TYNDP 2020 ENTSO-E dataset specification

October 2020

To satisfy growing stakeholder expectations for transparency on grid and market data, ENTSO-E aims to have a systematized approach towards the availability of fit-for-purpose quality data to third parties. The Board adopted on 23 November 2017 a new Data Policy, aiming to increase data quality and data re-use with the ultimate objective of ensuring, when relevant, open data license. Increased transparency is also one of strategic priority of ENTSO-E Roadmap 2018 – 2022, approved by the Assembly at its 21 February 2018 meeting. ENTSO-E is implementing the Data Policy first and foremost on the Transparency Platform, and will progressively extend it to other relevant data projects in ENTSO-E.
At the 28 June 2018, the Assembly and Members approved a Memorandum of Understanding related to the Transparency Platform. This MoU complements the Transparency Regulation and guides the cooperation between the TSOs and ENTSO-E, as required by the Transparency Regulation, towards an increased transparency for TP end users, an increased quality of TP data, and a facilitation of TP data re-use.
According to ENTSO-E decision the data set will be provided in CGMES 2.4.15 format.
The purpose of the present document is to describe the content and capabilities of the ENTSO-E dataset created in 2020.

Revision History

Version	Date	Author	Summary of Changes	Changed Chapters
0.0	22/10/2020	WG DM		
0.01	05/03/2021	WG DM	Corrected balances, added notes	1, 3.2, 8

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1. Scope

The Specification for the ENTSO-E data se is intended to facilitate the use and understanding of the NT2025_European model by third parties performing power system studies. The reference grid dataset is a European model, with generation and demand according to Market simulation in Scenario NT2025.
The model is divided by synchronous areas: Continental Europe, Baltics, Great Britain and Ireland and Nordic TSOs. For TYNDP 2020 there are model available for Continental Europe and Baltics synchronous areas. The IGMs should be merged and solved for each synchronous area.

