ISO/IEC 15067-3

Edition 2.0 2024-09

INTERNATIONAL STANDARD

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Information technology – Home Electronic System (HES) application model – Part 3: Model of an energy management system for HES

ISO/IEC 15067-3:2024-09(en)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 35.200

ISBN 978-2-8322-9658-5

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INFORMATION TECHNOLOGY – HOME ELECTRONIC SYSTEM (HES) APPLICATION MODEL –

Part 3: Model of an energy management system for HES

FOREWORD

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ISO/IEC 15067-3 has been prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology. It is an International Standard.

This second edition cancels and replaces the first edition published in 2012. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) This edition revises ISO/IEC 15067-3:2012 by expanding beyond demand response to include a balance between multiple sources of power and appliance demands for this power.
b) This edition specifies a system framework that addresses the need for user-centric energy management by providing control options for consumers.

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

Draft	Report on voting
JTC1-SC25/3201/CDV	JTC1-SC25/3254/RVC

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 the ISO/IEC Directives, JTC 1 Supplement available at www.iec.ch/members_experts/refdocs and www.iso.org/directives.

A list of all parts of the ISO/IEC 15067 series, published under the general title *Information technology – Home Electronic System (HES) application model*, can be found on the IEC and ISO websites.

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INTRODUCTION

Throughout most of the twentieth century, public policy and regulations encouraged utilities to expand the supply of electric power. This expansion of electricity systems world-wide has been a major achievement. However, technology developments and plans to mitigate climate change are having profound effects on the utility industry. Standards are being developed to provide an orderly transition for adapting to these changes.

Electricity generation is gradually shifting to the edge of the grid with local power generated from wind and solar at homes, buildings, and community sites. This is similar to the morphing of the central-office telephone-switching network to edge computing in our PCs, laptops, and smart phones for accessing Internet services such as Voice over IP (VoIP: telephone calls using the Internet), text messages, and email. These shifts in the power grid are motivated by technology changes and public demands to ensure that the essential role of electricity continues but from a diversity of sources that are

– more reliable,
– resilient to climate change,
– less polluting, and
– more affordable than depending on a single utility.

Public policy encouraging the expansion of electric power systems produced a world-wide proliferation of electricity generation and power grids including transmission and distribution lines. It was not until the late 1980s that policy makers in some developed nations started to worry about whether the supply of electricity would be able to continue increasing indefinitely to meet the demand anticipated primarily from industrial growth. Some regulators mandated integrated resource planning, where utilities were ordered to consider both supply and demand when preparing budgets to justify tariffs. The utility industry responded by offering programmes to manage customer demand for power called "demand-side management."

The introduction of local power generation from wind and solar is adding impetus to demand-side management because the power generated by wind turbines and solar-voltaic cells can fluctuate quickly with changing weather and the availability of sunlight. Local power sources including solar, wind, and storage are collectively called "distributed energy resources" (DER). Traditional demand-side management has been a centralized command-and-control system usually operated by a utility.

Adoption of demand-side management programmes varies widely by nation and by utility. The term "demand response" has been applied to customer equipment that responds to control signals by changing power consumption, called the "demand" for electricity. Typically, these signals are sent by a public utility for direct control of water heaters or air conditioners.

ISO/IEC 15067-3:2012 redefined the concept of demand response (DR) to include indirect incentives such as price changes or event notices that motivate customers to control demand locally by altering appliance usage. This reflected the transformation of demand response from utility-focused to consumer-focused. This document revises ISO/IEC 15067-3:2012 by expanding beyond demand response to include a balance between multiple sources of power and appliance demands for this power. Hence, this document addresses consumer energy management more generally, rather than just demand response. For this reason, "demand-response" has been removed from the title to de-emphasize a focus on demand for power supplied mostly from a public utility. This is part of a family of Home Electronic System (HES) standards addressing energy management, listed in the Bibliography.

This document focuses on energy management controlled by consumers. Effective energy management is tailored to user wishes and equipment that is responsive to fluctuating supplies. It provides performance and cost benefits without mandates and penalties. The growth of local power sources requires effective energy management equipment that is responsive to and managed by consumers, as specified in this and related documents.

