



TECHNICAL SPECIFICATION



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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 25.040.40; 29.240.99; 35.100.05

ISBN 978-2-8322-7084-4

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references	8
3 Terms and definitions	8
3.1 General.....	9
3.2 Models in automation	11
3.3 Models in energy management system and smart grid	11
4 Abbreviated terms	15
5 Requirements	16
5.1 Considerations and approaches in industry.....	16
5.1.1 General	16
5.1.2 Approaches to maintain grid stability	18
5.1.3 Price-based and incentive-based demand response	18
5.2 Architecture requirements	20
5.2.1 General	20
5.2.2 Energy management in industrial facilities	22
5.3 System interface mode between facility and smart grid	25
5.4 Security requirements	26
5.5 Safety requirements.....	27
5.6 Communication requirements.....	27
5.6.1 General	27
5.6.2 Use of common communications technology.....	27
5.6.3 Communication security requirements	27
5.6.4 Network availability.....	27
5.6.5 Time synchronization.....	27
5.7 Audit logging requirements	28
5.8 Information requirements	28
5.8.1 General	28
5.8.2 Information attributes.....	28
5.8.3 Example of data and data type	44
Annex A (normative) User stories and use cases	47
A.1 General.....	47
A.2 User stories	47
A.3 Use cases.....	49
A.3.1 Use case analysis.....	49
A.3.2 Actor names and roles	51
A.3.3 Use case descriptions.....	54
Annex B (normative) Use cases of incentive-based DR programs	73
B.1 General.....	73
B.2 Use cases of incentive-based DR (IBDR) programs	74
B.2.1 Use case analysis.....	74
B.2.2 Use case description	75
Annex C (informative) Example of an application of demand response energy management model	86
C.1 General.....	86

C.2	Main architecture	86
C.3	Structure of a task	87
C.4	Approaches of energy management	87
C.4.1	General	87
C.4.2	Approach 1	88
C.4.3	Approach 2	88
C.5	Mapping industrial demand response energy management model to use cases	88
Annex D (normative)	Security services	90
Annex E (informative)	Solutions for information requirement	91
E.1	General	91
E.2	Existing standards	91
E.3	Analysis for each use case	93
E.3.1	General	93
E.3.2	Analysis of "OpenADR2.0b" (IEC 62746-10-1:2018)	93
E.3.3	Analysis of "OASIS Energy Interoperation 1.0"	95
E.3.4	Analysis of "NAESB Energy Services Provider Interface (ESPI)"	97
E.3.5	Analysis of "ISO 17800:2017 Facility Smart Grid Information Model" (FSGIM)	98
Bibliography	100
Figure 1	– Overview of interface between FEMS and smart grid	17
Figure 2	– General approach common today for grid management of DR	19
Figure 3	– Example facility electric power distribution	20
Figure 4	– Facility enterprise and control systems	21
Figure 5	– Model elements	23
Figure 6	– Model architecture	23
Figure 7	– Network architecture model	26
Figure A.1	– Use case overview	51
Figure A.2	– Generic communication diagram between the smart grid and the FEMS	51
Figure A.3	– Actors in role hierarchy (IEC 62264-1)	52
Figure A.4	– Sequence diagram for FG-100	56
Figure A.5	– Sequence diagram for FG-200	58
Figure A.6	– Sequence diagram for FG-300	60
Figure A.7	– Sequence diagram for FG-400	61
Figure A.8	– Sequence diagram for FG-500	63
Figure A.9	– Sequence diagram for FG-600	64
Figure A.10	– Sequence diagram for FG-710	66
Figure A.11	– Sequence diagram for FG-720	68
Figure A.12	– Sequence diagram for FG-810	70
Figure A.13	– Sequence diagram for FG-820	72
Figure B.1	– Role of incentive-based demand response in electric system planning and operations	74
Figure B.2	– Sequence diagram for IBDR-1 (DLC)	76
Figure B.3	– Sequence diagram for IBDR-2 (I/C)	78
Figure B.4	– Sequence diagram for IBDR-3 (EDRP)	79

