« INTEROPERABILITY BETWEEN TRANSMISSION AND DISTRIBUTION SYSTEM OPERATORS IN THE FRAMEWORK OF THE EUROPEAN PROJECT TDX-ASSIST AND THEIR COOPERATION IN SMART GRIDS »

Contribution to Task 1.6 Deliverable D1.11/D1.12

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I. Table of contents

I. Table of contents ... 2
II. Lists of figures ... 4
III. Introduction ... 6
A. CIM network related profiles history ... 6
B. TDX ASSIST project & objective of this document ... 6
IV. IOP tests ... 7
A. Objective ... 7
B. Dataset types (CDPSM, CGMES, MSITE,) and differences ... 7
C. Validation tools ... 8
1. DisNetSimPl: Distribution Network Simulation Platform ... 8
2. RiseClipse: Web Version ... 8
V. DITAM (Data Integration Toolbox And More) ... 9
A. Structure and Description ... 9
B. “Référentiel des JDD” : explanations and modifications ... 10
C. Improvements for future tests ... 10
VI. MV CDPSM DATASET NETWORK ... 11
A. Description and Representation ... 11
B. DisNet Validation ... 12
1. Network Information ... 12
2. Loadflow results ... 14
VII. LV CDPSM DATASET NETWORK ... 15
A. Description and Representation ... 15
B. DisNet Validation ... 15
1. Network Information ... 15
2. Loadflow results ... 17
C. Unbalanced system for LV dataset results ... 19
VIII. MV-LV fused CGMES DATASET NETWORK ... 20
A. Description and Representation ... 20
B. DisNet Validation ... 21
1. Network Information ... 21
2. Loadflow results ... 22
IX. MV CGMES DATASET NETWORK ... 23
A. Description and Representation ... 23
B. DisNet Validation ... 24
1. Network Information ... 24
2. Loadflow results ... 25

C. Results Analogy between MV CDPSM and MV CGMES datasets 26
D. MV CGMES exportation via DisNet from a CDPSM importation 28
E. MV CGMES exportation via DisNet from a CGMES importation 30
F. MV CGMES modifications and results 30
1. Removing some network loads 31
2. Network Topology modification 32
3. Additional network sources 33
X. MV CGMES DATA 3 NETWORK 34
A. DATA3 description 34
B. INESC scenarios and results 35
C. Compatibility with loadflow results generated by DisNet (Via OpenDSS) 36
XI. RISECLIPSE VALIDATION 37
A. VALIDATION OF DATA1 CDPSM 37
B. Validation of DATA 1 MSITE 38
C. Validation of DATA 2 CGMES 38
D. Validation of DATA 1 converted to CGMES by EDF tool 40
E. Validation of DATA 2 exported in CGMES 40
XII. French island using MSITE and CDPSM 42
A. Description and representation 42
B. Information and results comparison 43
XIII. CONCLUSION 44
XIV. REFERENCES 45
XV. APPENDIX 46

II. Lists of figures

Figure 1 CIM profiles history : CPSM, CDPSM, CGMES 6
Figure 2: Coordination of Transmission and Distribution data eXchanges 7
Figure 3: CGMES global file and split folder 8
Figure 4: CGMES split files 8
Figure 5: RiseClipse and DisNet Validation process 9
Figure 6: DITAM Toolbox interface 9
Figure 7: Datasets generation 10
Figure 8: Hierarchical view of MV CDPSM Network on DisNet 12
Figure 9: Geographical Representation of MV CDPSM Network 12
Figure 10: Network Information 13
Figure 11: Network Consistency 13
Figure 12: Voltage Levels for all network nodes 14
Figure 13: Capture example of voltage drop in % 14
Figure 14: Hierarchical view of LV CDPSM network 15
Figure 15: Geographical Representation of LV CDPSM network 16
Figure 16: LV CDPSM Network Information 16
Figure 17: LV Network Consistency 17
Figure 18: Voltage Levels for all LV network feeders 17
Figure 19: Hierarchical View for one secondary substation of the LV network 17
Figure 20: Geographical view for one secondary substation of the LV global network 18
Figure 21: Voltage node levels for one secondary substation 18
Figure 22: Capture example of voltage drop in % 18
Figure 23: example of an unbalance load 19
Figure 24: Voltage profile for LV dataset with unbalanced loads 19
Figure 25: One LV network with unbalanced load 20
Figure 26: Line loadflow results with balanced load 20
Figure 27: Line loadflow results with unbalanced load 20
Figure 28: Hierarchical view of the MV-LV fused network 21
Figure 29: Geographical Representation of MV-LV fused network 21
Figure 30: MV-LV fused network information 22
Figure 31: Network Consistency 22
Figure 32: Voltage Levels for all MV and LV network feeders 23
Figure 33: Hierarchical view of MV CGMES network 24
Figure 34: Geographical Representation of MV CGMES network 24
Figure 35: MV CGMES Network Information 25
Figure 36: Network Consistency 25
Figure 37: Voltage Levels in all MV CGMES nodes 26
Figure 38: Difference between some CDPSM and CGMES line characteristics 26
Figure 39: Shunts Reactive power Q difference between CDPSM and CGMES 27
Figure 40: Some network switches changing type 27
Figure 41: Voltage profile for CDPSM and CGMES MV network 28
Figure 42: The order magnitude modification of lines characteristics after a CGMES exportation 28
Figure 43: Exportation error generated by Matlab 29
Figure 44: Voltage profile after exportation in CGMES 29
Figure 45: Lines conductor parameter modification after a CGMES exportation on DisNet 29
Figure 46: Voltage profiles of CDPSM dataset and CGMES exported by DisNet 30
Figure 47: Voltage profiles of the the two CGGMES datasets 30
Figure 48: Removed loads reference 31
Figure 49: Network information before and after removing the loads 31

Figure 50: Network branch with a removed load 31
Figure 51: Load flow information in the above line 32
Figure 52: Switches changing their state from open to close 32
Figure 53: Network representation before and after topology modification 32
Figure 54: Voltage profile before and after topology modification 33
Figure 55: Line load flow results before changing switch state 33
Figure 56: Line load flow results after changing switch state 33
Figure 57: Added sources references 33
Figure 58: Network information before and after adding Network Sources 34
Figure 59: Part of the "DATA 2 exporté" network 34
Figure 60: Part of the "DATA 3" network 35
Figure 61: INESC scenarios 36
Figure 62: Voltage drop in different network branches 36
Figure 63: RiseClipse Web Platform 37
Figure 64: Validation of DATA 1 by Fraunhofer 37
Figure 65: Dataset converters 38
Figure 66: CIMTool Validation of DATA1 38
Figure 67: Hierarchical Representation of STANN outgoing feeder from French Island network 43
Figure 68: Geographical Representation of STANN departure from French Island network 43
Figure 69: STANN network information in MSITE and CDPSM 43
Figure 70: Voltage profiles of STANN network in MSITE and CDPSM 44

III. Introduction

A. CIM network related profiles history

The following figure illustrates the CIM network profiles history. It started with CPSM (Common Power System Model) profile which is described as follow:

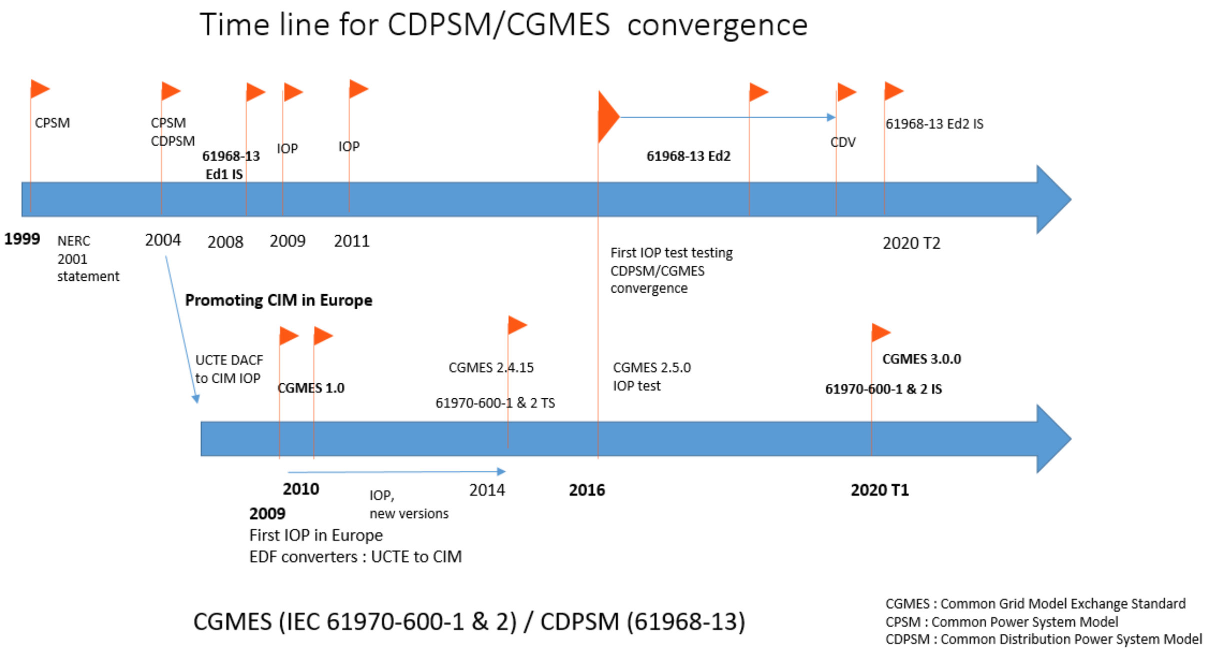


Figure 1 CIM profiles history : CPSM, CDPSM, CGMES

The CPSM[i] is a Data Profile document that defined the data required to meet the objective defined in a Use Case or by the NERC Data Exchange Working Group – in this case the minimum set of data that must be exchanged had to be sufficient to solve a Power Flow. The IEC 61970-452 was originally the CPSM IEC standards document. The work on the CPSM Profile began in 1999 and interoperability (IOP) Testing for this Profile began in 2000. Several versions were developed allowing to have have full and incremental data exchange.

EDF R&D participated in several interoperability tests[ii], and proposed to have a CDPSM profile, to represent Distribution Networks.

B. TDX ASSIST project & objective of this document

H2020 TDX-ASSIST is a European project funded by European Commission (www.tdx-assist.eu) aims to design and develop novel Information and Communication Technology (ICT) tools and techniques that facilitate scalable and secure information systems and data exchange between Transmission System Operator (TSO) and Distribution System Operator (DSO)**.** The three novel aspects of ICT tools and techniques to be developed in the project are: scalability – ability to deal with new users and increasingly larger volumes of information and data**;** security – protection against external threats and attacks; and interoperability –information exchange and communications based on existing and emerging international smart grid ICT standards.

Moreover, the workspace main goal will be based on testing and checking the compliance between the two network dataset models CDPSM and CGMES standing on IEC CIM standards. The contribution in the "Test-TDX-CIM" via different validation grid tools (RiseClipse, CIMTool, DisNetSimpl) helped to verify the consistency between the two xml CIM standards (CGMES and CDPSM) by identifying the errors generated after a result comparison. In some cases, the dataset were corrected by adding the missing information (elements attributes, classes, links…) which is not an optimized way to solve the problem. In fact, this report points out the errors provided and not respecting the IEC specifications thanks to RiseClipse tests, which allowed to modify EDF converter tools by adding the mandatory information trying to reach a convergence of CDPSM and CGMES.

DisNetSimpl is a Matlab based tool developed by EDF R&D, and the shortname DisNet will also be used in the document.

The figure 2 represents the data grid according to CIM specifications (CGMES/CDPSM compliancy) using different tools and the interoperability phase between TSO and DSO using grid tools and data exchange platforms allowing to exchange necessary information.

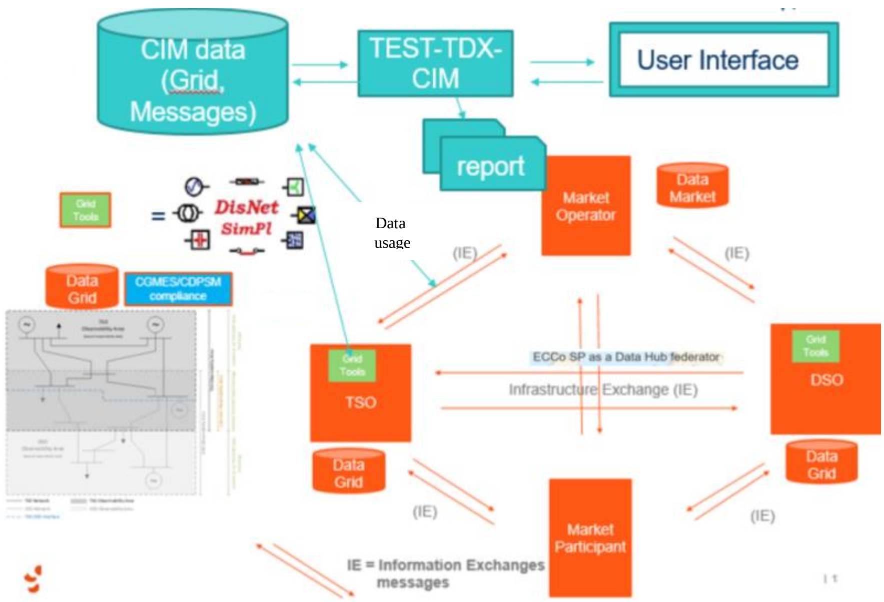


Figure 2: Coordination of Transmission and Distribution data eXchanges

IV. IOP tests

A. Objective

In this document, multiple validation tests were held on different datasets using two different tools (**DisNetSimPl** and **RiseClipse**). The purpose of these tests is to verify data consistency after passing through several converter or validation tools.

B. Dataset types (CDPSM, CGMES, MSITE,) and differences

The network models concerned in the IOP tests are the following:

- CDPSM (Common Distribution Power System Model): This data file is generated according to CDPSM specifications (IEC 61968-13) from real data sources in MSITE format (CIM with some EDF extensions) using a specific converter tool (MSITE-CDPSM). The files proposed and tested hereafter are based on CIM17 which is compatible with CIM100 (as fixed in 2018 by IEC TC57 working group 13).

- CGMES (Common Grid Model Exchange Standard): This dataset can be obtained by using EDF converter tool transforming a global CDPSM 2015 (CIM 17) file to global

CGMES 2.4 (CIM 16) file. The latter can be divided into fractioned profiles "Split CGMES 2.4.15" as shown below in the figure 3 and 4:

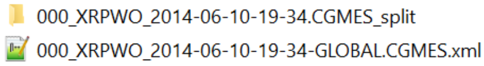


Figure 3: CGMES global file and split folder

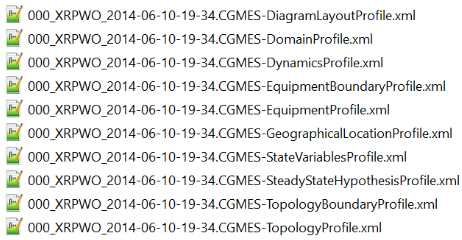


Figure 4: CGMES split files

Furthermore, CGMES global file can also be generated by a DisNet exportation in CIM 16 or CIM17 after an importation of the CDPSM global.

- MSITE: The converter tool ‘mercERDF-cimEDF’ is able to generate an MSITE 2.2 file from real data sources.

C. Validation tools

1. DisNetSimPl: Distribution Network Simulation Platform

Several functions are provided by this platform developed under Matlab, the following are the most important to our tests:

- Network Representation: Components are represented in different schematic ways with their characteristics. Treatments and modifications of the network are possible (aggregate LV to MV network, suppress switches …).
- Network information and load flow calculations: DisNet is able to generate power and voltage flows in each network node using OpenDSS, an open source simulator tool released by the EPRI (Electric Power Research Institute), in addition to network information about components numbers and characteristics.
  These results were compared before and after exportation in order to check the network data consistency.
- Importation and exportation: CDPSM CIM17 files are imported into DisNet and exported in CGMES CIM 16 or CIM17. A result comparison were held between the two files checking out the data reliability after the exportation.

2. RiseClipse: Web Version

This validation tool developed under Eclipse consists of validating an xml file in CDPSM 2.0 or CGMES 2.4.15 profiles. The output text file provide information about the network in addition to the existing errors in the xml. In our tests, the errors compatibility with IEC specifications should be checked and mentioned using Entreprise Architect showing the UML representation of the elements relations. A similar validation tool named CIMTool was able to test MSITE datasets because of the RiseClipse Web version that do not support this profile type yet.

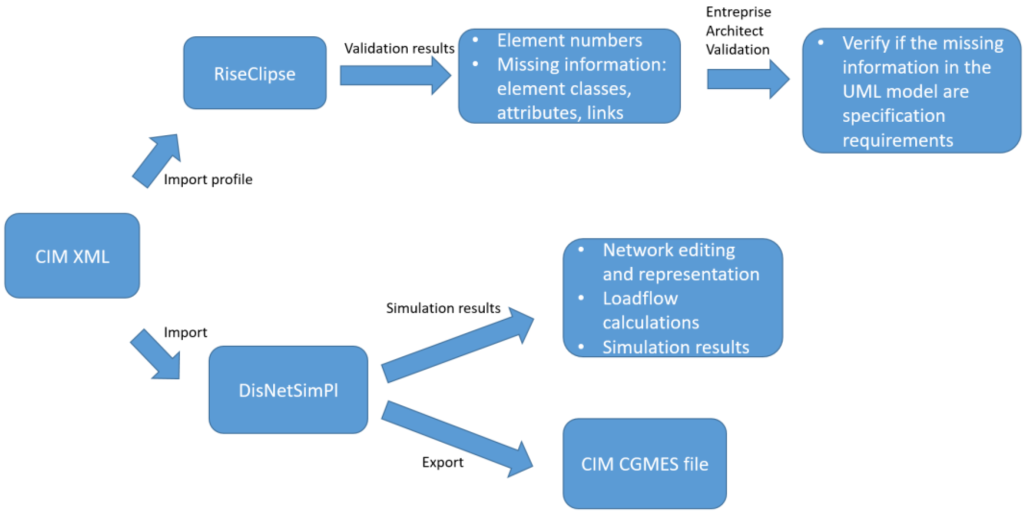


Figure 5: RiseClipse and DisNet Validation process

V. DITAM (Data Integration Toolbox And More)

A. Structure and Description

This EDF toolbox contains all the necessary information about networks data and their management. It describes the methods of data production and conversions from one format to another and shows the results provided by different validation tools.

The toolbox is divided into five sections as following:

- Modélisation CDPSM2015: Management of CDPSM for aggregation of split files into one fused dataset per example.
- Outils SEI (Système électrique insulaire): EDF entity managing the electrical system for French overseas departments.
- Production de données: It describes the ways to create network data in MSITE format from real data source and how to convert it into CDPSM xml file.
- Toute la base DITAM: This section groups all DITAM database (results, tools, datasets …).
- Référentiel des JDD: It refers to the results obtained by the tool to which is associated and a description of the xml file studied (data set).

