IEC 62872-2

Edition 1.0 2022-02

INTERNATIONAL STANDARD

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**Industrial-process measurement, control and automation –
Part 2: Internet of Things (IoT) – Application framework for industrial facility demand response energy management**

**Mesure, commande et automatisation dans les processus industriels –
Partie 2: Internet des objets (IdO) – Cadre d'application pour la gestion d'énergie de la réponse à la demande des installations industrielles**

IEC 62872-2:2022-02(en-fr)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 27.015; 35.020

ISBN 978-2-8322-1073-1

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INDUSTRIAL-PROCESS MEASUREMENT, CONTROL AND AUTOMATION –

Part 2: Internet of Things (IoT) – Application framework for industrial facility demand response energy management

FOREWORD

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

Draft	Report on voting
65/898/FDIS	65/911/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/standardsdev/publications.

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INTRODUCTION

The World Energy Outlook 2017 [19][1] reported that industry consumed over 40 % of world electricity generation in 2015. Furthermore, industry itself is a significant generator of internal power, with many facilities increasingly implementing their own generation, co-generation and energy storage resources. As a major energy consumer, the ability of some industries to schedule their consumption can be used to minimize peak demands on the electrical grid. As an energy supplier, industries with in-house generation or storage resources can also assist in grid load management. For example, in-house generation can supply energy to the smart grid and to the facility. Furthermore, storage resources can assist in smart grid load management. While some larger industrial facilities already manage their use and supply of electric power, more widespread deployment, especially by smaller facilities, will depend upon the availability of a readily available standard interface between industrial automation equipment and the "smart grid".

NOTE In this document "smart grid" is used to refer to the external-to-industry entity with which industry interacts for the purpose of energy management. In other documents this term can be used to refer to all of the elements, including internal industrial energy elements, which work together to optimize energy generation and use.

Standards are already being developed for home and building automation interfaces to the smart grid; however, the requirements of industry differ significantly and are addressed in this document. For industry, the planning of energy resources and production processes are under the responsibility of the facility energy planner and production planner while operations are under the responsibility of the facility energy operator and production operator.

Incorrect operation of a resource could impact the safety of personnel, the facility, the environment or lead to production failure and equipment damage. In addition, larger facilities may have in-house production planning capabilities which could be coordinated with smart grid planning, to allow longer term energy planning.

IEC TS 62872-1:2019 defines the interface, in terms of information flow, between industrial facilities and the "smart grid". It identifies, profiles and extends where required the standards needed to allow the exchange of the information needed to support the planning, management and control of electric energy flow between the industrial facility and the smart grid.

"Internet of Things" (IoT) is being applied into different domains to facilitate the application. Building on the system interface between industrial facilities and the smart grid defined in IEC TS 62872-1:2019, this document addresses IoT application for industrial facility demand response energy management (FDREM). The smart grid is a modern electric power grid infrastructure system, whereby advanced information and communication technologies (ICTs) are integrated with the power grid. Industry is the largest consumer of electricity among all end user sectors. This has led to significant interest in the development of industrial energy management around the world in recent years. Interconnectivity and interoperability are very important features in the development of integrated energy management systems for industrial facilities. Therefore, IoT technologies are needed and suitable for exchanging energy-related information in FDREM. By using the IoT for communication, it enables real-time data-acquisition (In this document, it means acquisition of real time data, not data in real time.) and efficient data-analysis, which can make industrial energy management more intelligent and cost-saving. Currently, there may exist different implementation of IoT-based FDREM. Thus, a standard specification is urgently needed to guide different kinds of IoT application to data-exchange in industrial energy management.

1 Numbers in square brackets refer to the Bibliography.

The proposed IoT application framework is divided into the utility side and industrial electricity demand side, with the utility meter as the boundary between the two. Functional components that are essential for building the automatic demand response energy management are described clearly in this framework. the IoT application framework is compliant with the IoT Reference Architecture (IoT RA) standardized in ISO/IEC 30141, therefore, functional components of the IoT application framework can be mapped to the IoT RA appropriately.

