

# TECHNICAL SPECIFICATION



**Energy management system application program interface (EMS-API) –  
Part 600-1: Common Grid Model Exchange Specification (CGMES) – Structure  
and rules**

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## CONTENTS

|  |    |
|--|----|
| FOREWORD.....  | 6  |
| INTRODUCTION.....  | 8  |
| 1 Scope.....   | 9  |
| 2 Normative references .....   | 9  |
| 3 Terms, definitions and abbreviated terms .....                           | 9  |
| 3.1 Terms and definitions.....   | 10 |
| 3.2 Abbreviated terms.....   | 10 |
| 4 Exchange process .....   | 11 |
| 5 Specifications and functionalities .....                                 | 13 |
| 5.1 General constraints.....   | 13 |
| 5.2 Model authority sets (MAS).....  | 14 |
| 5.3 File header .....  | 15 |
| 5.4 File body.....   | 16 |
| 5.5 Profiles and instance file types.....                                  | 17 |
| 5.5.1 General .....  | 17 |
| 5.5.2 CGMES profiles' properties .....                                     | 17 |
| 5.5.3 CGMES' extensions.....   | 19 |
| 5.5.4 Equipment profile and instance file .....                            | 22 |
| 5.5.5 Topology profile and instance file .....                             | 22 |
| 5.5.6 Steady state hypothesis profile and instance file.....               | 22 |
| 5.5.7 State variables profile and instance file .....                      | 22 |
| 5.5.8 Boundary equipment profile and instance file.....                    | 23 |
| 5.5.9 Boundary topology profile and instance file.....                     | 23 |
| 5.5.10 Diagram layout profile and instance file .....                      | 23 |
| 5.5.11 Geographical location profile and instance file .....               | 24 |
| 5.6 File exchange.....   | 25 |
| 5.7 Boundary point – properties and location .....                         | 26 |
| 5.8 Model assembling process.....  | 28 |
| 5.9 RDF/XML model validity.....  | 30 |
| 5.10 Naming Convention.....  | 30 |
| 6 CGMES governance .....   | 34 |
| 6.1 General.....   | 34 |
| 6.2 Versions of the CGMES and the profiles .....                           | 34 |
| 6.3 Conformity assessment.....   | 35 |
| 6.4 Implementation process .....   | 36 |
| Annex A (normative) Template for further restrictions on naming .....      | 37 |
| Annex B (normative) Summary of specific rules for naming conventions ..... | 38 |
| B.1 IdentifiedObject.name .....  | 38 |
| B.2 IdentifiedObject.description.....                                      | 38 |
| B.3 IdentifiedObject.energyIdentCodeEic .....                              | 38 |
| B.4 IdentifiedObject.shortName.....  | 38 |
| B.5 ConnectivityNode and TopologicalNode .fromEndIsoCode .....             | 38 |
| B.6 ConnectivityNode and TopologicalNode .toEndIsoCode .....               | 39 |
| B.7 ConnectivityNode and TopologicalNode .fromEndName.....                 | 39 |
| B.8 ConnectivityNode and TopologicalNode .toEndName .....                  | 39 |
| B.9 ConnectivityNode and TopologicalNode .fromEndNameTso .....             | 39 |