Figure 6: DITAM Toolbox interface

B. “Référentiel des JDD” : explanations and modifications

In this part, network datasets are tested via different platforms. The objective is to save all the results, procedures and explanations with a clear description. Below are the networks tested and stocked in the toolbox and the corresponding testing paragraph in this document:

- MV CDPSM network: 000_XRPWO_2014-06-10-19-34-GLOBAL.cdpsm-c17 (§ V)
- MV CGMES network :000_XRPWO_2014-06-10-19-34-GLOBAL.CGMES (§ VIII)
- MV-LV CGMES fused network: 000_XRPWO_2014-06-10-19-34-GLOBAL_MVLV_fused (§ VII)
- LV CDPSM network : 000_XRPWOC0001-XRPWOC0010-LV_2015-02-20-16-10-GLOBAL.cdpsm-c17 (§ VI)
- DATA 1 CDPSM: TDX_EDF1_MV_DistNetwork_CDPSM_CIM100_EQ (§ X – A)
- DATA 2 CGMES: TDX_EDF2_MV DistNetWork_CGMES_CIM100 (§ X – C)
- DATA 2 CGMES exported: TDX_EDF2_MV DistNetWork_CGMES_CIM100 – EQ (§ X – E)
- DATA 3 CGMES: TDX_EDF3_MV DistNetWork_GLOBAL_CGMES_CIM100_DG – EQ (§ IX – A)

Here’s an illustration in figure 7 of these previous datasets generation:

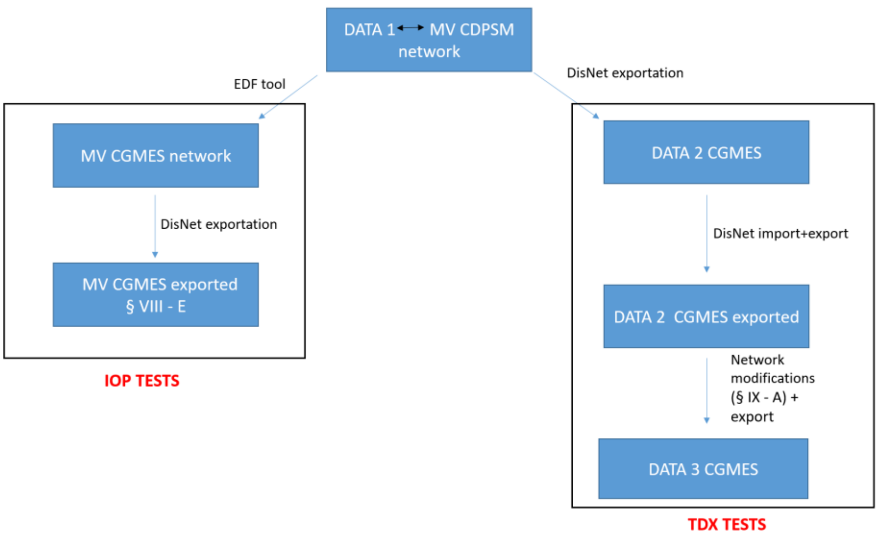


Figure 7: Datasets generation

C. Improvements for future tests

DITAM is a knowledge management tool allowing to collect information related to electrical network datasets. It helps the user to learn the way for generating network data from real sources and the procedures to convert from one dataset to another. The most important part of this toolbox is the description of the results (“Référentiel des JDD”) obtained by different validation tools.

In order to enhance the existing information of this platform, more datasets should be tested and implemented in this toolbox. Here are some examples of future improvements that can be done:

- Comparison of load flow results generated directly by OpenDSS after an importation of XML file and the results obtained by DisNet (using OpenDSS).
- Display the missing information checked by validation tools after the conversion from one dataset to another (MSITE→CDPSM→CGMES).
- Modification of the converter tools by adding the mandatory attributes according to specification and re-testing.

VI. MV CDPSM DATASET NETWORK

A. Description and Representation

This network is composed from one primary substation with a source of 63 kV feeding three transformers HV/MV (63kV/20 kV) connected to an MV transmission network that supply a distribution network through different MV/LV transformers.

The dataset is obtained from the converter tool described in details on DITAM (Section “production des données”) transforming an MSITE file to CDPSM CIM100 version 2017 compatible. It is imported on DisNet via the CGMES window by selecting the global combined profiles file displayed below:

Dataset name	000_XRPWO_2014-06-10-19-34-GLOBAL

DISTRIBUTION_NETWORK_000_XRPWO_2016-07-12

Combined profiles:

000_XRPWO_2014-06-10-19-34-GLOBAL.cdpsm-c17

Splitted profiles:

000_XRPWO_2014-06-10-19-34_split

000_XRPWO_2014-06-10-19-34-Asset.cdpsm-c17
000_XRPWO_2014-06-10-19-34-Catalog.cdpsm-c17
000_XRPWO_2014-06-10-19-34-DiagramLayout.cdpsm-c17
000_XRPWO_2014-06-10-19-34-ElectricalProperties.cdpsm-c17
000_XRPWO_2014-06-10-19-34-Functional.cdpsm-c17
000_XRPWO_2014-06-10-19-34-Geographical.cdpsm-c17
000_XRPWO_2014-06-10-19-34-StateVariables.cdpsm-c17
000_XRPWO_2014-06-10-19-34-SteadyStateHypothesis.cdpsm-c17
000_XRPWO_2014-06-10-19-34-Topology.cdpsm-c17

Network Representation:

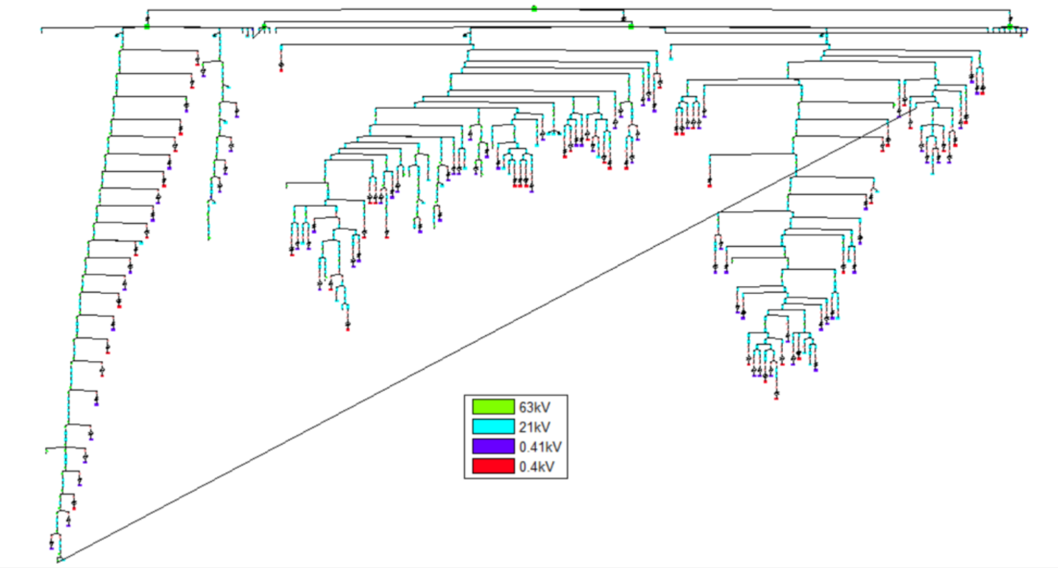


Figure 8: Hierarchical view of MV CDPSM Network on DisNet

B. DisNet Validation

1. Network Information

DisNetSimPl is also able to provide a geographical representation of the grid asset (Figure 8):

- Energy Sources are represented by a black dot.
- Line segments are represented by blue or brown break-lines whether the segment is overhead or underground.
- Switches are represented by triangles (green, yellow, light blue) depending on their type (Breaker, Disconnector, Fuse, LoadBreakSwitch…)
- Transformers are represented by large blue dots.
- Loads are represented by cyan squares.
- MV power generators are represented by orange plus signs.

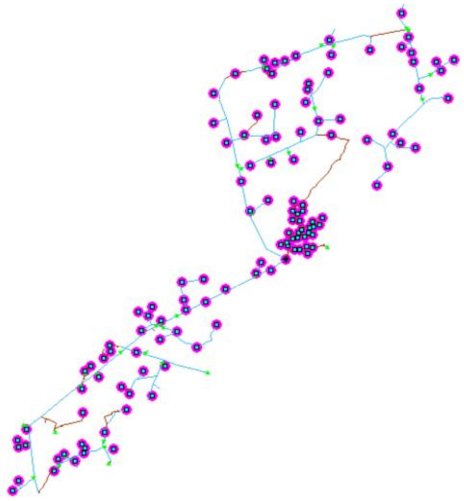


Figure 9: Geographical Representation of MV CDPSM Network

The Figure 10 below shows the MV network information providing the number of the nodes and components:

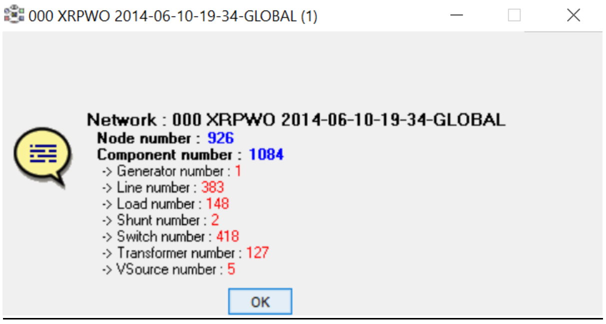
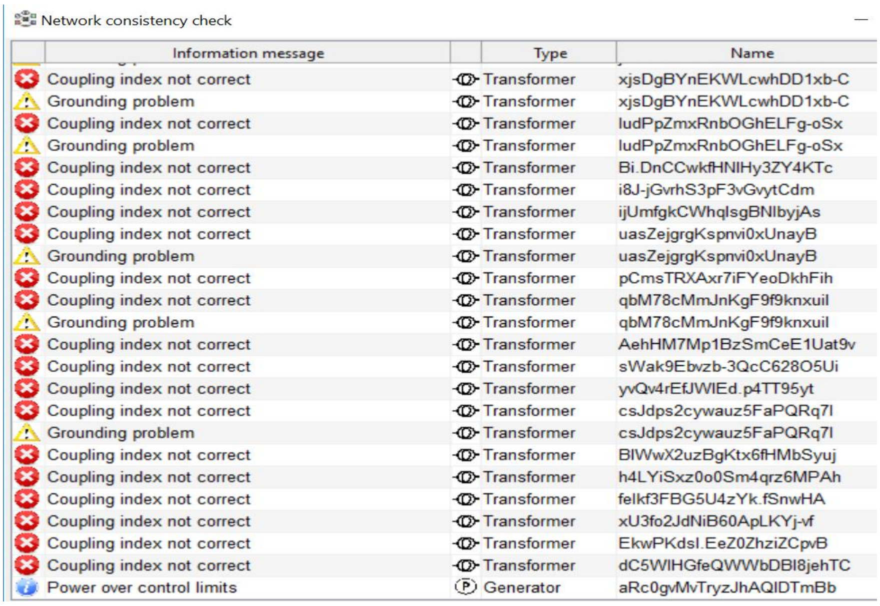


Figure 10: Network Information

A detailed excel file describing all the network components with their characteristics and references is uploaded on DITAM.

By checking the network consistency on DisNet, some errors, warnings and information appears (Figure 11):

- Warning: Many transformers are not grounded (primary and secondary)
- Error: Incorrect coupling index. In fact, the coupling index is fixed to 0 on DisNet because of OpenDSS that do not read this parameter while in reality a D/Y transformer connection is associated to an index equal to 11 in France. **In any case, this parameter will not affect any results and that is why DisNet allows the execution normally**.
- Information: Reactive power over control limits



Network consistency check

Information message	Type	Name
Coupling index not correct	Transformer	xjsDgBYnEKWLcwhDD1xb-C
Grounding problem	Transformer	xjsDgBYnEKWLcwhDD1xb-C
Coupling index not correct	Transformer	ludPpZmxRnbOGhELFg-oSx
Grounding problem	Transformer	ludPpZmxRnbOGhELFg-oSx
Coupling index not correct	Transformer	Bi.DnCCwkfHNIHy3ZY4KTc
Coupling index not correct	Transformer	i8J-jGvrhS3pF3vGvytCdm
Coupling index not correct	Transformer	ijUmfgkCWhqlsgBNIbyjAs
Coupling index not correct	Transformer	uasZejgrgKspnvi0xUnayB
Grounding problem	Transformer	uasZejgrgKspnvi0xUnayB
Coupling index not correct	Transformer	pCmsTRXAxr7iFYeoDkhFih
Coupling index not correct	Transformer	qbM78cMmJnKgF9f9knxuil
Grounding problem	Transformer	qbM78cMmJnKgF9f9knxuil
Coupling index not correct	Transformer	AehHM7Mp1BzSmCeE1Uat9v
Coupling index not correct	Transformer	sWak9Ebvzb-3QcC628O5Ui
Coupling index not correct	Transformer	yvQv4rEfJWIEd.p4TT95yt
Coupling index not correct	Transformer	csJdps2cywauz5FaPQRq7l
Grounding problem	Transformer	csJdps2cywauz5FaPQRq7l
Coupling index not correct	Transformer	BIWwX2uzBgKtx6fHMbSyuj
Coupling index not correct	Transformer	h4LYiSxz0o0Sm4qrz6MPAh
Coupling index not correct	Transformer	felkf3FBG5U4zYk.fSnwHA
Coupling index not correct	Transformer	xU3fo2JdNiB60ApLKYj-vf
Coupling index not correct	Transformer	EkwPKdsl.EeZ0ZhziZCpvB
Coupling index not correct	Transformer	dC5WIHGfeQWWbDBI8jehTC
Power over control limits	Generator	aRc0gvMvTryzJhAQIDTmBb

Figure 11: Network Consistency

2. Loadflow results

The loadflow simulation performed by OpenDSS is launched in current network mode. It is able to calculate the voltage and power quantities for all network nodes and components. The node voltage results obtained for MV CDPSM network are displayed in Figure 12.

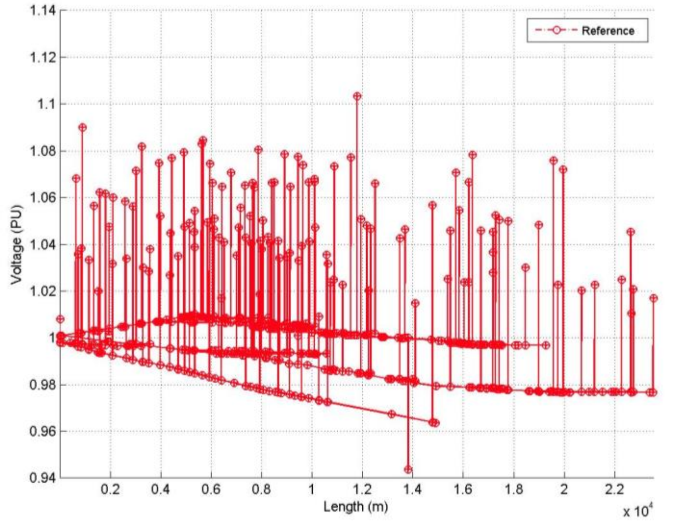


Figure 12: Voltage Levels for all network nodes

A detailed excel file (exported from DisNet) describing all the voltage and power flows through each network component is uploaded on DITAM for MV CDPSM.

Voltage node levels can also be displayed on the network representation directly in % showing as well the voltage drop through each element (Figure 13).

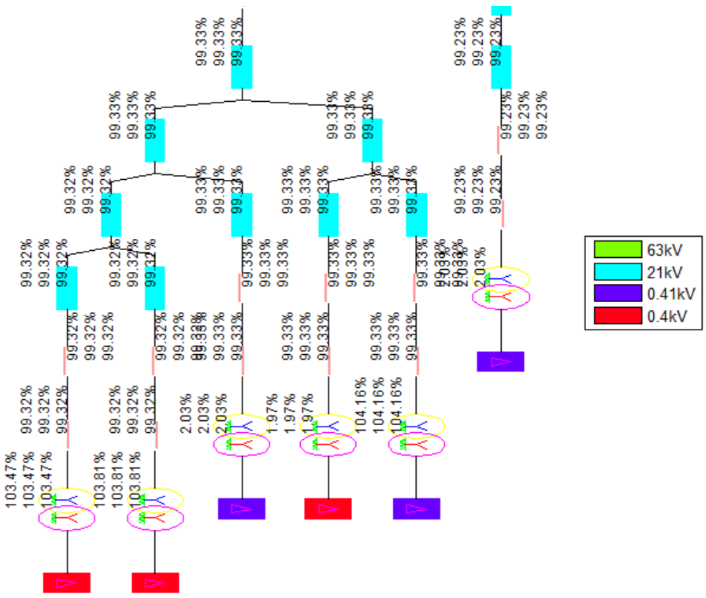


Figure 13: Capture example of voltage drop in %

VII. LV CDPSM DATASET NETWORK

A. Description and Representation

The LV distribution network model is composed from the loads uphill the MV/LV transformers in 2 of 4 feeders of the MV network. These transformers are dropped and replaced by source components in order to calculate the voltage and power flows.

The source of this dataset is an MSITE file transformed to CDPSM through a converter tool described in details on DITAM (section "Production des données")

Dataset name	000_XRPWO_LV-2016-07-13

DISTRIBUTION_NETWORK_000_XRPWO_LV-2016-07-13

Combined profiles:

000_XRPWOC0001-XRPWOC0010-LV_2015-02-20-16-10-GLOBAL.cdpsm-c17

Splitted profiles:

000_XRPWOC0001-XRPWOC0010-LV_2015-02-20-16-10_split

- 000_XRPWOC0001-XRPWOC0010-LV_2015-02-20-16-10-Asset.cdpsm-c17
- 000_XRPWOC0001-XRPWOC0010-LV_2015-02-20-16-10-Catalog.cdpsm-c17
- 000_XRPWOC0001-XRPWOC0010-LV_2015-02-20-16-10-Customers.cdpsm-c17
- 000_XRPWOC0001-XRPWOC0010-LV_2015-02-20-16-10-DiagramLayout.cdpsm-c17
- 000_XRPWOC0001-XRPWOC0010-LV_2015-02-20-16-10-ElectricalProperties.cdpsm-c17
- 000_XRPWOC0001-XRPWOC0010-LV_2015-02-20-16-10-Functional.cdpsm-c17
- 000_XRPWOC0001-XRPWOC0010-LV_2015-02-20-16-10-Geographical.cdpsm-c17
- 000_XRPWOC0001-XRPWOC0010-LV_2015-02-20-16-10-StateVariables.cdpsm-c17
- 000_XRPWOC0001-XRPWOC0010-LV_2015-02-20-16-10-SteadyStateHypothesis.cdpsm-c17
- 000_XRPWOC0001-XRPWOC0010-LV_2015-02-20-16-10-Topology.cdpsm-c17

Network Representation:

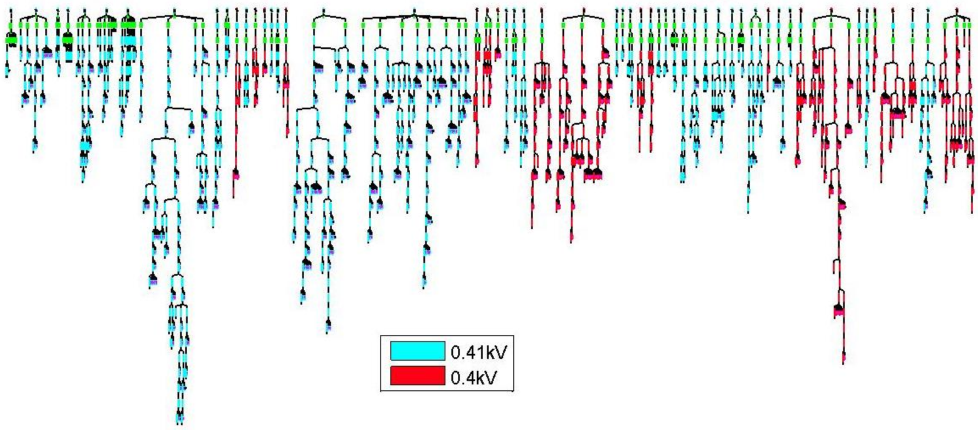


Figure 14: Hierarchical view of LV CDPSM network

B. DisNet Validation

1. Network Information

DisNetSimPl is also able to provide a geographical representation of the grid asset (Figure 15):

- Energy Sources are represented by a black dot.
- Line segments are represented by blue or brown break-lines whether the segment is overhead or underground.
- Switches are represented by triangles (green, yellow, light blue) depending on their type (Breaker, Disconnector, Fuse, LoadBreakSwitch…)
- Transformers are represented by large blue dots.
- Loads are represented by cyan squares.
- LV power generators are represented by green stars.