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This document specifies a system framework that addresses the need for user-centric energy management. This framework accommodates optimization of energy management across connected loads to balance consumer goals and constraints. It accommodates a diversity of internal and external power sources and was developed as options are proliferating for local DER equipment. This framework consists of a system model for equipment in homes and buildings that enables consumers to manage their usage of electricity in accordance with

– their activities requiring power for appliances, lights, electric vehicles, etc.;
– their budget; and
– other preferences related to power such as
  - using green sources, and
  - minimizing their environmental impact affecting climate change.

As the energy industry evolves, energy management will be enabled by on-premises control of power usage in response to fluctuations in power availability and cost from all sources, especially local sources on premises or in the neighbourhood. Energy management equipment (hardware and software) will be part of consumer electronics products from competitive suppliers rather than exclusively furnished for a utility programme. The goal of this document and related standards is to facilitate a marketplace where consumers have product choices for energy management.

The model in this document includes consumer equipment for energy management that is primarily located in homes and buildings. It consists of a system that

– interacts with occupants to determine user preferences for appliance operation, costs, and other factors influencing the consumer's use of energy, such as possible contributions to climate change;
– monitors power source availability and costs that are:
  - local (DER within the premises),
  - external (from a neighbourhood microgrid, transactive energy, an aggregator, or a public utility);
– maintains a database of power needs for appliances (including electric vehicle chargers) as a function of operating modes;
– measures power flows from local sources, storage, and appliance consumption for system performance and stability; and
– determines optimal power sourcing and allocation.

The energy management model specified in this document includes a controller that acts as an agent for the consumer to combine user preferences with power availability and power needs to meet the consumer's goals. Among these goals are convenience, comfort, health, and safety within budget constraints. Since this system controller is acting as an agent for the consumer, it is called the energy management agent (EMA). This model accommodates an EMA with features of artificial intelligence to facilitate energy management.

The EMA determines power allocation in part based on distributed energy measurement devices on premises. The system equipment can be stand alone, embedded in other consumer electronics, or hosted as an application in a gateway. This gateway can be a generic communications interface between a home network and an external network, an energy management gateway designed for handling energy-related data, or the HES gateway specified in the ISO/IEC 15045 series.

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INFORMATION TECHNOLOGY – HOME ELECTRONIC SYSTEM (HES) APPLICATION MODEL –

Part 3: Model of an energy management system for HES

1 Scope

This part of ISO/IEC 15067 focuses on a model of a system in homes and buildings that can manage energy consumption and generation of electricity by devices on premises dynamically in response to electricity availability from:

– sources within the home or building such as solar panels, wind turbines, or storage (stationary or mobile),
– neighbourhood microgrids,
– transactive energy,
– energy aggregators, and
– public utilities.

This document specifies a model including a framework and methods for energy management consisting of interconnected elements that can be configured to support various methods for a Home Electronic System (HES) energy management system. The methods specified are intended to be generic and representative of a wide range of situations. This document applies to the customer grid-edge portion of the electricity grid (within a home or building) and applies even if the consumer has sufficient local power generation to operate without connecting to a public utility.

This document includes an energy management model that balances power supplied from internal and external sources with demand from appliances and electric vehicle chargers. The model offers flexibility for locating the energy management equipment in a stand-alone product, embedded in consumer electronics, or hosted in a gateway. This gateway can be a generic communications interface between a home network and an external network, an energy management gateway designed for handling energy-related data, or the HES gateway specified in the ISO/IEC 15045 series.

This model specifies a local controller that achieves the allocation of power in accordance with available supplies, consumer preferences for appliance operation, and power requirements of these appliances within constraints set by the consumer. Such constraints are typically financial (a budget for electricity) but can also include goals such as using green sources and minimizing their impact on climate change. This controller is called the energy management agent (EMA) since it acts as an agent for the consumer. This model accommodates an EMA with technology of artificial intelligence to facilitate energy management.

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.

ISO/IEC 10192-3:2017, *Information technology – Home Electronic System (HES) interfaces – Part 3: Modular communications interface for energy management*

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ISO/IEC 14543-2-1, *Information technology – Home Electronic System (HES) architecture – Part 2-1: Introduction and device modularity*

ISO/IEC 15045 (all parts), *Information technology – Home Electronic System (HES) gateway*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

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

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

3.1.1
application cluster
logically related group of components that provides the functions of an application in a home or building

3.1.2
demand charge
total amount billed for demand in accordance with the relevant conditions of the tariff or supply agreement

Note 1 to entry: A demand charge for electricity is typically based on the peak power consumed during a specified interval of time, subject to a time-smoothing algorithm.

