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Energy efficiency - Customer energy management systems - Part 1: General requirements and architecture

Efficacité énergétique - Système de gestion d'énergie client - Partie 1: Exigences générales et architecture

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Energy efficiency - Customer energy management systems -
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It has the status of a group energy efficiency publication in accordance with IEC Guide 118.

The text of this International Standard is based on the following documents:

Draft	Report on voting
23K/120/FDIS	23K/126/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 63402 series, published under the general title *Energy efficiency – Customer energy management systems*, can be found on the IEC website.

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

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

In traditional electricity networks, energy flows in one direction and communications from the generator to the consumer is generally done via the transmission and distribution systems.

Although there is some monitoring and control of equipment in the transmission and distribution systems, there is no communication with, or control of, consumer equipment. In particular, there is no means of requesting short-term control of consumer equipment to match either the prevailing generation, or transmission and distribution grid conditions, or both. Generation equipment is controlled to match the open-ended (uncontrolled) demand of the consumer.

Today the world is faced with an increase of energy consumption, which is directly linked to an increase of CO_2 production. The increased CO_2 density in the atmosphere supports the climate warming of the earth.

One significant way to cope with the increased energy consumption without increasing the CO_2 production is to use more renewable energy resources.

Unfortunately, the available renewable energy supply is not aligned with the energy demand. To increase efficiency, the energy demand should be aligned as much as possible with the available energy supply. The future grid will become generation led rather than demand led as it is today. In order to reach this goal, communications between the various equipment and systems of the stakeholders within the energy field is necessary. This new form of grid which exchanges information and energy between producers, consumers, distributors and metering is known as the "Smart Grid".

The IEC 63402 series describes aspects of this Smart Grid that relate specifically to the premises (home or building) part of the Smart Grid, including the common interface between equipment in the premises and the Smart Grid.

1 Scope

This part of IEC 63402 specifies general requirements and the architecture between the Point of Common Coupling (PCC) and smart devices (SD) operating within the Smart Grid premises-side system (i.e. residential or commercial but not industrial premises).

This document does not include requirements for:

– safety
– electromagnetic compatibility (EMC);
– data security, as it is assumed that the underlying protocols will take the data security aspect into account

NOTE Although data security is not within the scope of this document, Clause 4 provides some high-level design guidelines for data security.

– special equipment (e.g. legacy heat pumps) with a direct physical connection to the grid, as such equipment bypasses the customer energy manager (CEM) and is not HBES/BACS enabled (covered by other standards than the IEC 63402 series).

This group EE publication is primarily intended to be used as an EE standard for the products mentioned in the scope, but is also intended to be used by TCs in the preparation of publications for products which are included in the boundary mentioned in the scope of this document.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

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

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

3.1 Terms and definitions

3.1.1
Customer Energy Manager
CEM
internal automation function for optimizing the energy consumption, production and storage within the premises according to the preferences of the customer using internal flexibilities and typically based on external information received through the Energy Management Gateway and possibly other data sources

3.1.2
Customer Energy Manager system
CEM system
system that allows the management of energy consumption, production and storage within the premises, consisting of a CEM connected to one or more resource managers (RMs) which themselves act as gateways to HBES/BACS, either SASS or smart appliances, or both

Note 1 to entry: In other standards this is often referred to as an Energy Management Systems (EMS).

3.1.3
Energy Management Gateway
EMG
access point (functional entity) sending and receiving smart grid related information and commands between an actor in the grid and the CEM, letting the CEM decide how to process the events

Note 1 to entry: The communication is often ensured through an internet connection.

3.1.4
Building Energy Management
BEM
internal automation function for observing the PCC, to avoid an overload of the PCC and share the available energy between the different subsystems which are represented by the connected CEMs

Note 1 to entry: BEM is also called sometimes facility energy manager (FEM).