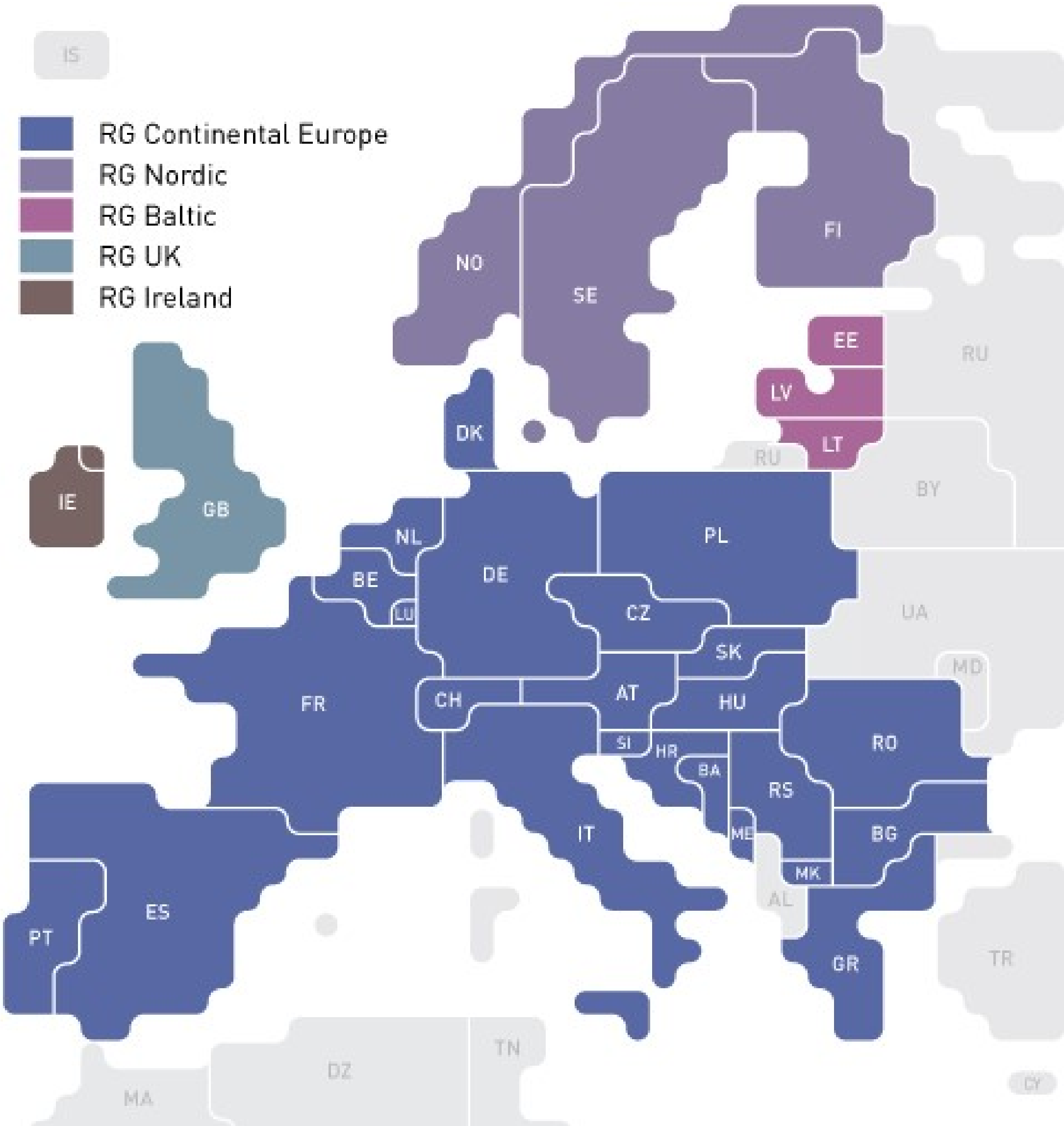


Figure.1

2. Abbreviations

BD	Boundary file
CE	Continental Europe
CGMES	Common Grid Model Exchange Standard
CIM	Common Information Model
HVDC	High Voltage Direct Current
IGM	Individual Grid Model
NMD	Network Modelling Database
NT	National Trends
NTC	Net Transfer Capacity
OHL	Overhead line
PATL	Permanent Admissible Transmission Line Loading
PEMMDB	Pan European Market Model Database.
PST	Phase Shifting Transformer
R	Resistance
RG	Regional group
RG CE	Regional Group Continental Europe
TP	Transparency Platform
TSO	Transmission System Operator
TYNDP	Ten Year Network Development Plan
X	Reactance

3. Starting data and IGM

The base for the TYNDP 2020 ENTSO-E Dataset is the market simulation for Scenario NT2025 and according to the generation types defined in PEMMDB.

3.1 Model inputs

The NT2025 market simulation provides the generation, demand and balances for each hour of the scenario time. For the grid model, a single hour is selected and the data for generation, demand, exchanges and balances is inserted in the grid model.

3.2 Generation/ demand and country balance

For the generation/ demand and cross border balance the following data were implemented in the models.

Continental Europe (CE):

		Installed power (MW)	*Generated Power (MW)*	Load (MW)	Balance (MW)
1	AL	2988.74	1429	1348	51
2	AT	28399.7	11169	11469	-417
3	BA	5050.7	3140	1725	1350
4	BE	25071.16	12504	11906	475
5	BG	10986.3	6018	5292	610
6	CH	24370	8877	8696.52	50
7	CZ	19094.6	11532	10246	1164
8	DE	283317	76180	76902	-2241
9	DK	13301.14	6391	6070	321
10	ES	130308.6	38429	35173	2455
11	FR	166760.5	77823	73461	2913
12	GR	31915	6952	6853	-43
13	HR	5637.15	1976	2191	-342
14	HU	11313.5	4529	5530	-1168
15	IT	128648	38583	46249	-8036
16	LU	2109	155	1191	-1044

17	ME	1944	454	535	-97
18	MK	2052.1	1189	1174	0
19	NL	42240.83	17363.54	16177	859
20	PL	46073.81	22818	25601	-3100
21	PT	25294.1	6538	6818	-373
22	RO	20391.66	9928	8282	1474
23	RS	10183.47	6506	5870	482
24	SI	4011.89	2484	2136	348
25	SK	7734	4054	4642	-615

Baltics:

		Installed power (MW)	*Generated Power (MW)*	Load (MW)	Balance
1	EE	2497	*1292*	1372	-33
2	LT	3403	*772*	1909	-1164
3	LV	2767	1263	1130	132

4. IGM analysis

4.1 Model description

The models submitted for 2025 Refgrid are aggregated bus branch models with the generation and load connected to the nearest High Voltage node.
For transmission lines rated voltages present in the model range from 110 kV to 750 kV.
All elements connected at 220 kV and above are modelled explicitly.
Representation of the non-radial 150 kV, 132 kV and 110 kV shall be represented at the 220-kV level.
Branches and substations of the network under the 220-kV voltage level shall not be represented in detail.
Loads shall be aggregated at the closest extra-high voltage (EHV) node to represent the actual loading on the connection point. Losses shall be considered. Embedded generation shall be represented as generation connected to the next EHV-HV node.

The step-up transformers are not usually represented in the model; however, it is not a mandatory requirement.