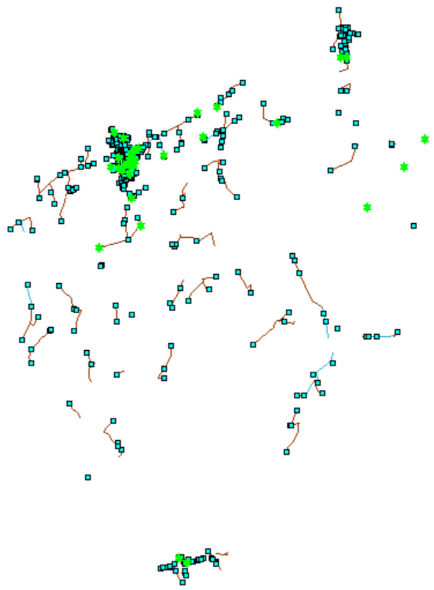


Figure 15: Geographical Representation of LV CDPSM network

The Figure 16 shows the LV CDPSM network information by providing the number of nodes and components:

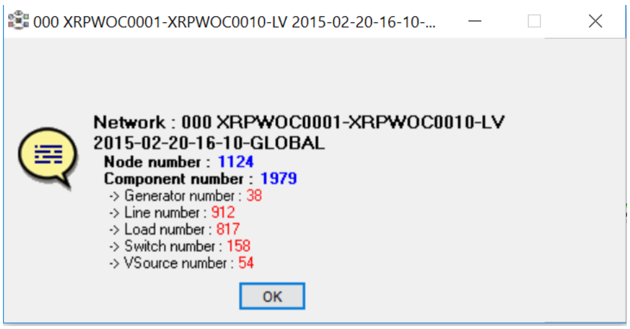
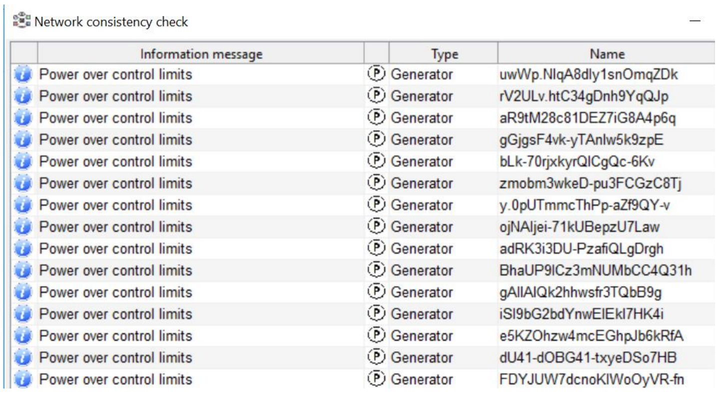


Figure 16: LV CDPSM Network Information

A detailed excel file describing all the network components with their characteristics and references is uploaded on DITAM.

By checking the network consistency some information notifications appears about generators reactive power over control limits (Figure 17):



Network consistency check

Information message	Type	Name
Power over control limits	Generator	uwWp.NIqA8dly1snOmqZDk
Power over control limits	Generator	rV2ULv.htC34gDnh9YqQJp
Power over control limits	Generator	aR9tM28c81DEZ7iG8A4p6q
Power over control limits	Generator	gGjgsF4vk-yTAnlw5k9zpE
Power over control limits	Generator	bLk-70rjxkyrQICgQc-6Kv
Power over control limits	Generator	zmobm3wkeD-pu3FCGzC8Tj
Power over control limits	Generator	y.0pUTmmcThPp-aZf9QY-v
Power over control limits	Generator	ojNAljei-71kUBepzU7Law
Power over control limits	Generator	adRK3i3DU-PzafiQLgDrgh
Power over control limits	Generator	BhaUP9ICz3mNUMbCC4Q31h
Power over control limits	Generator	gAIlAIQk2hhwsfr3TQbB9g
Power over control limits	Generator	iSI9bG2bdYnwElEkI7HK4i
Power over control limits	Generator	e5KZOhzw4mcEGhpJb6kRfA
Power over control limits	Generator	dU41-dOBG41-txyeDSo7HB
Power over control limits	Generator	FDYJUW7dcnoKIWoOyVR-fn

Figure 17: LV Network Consistency

2. Loadflow results

The node voltage results obtained for LV CDPSM network took all secondary substations into consideration. Each LV feeder is represented in Figure 18.

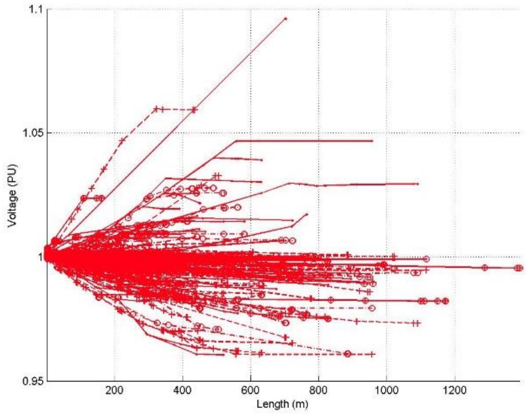


Figure 18: Voltage Levels for all LV network feeders

A detailed excel file (exported from DisNet) describing all the voltage and power flows through each network component is uploaded on DITAM for LV CDPSM.

DisNetSimPl is also able to display each secondary substation network separately. Figure 19 and figure 20 show the diagram layout and geographical view obtained for one of the secondary substations present in the LV dataset.

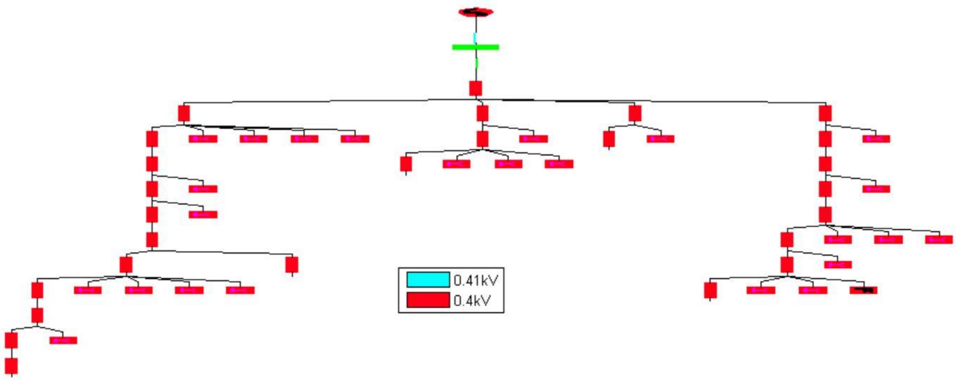


Figure 19: Hierarchical View for one secondary substation of the LV network

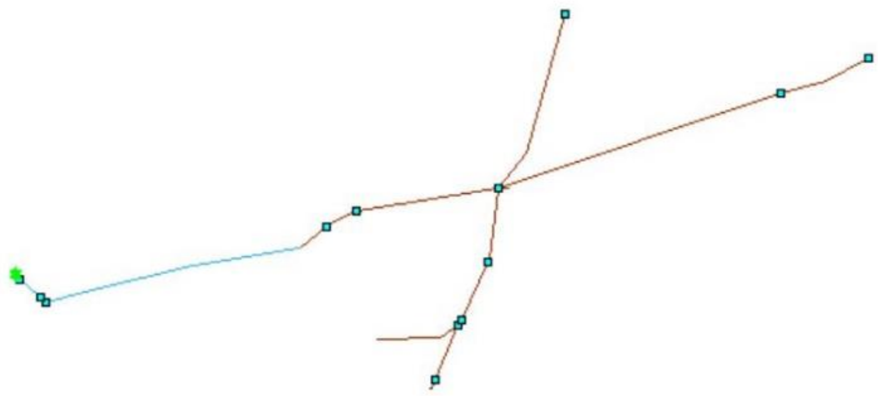


Figure 20: Geographical view for one secondary substation of the LV global network

N.B: LV power generators are represented by green stars and Loads by cyan squares.

The voltage level on each node of the secondary substation shown above is represented in figure 21 below:

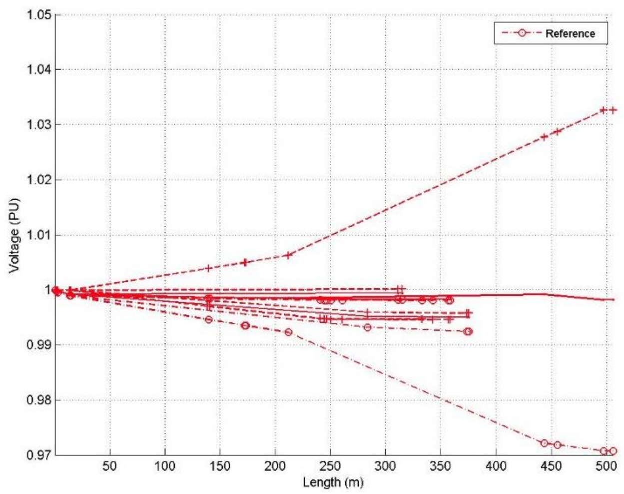


Figure 21: Voltage node levels for one secondary substation

Voltage node levels can also be displayed on the network representation directly in % showing as well the voltage drop through each element (Figure 22):

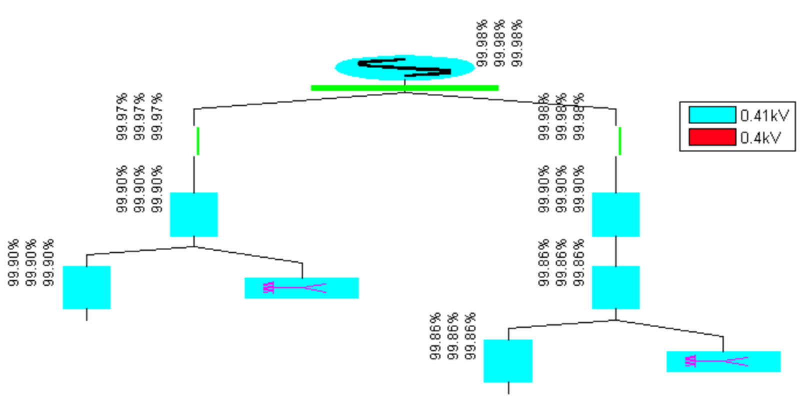


Figure 22: Capture example of voltage drop in %

C. Unbalanced system for LV dataset results

In this part, **we will force to unbalance some loads in the distribution network for every downstream of the MV/LV transformers replaced by sources and then export it into CGMES**.

The unbalance of the loads is made manually by replacing the parameter "is balanced?" with 'no' in the "edit component infos" label of any load. After that, the values of the active power P should be changed in a way to have different values on the three phases (+/- 10% from the active power on the phase B). Fixing the $\tan\varphi = 0.4$ (Reactive power Q is 40% of the active power P), the values of the reactive power demanded by the load are automatically generated (Figure 23).

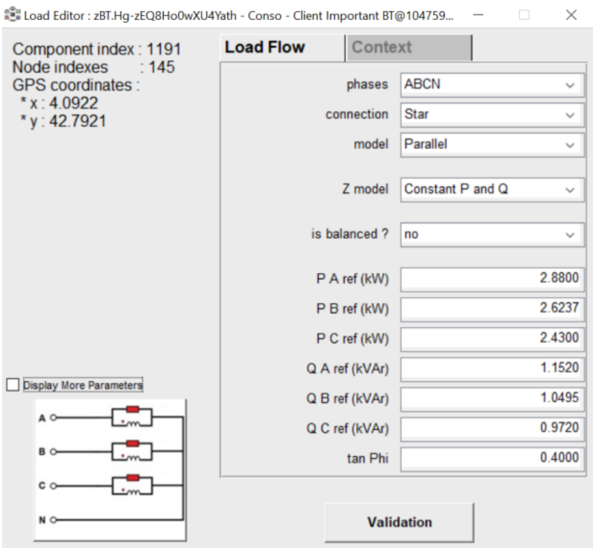


Figure 23: example of an unbalance load

<u>**N.B**</u>: An exportation in CGMES of the modified dataset network leads to an **initial LV CGMES dataset without any load modifications (all the loads are balanced again)**. **These modifications should be saved in Disnet format '.dst' and then compared to the results obtained by an LV CDPSM dataset**.

As a result of replacing balanced loads by some unbalanced ones in each LV network, we notice that voltage level is not affected in the network nodes which leads to an identical voltage profile as for a LV CDPSM dataset without modification (Figure 24).The maximum voltage difference between two similar nodes is about 0.3 %

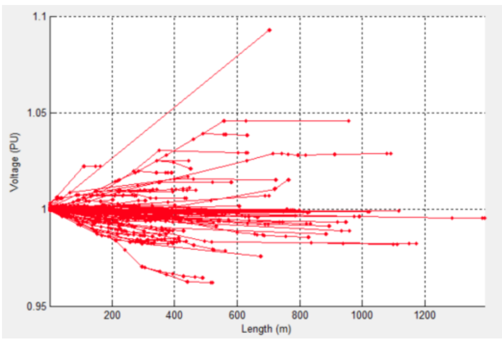


Figure 24: Voltage profile for LV dataset with unbalanced loads

Power flow results will definitely change for each phase in network components. In fact, unbalancing a load creates a difference between the current flowing in each phase. This disproportion of current at the load level will be extended to the components upstream. The active and reactive power values in these components (lines, switches…) will be directly affected by different values in each phase according to the modifications inside the concerned load.

Let's take an example of the unbalanced load described above after launching a load flow calculations by OpenDSS:

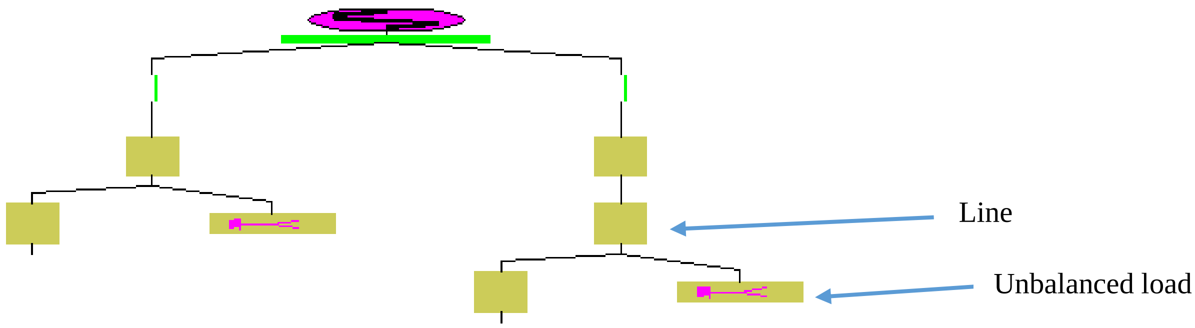


Figure 25: One LV network with unbalanced load

<u>Results:</u>

	V in (V)	V in (phi)	I in (A)	I in (phi)	P in (kW)	Q in (kVar)
AN	230.7041	359.9668	12.2537	338.1567	2.6246	1.0503
BN	230.7041	239.9668	12.2537	218.1567	2.6246	1.0503
CN	230.7041	119.9668	12.2537	98.1567	2.6246	1.0503
N	0	0	0	0	0	0
Total			1.0000e-06		7.8739	3.1509

Figure 26: Line loadflow results with balanced load

	V in (V)	V in (phi)	I in (A)	I in (phi)	P in (kW)	Q in (kVar)
AN	230.6465	359.9778	13.4555	338.1718	2.8822	1.1528
BN	230.7267	239.9617	12.2520	218.1479	2.6241	1.0511
CN	230.7737	119.9849	11.3439	98.1818	2.4303	0.9717
N	0	0	1.8284	132.7506	-1.0300e-04	-4.9000e-05
Total			9.9301e-16		7.9365	3.1756

Figure 27: Line loadflow results with unbalanced load

To conclude this part, the loadflow results of the LV network components are affected with the presence of an unbalanced load. The current is not proportional in each phase and the power values are changed according to the load modification (Figure 26 and 27).

VIII. MV-LV fused CGMES DATASET NETWORK

A. Description and Representation

This Network is resulting from the MV and LV networks concatenation. DisNetSimPl automatically removes the EnergySource, EnergyConsumer and GenerationUnits components directly connected to the LV busbar below a MV/LV transformer in order to obtain a consistent fused network representation. Furthermore, two secondary substations are not connected to the MV part of the network description. The dataset is obtained by an exportation from DisNet after a concatenation of the medium voltage and low voltage networks.

Dataset name	000_XRPWO_MVLV-2016-07-14

03_DISTRIBUTION_NETWORK_000_XRPWO_MVLV-2016-07-14

<u>Combined profiles</u>:

000_XRPWO_2014-06-10-19-34-GLOBAL_MVLV_fused.xml

<u>Splitted profiles</u>:

000_XRPWO_2014-06-10-19-34_MVLV_fused_split

- 000_XRPWO_2014-06-10-19-34_MVLV_fused-Asset.xml
- 000_XRPWO_2014-06-10-19-34_MVLV_fused-Catalog.xml
- 000_XRPWO_2014-06-10-19-34_MVLV_fused-Customers.xml
- 000_XRPWO_2014-06-10-19-34_MVLV_fused-DiagramLayout.xml
- 000_XRPWO_2014-06-10-19-34_MVLV_fused-ElectricalProperties.xml
- 000_XRPWO_2014-06-10-19-34_MVLV_fused-Functional.xml
- 000_XRPWO_2014-06-10-19-34_MVLV_fused-Geographical.xml
- 000_XRPWO_2014-06-10-19-34_MVLV_fused-StateVariables.xml
- 000_XRPWO_2014-06-10-19-34_MVLV_fused-SteadyStateHypothesis.xml
- 000_XRPWO_2014-06-10-19-34_MVLV_fused-Topology.xml

Network Representation:

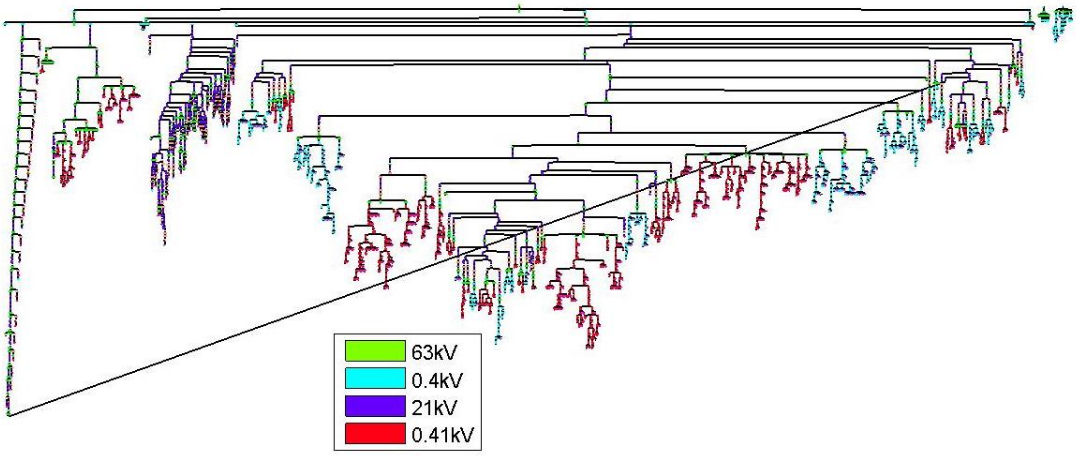


Figure 28: Hierarchical view of the MV-LV fused network

B. DisNet Validation

1. Network Information

DisNetSimPl is also able to provide a geographical representation of the grid asset (Figure 29):

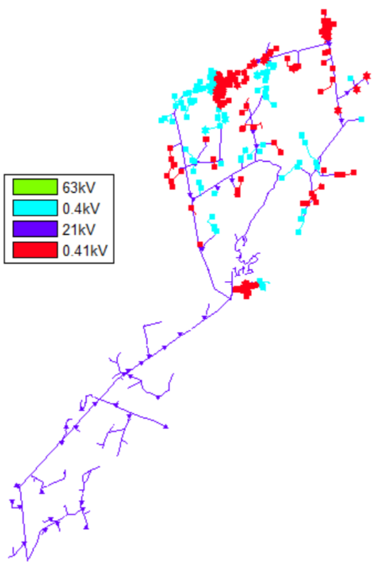


Figure 29: Geographical Representation of MV-LV fused network

The Figure 30 below shows the network information by providing the nodes and components numbers:

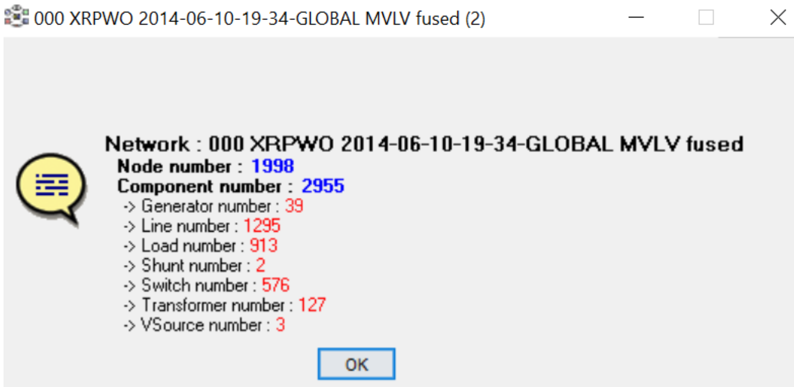
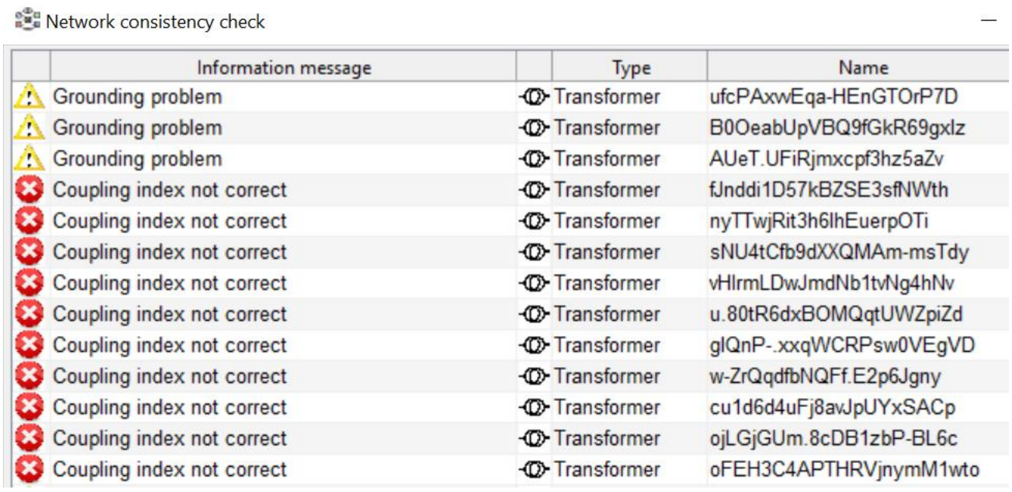


Figure 30: MV-LV fused network information

A detailed excel file describing all the network components with their characteristics and references is uploaded on DITAM for MV-LV fused network

By checking the network consistency some errors and warnings appears (Figure 31):

- Warnings: Some transformers are not grounded (primary and secondary)
- Errors: Incorrect coupling index (cf. MV CDPSM network consistency)



Network consistency check

Information message	Type	Name
Grounding problem	Transformer	ufcPAxwEqa-HEnGTOrP7D
Grounding problem	Transformer	B0OeabUpVBQ9fGkR69gxlz
Grounding problem	Transformer	AUeT.UFiRjmxcpf3hz5aZv
Coupling index not correct	Transformer	fJnddi1D57kBZSE3sfNWth
Coupling index not correct	Transformer	nyTTwjRit3h6lhEuerpOTi
Coupling index not correct	Transformer	sNU4tCfb9dXXQMAm-msTdy
Coupling index not correct	Transformer	vHlrmLDwJmdNb1tvNg4hNv
Coupling index not correct	Transformer	u.80tR6dxBOMQqtUWZpiZd
Coupling index not correct	Transformer	glQnP-.xxqWCRPsw0VEgVD
Coupling index not correct	Transformer	w-ZrQqdfbNQFf.E2p6Jgny
Coupling index not correct	Transformer	cu1d6d4uFj8awJpUYxSACp
Coupling index not correct	Transformer	ojLGjGUm.8cDB1zbP-BL6c
Coupling index not correct	Transformer	oFEH3C4APTHRVjnymM1wto

Figure 31: Network Consistency

2. Loadflow results

The load flow simulation performed by OpenDSS is launched in current network mode. It is able to calculate the voltage and power quantities for all network nodes and components. The node voltage results obtained for MV-LV fused CGMES network took all MV and LV feeders into consideration (Figure 32).

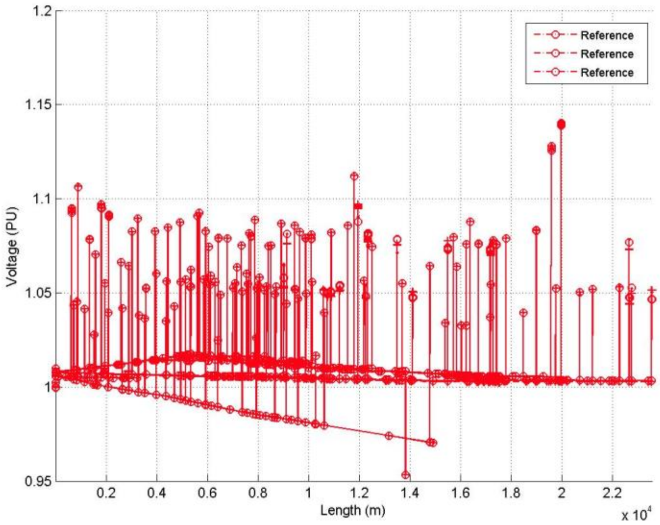


Figure 32: Voltage Levels for all MV and LV network feeders

A detailed excel file (exported from DisNet) describing all the voltage and power flows through each network component is uploaded on DITAM for MV-LV fused CGMES.

IX. MV CGMES DATASET NETWORK

A. Description and Representation

This network is obtained from MV CDPSM network using EDF converter tool. The objective is to compare the results of the two datasets in order to test the network reliability through this converter tool.

Dataset name	000_XRPWO_CGMES-2016-07-13

04_DISTRIBUTION_NETWORK_000_XRPWO_CGMES-2016-07-13

Combined profiles:

000_XRPWO_2014-06-10-19-34-GLOBAL.CGMES.xml

Splitted profiles:

000_XRPWO_2014-06-10-19-34.CGMES_split

- 000_XRPWO_2014-06-10-19-34.CGMES-DiagramLayoutProfile.xml
- 000_XRPWO_2014-06-10-19-34.CGMES-DomainProfile.xml
- 000_XRPWO_2014-06-10-19-34.CGMES-DynamicsProfile.xml
- 000_XRPWO_2014-06-10-19-34.CGMES-EquipmentBoundaryProfile.xml
- 000_XRPWO_2014-06-10-19-34.CGMES-EquipmentProfile.xml
- 000_XRPWO_2014-06-10-19-34.CGMES-GeographicalLocationProfile.xml
- 000_XRPWO_2014-06-10-19-34.CGMES-StateVariablesProfile.xml
- 000_XRPWO_2014-06-10-19-34.CGMES-SteadyStateHypothesisProfile.xml
- 000_XRPWO_2014-06-10-19-34.CGMES-TopologyBoundaryProfile.xml
- 000_XRPWO_2014-06-10-19-34.CGMES-TopologyProfile.xml

Network Representation:

The representation in Hierarchical view in DisNet will be the same as for the CDPSM network:

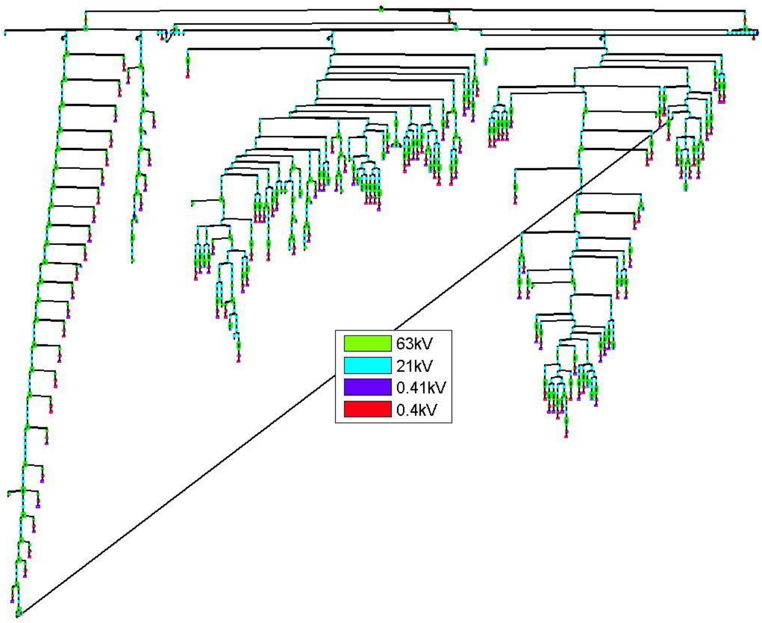


Figure 33: Hierarchical view of MV CGMES network

B. DisNet Validation

1. Network Information

Identically as for the CDPSM network, DisNetSimPl is also able to provide a geographical representation of the grid asset (Figure 34):

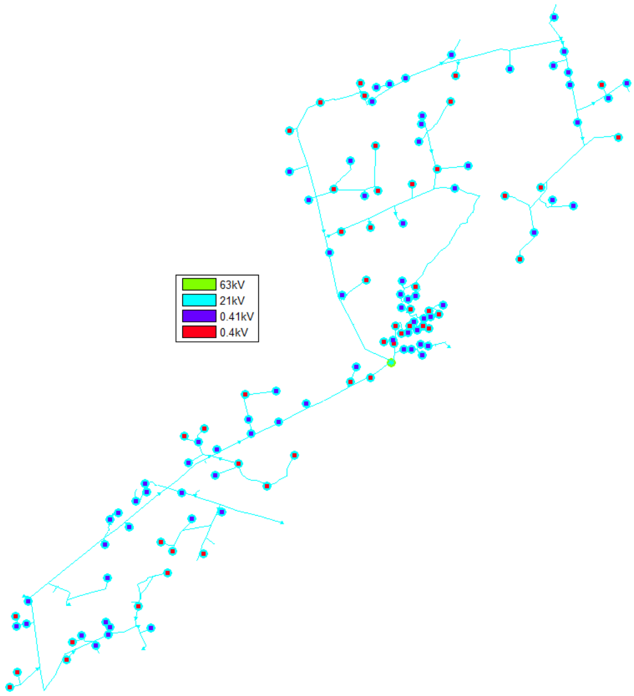


Figure 34: Geographical Representation of MV CGMES network

As before, figure 35 provide information about the MV network by showing the number of nodes and components:

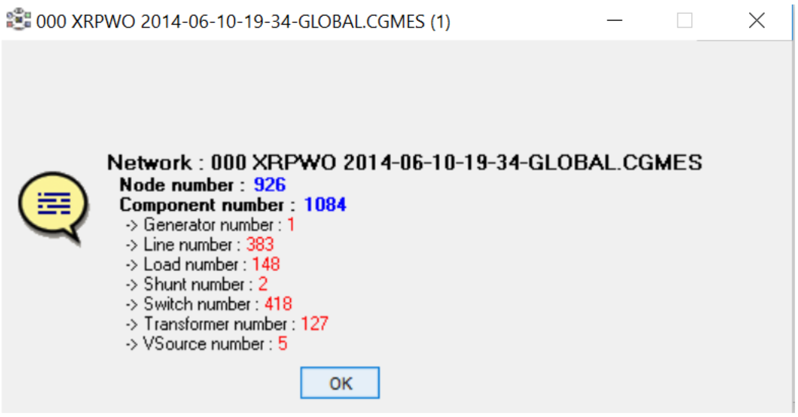
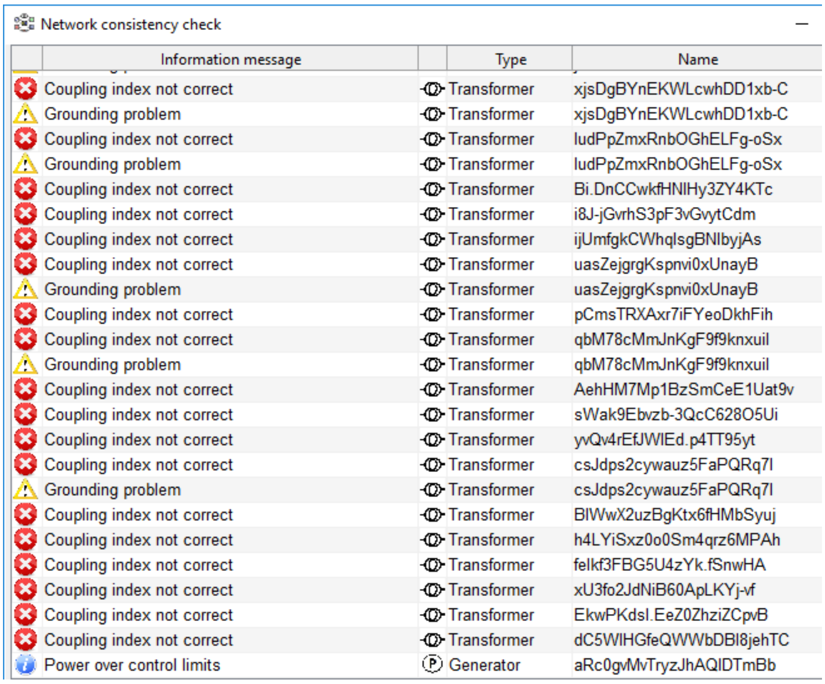


Figure 35: MV CGMES Network Information

A detailed excel file describing all the network components with their characteristics and references is uploaded on DITAM for MV CGMES.

By checking the network consistency, some errors, warnings and information appears (figure 36):

- Warning: Many transformers are not grounded (primary and secondary)
- Error: Incorrect coupling index (cf. MV CDPSM network consistency)
- Information: Reactive power over control limits



Network consistency check

Information message	Type	Name
Coupling index not correct	Transformer	xjsDgBYnEKWLcwhDD1xb-C
Grounding problem	Transformer	xjsDgBYnEKWLcwhDD1xb-C
Coupling index not correct	Transformer	ludPpZmxRnbOGhELFg-oSx
Grounding problem	Transformer	ludPpZmxRnbOGhELFg-oSx
Coupling index not correct	Transformer	Bi.DnCCwkfHNlHy3ZY4KTc
Coupling index not correct	Transformer	i8J-jGvrhS3pF3vGvytCdm
Coupling index not correct	Transformer	ijUmfgkCWhqlsgBNlbyjAs
Coupling index not correct	Transformer	uasZejgrgKspnvi0xUnayB
Grounding problem	Transformer	uasZejgrgKspnvi0xUnayB
Coupling index not correct	Transformer	pCmsTRXAxr7iFYeoDkhFih
Coupling index not correct	Transformer	qbM78cMmJnKgF9f9knxuil
Grounding problem	Transformer	qbM78cMmJnKgF9f9knxuil
Coupling index not correct	Transformer	AehHM7Mp1BzSmCeE1Uat9v
Coupling index not correct	Transformer	sWak9Ebvzb-3QcC628O5Ui
Coupling index not correct	Transformer	yvQv4rEfJWIEd.p4TT95yt
Coupling index not correct	Transformer	csJdps2cywauz5FaPQRq7l
Grounding problem	Transformer	csJdps2cywauz5FaPQRq7l
Coupling index not correct	Transformer	BlWwX2uzBgKtx6fHMbSyuj
Coupling index not correct	Transformer	h4LYiSxz0o0Sm4qrz6MPAh
Coupling index not correct	Transformer	felkf3FBG5U4zYk.fSnwHA
Coupling index not correct	Transformer	xU3fo2JdNiB60ApLKYj-vf
Coupling index not correct	Transformer	EkwPKdsl.EeZ0ZhziZCpvB
Coupling index not correct	Transformer	dC5WIHGfeQWWbDBl8jehTC
Power over control limits	Generator	aRc0gvMvTryzJhAQIDTmBb

Figure 36: Network Consistency

2. Loadflow results

The load flow simulation performed by OpenDSS is launched in current network mode. It is able to calculate the voltage and power quantities for all network nodes and components. The node voltage results obtained for MV CGMES network are shown below in Figure 37.

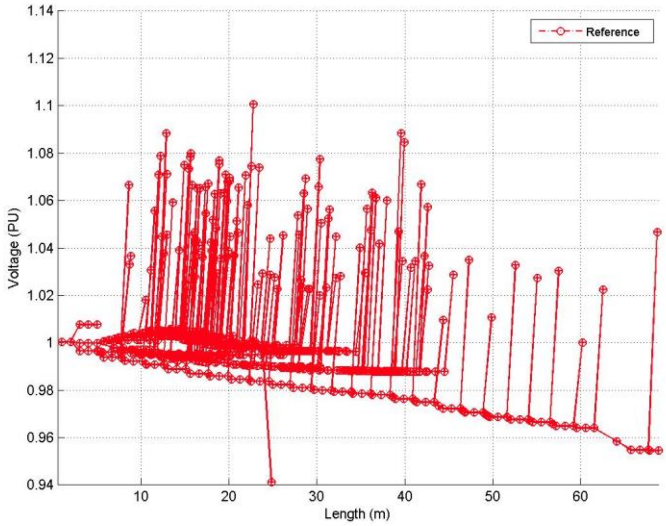


Figure 37: Voltage Levels in all MV CGMES nodes

A detailed excel file (exported from DisNet) describing all the voltage and power flows through each network component is uploaded on DITAM for MV CGMES.

C. Results Analogy between MV CDPSM and MV CGMES datasets

In this paragraph, we are interested in comparing the network characteristics and the load flow results between CDPSM and CGMES (obtained by the EDFconverter tool) datasets after a DisNet importation.

DisNet offers the option to export an excel file describing the network components (lines, loads, generators…) characteristics and information.