[SOURCE IEC 60050-691:1973, 691-03-05, modified – Note 1 to entry has been added.]

3.1.3
demand response
action resulting from management of the electricity demand in response to supply conditions

Note 1 to entry: "Demand response" includes a variety of methods for matching the demand for electricity to the available supply.

[SOURCE IEC 60050-617:2011, 617-04-16, modified – Note 1 to entry has been added.]

3.1.4
direct load control
demand response via remote control of one or more appliances by a utility or third-party service provider

Note 1 to entry: With direct control the utility uses a communications network or other signalling method (e.g. a signal embedded in the power service line) to control appliance operation remotely.

3.1.5
disaggregated bill
utility bill that shows energy consumption by major appliances

3.1.6
distributed load control
demand response based on dynamic price for electricity, event notices, or other information sent from the utility to smart appliances or to an energy management agent

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3.1.7
DR supplier
utility or third-party supplier of demand response energy management services

3.1.8
electricity grid
electricity supply network

3.1.9
energy management agent
set of control functions that manage energy use, generation, and storage as an agent for the occupants

3.1.10
energy management gateway
residential gateway facilitating energy management agent services

3.1.11
energy reliability
enhanced availability of energy enabled for example by business and technical procedures

3.1.12
HAN device
device located in the home that can communicate via a home area network (HAN) wirelessly or via wires

Note 1 to entry: HAN is defined in ISO/IEC 15045-1. A wired HAN can use cabling specified in ISO/IEC 11801-4.

3.1.13
HES gateway
electronic device that transfers messages among wide area networks (WANs) and home area networks (HANs) providing interoperability, privacy, security, and safety in accordance with the requirements of the ISO/IEC 15045 series and the ISO/IEC 18012 series

Note 1 to entry: For an HES gateway, a WAN is a network outside the protected area and a HAN is a network within the protected area.

3.1.14
local load control
demand response via publication of time-of-use electricity rates

Note 1 to entry: With local load control the utility typically informs customers of the electricity rates by a notice sent with the electricity bill or via simple electrical signalling to a user interface such as various coloured lamps at the customer premises and does not directly control appliances. The customer would be able to use these rate data to select the times for an appliance to operate.

Note 2 to entry: In some implementations the utility sends a signal across the grid to a receiver at the premises that switches device operation between at least two different states in accordance with the electricity tariff.

3.1.15
major appliance
household device using large amounts of energy compared to other appliances

Note 1 to entry: Examples include an oven, microwave, refrigerator, cooking range, washing machine, and dryer, which are also called "white goods". Most of the appliances listed use relatively large amounts of power when operating in some modes. Therefore, these appliances are candidates for energy management.

Note 2 to entry: "White goods" is a term used in the appliance industry for major appliances because many such products are sold in white cabinets.

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3.1.16
premises energy resources
PER
distributed energy resources located on premises

3.1.17
residential gateway
communications function that interconnects two or more networks using different communication protocols, with at least one network outside the premises and one or more networks inside the premises

3.1.18
smart appliance
home appliance that exchanges command and control data with other units on a home area network (HAN)

Note 1 to entry: Depending on the application, smart appliances can communicate via the HAN with other appliances, with an application controller, or with a utility for energy management. Smart appliance specifications are under development by appliance manufacturers and trade associations.

3.1.19
smart grid
electric power system that utilizes information exchange and control technologies, distributed computing and associated sensors and actuators, for purposes such as:
- to integrate the behaviour and actions of the network users and other stakeholders,
- to efficiently deliver sustainable, economic and secure electricity supplies

Note 1 to entry: Some smart grids integrate into the electric grid excess power generated locally from sun and wind-driven devices.

Note 2 to entry: Technically, a grid is a network. However, in common usage the term "smart grid" refers to the entire energy system, which includes generation, transmission, distribution, and customer systems.

[SOURCE: IEC 60050-617:2011, 617-04-13, modified – The notes to entry have been added.]