Requirement	Comment or additional specification	ENTSO-E dataset
Bus-branch model		✓
Reduced model 110- 750 kV Level with generation and load aggregated in the HV nodes.		✓
Generation types	Generation types according to CGMES classes: Thermal, Nuclear, Hydro, Wind, Generating unit (generic)	✓
Existing thermal generating units are present in the model		✓
Existing and planned units for other generating units are aggregated.		✓
Substations are usually represented as one busbar per substation. Retained switches are allowed to couple several bus bar sections.	See figure 2 Sample substation type 1 Figure 3 substation type 2	✓
All load flow models shall be submitted after a solution from a flat start with a mismatch tolerance of 1 MW or 1 MVAR per node and total mismatch less than 5 MVA.		✓
Models are checked for voltage violations.		✓
There shall be no overloaded elements in the load flow models prior to a contingency run and model assembling.	Valid for all IGMs	✓
Assembled models shall have solution with a mismatch tolerance of 1 MW or 1 Mvar per node and total mismatch less than 5 MVA.	Valid for the assembled models	✓
Controls present in the model are: • Voltage controllers • Power- Frequency control • Shunt controls		✓
Voltage of nodes next to a tie-line are not in the following ranges: • for 380 (400) kV nodes: 405 kV – 415 kV • for 220 (225) kV nodes: 220 kV – 231 kV		✓
Reactive transit flow on tie-lines for assembled models shall be lower than 50 Mvar for 380 (400) kV lines and 25 Mvar for 220 (225) kV lines considering the voltage difference is smaller than 1% between the ends of tie-lines. Therefore, individual models part of the assembled model shall target minimal reactive power exchange at boundary points (e.g. preferable close to zero Mvar).		✓

Active Power limits for generators Pmax, Pmin		✓
Reactive power capability limits as percentage of rated P	Limits in ENTSO-E dataset will be only Qmin, Qmax as a function of rated P.	✓
Thermal ratings AC lines		✓
HVDC lines	HVDC lines are represented as unconnected buses with equivalent injections.	✓

Figure 3.

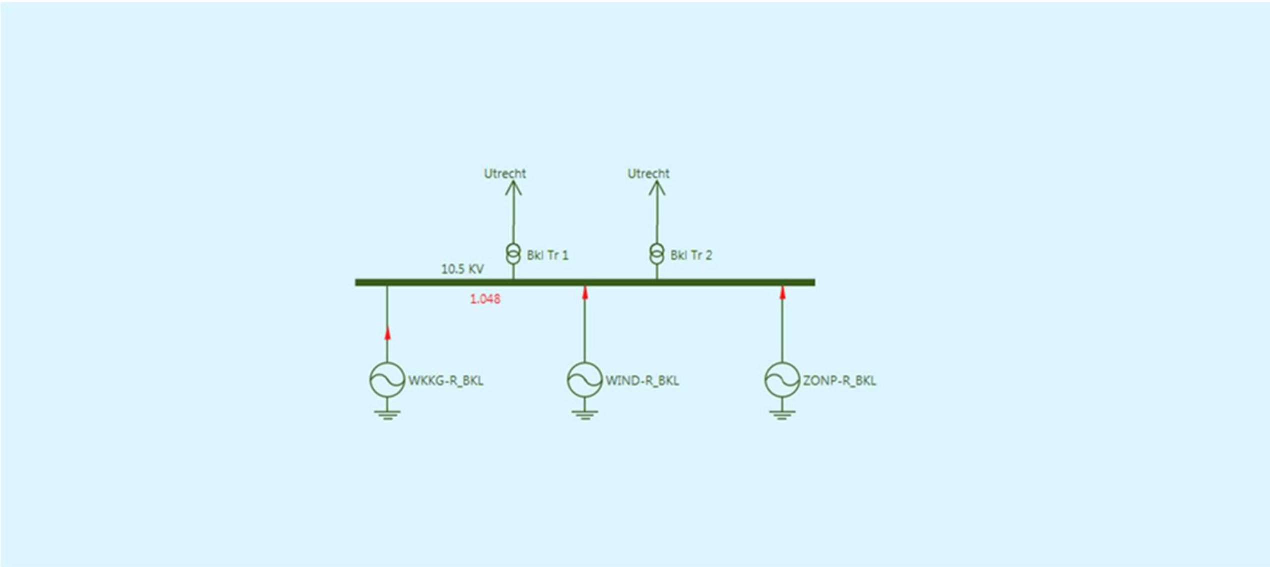
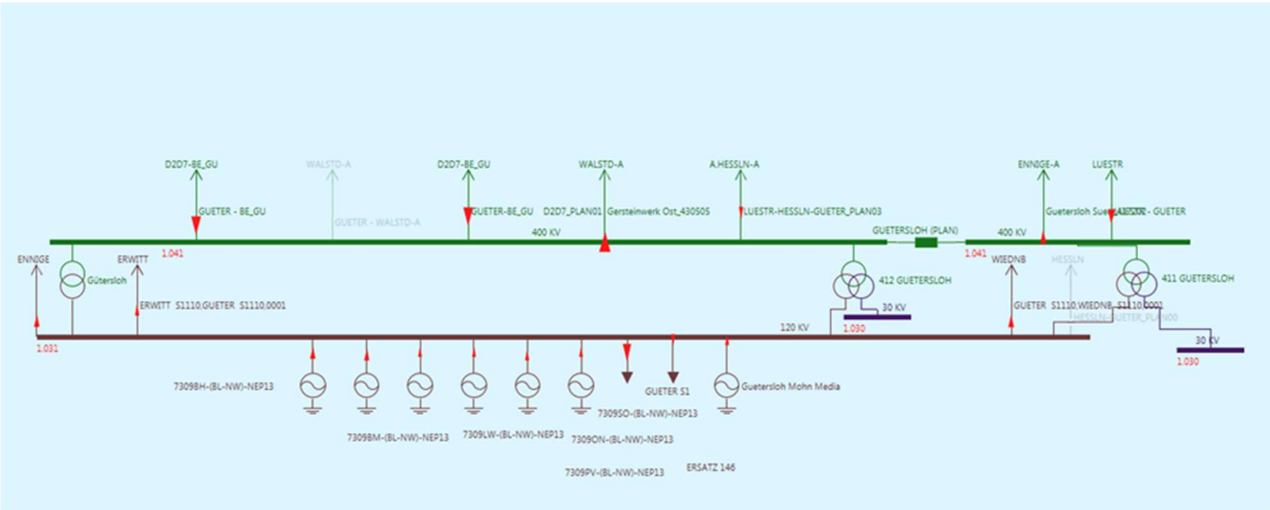


