IEC SRD 63520

Edition 1.0 2024-10

SYSTEMS REFERENCE DELIVERABLE

Smart cities – Application of IEC SRD 63235 – Concept system building for energy challenge

IEC SRD 63520:2024-10(en)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 01.040.01; 13.020.20

ISBN 978-2-8322-9782-7

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CONTENTS

FOREWORD 4
INTRODUCTION 6
1 Scope 8
2 Normative references 8
3 Terms and definitions 8
4 General 10
4.1 A system of systems view 10
4.2 Methodology framework 11
5 Principles for concept system building 11
5.1 Concept system building steps 11
5.2 Concept relation 12
6 Extract concepts 13
6.1 General 13
6.2 Extracting concepts from the components 13
6.3 Extracting concepts from the extension 15
7 Identify core concepts 18
7.1 Concept relevance assessment 18
7.2 Core concepts relating to energy challenges in smart cities 22
8 Visualize concept system 23
8.1 Overview 23
8.2 Fundamental concepts 24
8.3 Physical system concepts 25
8.4 Digital system concepts 27
8.5 Social system concepts 28
Annex A (informative) Concepts related to energy challenges in smart cities from different SDOs 30
Bibliography 42

Figure 1 – A system of systems view of energy challenges in smart cities 10
Figure 2 – Methodology framework for building concept system of energy challenge in smart city 11
Figure 3 – Concept system building steps 12
Figure 4 – UML-based concept model to represent generic relation 13
Figure 5 – UML-based concept model to represent partitive relation 13
Figure 6 – UML-based concept model to represent associative relation 13
Figure 7 – Concepts category for energy challenges in smart cities based on the components 15
Figure 8 – Concept system for energy challenges in smart cities 24
Figure 9 – Concept system for fundamental concepts of energy challenge in smart city 25
Figure 10 – Concept system for physical system of energy challenges in smart cities 26
Figure 11 – Concept system for digital system of energy challenges in smart cities 27
Figure 12 – Concept system for social system of energy challenges in smart cities 28

Table 1 – Concepts relating to energy challenges in smart cities 14

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Full document details: IEC SRD 63520 2024

Table 2 – Clustering concepts extracted from the extension 16
Table 3 – Domain and stakeholder matrix relevance assessment 19
Table A.1 – Concepts related to energy challenges in smart cities from different SDOs (fundamental) 30
Table A.2 – Concepts related to energy challenges in smart cities from different SDOs (physical system) 31
Table A.3 – Concepts related to energy challenges in smart cities from different SDOs (digital system) 38
Table A.4 – Concepts related to energy challenges in smart cities from different SDOs (social system) 39

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SMART CITIES – APPLICATION OF IEC SRD 63235 – CONCEPT SYSTEM BUILDING FOR ENERGY CHALLENGE

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

Draft	Report on voting
SyCSmartCities/346/DTS	SyCSmartCities/352/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.

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INTRODUCTION

As global climate change and energy scarcity become increasingly prominent, it is important that cities and stakeholders proactively address energy challenges to achieve the Sustainable Development Goals. According to the IEC White Paper *Coping with the Energy Challenge – The IEC's role from 2010 to 2030*, cities are facing the following major energy challenges: stabilizing climate impact from fossil fuel use; meeting the energy demands of a growing urban population; bringing electricity to citizens without access; ensuring stable and secure energy access for all cities.

Cities are very complex "system of systems", including power grid (energy), industry, buildings, transport, water, waste and other domains, each of which plays an important role. Various domains play an important role in coping with urban energy challenges. On the one hand, not only is it important for the power grid domain to be transformed, but also for industry, buildings, transport and other domains to take proactive measures. Therefore, it is essential for stakeholders in different domains to reach a consensus on energy challenges (including but not limited to the intension, solutions, visions, etc.), which is conducive to improving the pertinency, systematization and effectiveness of the city's response to energy challenges. On the other hand, from the perspective of urban governance, it is not the most effective for each domain to cope with energy challenges independently, and the comprehensive governance capacity of cities to cope with energy challenges can be significantly improved through cross-domain collaboration, interoperability and integration.