3.1.20
supply indication
static or dynamic signal or message related to electricity supply

3.1.21
transactive energy
system of economic and control mechanisms that allows the dynamic balance of supply and demand across the entire electrical infrastructure using value as a key operational parameter

[SOURCE: ISO/IEC TR 15067-3-8:2020, 3.28]

3.1.22
value-added services
optional services that can be related to energy offered by a utility, possibly for a fee

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3.2 Abbreviated terms

CFL	compact fluorescent lamp
DER	distributed energy resources
DR	demand response
DRAM	Demand Response and Advanced Metering Coalition
DSL	digital subscriber line
DSM	demand-side management
EEMS	electrical energy measurement system
EMA	energy management agent
EPRI	Electric Power Research Institute
EV	electric vehicle
FC	fuel cell
FM	frequency modulation
HAN	home area network
HES	Home Electronic System
HVAC	heating, ventilation and air-conditioning
IoT	Internet of Things
LED	light emitting diode
PER	premises energy resources
PV	photo-voltaic
RTP	real-time pricing
SB	stationary battery
TOU	time-of-use
UPS	uninterruptible power supply
WAN	wide area network

4 Conformance

This document specifies a framework including a model, principles and methods for premises-based energy management that constitute an HES energy management system.

The framework for an HES energy management system specified in Clause 5 shall be implemented to support one or more of the methods for energy management specified in Clause 6. The chosen methods shall be based on one or more energy management use-case models in 7.2 and 7.3. Message exchanges among elements of the HES energy management model shall be based on the generic messages specified in 7.4. Message set formats (syntax and semantics) for energy management are specified in other HES standards such as the ISO/IEC 14543-3, ISO/IEC 14543-4 and ISO/IEC 14543-5 series.

The elements of the HES energy management framework shall include an energy management agent (EMA) specified in 5.3 and interfaces to some or all of the following equipment.

a) On-premises equipment:
   1) energy sources such as solar and wind power;
   2) energy storage (stationary or mobile);
   3) appliances and electric vehicle charging stations;
   4) HVAC equipment;
   5) energy measurement devices.

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b) Off-premises equipment:
   1) energy service provider such as
      i) microgrid,
      ii) aggregator,
      iii) power utility;
   2) energy sources and storage at another home, building, or local facility.

These equipment interfaces enable the EMA to perform energy management for the user by exchanging data such as pricing, quantity of energy available during a specified time interval, and fuel type in order to determine how and when to control energy consumption.

NOTE 1 Which method of energy management is chosen is subject to local regulations and market conditions. In some countries, approvals from government regulators are needed for the implementation of energy management programmes such as demand response by public utilities.

NOTE 2 Access to energy sources and storage at another home or building enables users to engage in transactive energy markets by sharing or selling excess power, which can be facilitated by the EMA.

5 HES framework for energy management

5.1 HES energy management elements and model

The framework for energy management supports premises-based energy generation, storage, and consumption with options for exchanging energy with entities operating on an external grid. The external grid provides access to microgrids, aggregators, energy service providers including public utilities, and consumers offering to share or sell excess power through transactive energy.

This document accommodates consumers who choose to operate with grid connection, with limited grid connection or with no grid connection:

– islanded: no external grid connection, at least some of the time;
– prosumer: external grid connection to sell or buy power some of the time;
– consumer: external grid connection to buy power all the time.

The basis for choosing a grid connection depends on costs and consumer preferences regarding generation fuels and greenhouse gas emissions. For example, grid power sources can include fossil-fuel power generation plants, nuclear plants, wind turbines, hydro-electric power plants, or solar power farms. On-premises power generation sources are usually solar and wind powered.

According to IEC 60050-617:2017, 617-04-20, the term distributed energy resources (DER) means "generators (with their auxiliaries, protection, and connection equipment), including loads having a generating mode (such as electrical energy storage systems), connected to a low-voltage or a medium-voltage network". Most common usage of the term DER implies locally situated equipment. To add precision to the term DER and to avoid confusion, this document introduces the term PER for premises-based energy resources including local power generation and storage elements.

In this document power distribution on premises is carried by a "power bus", optionally connected directly to an external grid. In some cases the power bus and the grid do not use the same electrical parameters. For example, some power buses can carry DC power as generated by solar panels and stored in batteries.

Efficient interaction of energy management in premises (homes and buildings) with the power buses and PER requires a common model for

– the elements of an electrical power system,

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– measurement points to manage the energy flow within the premises, and

– the interfaces between premises control systems, power bus systems, and PER.