|         |   |    |
|---------|---|----|
| B.10    | ConnectivityNode and TopologicalNode .toEndNameTso .....  | 40 |
| B.11    | Future developments on CIM for dynamics .....   | 40 |
| Annex C | (normative) File header guidelines .....  | 41 |
| C.1     | General.....  | 41 |
| C.2     | Exchange scenarios.....   | 41 |
| C.3     | Examples.....   | 42 |
| C.3.1   | Example 1: File header of full model .....  | 42 |
| C.3.2   | Example 2: File header of full model that is depending on another model .....   | 43 |
| C.3.3   | Example 3: File header of full model that is depending on a model and supersedes another model.....                             | 44 |
| C.3.4   | Example 4: File header of difference model that is depending on a full model and supersedes another full model.....             | 45 |
| C.3.5   | Example 5: File header of difference model that is depending on a difference model and supersedes another difference model..... | 46 |
| Annex D | (normative) PST transformer modelling.....  | 48 |
| D.1     | General.....  | 48 |
| D.2     | Mapping to CIM classes and attributes.....  | 48 |
| D.3     | Reactance formulas summary table .....  | 49 |
| D.4     | Symmetrical Phase shifters.....   | 50 |
| D.4.1   | Single phase diagram and equations.....   | 50 |
| D.4.2   | Expression of the angle and ratio per tap.....  | 51 |
| D.4.3   | Expression of the equivalent series reactance given the angle .....   | 51 |
| D.4.4   | Three-phase diagrams.....   | 52 |
| D.5     | Quadrature booster.....   | 53 |
| D.5.1   | Single phase diagram and equations.....   | 53 |
| D.5.2   | Expression of the angle and ratio per tap.....  | 53 |
| D.5.3   | Expression of the equivalent series reactance given the angle .....   | 54 |
| D.5.4   | Three-phase diagrams.....   | 54 |
| D.6     | Asymmetrical Phase Shifter.....   | 55 |
| D.6.1   | Single phase diagram and equations.....   | 55 |
| D.6.2   | Expression of the angle and ratio per tap.....  | 55 |
| D.6.3   | Expression of the equivalent series reactance given the angle .....   | 55 |
| D.6.4   | Three-phase diagram.....  | 56 |
| D.7     | In-phase transformer and symmetrical phase shifter .....  | 56 |
| D.7.1   | Single phase diagram and equations.....   | 56 |
| D.7.2   | Expression of the angle and ratio per tap.....  | 57 |
| D.7.3   | Expression of the equivalent series reactance given the angle and the in-phase transformer ratio.....                           | 57 |
| D.8     | In-phase transformer and asymmetrical phase shifter .....   | 58 |
| D.8.1   | Single phase diagram and equations.....   | 58 |
| D.8.2   | Expression of the equivalent series reactance given the angle and the in-phase transformer ratio.....                           | 58 |
| D.8.3   | Technology principles .....   | 59 |
| D.9     | Detailed calculations and examples .....  | 59 |
| D.9.1   | Symmetrical phase shifters with two cores.....  | 59 |
| D.9.2   | Quadrature boosters.....  | 63 |
| D.9.3   | Asymmetrical phase shifter.....   | 67 |
| Annex E | (normative) Implementation guide .....  | 74 |
| E.1     | General.....  | 74 |