Semantic interoperability is proposed by the IEC White Paper *Semantic Interoperability: challenges in the digital transformation age*. Research on semantic interoperability is being carried out or planned in the future in the domains of city, power grid (energy), industry, buildings, transport, etc. For example, in the domain of city, IEC SRD 63476-1 provides a gap analysis of smart city ontology; in the domain of power grid (energy), IEC SRD 63417:–[1] provides guidance and planning for the development of smart energy ontologies. Domain-based ontologies have been developed for semantic interoperability in a specific domain, but there is a lack of cross-domain semantic interoperability research. IEC SRD 63417:– includes the following recommendation: "Start a joint work with IEC SyC Smart Cities and IEC SyC Smart Energy on cross domain ontologies".

From the perspective of urban governance, focusing on cross-domain semantic interoperability and at the same time considering the diversity of technology application in rural and remote areas, this document builds a concept system for energy challenges in smart cities, covering core concepts such as intension, stakeholders, solutions and visions of energy challenges. As semantic interoperability research is being carried out or planned in power grid (energy), industry, buildings, transport and other domains, SyC Smart Cities will not be involved in semantic interoperability within these domains. The concept system of this document contains the core concepts of the city domain and the core concepts of cross-domain. The core concepts relevant to energy challenges in other domains, such as power grid (energy), industry, buildings, transport, etc., are developed for semantic interoperability within each domain and fall outside the scope of this document. The purpose of this document includes, but is not limited to:

– fostering the coordination of perspectives on energy challenges among stakeholders in different domains of city, and helping stakeholders identify the intension, solutions, visions, etc. of energy challenges;
– providing a basic framework for semantic coherence and standardization of energy challenges in different domains of city, and promoting cross-domain collaboration, interoperability and integration;
– helping relevant standards development organizations (SDOs) identify gaps in concepts and standards related to energy challenges in smart cities.

[1] Under preparation. Stage at the time of publication: IEC SRD CD 63417:2023.

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This document provides a basic framework for cities to adopt top-down, bottom up and federated planning and design, engineering construction, management and operation, standard setting and other measures to effectively respond to energy challenges. This document promotes the collaboration, integration and sustainable development of global smart cities.

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SMART CITIES – APPLICATION OF IEC SRD 63235 – CONCEPT SYSTEM BUILDING FOR ENERGY CHALLENGE

1 Scope

This document, which is a Systems Reference Deliverable (SRD), provides the concept system of energy challenges in smart cities, using the methodology framework and development processes in IEC SRD 63235.

This document is applicable to development and improvement of the terms and concepts relevant to energy challenges in smart cities.

2 Normative references

There are no normative references in this document.

3 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
associative relation
associative concept relation
pragmatic relation
non-hierarchical concept relation (3.5)

[SOURCE: ISO 1087:2019, 3.2.23, modified – The EXAMPLE has been deleted.]

3.2
characteristic
abstraction of a property

Note 1 to entry: Characteristics are used for describing concepts (3.3).

[SOURCE: ISO 1087:2019, 3.2.1, modified – The EXAMPLE has been deleted.]

3.3
concept
unit of knowledge created by a unique combination of characteristics (3.2)

Note 1 to entry: Concepts are not necessarily bound to particular natural languages. They are, however, influenced by the social or cultural background, which often leads to different categorizations.

Note 2 to entry: This is the concept "concept" as used and designated by the term "concept" in terminology work. It is a very different concept from that designated by other domains such as industrial automation or marketing.

[SOURCE: ISO 1087:2019, 3.2.7]

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3.4
concept model
concept diagram formed by means of a formal language

[SOURCE: ISO 24156-1:2014, 3.2]

3.5
concept relation
relation between concepts (3.3)

[SOURCE: ISO 1087:2019, 3.2.11]

3.6
concept system
system of concepts
set of concepts (3.3) structured in one or more related domains (3.8) according to the concept relations among its concepts (3.3)

[SOURCE: ISO 1087:2019, 3.2.28]

3.7
core concept
concept (3.3) that has focus of interest in a group of related concepts

[SOURCE: ISO/TR 24156-1:2008, 3.4]

3.8
domain
subject field
field of special knowledge

Note 1 to entry: The borderlines and granularity of a domain are determined from a purpose-related point of view. If a domain is subdivided, the result is again a domain.

[SOURCE: ISO 1087:2019, 3.1.4]

3.9
extension
set of all of the objects to which a concept (3.3) corresponds

[SOURCE: ISO 1087:2019, 3.1.2]

3.10
generic relation
generic concept relation
genus-species relation
concept relation (3.5) between a generic concept and a specific concept where the intension of the specific concept includes the intension of the generic concept plus at least one additional delimiting characteristic (3.2)

Note 1 to entry: Outside the terminology community, "type-of relation" and "is-a relation" are also used instead of "generic relation".