By starting firstly with lines comparison, we end up with the following differences (Figure 38):

- Lines conductors changed to 7 CU
- All lines become type "Aerien" in CGMES after some of them were type "Souterrain" in CDPSM
- Lines model changed to 7_CU
- The maximum current permissible in all lines changed to 1000 A in CGMES after it has different values depending on the lines (127 A, 135 A,144 A, 395 A …) in CDPSM

	CDPSM				CGMES			
name	conductor	type	model	I_max (A)	conductor	type	model	I_max (A)
i0ttkepFFcQtTocvhsjLHu	p-eNitxwPyPcQ3D9P3ZbPF	Souterrain	p-eNitxwPyPcQ3D9P3ZbPF	295	7 CU	Aerien	7_CU	1000
kujtXk5ce.0d.AvzwyclCj	t8QYQpUzdYPJekp7qePchF	Aerien	t8QYQpUzdYPJekp7qePchF	127	7 CU	Aerien	7_CU	1000
dnoMvmnAOxjkulsc8wLi3l	degkQaGhscUg6xsIAVwy7h	Souterrain	degkQaGhscUg6xsIAVwy7h	220	7 CU	Aerien	7_CU	1000
tRH32fJuHWVxYAa38jgRkC	sqWx6HYdt47-c4E1O-x1gi	Aerien	sqWx6HYdt47-c4E1O-x1gi	144	7 CU	Aerien	7_CU	1000
kNxkKWmA0ad5GjwFDeCCLF	nLoG6NzhFx351Aq-Bkk87j	Aerien	nLoG6NzhFx351Aq-Bkk87j	135	7 CU	Aerien	7_CU	1000
cWL.usFnNIthSdiKPDWOAr	sqWx6HYdt47-c4E1O-x1gi	Aerien	sqWx6HYdt47-c4E1O-x1gi	144	7 CU	Aerien	7_CU	1000
sb1swhTtdJwrhSpvOb4b5s	nLoG6NzhFx351Aq-Bkk87j	Aerien	nLoG6NzhFx351Aq-Bkk87j	135	7 CU	Aerien	7_CU	1000
ougv6tUl39x5YIvGUmVQDf	r21OACzo-X9Gm4ikB7bmom	Aerien	r21OACzo-X9Gm4ikB7bmom	364	7 CU	Aerien	7_CU	1000
F0uEGRvjVutwrLixarSe3A	r21OACzo-X9Gm4ikB7bmom	Aerien	r21OACzo-X9Gm4ikB7bmom	364	7 CU	Aerien	7_CU	1000
F1RDEuYeXSJoWNcb8HZyMw	p-eNitxwPyPcQ3D9P3ZbPF	Souterrain	p-eNitxwPyPcQ3D9P3ZbPF	295	7 CU	Aerien	7_CU	1000
wCEocl1kYvlhr7FOWLJeZc	sqWx6HYdt47-c4E1O-x1gi	Aerien	sqWx6HYdt47-c4E1O-x1gi	144	7 CU	Aerien	7_CU	1000
oQ2mUsjovAWm2ilZRmJihr	sqWx6HYdt47-c4E1O-x1gi	Aerien	sqWx6HYdt47-c4E1O-x1gi	144	7 CU	Aerien	7_CU	1000
tzHloJzeFY6mFJwc4bXZ8p	nLoG6NzhFx351Aq-Bkk87j	Aerien	nLoG6NzhFx351Aq-Bkk87j	135	7 CU	Aerien	7_CU	1000
kiCO-Occ.1XufSciVoWR2p	bb1P0KeqilCCt2zBojb.Ws	Souterrain	bb1P0KeqilCCt2zBojb.Ws	295	7 CU	Aerien	7_CU	1000
iRIZ.snjtxjesnhex.X52y	AfNML2amnopfwDuhG9z3Ea	Souterrain	AfNML2amnopfwDuhG9z3Ea	220	7 CU	Aerien	7_CU	1000
s8XOpvVdivlxyikDMMJH9A	r21OACzo-X9Gm4ikB7bmom	Aerien	r21OACzo-X9Gm4ikB7bmom	364	7 CU	Aerien	7_CU	1000
alh8LxhrE6tXUDFRaOztba	t8QYQpUzdYPJekp7qePchF	Aerien	t8QYQpUzdYPJekp7qePchF	127	7 CU	Aerien	7_CU	1000
dgoX9vQuFpPNfJiVuN9n7p	t8QYQpUzdYPJekp7qePchF	Aerien	t8QYQpUzdYPJekp7qePchF	127	7 CU	Aerien	7_CU	1000
AdHsbwGaQblFNWjfiPE-cp	t8QYQpUzdYPJekp7qePchF	Aerien	t8QYQpUzdYPJekp7qePchF	127	7 CU	Aerien	7_CU	1000
bvhemlThgQ7UuqEQBdzm9C	t8QYQpUzdYPJekp7qePchF	Aerien	t8QYQpUzdYPJekp7qePchF	127	7 CU	Aerien	7_CU	1000
n2wSiL.wdMeLhpeBWedzas	sqWx6HYdt47-c4E1O-x1gi	Aerien	sqWx6HYdt47-c4E1O-x1gi	144	7 CU	Aerien	7_CU	1000

Figure 38: Difference between some CDPSM and CGMES line characteristics

After the exportation in CGMES, these parameters were not found in the line model so they were added to a standard values by default.

Secondly, the total reactive power values generated by the two shunt compensators placed on the main feeder downstream the HV/MV transformers has been decreased after the transit from CDPSM to CGMES file (Figure 39).

	CDPSM		CGMES	
name	total_Q (kVar)	Q_section	total_Q (kVar)	Q_section
l9gntXZxw2TlO7nAmwSGbl	3000	50	2972,651605	49,5441934
sbiDGiRoHXFkiQfaxcTesv	1200	100	1189,060642	99,0883868

Figure 39: Shunts Reactive power Q difference between CDPSM and CGMES

This drop in reactive power Q values generated by the shunts from one file to another leads to a power factor reduction. The transmittable active power is decreased and the power flow in the network will be affected. Hereafter, we will compare the load flow results between CDPSM and CGMES to check if such a difference in Q values could have an important effect.

Finally, some network switches changed type from “jumper” to “switch” that is not a specific type because a switch can be a jumper, a breaker, a disconnector, a loadbreakswitch…The reason after this modification is the CGMES normalization model in Entreprise Architect that do not contain a jumper class inherited from a switch class, so all the jumpers in the CDPSM dataset will turn out by default to switch type (Figure 40).

	CDPSM	CGMES
name	switch_type	switch_type
mXt-KfVB6c6UfSyuBlWdvn	Jumper	Switch
j-VLMxmwsysKs0tTfdcTli	Jumper	Switch
BX3Zhz5tVdwb9IpPOo0eJi	Jumper	Switch
yRXAv5VaMQT2QjoHqN.FDn	Jumper	Switch
bQMhs4ue51bWZgcp7b7g0g	Jumper	Switch
Dua1vfkasw2RN3x0k43R.F	Jumper	Switch
yNLPsuancACGnYulv.bypn	Jumper	Switch
xm7bv8gnZtOTpIApS0O8Av	Jumper	Switch
r0br.E3iLIQxAQmdA9j-Dz	Jumper	Switch
yGqckMsrvdH46YgWLT5DOe	Jumper	Switch
AZ7IbKKDdUMXtFAaaX.zbf	Jumper	Switch

Figure 40: Some network switches changing type

Therefore, a load flow execution is launched for CDPSM and CGMES datasets after an importation on DisNet (via OpenDSS). The results are exported in excel files (uploaded on DITAM for each network) in order to evaluate the difference.

The excel file generated provide the real and the imaginary part of the voltage magnitude in each node. Voltage level in p.u. is calculated by dividing the module of the complex number by the base voltage depending on the node (63 kV, 21 kV and 480 V).After a comparison between the voltage flows in the CDPSM and CGMES networks, **we can deduce that the values are almost the same and the maximum gap value is 0.009 p.u**.

This result was predictable from the fact that lines characteristics (resistance and inductance) doesn't change after the passage to a CGMES dataset and those are responsible of the voltage drop through the network.

Despite all the dissimilarities mentioned above, power flows in the lines and all other components (loads, switches, generators…) between the two datasets are comparable.

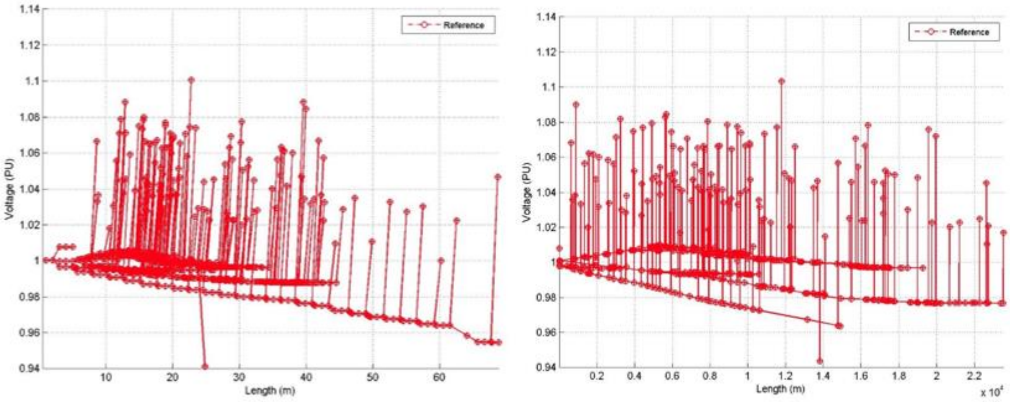


Figure 41: Voltage profile for CDPSM and CGMES MV network

In the figure 41, the scale of the 'X' axis is different because of the lines length (m) and resistance (ohm/m) that changed scale after the conversion to a CGMES file in the network information file (cf. network information excel file uploaded on DITAM).

The figure 42 is an example of this modification realized by DisNet:

CDPSM			CGMES		
length (m)	r_ph (Ohm/m)	x_ph (Ohm/m)	length (m)2	r_ph (Ohm/m)3	x_ph (Ohm/m)4
397,2	0,0002	0,0001	0,3972	0,208	0,118
181,2	0,0002	0,0001	0,1812	0,209	0,104
292,8	0,0002	0,0001	0,2928	0,209	0,115
68,4	0,0002	0,0001	0,0684	0,209	0,104
172,8	0,0002	0,0001	0,1728	0,208	0,118

Figure 42: The order magnitude modification of lines characteristics after a CGMES exportation

To conclude this part, we can affirm that a passage from a reference CDPSM dataset to a CGMES dataset via EdF converter tool doesn't affect the load flow results calculated by OpenDSS and provided by DisNet (cf. load flow results on DITAM).

D. MV CGMES exportation via DisNet from a CDPSM importation

In this case, the CGMES dataset is generated using a DisNet exportation in CIM16 v2013 or CIM17 v2016. It is important to compare the network before and after the exportation in order to test if the platform leads to missing information.

After a CDPSM importation on DisNet, we noticed an error notification on Matlab command window while trying to export it in CGMES (CIM 16 or CIM17).This error indicates the absence of the element 'control' responsible of generating a shunt structure (Figure 43):

```
Reference to non-existent field 'is_controlled'.

Error in CGMES.Writer.Network.Shunt (line 36)
    if strcmpi(equipment.ct_infos{1}.is_controlled,'yes')

Error in CGMES.Writer.Network.Create (line 71)
        structure_eq = ...

Error in CGMES.Writer.Write_NW (line 48)
    [eq_xml_structure,tp_xml_structure] = ...

Error in IHM.IO.CGMES.Write_NW (line 40)
    CGMES.Writer.Write_NW(c_infos, c_links, eq_file, tp_file, ...

Error while evaluating uimenu Callback
```

Figure 43: Exportation error generated by Matlab

After forcing a CGMES file generation by a debugging, we end up with a dataset having two shunt compensators in star topology with generated reactive power equal to zero kVAR. Therefore, when load flow calculations will be launched, a short circuit is created at the shunt levels and all the current will flow into them (V ~ 0). All the other components will not see any current on their terminals (I ~ 0) which means that active and reactive power values will be zero (Figure 44):

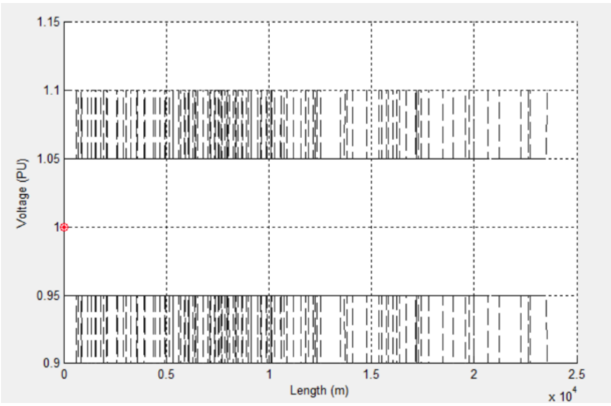


Figure 44: Voltage profile after exportation in CGMES

For this reason, reactive power Q are introduced again with the similar values in the CDPSM dataset in order to obtain load flow results.

Identically as above in paragraph C, network information has been compared through the excel files exported with DisNet. The only difference noticed compared to the CDPSM dataset is the concatenation of the string “HTA_” as prefix and the string “_Souterrain_CIPh” as suffix to the conductor and model lines parameters (Figure 45):

	CDPSM	CGMES
name	conductor	conductor
name	conductor	conductor
ngGRw2nzW8k0WTC8-rDt9t	bb1P0KeqilCCt2zBojb.Ws	HTA_bb1P0KeqilCCt2zBojb.Ws_Souterrain_CIPh
mm5ThQmkjwR7b3ndX1AMSt	DmllbxPeZfJzvzvBWw1WKn	HTA_DmllbxPeZfJzvzvBWw1WKn_Souterrain_CIPh
fMrqpg8E7mNkXZvY6zZ5Zc	bmzFLuub4Cp7wOgkydsM-w	HTA_bmzFLuub4Cp7wOgkydsM-w_Souterrain_CIPh
fhDNXXLC0oYw24xSXSfQko	DmllbxPeZfJzvzvBWw1WKn	HTA_DmllbxPeZfJzvzvBWw1WKn_Souterrain_CIPh
dZ1611krmrVNF9oyuSnKSh	bb1P0KeqilCCt2zBojb.Ws	HTA_bb1P0KeqilCCt2zBojb.Ws_Souterrain_CIPh
ERJhhalFpObkg-epYsag9B	DmllbxPeZfJzvzvBWw1WKn	HTA_DmllbxPeZfJzvzvBWw1WKn_Souterrain_CIPh
jXdBdkAnk48t7RbGHzAL-o	DmllbxPeZfJzvzvBWw1WKn	HTA_DmllbxPeZfJzvzvBWw1WKn_Souterrain_CIPh
pMcJsKCvueaJAeo.tnBtZA	qyYXDo6r9cdFxZrd-nw8dn	HTA_qyYXDo6r9cdFxZrd-nw8dn_Souterrain_CIPh
FsuR6o5i5F.vznklq9QmtA	DmllbxPeZfJzvzvBWw1WKn	HTA_DmllbxPeZfJzvzvBWw1WKn_Souterrain_CIPh
o2YGcjfpol35CMBEEQ96kv	bb1P0KeqilCCt2zBojb.Ws	HTA_bb1P0KeqilCCt2zBojb.Ws_Souterrain_CIPh

Figure 45: Lines conductor parameter modification after a CGMES exportation on DisNet

Finally, the load flow results of the CGMES dataset obtained by an exportation of the CDPSM via DisNet and a correction of the shunts reactive power values are exactly the same to the previous results (Figure 46):

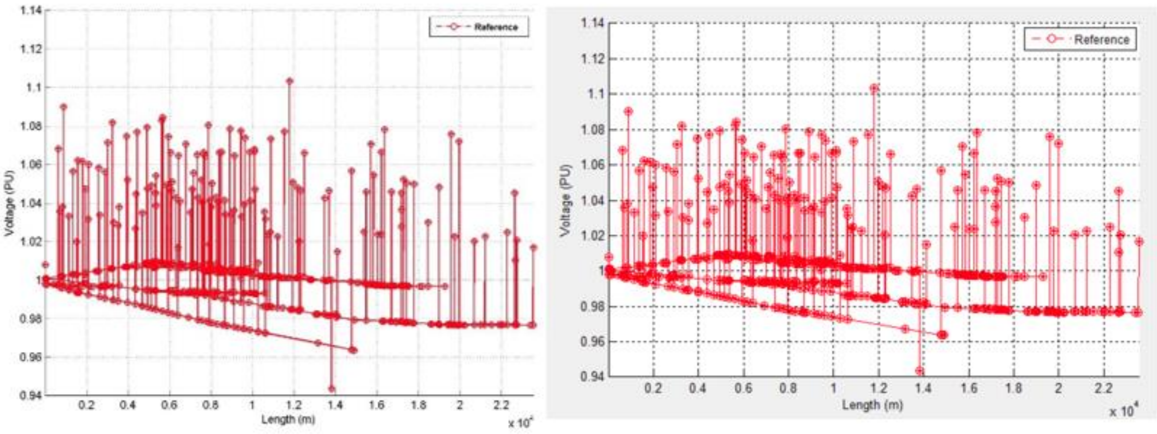


Figure 46: Voltage profiles of CDPSM dataset and CGMES exported by DisNet

E. MV CGMES exportation via DisNet from a CGMES importation

At this level, we are interested in comparing the results between the same CGMES dataset imported and exported via DisNet. As mentioned above in paragraph D, an exportation leads to a none- generation of shunts structure in addition to a concatenation of strings for the model and conductor lines.

Despite these changes and after introducing the shunt reactive values again, OpenDSS is called via DisNet platform for a load flow calculations and the results obtained are exactly the same between the two CGMES datasets (Figure 47):

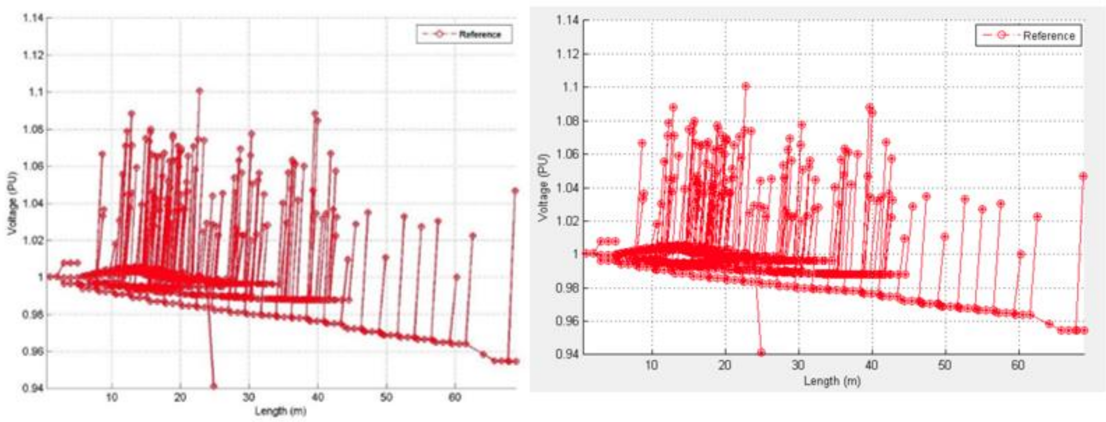


Figure 47: Voltage profiles of the the two CGGMES datasets

Finally, these results are also applicable for an MV-LV fused dataset (§ VIII) after a CGMES export via DisNet. In fact, the load flow results will not change but the shunt structure error will appear again in addition to the concatenation of the strings at the beginning and the end of the lines conductor parameter.

F. MV CGMES modifications and results

In this part, the objective is to test the network datasets before and after the following modifications:

- Taking off some network loads
- Network Topology modification

- Additional network sources

1. Removing some network loads

Hereafter a table providing the component ID and index of the loads removed from the CGMES exported network (Figure 48):

Loads Removed	Component ID	Component index
Load 1	vCqSdRyB35hy3whlyHr86u	1049
Load 2	fDUuDXEiKgqQ7zg1wtWnnx	1055
Load 3	or1XXiFfXc2GpvkmgH6JdA	1060
Load 4	DI3dv72w1-ixh1Ab2O2Tey	999
Load 5	uRr3k4uyBvOf6qxrxKlvZg	959
Load 6	E7akshneC0fIE.fXW8uunf	1022
Load 7	weUnYVYtdzkzZ.CY8njTNk	1020

Figure 48: Removed loads reference

Network information is provided in Figure 49.

Before	After
Node number : 926	**Node number : 926**
Component number : 1084	**Component number : 1077**
-> Generator number : 1	-> Generator number : 1
-> Line number : 383	-> Line number : 383
-> Load number : 148	-> Load number : 141
-> Shunt number : 2	-> Shunt number : 2
-> Switch number : 418	-> Switch number : 418
-> Transformer number : 127	-> Transformer number : 127
-> VSource number : 5	-> VSource number : 5

Figure 49: Network information before and after removing the loads

A load flow calculation is then launched and exported in excel sheet in order to compare the results:
On one hand, the voltage flow inside the network did not change after removing these loads and we end up with an identical voltage profile as before.
On the other hand, power flow has been changed in some network components (transformers, switches, lines …). This result should be predictable because of the current that is not flowing anymore in the branch where the load is removed (open circuit). The current distribution will change on the concerned nodes which affects directly the power values in the lines according to $P = R \times I^2$
Let’s show an example of the power values for one line above the removed load:

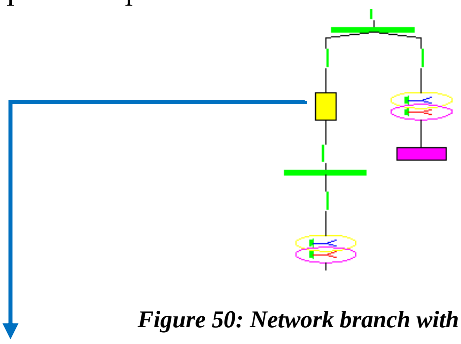


Figure 50: Network branch with a removed load

Component Information

Component: BboX2-jp52HReexv5EPEqe
ID : 456

Node: b7O3v.CmxUr6qcvM3dAoPr, tgj1Y59bkL6cfag3Au0HuB
ID : 711, 703

Load Flow information | LF Voltage Profile

Display mode : Line to Neutral

	V in (V)	V in (phi)	I in (A)	I in (phi)	P in (kW)	Q in (kVar)
AN	1.2075e+04	359.9292	0.0109	0.0791	0.1311	-3.4600e-04
BN	1.2075e+04	239.9292	0.0109	240.0823	0.1311	-3.4600e-04
CN	1.2075e+04	119.9292	0.0109	120.0806	0.1311	-3.4600e-04
N	0	0	0	0	0	0
Total			8.6736e-19		0.3934	-0.0010

	V out (V)	V out (phi)	I out (A)	I out (phi)	P out (kW)	Q out (kVar)
AN	1.2075e+04	359.9292	0.0109	179.9525	-0.1311	5.1000e-05
BN	1.2075e+04	239.9292	0.0109	59.9502	-0.1311	5.1000e-05
CN	1.2075e+04	119.9292	0.0109	299.9530	-0.1311	5.1000e-05
N	0	0	0	0	0	0
Total			1.0000e-06		-0.3934	1.5300e-04

Figure 51: Load flow information in the above line

2. Network Topology modification

Modifying the network topology consists of changing the state of some switches from open to close per example or vice versa. This change is applied to the MV CGMES file exported by DisNet from CDPSM and then exported another time to execute our test.