Note 2 to entry: The BEM gets additional information (voltage, frequency, cos phi) from a grid observer which allows to support the grid even in the case the internet protocol (IP) communication is broken.

3.1.5
Head End System
HES
system that receives metering data in the advanced metering infrastructure

3.1.6
Home and Building Electronic System/Building Automation Control System
HBES/BACS
logical group of devices which uses a multi-application communication system where the functions are distributed and linked through a common communication process

Note 1 to entry: HBES/BACS is used in homes and buildings plus their surroundings. Functions of the system are, for example: switching, open loop controlling, closed loop controlling, monitoring and supervising.

Note 2 to entry: In literature, HBES or BACS can be referred also as "home control system or network", "home electronic systems", "building automation systems", etc.

EXAMPLE Management of lighting, heating, energy, water, fire alarms, blinds, different forms of security, etc. See introduction of EN 50491-4-1.

3.1.7
schema
abstract model that documents and organizes the data required in a defined way, so it can be used for different purposes such as exchanging and / or storing information

3.1.8
Meter Data Management
MDM
software system that performs long-term data storage and management for the vast quantities of data delivered by smart metering systems

3.1.9
resource manager
RM
function that exclusively represents a logical group of devices or a single smart device, and is responsible for sending unambiguous instructions to the logical group of devices or to a single device, typically using a device-specific protocol

Note 1 to entry: In the context of this document the resource manager manages the energy flexibility of a logical group of devices or a single smart device.

Note 2 to entry: The resource manager can be implemented in a special device, in the smart device itself or outside of the device.

3.1.10
premises
public or private building/home where energy is used or produced, or both

3.1.11
smart appliance
device that consumes energy that can be controlled by a resource manager

EXAMPLE Washing machines, freezers, dishwashers, etc.

3.1.12
smart device
SD
device that can consume, produce or store energy (or a combination thereof) and that can be controlled by a resource manager for the purpose of energy management

EXAMPLE lighting controllers, electric vehicles, smart appliances, renewable power sources, energy storage systems, etc.

3.1.13
Single Application Smart System
SASS
group of devices having a communication interface for a single application such as heating or lighting, that consume, produce or store energy (or a combination thereof) and that can be controlled by a resource manager for the purpose of energy management

3.1.14
aggregator
party which contracts with a number of other network users (e.g. energy consumers) in order to combine the effect of smaller loads or distributed energy resources for actions such as demand response or for ancillary services

3.1.15
Point of Common Coupling
PCC
point in an electric power system, electrically nearest to a particular load, at which other loads, can be, connected

Note 1 to entry: These loads can be either devices, equipment or systems, or distinct network users' installations.

Note 2 to entry: Point of Common Coupling is equal to grid connection point.

3.1.16
Point of Common Coupling monitor
PCC monitor
device that measures the voltage, frequency, current at the PCC and sends this information to the BEM

3.1.17
energy metering service provider
party providing energy metering services

3.1.18
distribution system operator
DSO
component that securely operates and develops an active distribution system comprising networks, demand, generation and other flexible distributed energy resources

3.1.19
energy service provider
party providing energy (utility) or energy services (aggregator, e-mobility service provider, etc.)

3.2 Abbreviated terms

BACS	Building Automation Control Systems
BEM	Building Energy Manager (sometimes also called FEM)
CEM	Customer Energy Manager
CHP	Combined Heat and Power
CSC	Charging Station Controller, as defined in the IEC 63110 series
CSMS	Charging System Management Systems, as defined in the IEC 63110 series
DER	Distributed Energy Resources
DSO	Distribution System Operator
EMG	Energy Management Gateway
EMS	Energy Management System
EV	Electrical Vehicle Energy
EV	Electrical Vehicle
EVSE	Electric Vehicle Supply Equipment, as defined in IEC 63110
FEM	Facility Energy Manager
H1	Local connection to simple external consumer display
H2	Connection between the SMG and EMG
HES	Head End System
HBES	Home and Building Electronic System
MDM	Meter Data Management
MDU	Multi dwelling unit
MCF	Meter Communication Function
PCC	Point of common coupling
RM	Resource manager
SASS	Single Application Smart System
SD	Smart Device
SGAM	Smart Grid Architecture Model
SGCG	Smart Grid Co-ordination Group, reporting to CEN-CENELEC-ETSI and in charge of answering the M/490 mandate
SMG	Smart Meter Gateway
S0	Interface between DSO and Energy management gateway
S1	Interface between Energy management gateway and CEM
S2	Interface between CEM and Resource Manager