|                     |  |    |
|---------------------|--|----|
| E.2                 | TapChanger.neutralU vs PowerTransformerEnd.ratedU vs. VoltageLevel.BaseVoltage ..... | 74 |
| E.2.1               | Issue description .....  | 74 |
| E.2.2               | Required implementation .....  | 75 |
| E.3                 | Angle of PhaseTapChangerTaple Point.....   | 75 |
| E.4                 | Slack generator.....   | 75 |
| E.5                 | qPercent SynchronousMachine .....  | 76 |
| E.6                 | TopologicalIsland.....   | 76 |
| E.7                 | Implementation of SSH and SV profiles.....   | 76 |
| E.8                 | Ground voltage levels .....  | 76 |
| E.9                 | LTCflag.....   | 76 |
| E.9.1               | Issue description .....  | 76 |
| E.9.2               | Use cases.....   | 77 |
| E.9.3               | Required implementation .....  | 78 |
| E.10                | ACLineSegment-s between different terminal voltages.....                             | 79 |
| E.10.1              | Issue description .....  | 79 |
| E.10.2              | Required implementation .....  | 79 |
| E.11                | Association from ConformLoadGroup/NonConformLoadGroup.....                           | 80 |
| E.11.1              | Issue description .....  | 80 |
| E.11.2              | Required implementation.....   | 80 |
| E.12                | Regulating control.....  | 81 |
| E.13                | Implementation of the GeographicalRegion and SubGeographicalRegion .....             | 81 |
| E.14                | Implementation of GeneratingUnit.normalPF.....                                       | 81 |
| E.15                | Implementation of Power Transformer.....   | 82 |
| E.16                | Interpretation of parameters of PowerTransformerEnd .....                            | 82 |
| E.17                | Implementation of Switch.....  | 82 |
| E.18                | UnitMultiplier.....  | 83 |
| E.19                | EnergySource: "voltageMagnitude" and "voltageAngle".....                             | 83 |
| Annex F (normative) | CGMES profiles versions.....   | 84 |
| Bibliography.....   |  | 85 |
| Figure 1            | – Dependencies between the profiles belonging to CGMES .....                         | 19 |
| Figure 2            | – Boundary point placed on a tie-line .....  | 26 |
| Figure 3            | – Boundary point placed in a substation .....  | 26 |
| Figure 4            | – HVDC as interconnection or internal line .....                                     | 27 |
| Figure 5            | – HVDC grid.....   | 27 |
| Figure 6            | – Assembly process .....   | 29 |
| Figure 7            | – Main development stages of the CGMES .....   | 34 |
| Figure C.1          | – Example work flow events.....  | 41 |
| Figure D.1          | – Single phase diagram, phasor diagram and equations .....                           | 51 |
| Figure D.2          | – Example for symmetrical double core phase shifter .....                            | 52 |
| Figure D.3          | – Dual core and single core .....  | 52 |
| Figure D.4          | – Single core, delta hexagonal.....  | 53 |
| Figure D.5          | – Single phase diagram, phasor diagram and equations .....                           | 53 |
| Figure D.6          | – Dual core and single core .....  | 54 |
| Figure D.7          | – Single phase diagram, phasor diagram and equations .....                           | 55 |
| Figure D.8          | – Dual core.....   | 56 |

|  |    |
|--|----|
| Figure D.9 – Single phase diagram, phasor diagram and equations .....  | 57 |
| Figure D.10 – Single phase diagram, phasor diagram and equations .....   | 58 |
| Figure D.11 – In-phase regulating auto-transformer .....   | 59 |
| Figure D.12 – Symmetrical phase shifters with two cores .....  | 60 |
| Figure D.13 – Detailed three phase diagram .....   | 60 |
| Figure D.14 – Detailed three phase diagram .....   | 63 |
| Figure D.15 – Single phase diagram .....   | 64 |
| Figure D.16 – Phasor diagram .....   | 65 |
| Figure D.17 – Detailed three phase diagram .....   | 66 |
| Figure D.18 – Phasor diagram .....   | 67 |
| Figure D.19 – Asymmetrical phase shifter with two cores .....  | 67 |
| Figure D.20 – Detailed three phase diagram .....   | 68 |
| Figure D.21 – Phasor diagram .....   | 69 |
| Figure D.22 – Asymmetrical phase shifter with a single core .....  | 70 |
| Figure D.23 – Phasor diagram .....   | 71 |
| Figure D.24 – Example of detailed three-phase diagram of voltage regulating auto-transformer and quadrature booster .....  | 72 |
| Figure D.25 – Example of detailed winding diagram of voltage regulating auto-transformer and quadrature booster .....      | 73 |
| Figure E.1 – Diagram ConformLoadGroup/NonConformLoadGroup .....  | 80 |
| Figure E.2 – Regulating control setup .....  | 81 |
| Figure E.3 – Power transformer modelling .....   | 82 |
| Table 1 – IdentifiedObject attributes .....  | 33 |
| Table 2 – IdentifiedObject attributes for ConnectivityNode in EQ_BD profile and for TopologicalNode in TP_BD profile ..... | 33 |
| Table D.1 – Mapping of phase shift transformers to CIM classes .....   | 48 |
| Table D.2 – Mapping of symbols used in formulas to CIM attributes .....  | 49 |
| Table D.3 – Impedance variations in a phase shift transformer .....  | 50 |
| Table D.4 – Description of variables .....   | 50 |
| Table E.1 – Meaning of the combinations for TapChanger.TapChangerControl and TapChanger.ItcaFlag .....                     | 79 |

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### ENERGY MANAGEMENT SYSTEM APPLICATION PROGRAM INTERFACE (EMS-API) –

#### Part 600-1: Common Grid Model Exchange Specification (CGMES) – Structure and rules

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IEC TS 61970-600-1, which is a technical specification, has been prepared by IEC technical committee 57: Power systems management and associated information exchange.