Switch:Open to close	Component ID	Component index
Breaker	AC48YIlkEeSJrEzzxPz0uE	535
LoadBreakSwitch	mb6W0aabTUWzZYir5hBQlC	676

Figure 52: Switches changing their state from open to close

The network representation has changed after this type of modification because of the current flowing through the closed switches that are feeding other network components (Figure 53).

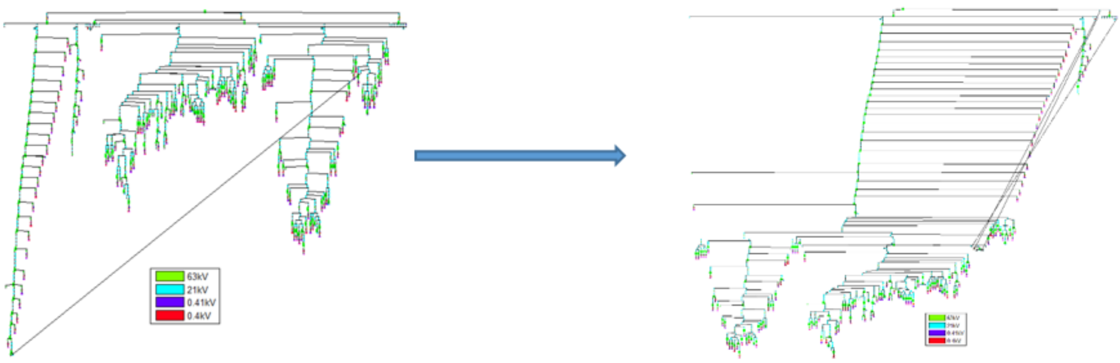


Figure 53: Network representation before and after topology modification

In fact, the network structure is modified and the connection points differ from one network to another. For that reason, it is normal to distinguish a difference between the two voltage flow profile (Figure 54):

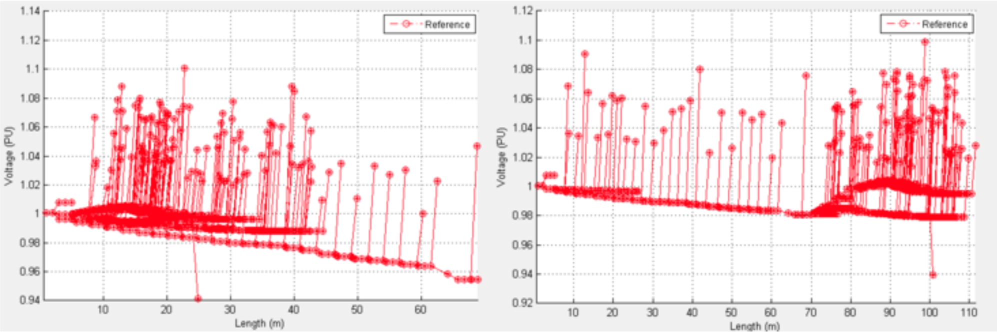


Figure 54: Voltage profile before and after topology modification

Eventually, power flow results provided by the modified network topology are not similar to the one without any modification. Indeed, when a switch is changing state from open to closed, a current will flow into it in order to insure the demanded power downstream the switch. Here's an example of the load flow results for a line placed directly above the concerned switch (Figure 55 and 56):

	V in (V)	V in (phi)	I in (A)	I in (phi)	P in (kW)	Q in (kVar)
AN	1.1576e+04	358.4488	112.0152	336.5718	1.2033e+03	483.1560
BN	1.1576e+04	238.4488	112.0152	216.5718	1.2033e+03	483.1560
CN	1.1576e+04	118.4488	112.0152	96.5718	1.2033e+03	483.1560
N	0	0	0	0	0	0
Total			1.0000e-06		3.6098e+03	1.4495e+03

Figure 55: Line load flow results before changing switch state

	V in (V)	V in (phi)	I in (A)	I in (phi)	P in (kW)	Q in (kVar)
AN	1.1891e+04	359.2333	30.2326	337.1427	333.1184	135.2020
BN	1.1891e+04	239.2333	30.2326	217.1427	333.1184	135.2020
CN	1.1891e+04	119.2333	30.2326	97.1427	333.1184	135.2020
N	0	0	0	0	0	0
Total			1.4142e-06		999.3552	405.6061

Figure 56: Line load flow results after changing switch state

3. Additional network sources

In this part, new Distributed Energy Ressources (DER) components has been added to the network at the load level in order to test their effect on the load flow results generated. The table below provide the component ID and index of the added sources to the CGMES exported network (Figure 57):

Sources added	Component ID	Component index
Wind power 1	Generator_2	1083
Photovoltaic power 1	Generator_3	1084
Photovoltaic power 2	Generator_4	1085
Wind power 2	Generator_5	1086

Figure 57: Added sources references

Network information is provided in Figure 58.

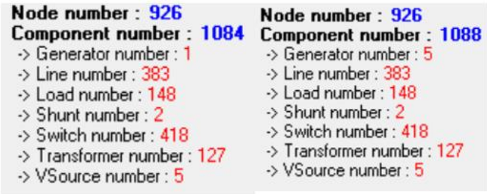


Figure 58: Network information before and after adding Network Sources

In this case, voltage flow profile presents the same graph as for an exported CGMES dataset without any modification. Furthermore, power flow results are nearly the same because all the added sources has a low power value. Normally, this type of modification should affect the rest of the circuit because more power is generated into the network components.

X. MV CGMES DATA 3 NETWORK

A. DATA3 description

The Dataset "*TDX_EDF1_MV_DistNetwork_CDPSM_CIM100"* called DATA 1 represents the MV network obtained from an MSITE. DATA 2 is generated by using the converter tool of EDF that transforms from CDPSM to a CGMES file. Subsequently, the DATA 2 CGMES is imported via Disnet and exported in CIM 16 to provide a new dataset "*TDX_EDF2_MV DistNetWork_CGMES_CIM100 – EQ*" named "DATA 2 exporté" on DITAM.

Finally, the network "*TDX_EDF3_MV DistNetWork_GLOBAL_CGMES_CIM100_DG – EQ*" called "DATA 3" is provided by a DisNet exportation of "DATA 2 exporté" **after the following network modifications realized manually by EDF, using DisNet**:

- Aggregation of the LV and MV networks by removing the MV/LV transformers using the treatment option "Prepare linked MV & LV networks" offered by DisNet
- Adding nine static generators in parallel with some loads

The figure 59 and 60 below shows the difference between the "DATA 2 exporté" and "DATA 3" representation:

N.B: The added static generators are represented in Figure 60 by a yellow filled square with a "P" written in black

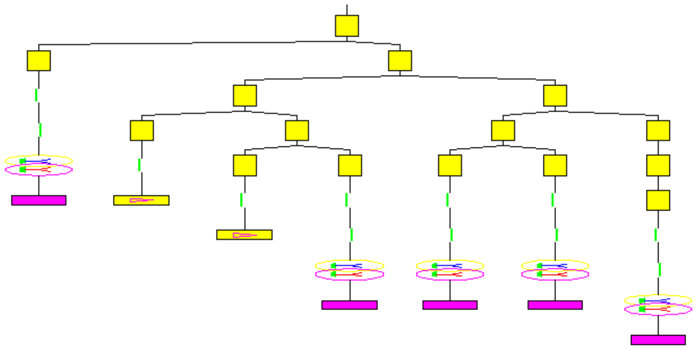


Figure 59: Part of the "DATA 2 exporté" network

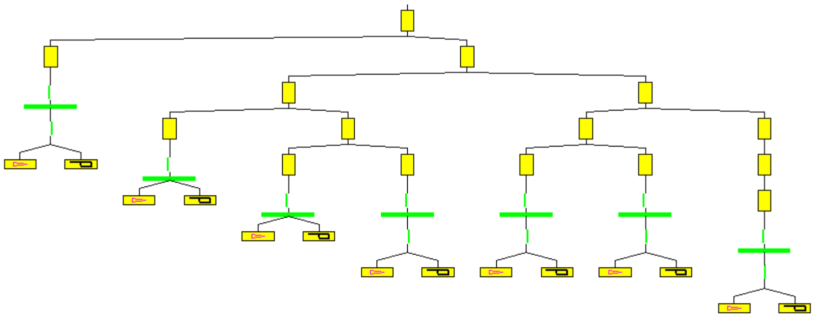


Figure 60: Part of the "DATA 3" network

B. INESC scenarios and results

INESC TEC is a research institution dedicated to scientific research and technological development that is member of TDX-ASSIST European project. Based on network constraints, an optimization process is executed to determine the power flow and power loss in each line as following:

- Active Power:

$$P^i_{G(t)} - P^i_{D(t)} = V^2_{i(t)} \times G_{ii} + V_{i(t)} \times \sum_{j \in L^i} V_{j(t)} G_{ij} \cos\left(\theta_{i(t)} - \theta_{j(t)}\right) + B_{ij} \sin\left(\theta_{i(t)} - \theta_{j(t)}\right)$$

- Reactive power:

$$Q^i_{G(t)} - Q^i_{D(t)} = V_{i(t)} \times \sum_{j \in L^i} V_{j(t)} G_{ij} \sin\left(\theta_{i(t)} - \theta_{j(t)}\right) - B_{ij} \cos\left(\theta_{i(t)} - \theta_{j(t)}\right) - V^2_{i(t)} \times B_{ii}$$

Where:

- P active power and Q reactive power
- G conductance and B susceptance
- θ the phase
- Index G for generated power and index D for demanded power
- Index i for node i and j for the following node j
- t represents the time at which this formula is applied

In order to determine the voltage flow in the network, the generated and demanded powers are known. Similarly, the susceptance b and conductance g are fixed by the lines characteristics. The voltage level at each node could be calculated at this moment using the formulas above.

The objective is now to compare the voltage and power flow results obtained by INESC TEC optimization tool and the load flow results provided by DisNet using OpenDSS for the "DATA3" dataset described in paragraph A. For that, INESC created four different scenarios of DATA3 shown in the figure 61 below and launched the voltage and power flow calculations:

- Scenario 1:No wind
- Scenario 2:Forecast 1
- Scenario 3:Forecast 2
- Scenario 4:Wind forced to 12 MW

Active Power (MW)					
Generator Number	Generator rdfID	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Generator 1	tT2LFWxmaKvUWgt3AofvGt	11,444	3,233	-4,592	-12,403
Generator 2	aRc0gvMvTryzJhAQIDTmBb	5,654	5,654	5,654	5,654
Generator 3	Generator_2	0,000	3,560	7,120	12,000
Generator 4	Generator_3	0	0	0	0
Generator 5	Generator_4	0	0	0	0
Generator 6	Generator_5	0	0	0	0
Generator 7	Generator_6	0	0	0	0
Generator 8	Generator_7	0	0	0	0
Generator 9	Generator_8	0	0	0	0
Generator 10	Generator_9	0	0	0	0
Generator 11	Generator_10	0,000	4,322	8,643	12,000
	Total P	17,098	16,770	16,826	17,252

Reactive Power (Mvar)					
Generator Number	Generator rdfID	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Generator 1	tT2LFWxmaKvUWgt3AofvGt	3,307	3,307	3,307	3,307
Generator 2	aRc0gvMvTryzJhAQIDTmBb	0	0	0	0
Generator 3	Generator_2	0,000	-0,140	-0,205	-0,034
Generator 4	Generator_3	0	0	0	0
Generator 5	Generator_4	0	0	0	0
Generator 6	Generator_5	0	0	0	0
Generator 7	Generator_6	0	0	0	0
Generator 8	Generator_7	0	0	0	0
Generator 9	Generator_8	0	0	0	0
Generator 10	Generator_9	0	0	0	0
Generator 11	Generator_10	0,000	-0,216	-0,200	-0,018
Capacitors Banks	Capacitors Banks rdfID	Reactive power injected	Reactive power injected	Reactive power injected	Reactive power injected
1	l9gntXZxw2TlO7nAmwSGbl	2,923	2,923	2,923	2,923
2	sbiDGiRoHXFkiQfaxcTesv	1,090	1,090	1,090	1,090
	Total Q	7,383	6,954	6,915	7,261

Figure 61: INESC scenarios

C. Compatibility with loadflow results generated by DisNet (Via OpenDSS)

The four network scenarios have been realized by changing the generators active and reactive powers using DisNet for each scenario. A load flow calculation is executed using OpenDSS and the results are exported in an excel file so we can compare them with INESC results.

After a result analysis, a difference between INESC and OpenDSS voltage flow in each network node is noticed. Furthermore, the minimum of the voltage in p.u. has decreased below the standard value fixed to +/- 5% to reach 0.9 p.u.

Lines characteristics have been sent from INESC to check the compatibility between the two networks and no differences have been recorded.

At the end, voltage drop is compared in different network branches between INESC and DisNet results from downstream of the HV/MV transformers to the endpoint of the distributed loads. The voltage flow are almost the same between the two networks and the main cause of this difference was based in the transformers TapChanger that should be varied to reach the same voltage level at the secondary. The figure 62 below represents the voltage drop in three different branches of the network.

	Branch 1		Branch 2		Branch 3	
	DisNet	INESC	DisNet	INESC	DisNet	INESC
Start point	0,97951741	0,994065375	0,98420912	0,99839872	0,98420912	0,99839872
End point	0,90559821	0,921404661	0,97790967	0,995	0,98707631	1,0013188
Voltage drop	0,0739192	0,072660715	0,00629945	0,00339872	-0,0028672	-0,0029201

Figure 62: Voltage drop in different network branches

Concerning the active, reactive and apparent power flow through the network lines, the results are exactly the same due to the identical characteristics used.

XI. RISECLIPSE VALIDATION

RiseClipse Web is a validation tool able to provide information, warnings and errors about any network dataset (Figure 63). This validation is executed in order to define the missing information and to check the data consistency while passing from a real data source to CIM files (CDPSM, CGMES). The errors generated must comply with IEC standards and that is why the relations between the elements classes should be verified in Entreprise Architect by checking the UML (unified modeling language) network components links. In case of non-compliance, network data should be modified (adding attributes, correcting links...) to insure a conformity with the IEC specifications.

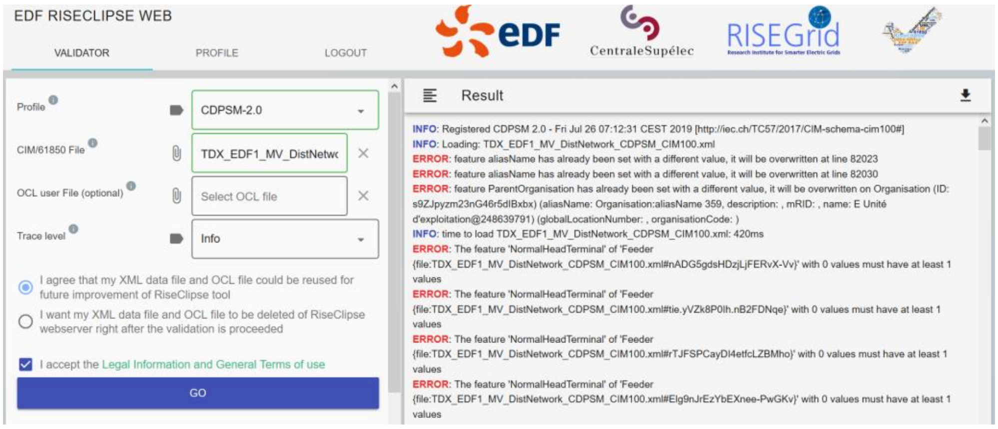


Figure 63: RiseClipse Web Platform

A. VALIDATION OF DATA1 CDPSM

After a validation by FraunHofer, German research institute partipating in TDX-ASSIST, the errors mentioned below are noticed in the CDPSM dataset obtained from MSITE. A verification of these errors according to CDPSM UML specifications leads to highlight the mandatory attributes that should be added to the dataset as follow (Figure 64):

Erreurs mentionnées par FraunHofer pour le DATA 1 CDPSM
ACLineSegment.r at profile eq at cim item ACLineSegment is missing
ACLineSegment.x at profile eq at cim item ACLineSegment is missing
ACLineSegment.bch at profile eq at cim item ACLineSegment is missing
ACDCTerminal.sequenceNumber at profile eq at cim item Terminal is missing
EnergySource.nominalVoltage at profile eq at cim item EnergySource is missing
EnergySource.EnergySchedulingType at profile eq at cim item EnergySource is missing
PowerTransformerEnd.b at profile eq at cim item PowerTransformerEnd is missing
ShuntCompensator.nomU at profile eq at cim item LinearShuntCompensator is missing
LinearShuntCompensator.gPerSection at profile eq at cim item LinearShuntCompensator is missing
LinearShuntCompensator.bPerSection at profile eq at cim item LinearShuntCompensator is missing

Figure 64: Validation of DATA 1 by Fraunhofer

In fact, some missing information already exist in the CDPSM dataset (DATA1) obtained from MSITE file. The structure and the converter tools of a dataset transformation is illustrated below in Figure 65:

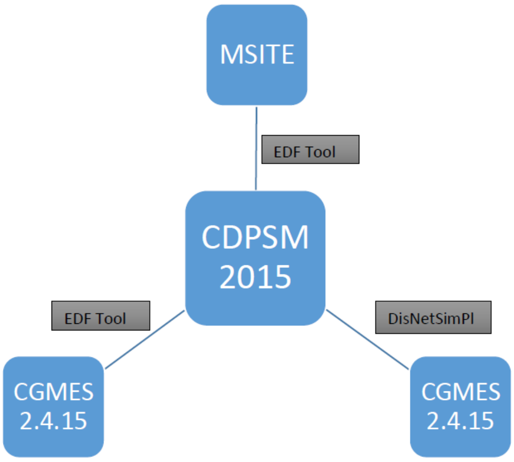


Figure 65: Dataset converters

The objective is to start with the validation of the MSITE dataset of DATA1 using CimTool and verify the requirements according to specifications. After the validation of the datasets above, we can identify the mandatory missing information when converting from one dataset to another. At this stage, the converter tools from MSITE to CDPSM 2015 and then to CGMES 2.4.15 could be modified by adding these required elements or attributes.

B. Validation of DATA 1 MSITE

CimTool allows to test an MSITE file by providing the missing information of the dataset. Hereafter an execution of the DATA1 in MSITE (Figure 66):

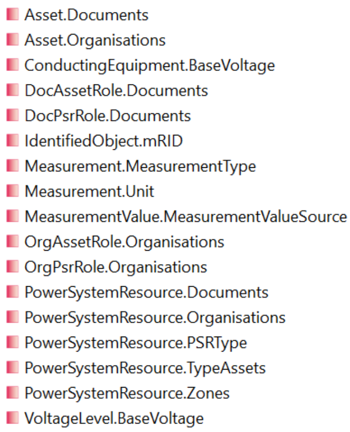


Figure 66: CIMTool Validation of DATA1

C. Validation of DATA 2 CGMES

This dataset has been described in paragraph IX part A “DATA3 description” and represents the DATA 1 exported by DisNetSimPl in CGMES. Using the Web version of RiseClipse, two profiles are allowed: CDPSM 2.0 and CGMES 2.4.15.