4 Design considerations

4.1 General

When designing a system such as a Smart Grid, some general design considerations have to be taken into account. One important requirement for the Smart Grid is data security and data privacy.

4.2 Data security and privacy design guidelines

4.2.1 General

Data security and privacy shall protect the system and keep the data private as much as possible.

Data security and privacy shall make a distinction between the data security and privacy related to the Smart Grid side and the data security and privacy within the premises side. The risk level and the required security can be derived from a risk assessment according to the IEC 62443 series for the communication channels.

4.2.2 Data security and privacy on the Smart Grid side

The risk of a possible attack and impair data should be minimized by applying relevant standards. Data privacy can be achieved by only permitting the exchange of aggregated energy management related data and or private data for which the customer has given permission to be used by a third party.

4.2.3 Data security and privacy on premises side

Data security and privacy on the premises side shall ensure that the data can only be read by authorized persons and cannot be manipulated. Depending on the implementation of the system, this can be reached with different methods, for example:

– data encryption and decryption.

– constructive design (avoid that no one except authorized persons can gain access to the devices and communication channels).

4.2.4 Customer Energy Manager system security

The security of the Customer Energy Manager system is linked to the number of connections between the Customer Energy Manager system and the neighbourhood network. Every connection attempt between the Customer Energy Manager system and the neighbourhood network shall be vetted to avoid unauthorized access to the Customer Energy Manager system. The more connections are between the two networks then the more effort shall be spent for configuring of the different Firewalls and the higher is the risk of security holes. Therefore, it is recommended to limit the connection points between the Customer Energy Manager system and the neighbourhood network as much as possible. Ideally there is only one connection between the Customer Energy Manager system and the neighbourhood network.

4.3 Device type agnostic energy management

While today there is a set of common devices and appliances (e.g. freezers, TV sets, electric bikes, etc.), the data structures of the interface between the CEM and a resource manager should be designed in such a way that even future device types can be correctly managed without the need to update the communication standard.

4.4 Clock alignment

The main task for a CEM is to manage energy, which basically is variations of (average) power over time. One of the key CEM data structures is therefore a power profile and it makes "time" a central and very important aspect.

"Time" seems like a trivial concept. Humans tend to think of "absolute" time in the form of a "date" plus a "24 h clock" information. But on a technical level it is not that trivial at all, because there are aspects like time zones, different calendars, daylight saving time, leap seconds, hardware clock drift and the overall question of how to actually synchronize multiple clocks to a desired type and precision of alignment.

This is why the CEM architecture shall incorporate a concept of clock alignment with a well-defined master clock and time synchronization rules and procedures.

4.5 Energy management system resilience

The CEM is a logical function which relies on communication to other actors. Therefore, the resilience of the entire energy management system is primarily linked to cybersecurity requirements.

The system's resilience can be improved if the physical aspects are also taken into account. Observing the PCC by measuring the frequency, voltage and current provides additional information. Frequency provides information about the global power balance in the interconnection, voltage provides information about the local power balance of the relevant distribution network, and current provides information about the power balance of the customer cell in the premises. It also allows to estimate the ratio of loads and generators which are controllable or observable by resource managers (RMs) to those which are unmanaged in the premises.

This information enables validation of the digital representation (model) to check if it matches the physical reality (measurement). Discrepancies allow the detection of potential system malfunctions or breaches of cybersecurity techniques.