Note 2 to entry: In a generic relation the subordinate concept is a specific concept and the superordinate concept is a generic concept.

[SOURCE: ISO 1087:2019, 3.2.13, modified – The EXAMPLE has been deleted.]

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3.11
hierarchical relation
hierarchical concept relation
generic relation (3.9) or partitive relation (3.13)

[SOURCE: ISO 1087:2019, 3.2.12]

3.12
intension
set of characteristics (3.2) that make up a concept (3.3)

[SOURCE: ISO 1087:2019, 3.2.6]

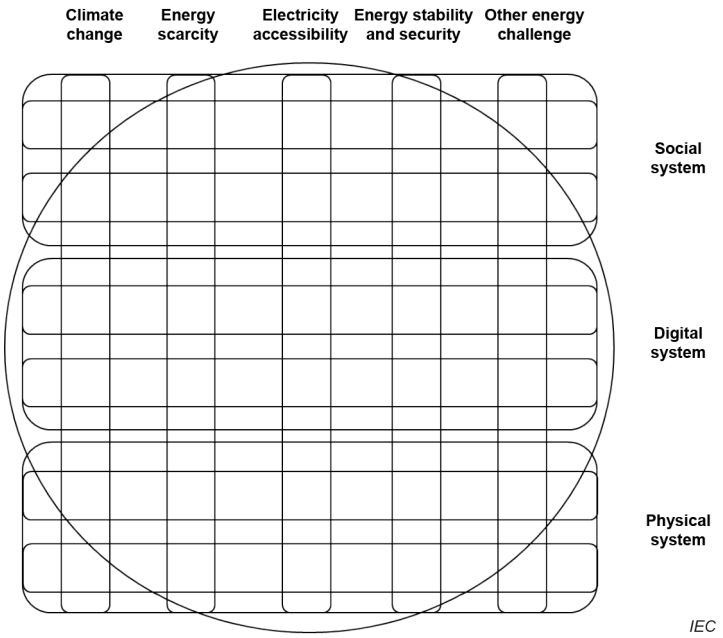
3.13
partitive relation
partitive concept relation
part-whole relation
part-of relation
concept relation (3.5) between a comprehensive concept and a partitive concept

[SOURCE: ISO 1087:2019, 3.2.14, modified – The EXAMPLE has been deleted.]

4 General

4.1 A system of systems view

There are different economic models and levels of development in different countries. Even within the same country, there are significant differences in the level of urbanization in different regions. In consequence, the content of energy challenge is not exactly the same. Although the specifics of energy challenges are not identical, it is important to identify common energy challenges and find solutions accordingly. This document analyses energy challenges in smart city from a system of systems view, as shown in Figure 1, which integrates social system, digital system and physical system of a city to cope with energy challenge.



SOURCE: Figure 1 of IEC SRD 63235:2021, modified by adding energy challenge concerns.

Figure 1 – A system of systems view of energy challenges in smart cities

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The social system, digital system and physical system work together as a complementary whole in responding to the concerns and interests of different stakeholders. In vertical dimension, it is made up of many energy challenges in smart city referring to IEC White Paper "Coping with the Energy Challenge – The IEC's role from 2010 to 2030", such as climate change, energy scarcity, electricity accessibility, energy stability and security, and so on. Taking system of systems view enables the total capability of a city to be enhanced in a way that none of the constituent systems can accomplish on its own.

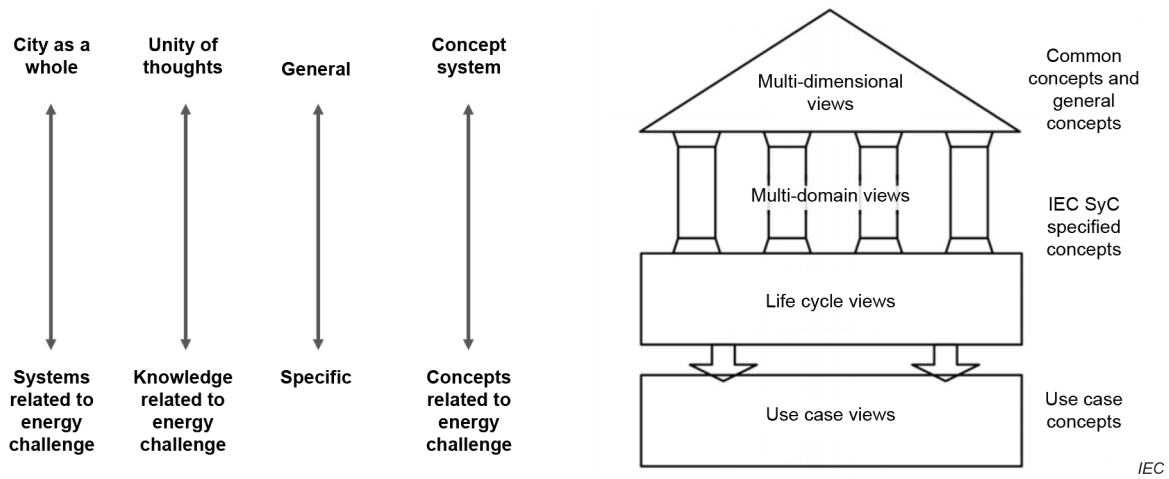
The physical system provides an application framework that promotes the energy connection of infrastructure in energy network, industry, building, transport and other domains in smart city, and supports the energy interconnection and interaction among these domains in physical layer.