The text of this technical specification is based on the following documents:

|               |                  |
|---------------|------------------|
| Enquiry draft | Report on voting |
| 57/1815/DTS   | 57/1871/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 list of all parts in the IEC 61970 series, published under the general title *Energy management system application program interface (EMS-API)*, can be found on the IEC website.

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## INTRODUCTION

The purpose of the Common Grid Model Exchange Specification (CGMES) is to define the interface between Transmission System Operators (TSO) software in order to exchange power system modelling information as required by the European Network of Transmission System Operators for Electricity (ENTSO-E) and TSO business processes.

The CGMES is used as a baseline exchange specification for the implementation of the Common Grid Model (CGM) methodologies in accordance with the requirements for the implementation of various European network codes and guidelines. The CGMES applies to applications dealing with power system data management, as well as applications supporting the following analyses:

- load flow and contingency analyses,
- short circuit calculations,
- market information and transparency,
- capacity calculation for capacity allocation and congestion management, and
- dynamic security assessment.

The conformity of the applications used for operational and system development exchanges with the CGMES is crucial for the needed interoperability of these applications. ENTSO-E therefore developed and approved the CGMES Conformity Assessment Framework as the guiding principles for assessing applications' CGMES conformity. This technical specification relies on the CGMES Conformity Assessment Process operated by ENTSO-E in order to ensure that the CGMES is properly implemented by suppliers of the applications used by TSOs.

The CGMES is a superset of the former ENTSO-E CIM based data exchange standard (Profile 1) which was based on CIM14 (UML14v02) and has been used for certain network models exchanges since 2009. The CGMES reflects TSO requirements (as known by 2014) for accurate modelling of the ENTSO-E area for power flow, short circuit, and dynamics applications whilst also allowing for the exchange of any diagram layouts including GIS data of a grid model.

# ENERGY MANAGEMENT SYSTEM APPLICATION PROGRAM INTERFACE (EMS-API) –

## Part 600-1: Common Grid Model Exchange Specification (CGMES) – Structure and rules

### 1 Scope

This technical specification on the CGMES defines the main rules and requirements related to the CGMES which are mandatory for achieving interoperability with the CGMES and for satisfying business processes. In this document requirements are indicated as such in a tabular format. Some descriptions are merely used for clarification and are marked “Informational”.

The profiles which belong to CGMES are defined in IEC 61970-600-2:2017. The related technical information and documentation (i.e. RDFS, OCL, XMI and HTML) needed for the implementation of the CGMES, which is not copyrighted by either IEC or CENELEC, is available at the ENTSO-E web site.

The CGMES is defined using information on the Common Information Model (CIM) available in the public domain.

Future editions of this technical specification will be released to describe following CGMES versions which will reflect additional requirements due to European network codes or guidelines.

### 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 61970-452, *Energy management system application program interface (EMS-API) – Part 452: CIM model exchange specification*

IEC 61970-453, *Energy management system application program interface (EMS-API) – Part 453: Diagram layout profile*

IEC 61970-456, *Energy management system application program interface (EMS-API) – Part 456: Solved power system state profiles*

IEC 61970-552, *Energy management system application program interface (EMS-API) – Part 552: CIMXML Model exchange format*

IEC 61968-4, *Application integration at electric utilities – System interfaces for distribution management – Part 4: Interfaces for records and asset management*

### 3 Terms, definitions and abbreviated terms

For the purposes of this document, the following terms, definitions and abbreviated terms 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>

NOTE For definitions which are not specified in the CGMES the definitions in the IEC 61970 standards shall be applied.