Furthermore, the correct delivery of grid supporting functions (ancillary services) – which ensure the resilience of upstream networks – will require the CEM to be aware of the measurements at the PCC and the electrical dynamics of the premises' electrical power system. A CEM which is aware of the grid state is more resilient in situations of disrupted communication to upstream actors because the physical information allows adjustments of its optimization strategies (e.g. activation of stabilization measures).

5 Background

The traditional model of the grid will lead to increased inefficiencies as electricity energy consumption and the connection of distributed (renewable) energy resource equipment is increased.

In order to address these issues, the architecture of traditional grids is being extended to include remote control of distributed loads and energy resources, requiring bi-directional communication. This is the "Smart Grid" (see Figure 1):

Smart grids rely on flexibility in energy production or consumption, or both, to compensate for imbalance and congestion in the grid, for example caused by:

– increasing electricity demand by electric vehicle charging.
– increasing numbers of renewable energy sources that are far less predictable or controllable than traditional power plants.

The use of devices and equipment in homes and buildings that are able to control their energy consumption or generation (either locally or remotely) greatly enhances the flexibility capability of a Smart Grid.

Energy flexibility can be defined as the ability to willingly deviate from either the normal energy production or consumption or both pattern(s), either over time or by power level, or both. This flexibility can be used by third parties to help alleviate imbalance or congestion.

Third parties will use different incentive schemes to unlock the flexibility potential, such as time of day pricing, real time pricing, feed-in tariffs and variable grid tariffs. These incentives should be mapped in some way to the capabilities of smart devices in order to deliver energy flexibility.

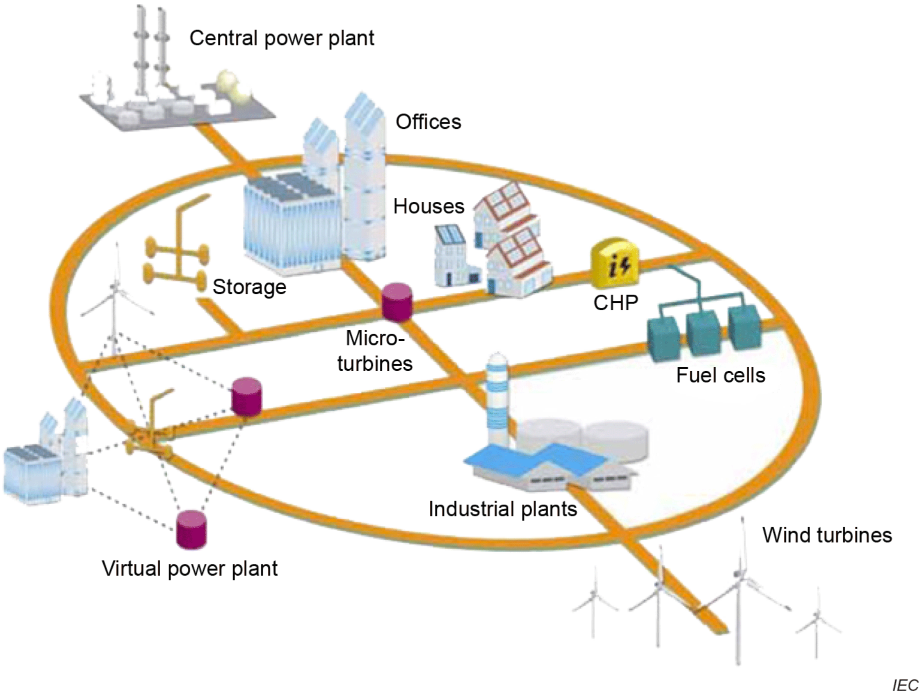

Figure 1 – Future electricity network

The Smart Grid Architecture Model (SGAM) was developed by the CEN-CENELEC-ETSI Smart Grid Coordination Group in order to provide a general representation of the architecture of a Smart Grid. It is used here in order to show the scope of this specification within the general context of the Smart Grid.