This document will also describe the functionality of each IoT protocol stack layers in regard to communication of the IoT application framework, aiming to provide related information exchange services for functional components. Identification of existing IoT protocols will be executed to support this kind of information exchange. Non-functional communication requirements will also be analysed to ensure comprehensive performance of the information exchange.

There are gaps in existing standards for supporting industrial facility energy management with IoT technologies; this document fills the gaps to support IoT frameworks, but also can guide the deployment of IoT into different energy management applications. For this purpose, this document will specify a general IoT-based communication framework for industrial FDREM.

INDUSTRIAL-PROCESS MEASUREMENT, CONTROL AND AUTOMATION –

Part 2: Internet of Things (IoT) – Application framework for industrial facility demand response energy management

1 Scope

This part of IEC 62872 presents an IoT application framework for industrial facility demand response energy management (FDREM) for the smart grid, enabling efficient information exchange between industrial facilities using IoT related communication technologies. This document specifies:

– an overview of the price-based demand response program that serves as basic knowledge backbone of the IoT application framework;
– a IoT-based energy management framework which describes involved functional components, as well as their relationships;
– detailed information exchange flows that are indispensable between functional components;
– existing IoT protocols that need to be identified for each protocol layer to support this kind of information exchange;
– communication requirements that guarantee reliable data exchange services for the application framework.

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 TS 62872-1:2019, *Industrial-process measurement, control and automation – Part 1: System interface between industrial facilities and the smart grid*

ISO/IEC 30141:2018, *Internet of Things (IoT) – Reference architecture*

ISO/IEC TR 22417:2017, *Information technology – Internet of things (IoT) use cases*

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 General

3.1.1
Internet of Things
IoT
infrastructure or interconnected entities, people, systems and information resources together with services which processes and reacts to information from the physical world and virtual world

[SOURCE: ISO/IEC 20924:2021, 3.2.4]

3.1.2
facility
industrial facility
site, or area within a site, that includes the resources within the site or area and includes the activities associated with the use of the resources

[SOURCE: IEC 62264-1:2013, 3.1.20, modified – The preferred term facility and the admitted term industrial facility have been replaced by facility]

3.1.3
profile
set of one or more base standards, where applicable, the identification of chosen classes, conforming subsets, options and parameters of those base standards, necessary to accomplish a particular function

[SOURCE: IEC/ISO TR 10000-1:1998, 3.1.4, modified – "ISPs" has been removed]

3.1.4
enterprise
one or more organizations sharing a definite mission, goals and objectives which provides an output such as a product or service

[SOURCE: IEC 62264-1:2013, 3.1.10]

3.1.5
area
physical, geographical or logical grouping of resources determined by the site

[SOURCE: IEC 62264-1:2013, 3.1.2, modified – The example has been removed]

3.1.6
site
identified physical, geographical, and/or logical component grouping of a manufacturing enterprise

[SOURCE: IEC 62264-1:2013, 3.1.39]

3.1.7
planner
facility energy planner
FEP
entity responsible for the advanced planning of facility energy use, storage and generation, taking into account the requirements of future production and the overall operation of the facility

Note 1 to entry: The facility energy planner is responsible for defining the overall future energy plan for the facility, to include both the energy requirements of production and the overall needs and capabilities of the facility to generate, store, and consume energy.

Note 2 to entry: Plans developed by the facility energy planner will typically be made at least a day prior to intended use.

Note 3 to entry: The facility energy planner will assemble the overall energy plan based on the individual plans developed by production planners and the non-production requirements and capabilities of the facility.

3.1.8
production planner
PP
entity responsible for developing, monitoring and modifying the production plan based on facility requirements and the availability of inputs

Note 1 to entry: Example of inputs are equipment, labour, raw materials and energy.

3.1.9
facility energy operator
entity responsible for the supply of energy in a real time to support current production and current facility operation

Note 1 to entry: The facility energy operator monitors facility energy use, generation and storage, and makes adjustments in response to changes related to shifting energy supplies, material disruptions, and equipment breakdowns.

3.1.10
production operator
entity responsible for the use of energy in a real time to carry out production plans, and authorized to respond to real-time changes based on feed-back from the process and other internal or external event

Note 1 to entry: The production plan is provided by the production planner.