Figure B.5 – Sequence diagram for IBDR-4 (DB)	81
Figure B.6 – Sequence diagram for IBDR-5 (CMP).....	83
Figure B.7 – Sequence diagram for IBDR-6 (ASM).....	85
Figure C.1 – An application example of demand response energy management model	86
Figure C.2 – Structure of water cooling task.....	87
Figure E.1 – Interaction to register report.....	93
Figure E.2 – Interaction to request report.....	94
Figure E.3 – Simple setup exchange.....	94
Table 1 – Required information	29
Table 2 – Example of data and data type	45
Table A.1 – Facility user stories: facility operation view points	48
Table A.2 – Utility user stories: utility operation view points	49
Table A.3 – Dependency between user stories and use cases	50
Table A.4 – Actors and roles.....	53
Table A.5 – Exchanged information in FG-100	56
Table A.6 – Exchanged information in FG-200	58
Table A.7 – Exchanged information in FG-300	60
Table A.8 – Exchanged information in FG-400	61
Table A.9 – Exchanged information in FG-500	63
Table A.10 – Exchanged information in FG-600	64
Table A.11 – Exchanged information in FG-710	66
Table A.12 – Exchanged information in FG-720	68
Table A.13 – Exchanged information in FG-810	70
Table A.14 – Exchanged information in FG-820	72
Table B.1 – Dependency between user stories and use cases	75
Table B.2 – Exchanged information in IBDR-1 (DLC)	76
Table B.3 – Exchanged information in IBDR-2 (I/C).....	78
Table B.4 – Exchanged information in IBDR-3 (EDRP).....	80
Table B.5 – Exchanged information in IBDR-4 (DB)	81
Table B.6 – Exchanged information in IBDR-5 (CMP).....	83
Table B.7 – Exchanged information in IBDR-6 (ASM).....	85
Table E.1 – Overview of existing standard applicability	92

INTERNATIONAL ELECTROTECHNICAL COMMISSION

INDUSTRIAL-PROCESS MEASUREMENT, CONTROL AND AUTOMATION –**Part 1: system interface between industrial facilities and the smart grid**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

- 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 62872-1, which is a technical specification, has been prepared by IEC technical committee 65: Industrial-process measurement, control and automation.

This first edition edition cancels and replaces IEC TS 62872, published in 2015. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to IEC TS 62872:

- Normative references, Terms and definitions, and Abbreviations were updated;
- Subclause 5.1 was reformulated with price-based and incentive-based demand response;
- Subclause 5.8.3 “Example of data and data type” was added;
- New actors were added in Annex A;
- Use cases FG-7xx and FG-8xx were added in Annex A;
- Annex B “Use cases of incentive-based DR programs” was added.

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

Enquiry draft	Report on voting
65/731/DTS	65/743/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 review of this document will be carried out not later than 3 years after its publication with the options of: extension for another 3 years; conversion into an International Standard; or withdrawal.

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.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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. 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.

Industry is a major consumer of electric power and in many cases this consumption can be scheduled to assist in minimizing overall peak demands on the smart grid. In addition, many industrial facilities have in-house generation or storage resources. These facilities can assist in smart grid load and supply 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 readily available standard automated interfaces.

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 and the 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 might be co-ordinated with smart grid planning, to allow longer term energy planning.

¹ Numbers in square brackets refer to the Bibliography.

INDUSTRIAL-PROCESS MEASUREMENT, CONTROL AND AUTOMATION –

Part 1: system interface between industrial facilities and the smart grid

1 Scope

This part of IEC 62872 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.

The scope of this document specifically excludes the protocols needed for the direct control of energy resources within a facility where the control and ultimate liability for such control is delegated by the industrial facility to the external entity (e.g. distributed energy resource (DER) control by the electrical grid operator).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62264-1:2013, *Enterprise-control system integration – Part 1: Models and terminology*

IEC 62443 (all parts), *Industrial communication networks – Network and system security*

IEC TS 62443-1-1:2009, *Industrial communication networks – Network and system security – Part 1-1: Terminology, concepts and models*

IEC 62443-2-1, *Industrial communication networks – Network and system security – Part 2-1: Establishing an industrial automation and control system security program*

IEC TR 62443-3-1, *Industrial communication networks – Network and system security – Part 3-1: Security technologies for industrial automation and control systems*

IEC 62443-3-3, *Industrial communication networks – Network and system security – Part 3-3: System security requirements and security levels*