The SGAM incorporates the main elements of the electricity energy supply system as a set of domains. Each domain is further split into hierarchical levels of power system management, referred to as zones, ranging from process to market (see Figure 2). Finally, five interoperable layers are mapped over the domains and zones. More information can be found in CEN-CENELEC-ETSI Smart Grid Coordination – Group Smart Grid Reference Architecture (November 2012). This document relates to the customer premises domain, the process to field zones and communication, information and function interoperability layers.

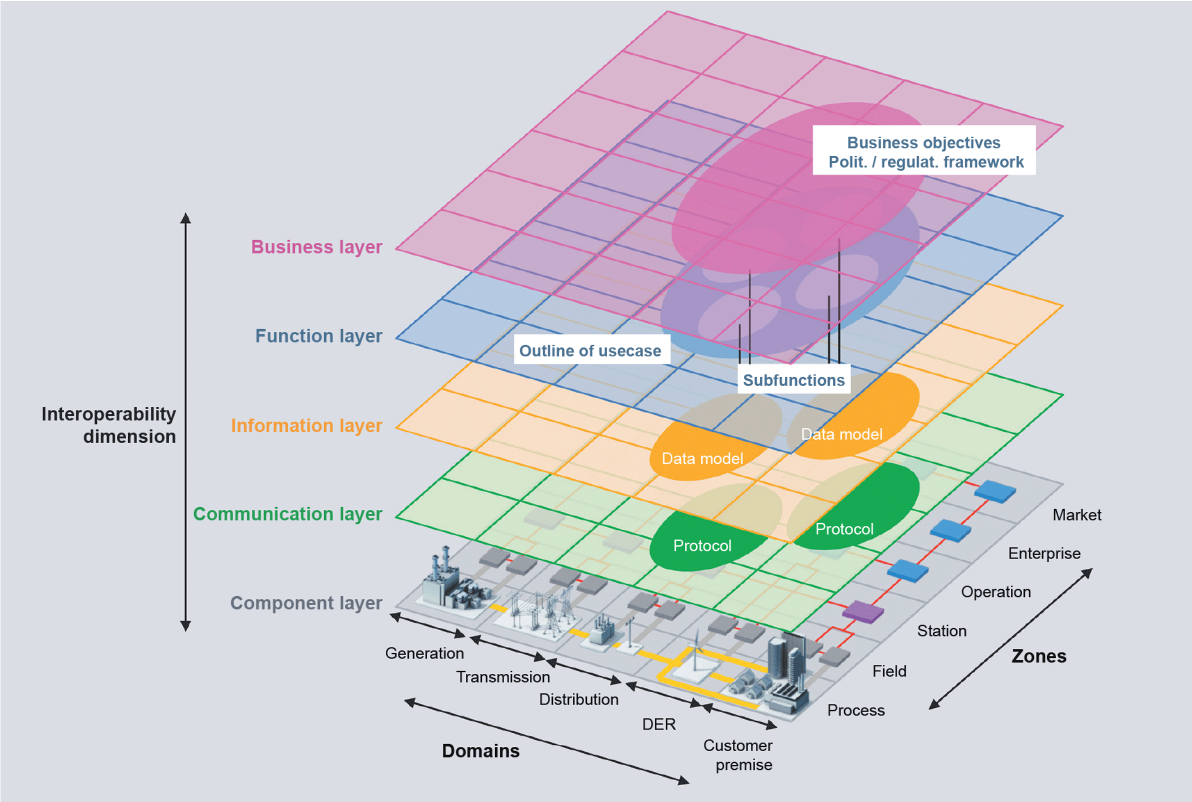

Figure 2 – Abstract view of Future Electricity Network described by the Smart Grid Reference Architecture (SGAM) Model