3.2 Models in automation

3.2.1
asset
physical or logical object owned by or under the custodial duties of an organization, having either a perceived or actual value to the organization

Note 1 to entry: In the case of industrial automation and control systems the physical assets that have the largest directly measurable value may be the equipment under control.

[SOURCE: IEC TS 62443-1-1:2009, 3.2.6]

3.2.2
automation asset
asset with a defined automation role in a manufacturing or process plant

Note 1 to entry: It would include structural, mechanical, electrical, electronics and software elements (e.g. controllers, switches, network, drives, motors, pumps). These elements cover components, devices but not the plant itself (machine, systems). It would not include human resources, process materials (e.g. raw, in-process, finished), or financial assets.

3.2.3
process
set of interrelated or interacting activities that transforms inputs into outputs

[SOURCE: ISO 14040:2006, 3.11]

3.2.4
product
result of labour or of a natural or industrial process

Note 1 to entry: This term is defined by "any goods or service" in IEC 62430 and ISO 20140-1. The European Commission adopts a similar understanding in the directive "Ecodesign requirements for energy-related products". In the context of this document, the term "product" does not cover the automation assets but only the output of the manufacturing or process plant.

[SOURCE: IEC TR 62837:2013, 3.7.7]

3.3 Models in energy management system and smart grid

3.3.1
smart grid
SG
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, and to efficiently deliver sustainable, economic and secure electricity supplies

Note 1 to entry: In this document, smart grid is the counterpart system to which FEMS is connected.

[SOURCE: IEC 60050-617:2009, 617-04-13, modified – Abbreviation to term and Note 1 to entry have been added]

3.3.2
smart meter
SM
embedded-computer-based energy meter with a communication link

Note 1 to entry: In this document, smart meters are used to measure both the consumption and supply of energy by the facility. They may also be deployed within the facility to measure internal energy flows.

3.3.3
utility smart meter
USM
smart meter deployed by the utility company to measure energy consumption and supply by the facility

Note 1 to entry: This meter typically forms part of the advanced metering infrastructure of smart grid.

3.3.4
facility smart meter
FSM
smart meter deployed and used by the facility to measure energy flows

3.3.5
energy resource
electricity, fuels, steam, heat, compressed air, and other like identifiable entity whose use and state at any time can be unambiguously determined to provide external activity or perform work

[SOURCE: ISO/TR 19815:2018, 3.7, modified – The term has been changed from "energy" to "energy resource", in the definition "media" has been replaced with "identifiable entity whose use and state at any time can be unambiguously determined" from 715-02-01 of IEC 60050-715:1996, "to provide external activity or perform work" has been added, the two Notes to entry have been removed]

3.3.6
distributed energy resource
DER
energy resource, often of a small size, operated by the utility to augment the local supply of energy

Note 1 to entry: In this document, DER, in contrast to FER, is used to refer to resources under the direct control of the utility. Such resources may include generation and/or storage capabilities.

3.3.7
facility energy resource
FER
energy resource, operated by the facility, which is used to supply energy to the facility

Note 1 to entry: May also be used to provide energy to the grid.

Note 2 to entry: This terminology, rather than distributed energy resource (DER) terminology, is used to emphasize that the FER is operated by the facility and not under the direct control of the utility. Such resources may include generation and/or storage capabilities.

3.3.8
demand response
DR
mechanism to manage customer load demand in response to supply conditions, such as prices or availability signals

3.3.9
price-based demand response
PBDR
mechanism that gives customers time-varying rates that reflect the value and cost of electricity in different time periods

Note 1 to entry: Armed with this information, customers tend to use less electricity at times when electricity prices are high.

3.3.10
time of use
TOU
rate with different unit prices for usage during different blocks of time, usually defined for a 24-hour day

Note 1 to entry: TOU rates reflect the average cost of generating and delivering power during those time periods.

3.3.11
day-ahead price
DAP
rate notified on a day-ahead basis, in which the price for electricity fluctuates hourly reflecting changes in the wholesale price of electricity

3.3.12
real-time price
RTP
rate notified on hourly-ahead basis, in which the price for electricity fluctuates hourly reflecting changes in the wholesale price of electricity