighbours from their own renewable power sources. Each house owner may have installed private renewable energy power sources which can either supply the private electrical installation or supply the group of private electrical installations.

This defines a Shared Smart Electrical Installation. Three operating modes are considered for the Shared Smart Electrical Installation. These are: charging mode (where the installation is supplied from the grid/supply network); autonomous mode (where the installation is supplied from its own generator); and reverse-feeding mode (where the installation supplies electricity back to the grid (supply network).

However, it is important to point out that this is only a new work item in IEC at this stage and may not become an international standard. This article is based on draft proposals and, therefore, the actual requirements (if it became an international standard) would probably be different.

The smart electrical installation

A smart installation is defined as an electrical installation that can operate connected to the grid (supply network) or isolated from the grid (supply network) by optimally controlling elements such as dispersed generation (for example, photovoltaic panels or wind turbine), electrical energy storage equipment (for example, batteries), and the various loads (examples include motors, heating, lighting, appliances such as washing machines) by using information exchange.

There are a wide range of micro generation technologies including: solar photovoltaic (PV); wind turbines; small scale hydro;and micro CHP (combined heat and power).

One of the key components of the smart electrical installation is the Electrical Energy Management System (EEMS). The objectives of the EEMS are to control the connection of the smart electrical installation to the smart power grid, and to manage locally the electrical energy production and consumption. In addition, the EEMS manages the energy procurement from the grid (supply network). This is carried out using meters and measuring equipment in order to communicate the required electricity parameters, along with information on the direction of energy flows, to the EEMS.

Metering – general

Energy measurement is essential for energy management in any electrical installation, not just a smart installation. To be able to measure the amount of electrical energy consumed and monitor and control energy effectively in any electrical installation metering equipment needs to be allowed for at the planning stage. Although this will increase the initial cost of the switchboards, it will prove more economical than having to add metering at a later date.

How metering information will be used needs careful consideration. The system may be required to measure power quality, voltage levels and loads. It may also produce alarms, control loads or change tariffs if pre-set limits are exceeded. Consideration should always be given to the environment where the meter is installed, which should be in accordance with the manufacturer's instructions. Metering needs to be installed in an area that is accessible for the meter reader and where the display can easily be read. Areas where the instrument is likely to be subjected to excessive heat, moisture, and vibration should be avoided. Meters are available that provide pulse generation. These can be linked to building management systems to provide an electrical pulse proportional to a unit of measurement.

Metering – the smart electrical installation

Metering is an essential part of the smart electrical installation (SEI). In the individual SEI, meters and sensors measure and detect energy flow. Metering is provided to measure energy supplied from the grid and supplied back to the grid (for example where the installation includes photovoltaic panels or a wind turbine). Electricity generated on site by the installation's own micro generation technologies is also metered and energy supplied from storage units such as batteries is metered. In addition, metering is provided to measure energy consumed by the various loads such as motors, heating, lighting etc. The collective and shared smart electrical installations include a wide range of meters and sensors to monitor and control energy.

Safety issues, interaction with HV public network, energy storage and functional issues

The proposals on smart electrical installations include requirements for earthing when in any of the three operating modes.

When designing an electrical installation, one of the first things to determine is the type of earthing system. For an LV supply the Distribution Network Operator (DNO) will be able to provide this information. The system will either be TN-S, TN-C-S (PME) or TT >

Smart installations will have to interface with smart grid energy storage facilities, like this liquid-air-based plant

for a low-voltage supply given in accordance with the Electricity Safety, Quality and Continuity Regulations 2002 as amended.

This is because TN-C requires an exemption from the Electricity Safety, Quality and Continuity Regulations, and an IT system is not permitted for a low-voltage public supply in the UK because the source is not directly earthed. Therefore TN-C and IT systems are both very uncommon in the UK.

Protection against overcurrent is also included. Overload and short-circuit currents are to be determined in all points of the SEI where a protective device shall be installed for all possible configurations of the type of SEI, and for situations corresponding to the minimum and maximum current magnitudes. The proposals on smart electrical installations require compliance with IEC 60364-4-43 which is the international standard that chapter 43 of BS 7671 is based on.

Interaction with HV public network including active and reactive power control, voltage control, frequency control, and load shedding are mentioned. Energy storage, including electric vehicles. is also mentioned in the proposals.

Requirements of BS 7671:2008 (2013) Chapter 55 – Other Equipment. Regulation 551 – Low Voltage Generation Sets

It is important to point out that there are mandatory requirements concerning parallel connection of generators, before they can be interconnected with the supply network. In addition Chapter 55 of BS 7671:2008 (2013) contains requirements for Low-Voltage Generation Sets. This set of regulations includes additional requirements contained in Regulation 551.2 to ensure the safe connection of low-voltage generating sets including small-scale embedded generators. Regulation 551.4.2 covers the use of RCDs. Regulation 551.4.2 states:

"The generating set shall be connected so that any provision within the installation for protection by RCDs in accordance with Chapter 41 remains effective for every intended combination of sources of supply."

Regulation 551.1 includes a note stating that the procedure for connecting generating sets up to 16A in parallel with the public supply is given in 'The Electricity Safety, Quality and Continuity Regulations 2002 (as amended)'. For sets above 16A the requirements of the DNO must be ascertained. The 17th Edition recognises that there are two connection options:

(i) Connection into a separate dedicated circuit

(ii) Connection into an existing final circuit.

Connection into a dedicated circuit is preferred.

Regulation 551.7.2 sets out the requirements for the two options. The Regulation requires that a generating set used as an additional source of supply in parallel with another source shall either be installed on the supply side of all protective devices for the final circuits of the installation (connection into a separate dedicated circuit) or if connected on the load side of all protective devices for the final circuits must fulfil a number of additional requirements. These additional requirements are:

(i) the current-carrying capacity of the final circuit conductors shall be greater than or equal to the rated current of the protective device plus the rated output of the generating set

(ii) a generating set shall not be connected to a final circuit by a plug and socket

(iii) a residual current device providing additional protection of the final circuit in accordance with Regulation 415.1 shall disconnect all live conductors including the neutral conductor

(iv) the line and neutral conductors of the final circuit and of the generating set shall not be connected to earth

(v) unless the device providing automatic disconnection of the final circuit in accordance with Regulation 411.3.2 disconnects the line and neutral conductors, it shall be verified that the combination of the disconnection time of the protective device for the final circuit and the time taken for the output voltage of the generating set to reduce to 50 V or less is not greater than the disconnection time required by Regulation 411.3.2 for a final circuit.

The Electricity Safety, Quality and Continuity Regulations 2002 (as amended) (ESQCR)

Solar photovoltaic (PV) power supply systems are required to meet the Electricity Safety, Quality and Continuity Regulations 2002 (as amended) as they are embedded generators. These are mandatory requirements.

However, where the output does not exceed 16 A per phase they are classed as small-scale embedded generators (SSEG) and are exempted from certain of the requirements provided that:

(i) the equipment should be type tested and approved by a recognised body

(ii) the consumer's installation should comply with the requirements of BS 7671

(iii) the equipment must disconnect itself from the DNO's network in the event of a network fault

(iv) the DNO must be advised of the installation within 28 days of commissioning.

See 'Engineering Recommendations G83/2, for PV systems up to 16A (3.685kW) and G59/3', published by the Energy Networks Association (ENA) for larger systems and generators, etc. Further information can be obtained at: www.energynetworks.org.

Work in progress Please note this article is only intended as a brief overview of issues being considered at a very early stage; as such, they may not lead to new international standards.