Figure 1 depicts a generalized, logical, on-premises energy management framework model that shall be the basis for any implementation of an HES energy management system. It shows the system architecture and interrelationship among the elements. When applying this model to a specific home or building, the elements needed vary in accordance with the presence of devices such as smart appliances, local power generation, local energy storage, and sensors.

NOTE The HES energy management model is similar to the model of a building energy management system presented in Annex A.

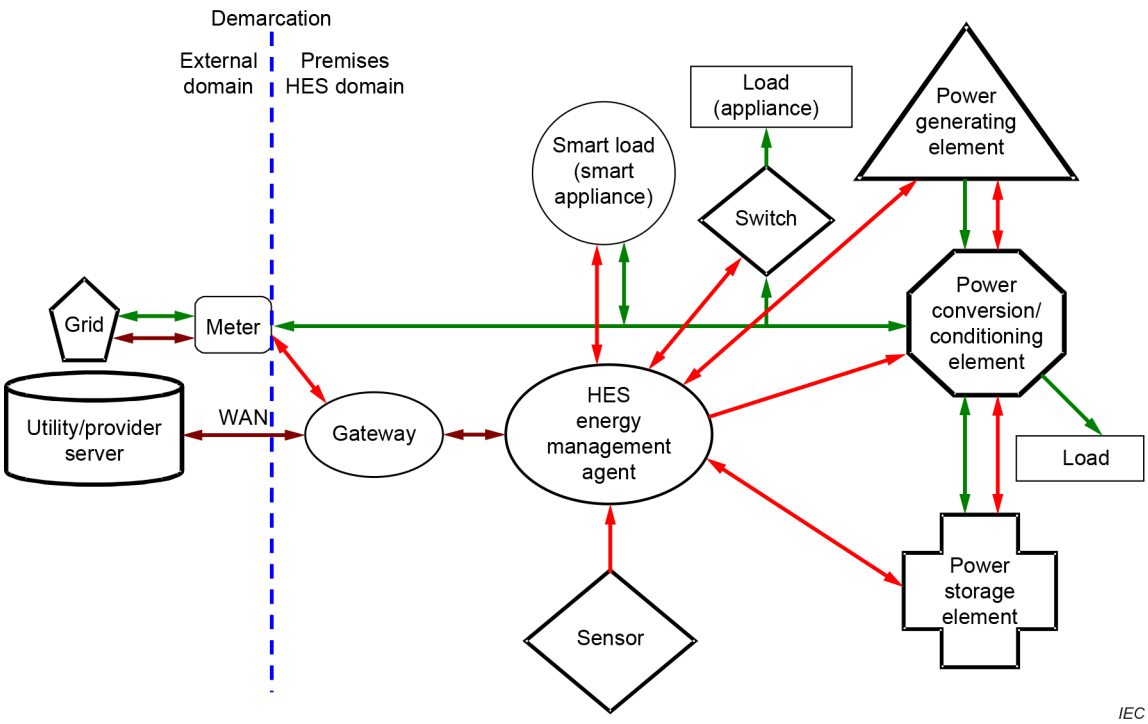

Figure 1 – HES energy management framework model

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Each element is identified by one of the following unique graphical shapes:

Power using elements that communicate via a HAN:

– communicating appliances or other loads

Power using non-communicating elements:

– non-communicating appliances or other loads

Power controlling and sensor elements:

– sensors, switching actuators

Power generating elements:

– solar PV, wind turbines, generators, fuel cells, other PER

Power storage elements:

– batteries, flywheels, electric vehicles, other PER elements

Power conditioning or power conversion device:

– inverters, chargers, power factor compensators, etc.

Utility elements – power exchange:

– utility meters, utility WANs, service entrance

Grid elements:

– generators (fossil fuel, nuclear, wind turbines, hydro-electric, solar power), transmission, and distribution

Communication network elements:

– gateways, energy management agents (EMAs)

HAN data

Power

WAN data

The green arrows represent electrical power paths, and the red and brown arrows represent communication paths. These paths can be two-way or one-way. The demarcation line is the boundary between the HES domain and the external domain. The optional WAN is any external access network (e.g. Internet access via fibre, cable, wireless, DSL, etc.). The optional utility-supplied meter provides the grid connection and premises service entrance for electricity. The grid communications network and home network do not usually use the same communications protocol. As explained in 5.6, the EMA can be designed as a separate device or reside inside consumer electronics or a gateway.

Documents
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Full document details: ISO IEC 15067-3-2024