### 3.1 Terms and definitions

#### 3.1.1

##### Common Grid Model Exchange Specification

##### CGMES

ENTSO-E specification used for the exchange of power system models between TSOs for the purpose of performing bilateral, regional or pan-European studies in the frame of TYNDP or TSOs' projects

Note 1 to entry: This is based on IEC CIM Standards and further extended to meet Network Codes' and projects' requirements. The standard defines a set of data model exchange profiles.

#### 3.1.2

##### profile

uniquely named subset of classes, associations and attributes needed to accomplish a specific type of interface and based upon a canonical model

Note 1 to entry: This term may be used to define either the semantic model for an instance data payload or the syntactic schema for an instance data payload. A profile may be expressed in XSD, RDF, and/or OWL files. An instance data conforming to a profile can be tested in exchanges between applications. A profile is necessary in order to "use" the canonical model.

#### 3.1.3

##### CIM Extension

collection of classes, attributes and associations, which extend the standard IEC CIM model in order to cover use cases not currently supported by IEC standards, and which are not considered to be international use cases or are covered by a later version of the standard which is not yet supported.

#### 3.1.4

##### ENTSO-E Extension

CIM Extension, specifically managed by ENTSO-E

#### 3.1.5

##### boundary set

set containing all boundary points necessary for a given grid model exchange

Note 1 to entry: A Boundary set can have different coverage depending on the requirements of the common grid model exchange. A complete boundary set is necessary to assemble a pan-European power system model.

#### 3.1.6

##### boundary point

##### BP

connection point between two Model Authority Sets (MAS)

Note 1 to entry: A Boundary point could be a ConnectivityNode or a TopologicalNode placed on a tie-line or in a substation. A Boundary point must be contained in a Boundary Set and must not be contained in the MAS of a TSO. A Boundary point is referenced by Terminals in the MAS of a TSO. ConnectivityNode and TopologicalNode are terms specified in IEC CIM standards. If a Boundary point is placed on a tie-line, the term X-Node is often used instead of Boundary point. X-Node is therefore a specific type of Boundary point.

### 3.2 Abbreviated terms

IEC The International Electrotechnical Commission, headquartered in Geneva

|         |   |
|---------|---|
| DSO     | Distribution System Operator  |
| TSO     | Transmission System Operator  |
| ENTSO-E | European Network of Transmission System Operators for Electricity<br>(ENTSO-E has 43 TSO members) |
| MRID    | CIM Master Resource Identifier  |
| CIM     | Common Information Model (electricity)  |
| CGMES   | Common Grid Model Exchange Standard   |
| MAS     | Model Authority Set   |
| IOP     | Interoperability Test   |
| RDF     | Resource Description Framework  |
| EQ_BD   | Boundary equipment profile or instance file   |
| TP_BD   | Boundary topology profile or instance file  |
| EQ      | Equipment profile or instance file  |
| TP      | Topology profile or instance file   |
| SSH     | Steady State Hypothesis profile or instance file  |
| SV      | State Variables profile or instance file  |
| DL      | Diagram Layout profile or instance file   |
| GL      | Geographical Location profile or instance file  |
| DY      | Dynamics profile or instance file   |
| BP      | Boundary point  |

#### 4 Exchange process

There are various levels at which the exchange of power system data/models is necessary. A pan-European model exchange level covers the territory of all TSOs. Regional model exchanges can be realised between different TSOs in one or more synchronous areas. A model exchange on the national level includes interfaces between TSOs and DSOs, as well as between different DSOs.

The purpose of model exchanges is not only to exchange the data from one authority to another but also to satisfy the ultimate goal, namely to perform common studies using shared data. All parties involved in the process should be able to perform the same types of studies and be able to share project tasks between different parties which are using different power system analysis applications. Indeed, the interoperability between different applications used in the exchange process is therefore crucial in both reaching seamless data exchange and obtaining comparable study results when using this data.