After the execution of the validation, we end up with the content of the dataset (class elements) and different errors types highlighted below:

INFO: Available classes (number / errors):
INFO:. ACLineSegment (383 / 2298)
INFO:. BaseVoltage (154 / 0)
INFO:. Bay (408 / 0)
INFO:. Breaker (27 / 27)
INFO:. BusbarSection (157 / 0)
INFO:. ConnectivityNode (906 / 0)
INFO:. Disconnector (3 / 3)
INFO:. EnergyConsumer (148 / 0)
INFO:. EnergySource (5 / 0)
INFO:. FullModel (1 / 0)
INFO:. GeneratingUnit (1 / 0)

INFO:. GeographicalRegion (2 / 0)
INFO:. Junction (161 / 0)
INFO:. Line (21 / 0)
INFO:. LinearShuntCompensator (2 / 10)
INFO:. LoadBreakSwitch (159 / 159)
INFO: . PowerTransformerEnd (254 / 2274)
INFO: . PowerTransformer (127 / 127)
INFO: . RatioTapChanger (124 / 124)
INFO: . SubGeographicalRegion (25 / 0)
INFO: . Substation (383 / 0)
INFO: . Switch (229 / 229)
INFO: . SynchronousMachine (1 / 7)
INFO: . Terminal (2310 / 0)
INFO: . VoltageLevel (162 / 0)
INFO: Total objects/errors: 6153 / 5258

As we can see in the validation information, a large number of errors is noticed comparing to the total network objects:

- There are errors of type "Exception Class '-' is not found or is abstract" and errors of type "Exception Feature '-' not found" as shown respectively in two columns below:

  - Location
  - Position Point
  - TopologicalNode
  - DiagramObject
  - DiagramObjectGluePoint
  - DiagramObjectPoint
  - SvStatus
  - SvVoltage
  - SvPowerFlow

  - Switch.open
  - TapChanger.controlEnabled
  - TapChanger.step
  - BusbarSection.ipMax
  - ConnectivityNode.TopologicalNode
  - ShuntCompensator.sections
  - EnergyConsumer.p
  - EnergyConsumer.pfixed
  - EnergyConsumer.q
  - EnergyConsumer.qfixed
  - PowerTransformerEnd.phaseAngleClock
  - TransformerEnd.grounded
  - ACLineSegment.b0ch

- There are errors of types "The required feature '-' of '-' must be set". Due to Entreprise Architect file 'ENTSOE Common Grid Model Exchange Specification', the UML relations classes of the elements has been checked. It is noticed that the missing attributes below should be added to reach a dataset compliant with the IEC specifications. An appendix has been added at the end in order to illustrate the Entreprise Architect representation for each error:

N.B: Each class attribute without the notation [0…1] in the appendix is mandatory.

- 'isPartOfGeneratorUnit' of 'PowerTransformer' (**Appendix 1**)
- 'grounded', 'b', 'b0', 'g0', 'phaseAngleClock', 'r0' and 'x0' of 'PowerTransformerEnd' (**Appendix 2**)
- 'ltcFlag' of 'RatioTapChanger' (**Appendix 3**)
- 'retained' of Breaker, Disconnector and LoadBreakSwitch (**Appendix 4**)
- 'nomU', 'normalSections','g0PerSection' and 'gPerSection' of 'LinearShuntCompensator' (**Appendix 5**)
- 'b0ch', 'bch', 'g0ch', 'r0', 'x0' and 'shortCircuitEndTemperature' of 'ACLineSegment' (**Appendix 6**)
- ACDCTerminal.connected (**Appendix 7**)
- Terminal.TopologicalNode (**Appendix 8**)

D. Validation of DATA 1 converted to CGMES by EDF tool

INFO:Available classes (number / errors):
INFO: . ACLineSegment (383 / 2298)
INFO: . Analog (3 / 0)
INFO: . BaseVoltage (154 / 0)
INFO: . Bay (408 / 0)
INFO: . Breaker (27 / 27)
INFO: . BusbarSection (157 / 0)
INFO: . ConnectivityNode (906 / 0)
INFO: . Disconnector (3 / 3)
INFO: . EnergyConsumer (148 / 0)
INFO: . EnergySource (1 / 0)
INFO: . FullModel (1 / 0)
INFO: . GeneratingUnit (1 / 0)
INFO: . GeographicalRegion (2 / 0)
INFO: . Junction (161 / 0)
INFO: . Line (6 / 0)
INFO: . LinearShuntCompensator (2 / 12)
INFO: . LoadBreakSwitch (159 / 159)
INFO: . PowerTransformerEnd (254 / 2274)
INFO: . PowerTransformer (127 / 127)
INFO: . RatioTapChanger (124 / 124)
INFO: . SubGeographicalRegion (360 / 0)
INFO: . Substation (383 / 0)
INFO: . Switch (229 / 229)
INFO: . SynchronousMachine (1 / 7)
INFO: . Terminal (2306 / 0)
INFO: . VoltageLevel (162 / 0)
INFO: Total objects/errors : 6468 / 5260

The CGMES dataset obtained from DATA1 with EDF tool do not differ a lot in terms of validation and errors generated by RiseClipse from the dataset obtained with DisNet exportation. The required attributes missing are exactly the same in addition to the following:

- ‘r’ and ‘x’ for ‘PowerTransformerEnd’
- ‘bPerSection’ and ‘b0PerSection’ for ‘LinearShuntCompensator’

E. Validation of DATA 2 exported in CGMES

After an exportation of DATA2 via DisNet, a new execution of RiseClipse Validation is held in order to compare the different results:

INFO: Available classes (number / errors):
INFO: . ACLineSegment (383 / 1915)
INFO: . BaseVoltage (4 / 4)
INFO: . Breaker (27 / 27)
INFO: . BusbarSection (5 / 0)
INFO: . ConnectivityNode (927 / 927)
INFO: . Disconnector (3 / 3)
INFO: . EnergyConsumer (148 / 0)
INFO: . EnergySource (1 / 0)
INFO: . GeneratingUnit (1 / 1)
INFO: . Line (4 / 0)
INFO: . LinearShuntCompensator (2 / 6)
INFO: . LoadBreakSwitch (159 / 159)
INFO: . LoadResponseCharacteristic (148 / 148)
INFO: . PowerTransformerEnd (254 / 1778)
INFO: . PowerTransformer (127 / 127)
INFO: . RatioTapChanger (124 / 124)
INFO: . Switch (229 / 229)
INFO: . SynchronousMachine (1 / 7)
INFO: . Terminal (2013 / 2013)
INFO: Total objects/errors: 4560 / 74

We can mention immediately the difference between the number of objects that decreased from 6153 to 4560 and the number of errors that increased from 5258 to 7468. It indicates the presence of missing information after the exportation from DATA2.

- “Exception Class” and “Exception Feature” errors are shown respectively in two columns below:

- CoordinateSystem
- Location
- Position Point

- PowerTransformerEnd.phaseAngleClock
- TransformerEnd.grounded
- TransformerEnd.rground
- TransformerEnd.xground
- TapChanger.controlEnabled
- EnergyConsumer.customerCount
- EnergyConsumer.pfixed
- EnergyConsumer.qfixed
- SynchronousMachine.operatingMode
- ShuntCompensator.phaseConnection
- ShuntCompensator.controlEnabled
- ShuntCompensator.phaseConnection

- "The required feature" errors are:

  - 'name' of 'BaseVoltage' and 'Terminal'
  - 'isPartOfGeneratorUnit' of 'PowerTransformer'
  - 'grounded', 'b' , 'b0' , 'g0', 'phaseAngleClock', 'r0' and 'x0' of 'PowerTransformerEnd'
  - 'tculControlMode' of 'RatioTapChanger'
  - 'b0ch', 'g0ch', 'r0', 'shortCircuitEndTemperature' and 'x0' of 'ACLineSegment'
  - 'retained' of Breaker, Switch and LoadBreakSwitch
  - 'exponentModel' of 'LoadResponseCharacteristic'
  - 'earthing', 'r', 'r0', 'r2', 'satDirectSubtransX', 'x0' and 'x2' of 'SynchronousMachine'
  - 'initialP' of 'GeneratingUnit'
  - 'nomU', 'b0PerSection' and 'g0PerSection' of 'LinearShuntCompensator'
  - 'ConnectivityNodeContainer' of 'ConnectivityNode'

On one hand, the exportation handles some errors by adding the required missing attributes:

- 'ltcFlag' for 'RatioTapChanger'
- 'bch' for 'ACLineSegment'
- 'normalSections' and 'gPerSection' for 'LinearShuntCompensator'

On the other hand, this exportation generates many other errors. The important part is to mention the errors that do not meet the specifications. The later will be described below and referenced to the appendix at the end illustrating the concerning attributes or classes in Entreprise Architect UML representation:

- 'tculControlMode' attribute of class 'RatioTapChanger' should be added (**Appendix 9**)
- 'exponentModel' attribute of class 'LoadResponseCharacteristic' should be added (**Appendix 10**)
- 'initialP' attribute of class 'GeneratingUnit' should be added (**Appendix 11**)
- 'earthing', 'r', 'r0', 'r2', 'satDirectSubtransX', 'x0' and 'x2' attributes of class 'SynchronousMachine' should be added (**Appendix 12**)
- Every network 'ConnectivityNode' should be assigned to a 'ConnectivityNodeContainer' after losing all the connections due to the export. In addition, each ConnectivityNodeContainer should be assigned to one or more 'VoltageLevel'. This problem was corrected in DATA2 exported after FRAUNHOFER request so they can execute the network on their own platform PANDAPOWER. In fact, by comparing with the initial DATA2 obtained by EDF tool, we were able to know which container is associated with which node and link them in the exported dataset. After that, all the containers dropped from DATA2 exported were copied again from the initial dataset with the corresponding 'VoltageLevel'. (**Appendix 13**)

This problem was not solved at this stage considering that the voltage levels should be specified to each ConnectivityNode. After the analysis of the initial dataset, we found out that every 'ConnectivityNode' is assigned to a 'TopologicalNode' which is assigned to a 'SvVoltage' defining the right Base Voltage. These topological nodes and SvVoltage was dropped out from DATA 2 exported and should be re-added. (**Appendix 14**)

- 'isPartOfGeneratorUnit' attribute of class 'PowerTransformer' should be added (**Appendix 1**)
- 'b0PerSection' and 'g0PerSection' of class 'LinearShuntCompensator' should be added (**Appendix 15**)
- 'retained' attribute of class Breaker, Switch and LoadBreakSwitch should be added (**Appendix 4**)
- 'b0ch', 'g0ch', 'r0', 'shortCircuitEndTemperature' and 'x0' attributes of class 'ACLineSegment' should be added (**Appendix 6**)
- 'grounded', 'b' , 'b0' , 'g0', 'phaseAngleClock', 'r0' and 'x0' attributes of class 'PowerTransformerEnd' should be added (**Appendix 2**)

The modification of the DATA 2 exported has been done in order to answer Fraunhofer request to some errors not allowing them to import the dataset on PANDAPOWER despite that the missing attributes are not mandatory in the specifications:

1. 'IdentifiedObjectByName' for the element BaseVoltage
2. The nominal voltage 'nomU' for the LinearShuntCompensator.This value was chosen according to the Shunt Voltage level equal to 21 kV
3. The susceptance 'b' has been calculated and added to the element 'PowerTransformerEnd' using the values of the resistance r, conductance g and inductance x according to the following formulas:

$$\begin{cases} Z = r + j.x \\ Y = g + j.b \end{cases}$$

The admittance Y is the reciprocal of the impedance Z: $Y = \frac{1}{Z} = \frac{r - j.x}{r^2 + x^2}$

By identification:

$$b = \frac{x}{r^2 + x^2}$$

In fact, the transformer model shows that the parameter b represents the reciprocal of the magnetization inductance and the x represents the leakage inductance so these two parameters are not related and the value of b could not be calculated this way. The solution for this problem is to modify the DATA2 one more time by affecting the value 0 for all the lines susceptance b.

XII. French island using MSITE and CDPSM

A. Description and representation

This network represents an EDF French island electrical grid divided into different substation departures in MSITE and CDPSM datasets. In this test, we will choose one outgoing feeder named 'STANN' to realize our comparison.

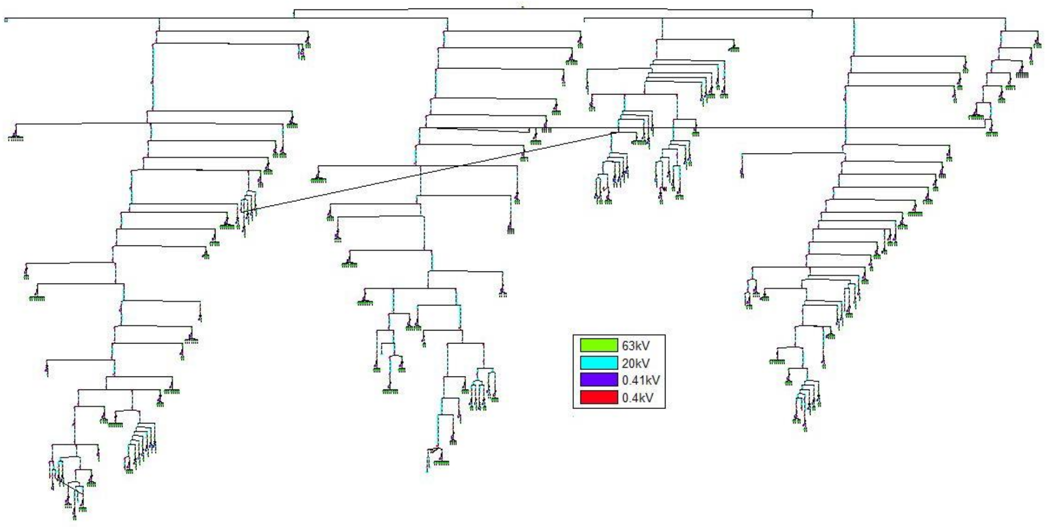


Figure 67: Hierarchical Representation of STANN outgoing feeder from French Island network

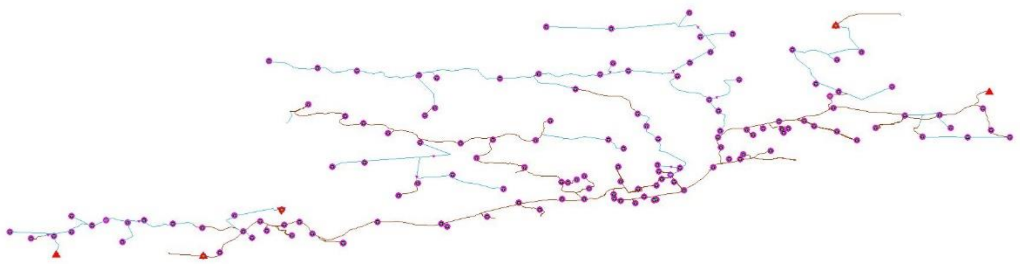


Figure 68: Geographical Representation of STANN departure from French Island network

B. Information and results comparison

We can notice a difference between the network information in MSITE and its importation in CDPSM for 'STANN' network:

- The suppression of the switches downstream the HTA/BT transformers after a CDPSM conversion (Node number will decrease automatically)
- The addition of a line, three loads and five Vsource

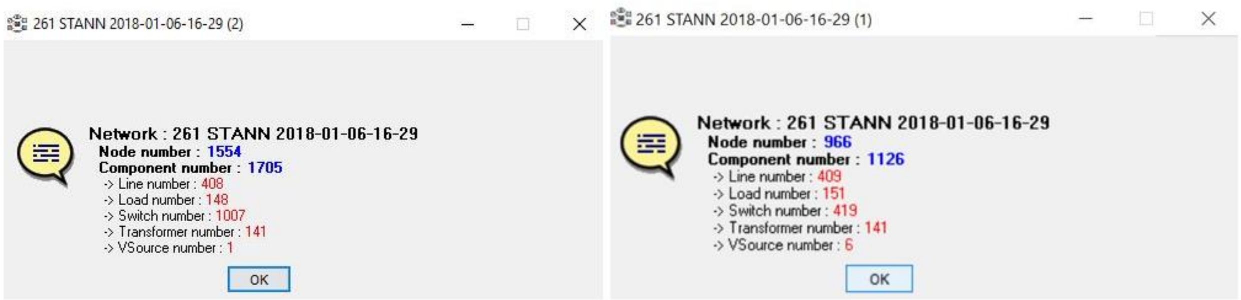


Figure 69: STANN network information in MSITE and CDPSM

The voltage profiles in this network after a load flow execution on DisNet leads to the following results:

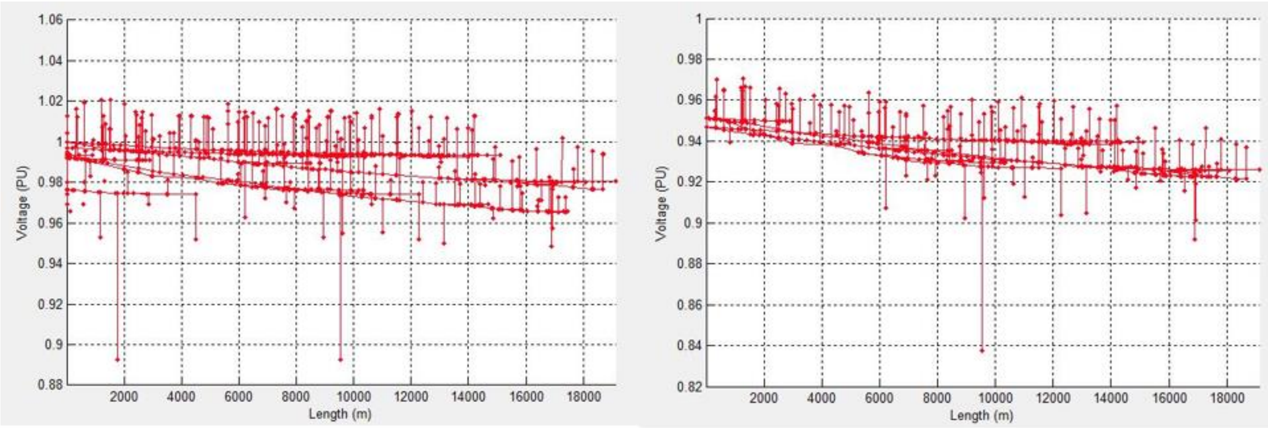


Figure 70: Voltage profiles of STANN network in MSITE and CDPSM

We can notice immediately the decrease of the nodes number. Apparently, the suppression of some network switches leads to a voltage drop in each node for the CDPSM dataset after it was in the acceptable voltage range (+/- 5% from 1 p.u.) before conversion from MSITE.

XIII. CONCLUSION

In conclusion, to ensure that the IEC CIM standards are developed in line with TSO requirements, ENTSOE-E runs interoperability tests on a regular basis to demonstrate its CIM based on data exchange specifications. In this report, many tests were done for different networks datasets seeking to compare CGMES and CDPSM information models.

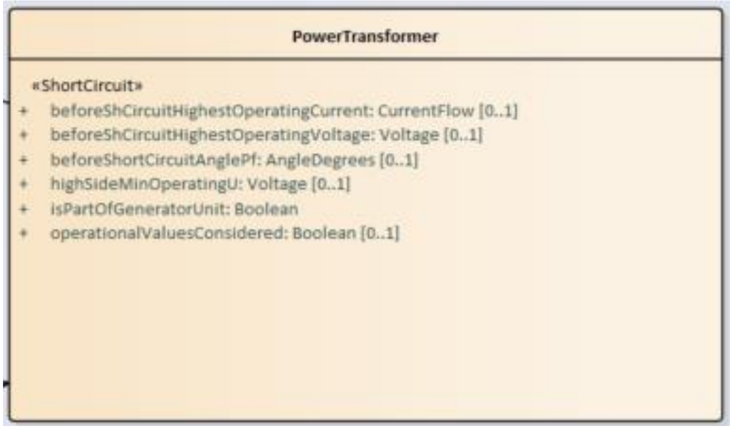
The validation tests mentioned previously contributed in identifying the missing information generated by each CIM model due to the validation tools used (RiseClipse, CIMTool and DisNet). Furthermore, the comparison between the results before and after the transit from one model to another allow us to affirm that the converter tools used needs to be improved in order to insure the compatibility with the IEC specifications checked in UML representation on Entreprise Architect.

