

SYSTEMS REFERENCE DELIVERABLE

Guidance and plan to develop smart energy ontologies

(<https://standards.iteh.ai>)
Document Preview

[IEC SRD 63417:2025](https://standards.iteh.ai/catalog/standards/iec/c2447174-2641-43db-8e61-44e60a071d0e/iec-srd-63417-2025)

<https://standards.iteh.ai/catalog/standards/iec/c2447174-2641-43db-8e61-44e60a071d0e/iec-srd-63417-2025>



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2025 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Secretariat
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search -

webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

[IEC SRD 63417:2025](https://standards.iteh.ai/catalog/standards/iec/c2447174-2641-43db-8e61-44e60a071d0e/iec-srd-63417-2025)

<https://standards.iteh.ai/catalog/standards/iec/c2447174-2641-43db-8e61-44e60a071d0e/iec-srd-63417-2025>

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

CONTENTS

FOREWORD	4
INTRODUCTION	6
1 Scope	8
2 Normative references	8
3 Terms and definitions	8
4 State of art on existing ontologies and their structure and architecture	9
4.1 General	9
4.2 Key concepts on semantic interoperability and ontologies	11
4.2.1 Definition and key concepts in ontologies	11
4.2.2 Definition and key concepts in semantic interoperability	12
4.2.3 Structure of an ontology	14
4.2.4 Ontology-based reasoning	15
4.3 Languages used within ontology	16
4.3.1 General	16
4.3.2 RDF/RDFS	16
4.3.3 OWL/RDFS-Plus	16
4.3.4 SHACL	17
4.3.5 SPARQL	17
4.3.6 XKOS	17
4.3.7 SKOS-reference	17
4.3.8 DCAT	17
4.3.9 The Reified Requirements Ontology	17
4.3.10 Schema.org	18
4.3.11 Articulation of languages in semantic through the semantic web layer cake	19
4.4 Landscape of ongoing ontology work in smart energy domain	19
4.4.1 General	19
4.4.2 SAREF4ENER	20
4.4.3 IEC Common Information Model (CIM)	23
4.4.4 Microsoft Energy Grid Ontology for Digital Twins	23
4.4.5 IEC Interface Reference Model (IRM)	24
4.4.6 Smart energy domain ontology (SARGON)	25
4.4.7 SEPA's Smart Grid Ontology	26
4.4.8 InterConnect ontologies	27
4.5 Relevant work on ontologies in cross-domains with smart energy	28
4.5.1 LOV4IoT-Energy Ontology Catalog	28
4.5.2 OpenADR	29
4.5.3 QUDT	29
4.5.4 GeoSPARQL	29
4.5.5 W3C SSN	30
4.5.6 The Organization Ontology	30
4.5.7 BRIDGE	30
4.6 Smart energy data models key for semantic interoperability	31
4.6.1 IEC Common Data Dictionary (CDD)	31
4.6.2 IEC 61850	32
4.6.3 DLMS/COSEM	33
4.6.4 Matter	34

4.6.5	KNX	35
4.7	Graphical representation and visualization of ontologies	37
4.8	Future trends	37
5	Smart energy cross-domain use cases involving ontology	38
5.1	Common Grid model, ENTSO-E – CGMES	38
5.1.1	Use cases description	38
5.1.2	Use of the ontology	38
5.1.3	Benefit to implement it	39
5.2	Illustration on energy management in buildings	39
5.2.1	Use cases description	39
5.2.2	Use of the ontology	39
5.2.3	Benefit to implement it	40
5.3	Illustration in electromobility	40
5.3.1	Use cases description	40
5.3.2	Use of the ontology	41
5.3.3	Benefit of implementing it	42
5.4	InterConnect	42
5.4.1	Use cases description	42
5.4.2	Use of the ontology	43
5.4.3	Benefit of implementing it	44
6	Proposal for a smart energy ontology framework	44
6.1	Smart energy ontology framework	44
6.1.1	General	44
6.1.2	Requirements	45
6.1.3	Processes on validation or evaluation of an ontology	46
6.1.4	Governance requirements	46
6.2	Guidance and best practices to build such a framework	47
6.2.1	General	47
6.2.2	Ontological requirements specification	48
6.2.3	Ontology implementation	49
6.2.4	Ontology publication	49
6.2.5	Ontology maintenance	49
7	Conclusion and recommendation for standardization work on smart energy ontology in the IEC	49
	Bibliography	51
	Figure 1 – Four layers of interoperability	13
	Figure 2 – Links between interoperability layers	14
	Figure 3 – Ontology languages layer cake	16
	Figure 4 – RRO illustration of a requirement	18
	Figure 5 – Semantic web layer cake	19
	Figure 6 – Smart energy main data models and related ontologies	20
	Figure 7 – Overview of the SAREF ontology	21
	Figure 8 – Overview of the SAREF4ENER ontology	22
	Figure 9 – IEC standardized Interface Reference Model	24
	Figure 10 – Smart energy domain ontology (SARGON) network structure	26
	Figure 11 – SEPA project ontology overview	27

Figure 12 – Ontology Catalog for Energy	28
Figure 13 – GeoSPARQL vocabulary	29
Figure 14 – European energy data exchange reference architecture DERA 3.0	31
Figure 15 – DLMS main data models	34
Figure 16 – HBES elements	36
Figure 17 – Main KIM source	36
Figure 18 – Main KIM ontology classes	37
Figure 19 – CIM-CGMES usage illustration	38
Figure 20 – Energy in buildings scenario with semantic interoperability problems	39
Figure 21 – Semantic interoperability problems solved without using SEN ontology	40
Figure 22 – Semantic interoperability problems solved using SEN	40
Figure 23 – Electromobility scenario with semantic interoperability problems	41
Figure 24 – Semantic interoperability problems solved without using SEN	41
Figure 25 – Semantic interoperability problems solved using SEN	42
Figure 26 – InterConnect ontologies extending SAREF ontologies	43
Figure 27 – Subset of the SAREF-compliant sensor dictionary applied to energy	44
Figure 28 – LOT Base methodology workflow	48
Figure 29 – FIESTA IoT ontology federation	50
Table 1 – Ontology best practices: check list summary	46

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[IEC SRD 63417:2025](https://standards.iteh.ai/catalog/standards/iec/c2447174-2641-43db-8e61-44e60a071d0e/iec-srd-63417-2025)

<https://standards.iteh.ai/catalog/standards/iec/c2447174-2641-43db-8e61-44e60a071d0e/iec-srd-63417-2025>

INTERNATIONAL ELECTROTECHNICAL COMMISSION

Guidance and plan to develop smart energy ontologies

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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 63417 has been prepared by IEC systems committee Smart Energy. It is a Systems Reference Deliverable (SRD).

The text of this Systems Reference Deliverable is based on the following documents:

Draft	Report on voting
SyCSmartEnergy/289/DTS	SyCSmartEnergy/295/RVDTS

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 Systems Reference Deliverable 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.

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.

iTeh Standards (<https://standards.iteh.ai>) Document Preview

[IEC SRD 63417:2025](https://standards.iteh.ai/catalog/standards/iec/c2447174-2641-43db-8e61-44e60a071d0e/iec-srd-63417-2025)

<https://standards.iteh.ai/catalog/standards/iec/c2447174-2641-43db-8e61-44e60a071d0e/iec-srd-63417-2025>