The digital system provides an ICT framework that achieves integration of energy network, industry, building, transport and other domains in information and communication layer, and turns isolated domains into horizontal integration of services using data from different domains, which is key to achieving interoperability.

The social system provides a governance framework that coordinates arrangements of energy challenge relevant strategies, policies, decisions, accountabilities, management measures, etc. to reflect multiple stakeholders' concerns in social layer.

4.2 Methodology framework

The methodology framework for concept system building of energy challenges in smart cities is a specific application of IEC SRD 63235. The methodology framework refers to a system of systems way of thinking that supports multi-dimensional, multi-domain and multi-layer, life-cycle and use-case analysis approaches to be used together as a complementary whole, as shown in Figure 2.



SOURCE: Figure 2 of IEC SRD 63235:2021, modified by adding energy challenge concerns.

Figure 2 – Methodology framework for building concept system of energy challenge in smart city

5 Principles for concept system building

5.1 Concept system building steps

Concept system building involves a series of steps, as shown in Figure 3.

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The concept system building steps include:

– selecting the concept field, which is "energy challenges in smart cities" (as shown in Clause 4);
– extracting characteristics according to the components of the concept "energy challenges in smart cities", and extracting concepts from these characteristics (as shown in 6.2);

NOTE Considering that the components which are given by IEC, ISO, ITU and other SDOs can be incomplete or not widely applicable, it is crucial to extract supplementary concepts through the extension of "energy challenges in smart cities".

– extracting concepts according to the extension of "energy challenges in smart cities" (as shown in 6.3);
– identifying core concepts by relevance assessment (as shown in Clause 7);
– determining the relations and positions of these core concepts within the concept system (as shown in Clause 8);
– visualizing the resulting concept system by means of a concept model (as shown in Clause 8).

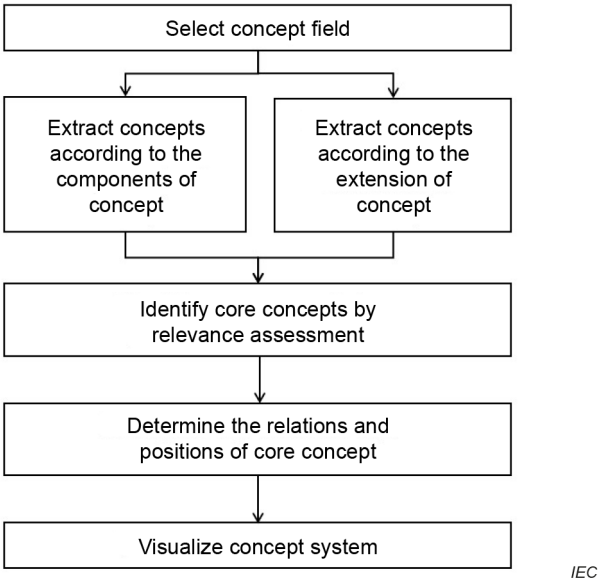

Figure 3 – Concept system building steps

5.2 Concept relation

Concept system describes concepts and their relations. Different concepts can be connected through different types of concept relations. The following relations are used to develop the concept system of energy challenges in smart cities:

a) hierarchical relation:
   1) generic relation;
   2) partitive relation;
b) associative relation.

In this document, Unified Modelling Language (UML)-based concept models are drawn in accordance with ISO 24156-1. The UML-based concept model of generic relation, partitive relation, and associative relation is shown in Figure 4, Figure 5, and Figure 6.

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