The CGMES covers these ENTSO-E and TSO business processes by defining the following main types of exchanges valid for a particular study or process:

- Exchange of boundary set: An exchange of a boundary Set is necessary to prepare an exchange of an internal TSO model and to assemble a common grid model. The latest information on Boundary Sets covering the pan-European area is available to TSOs and maintained in the ENTSO-E Network Modelling Database (NMD) where all TSOs negotiate and agree on the boundary information.
- Exchange of an internal TSO model: A number of business processes require each TSO to provide models of its internal territory. To describe its internal territory in a single stand-alone exchange, a TSO is treated as a single model authority set and shall be able to exchange all profiles defined in the CGMES. The TSO prepares its internal model in such a way that it is easily and unambiguously combined with other TSO internal models to make up complete models for analytical purposes. This type of exchange can also be

applied for the interface between a TSO and a DSO, where models covering transmission or distribution parts of the power system can be exchanged based on a mutual agreement between the TSOs and the DSOs. In this case, and if a TSO requests a DSO model, the DSO would provide its model in accordance with CGMES definitions which might be extended by the TSO requesting this type of exchange.

- Exchange of a common grid model: A common grid model refers to the concept of having one model which can be used for multiple purposes. The specification describes what is needed to create an assembly of multiple TSOs' Individual Grid Models (IGM) of their responsible territory into a regional or pan-European model. Different business processes will require specific implementation of the profiles part of the CGMES and the exchange of respective instance files to meet interoperability inside the business process. The Common Grid Model meta-model description will ensure interoperability across the business process.

ENTSO-E and TSO business processes (e.g. system development planning, protection planning, operational planning, operation, fault study/simulation, market operation, etc.) are, of course, more complex than these operations, but what is important to note is that all processes are supported using only these basic kinds of interoperation.

Note that each power system model in CIM normally consists of multiple datasets (instance files) as defined in IEC CIM standards and further specified by CGMES.

The CGMES supports node-breaker and bus-branch model exchanges. Moving forward the procedures of the model exchanges using the CGMES, it is expected that equipment and steady state hypothesis data (EQ and SSH instance files) will be the input source data for all processes. This type of model should be the fully detailed model with all disconnectors/breakers, etc. Any configuration changes are made by changing switch statuses.

| ID     | Specification  | Type        |
|--------|--|-------------|
| EXCH1. | The CGMES defines equipment and steady state hypothesis profiles as an input, meaning that all results, whether topology or state variables profiles data, must refer to the equipment and steady state hypothesis objects. Therefore, in the case that both equipment and steady state hypothesis instance files are available, there is no need to exchange topology or state variables instance files in order to obtain a load flow. | Requirement |
| EXCH2. | For node-breaker model exchanges the TopologicalNodes represent the output from a topology processing on the detailed input source operational data. These can be optionally exchanged to be used by tools which have an interest in the computed buses.   | Information |
| EXCH3. | For node-breaker model exchanges mRID (rdfIDs in serialisation) of the TopologicalNodes are not persistent.  | Information |
| EXCH4. | For node-breaker model exchanges a topology instance file is not exchanged using a difference file.  | Requirement |
| EXCH5. | For bus-branch model exchanges the TopologicalNodes must be persistent.  | Requirement |
| EXCH6. | If a contingency list is exchanged belonging to the model exchanged in bus-branch detail, it shall refer to ConductingEquipment (TopologicalNode, branches, etc.). This results in a constraint on interoperability between planning and operation processes.  | Requirement |
| EXCH7. | If a contingency list is exchanged belonging to the model exchanged in node-breaker detail, it shall refer to ConductingEquipment (ConnectivityNode, which is not artificial, Busbar, etc.).   | Requirement |
| EXCH8. | If a model has mixed representation (node-breaker and bus-branch) then the profile URI in the header related to the Equipment Operation is not included as only part of the network will include classes stereotyped with Operation.   | Requirement |