XIV. REFERENCES

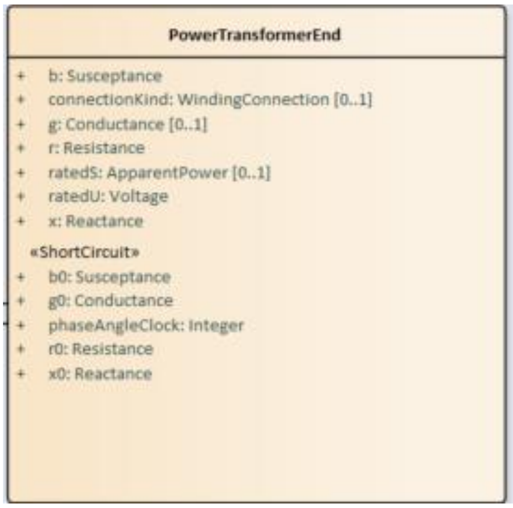
- http://www.tdx-assist.eu/
- https://www.entsoe.eu/digital/cim/cim-for-grid-models-exchange/
- https://www.edf.fr/en/the-edf-group/who-we-are/activities/research-and-development/our-activities
- https://54.37.166.107/
- https://akm.ardans.fr/DITAM/
- https://scholar.google.fr/scholar?q=energy+conversion+and+management+hugo+morais&hl=en&as_sdt=0&as_vis=1&oi=scholart

XV. APPENDIX

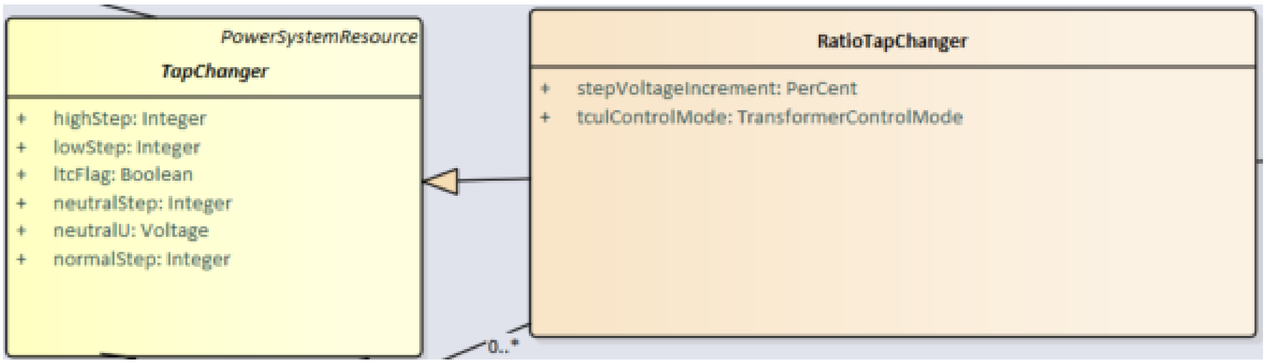
Appendix 1



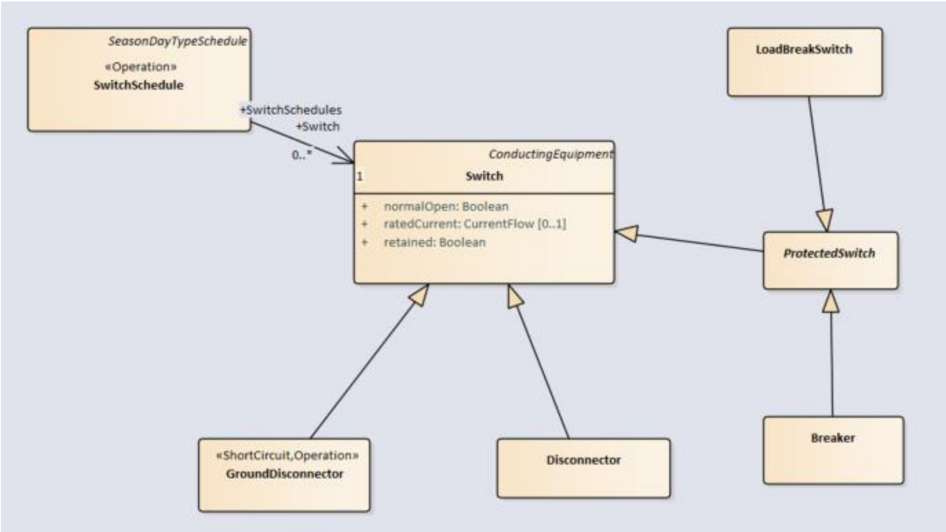
Appendix 2



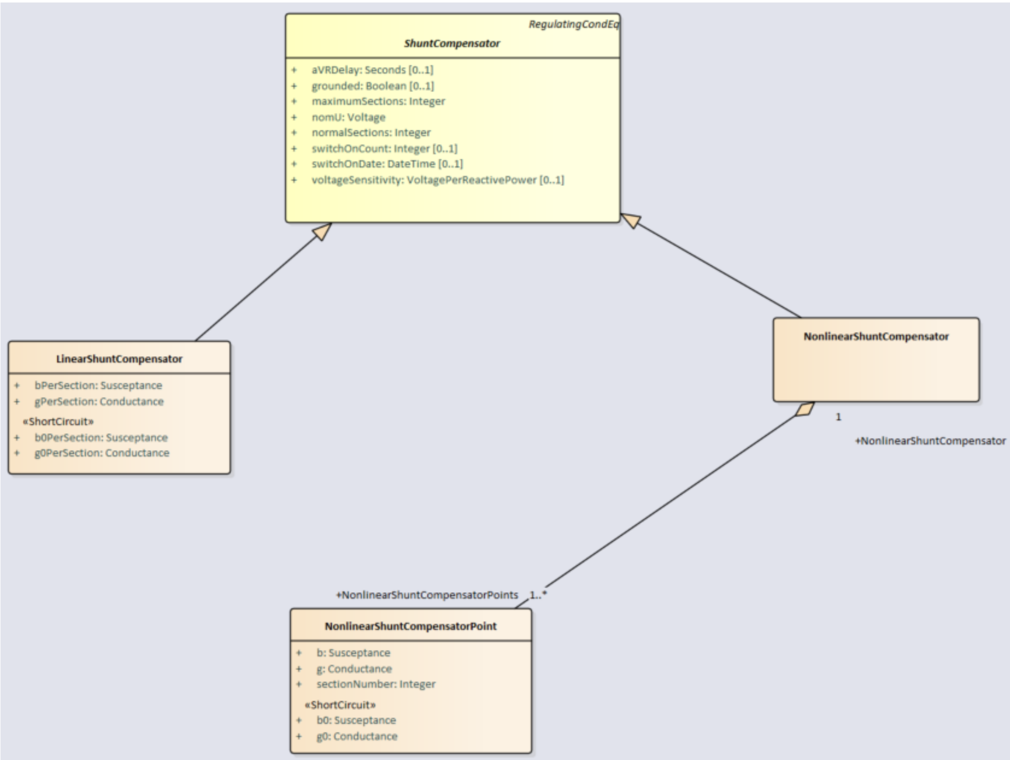
Appendix 3



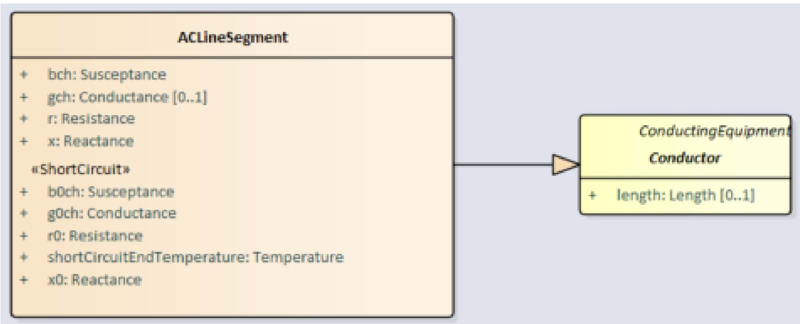
Appendix 4



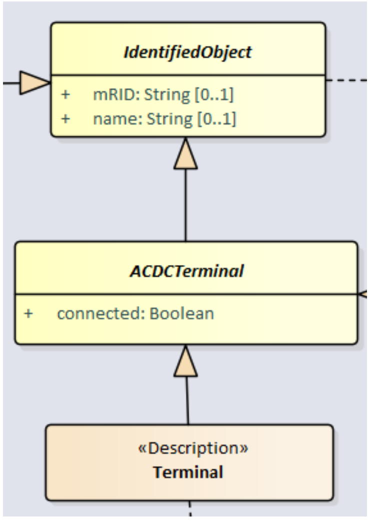
Appendix 5



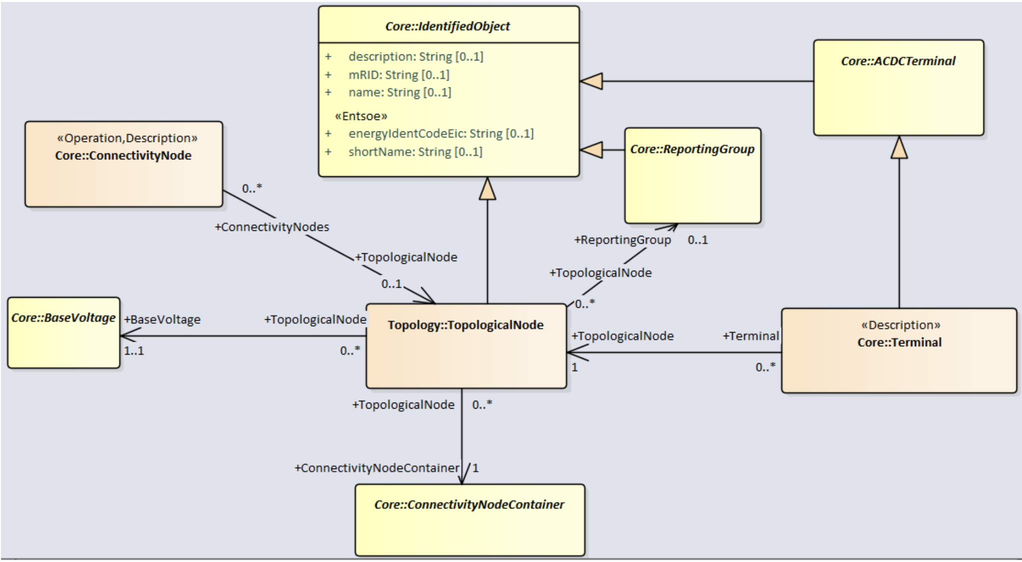
Appendix 6



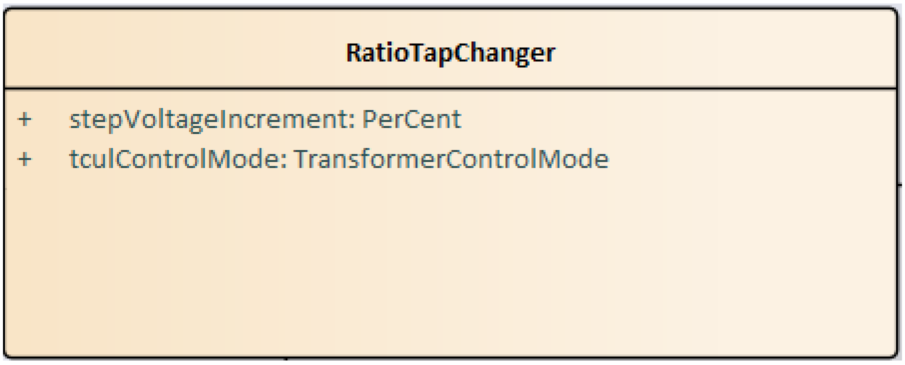
Appendix 7



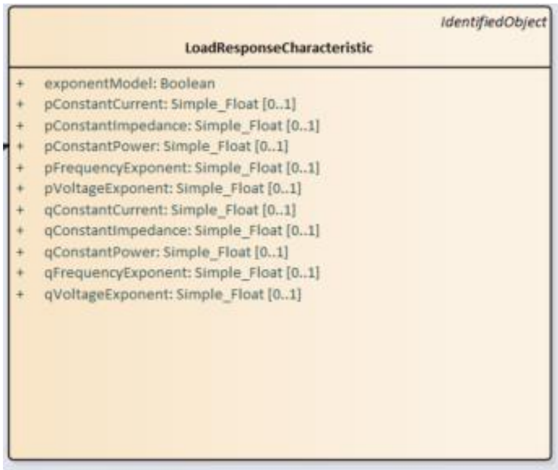
Appendix 8



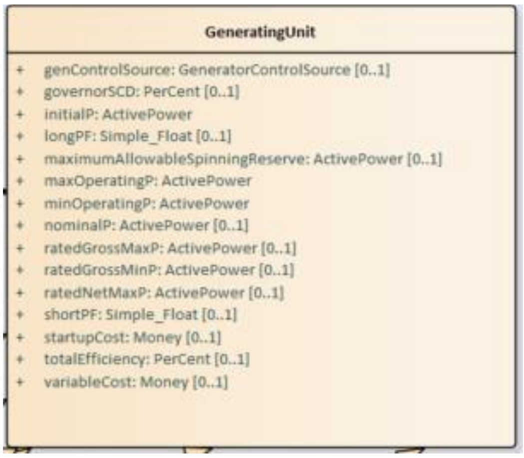
Appendix 9



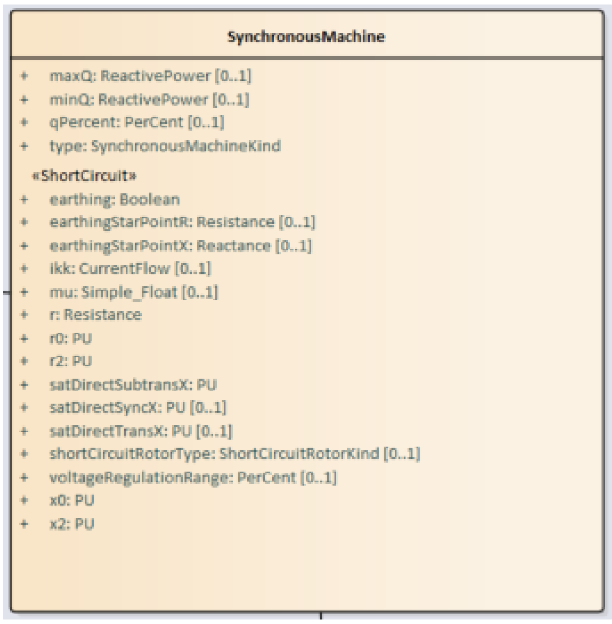
Appendix 10



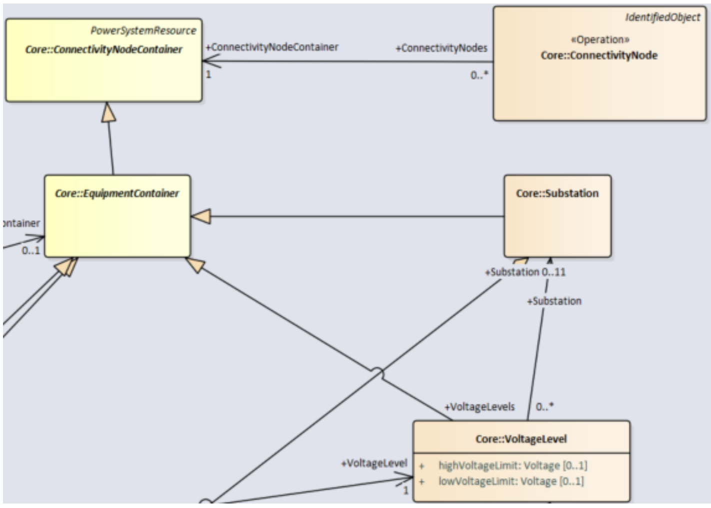
Appendix 11



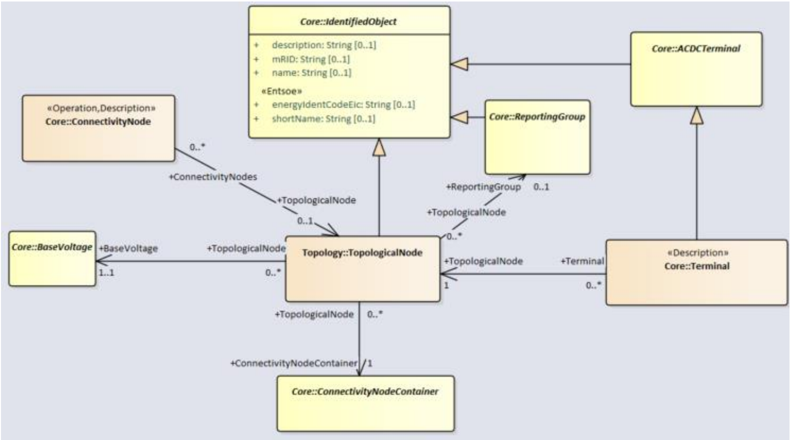
Appendix 12



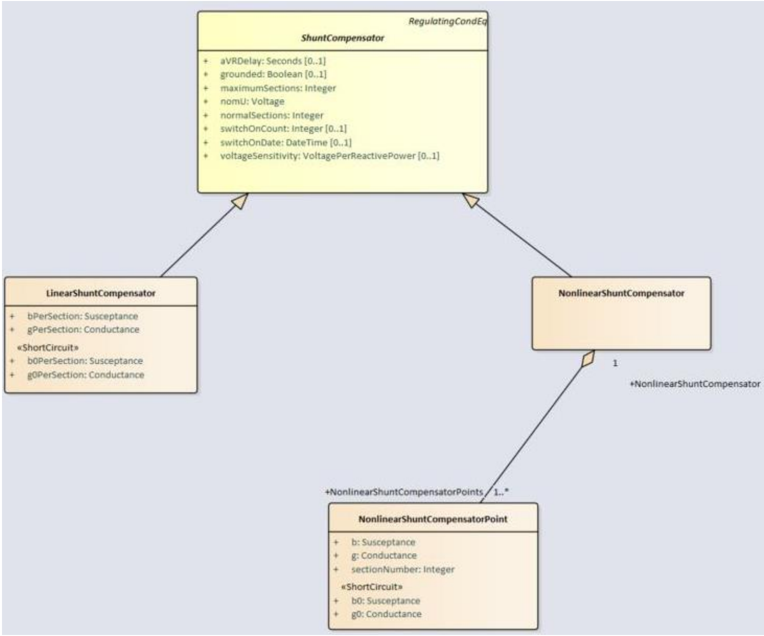
Appendix 13



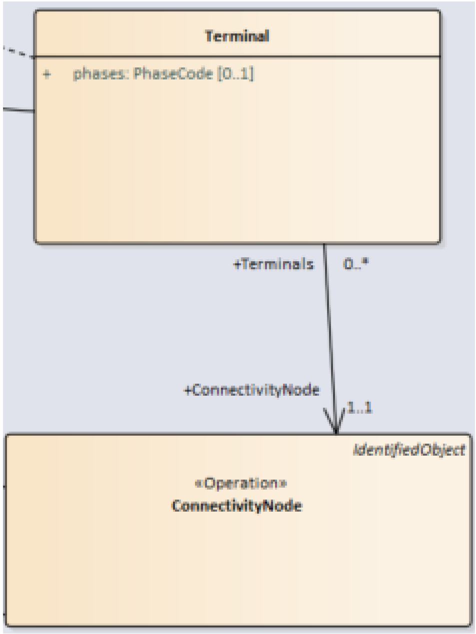
Appendix 14



Appendix 15



Appendix 16



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i Common Power System Model – DTE Training 2010 – M Goodrich – SISCO inc

ii EDF expectations regarding IOP tests – UCA CIMUg 2009 Charlotte - Eric Lambert