Figure 4.



4.2 Model content

4.2.1 CGMES files

All TSOs have provided the CGMES profiles EQ, TP, SSH, SV. So, a solved model is provided.

4.2.2 Classes used

The CGMES classes used in the ENTSO-E dataset are the following:

1 ACLineSegment
2 BaseVoltage
3 Breaker
4 BusbarSection
5 ConformLoad
6 ConformLoadGroup
7 ConnectivityNode
8 ControlArea
9 ControlAreaGeneratingUnit
10 CurrentLimit
11 Disconnector
12 EnergyConsumer
13 EquivalentBranch
14 EquivalentInjection
15 ExternalNetworkInjection
16 GeneratingUnit
17 GeographicalRegion
18 HydroGeneratingUnit
19 HydroPowerPlant
20 Junction
21 Line
22 LinearShuntCompensator
23 LoadBreakSwitch
24 LoadResponseCharacteristic
25 NonConformLoad
26 NonConformLoadGroup
27 NuclearGeneratingUnit
28 OperationalLimitSet
29 OperationalLimitType
30 PhaseTapChangerAsymmetrical
31 PhaseTapChangerSymmetrical
32 PhaseTapChangerTable
33 PhaseTapChangerTablePoint
34 PhaseTapChangerTabular
35 PowerTransformer
36 PowerTransformerEnd
37 RatioTapChanger
38 RegulatingControl
39 SeriesCompensator

40 StaticVarCompensator
41 SubGeographicalRegion
42 Substation
43 SvPowerFlow
44 SvShuntCompensatorSections
45 SvTapStep
46 SvVoltage
47 SynchronousMachine
48 TapChangerControl
49 Terminal
50 ThermalGeneratingUnit
51 TieFlow
52 TopologicalIsland
53 TopologicalNode
54 VoltageLevel
55 WindGeneratingUnit
56 EnergySchedulingType
57 FullModel

4.2.3 Base voltages

1	AC-0-4	AC-0-4	Base voltage defined by ENTSO-E 0.4 kV	AC-0-4	0.4
2	AC-10	AC-10	Base voltage defined by ENTSO-E 10 kV	AC-10	10
3	AC-10-25	AC-10-25	Base voltage 10-25 kV	AC-10-25	10.25
4	AC-10-5	AC-10-5	Base voltage defined by ENTSO-E 10.5 kV	AC-10-5	10.5
5	AC-11	AC-11	Base voltage defined by ENTSO-E 11 kV	AC-11	11
6	AC-11-5	AC-11-5	Base voltage defined by ENTSO-E 11.5 kV	AC-11-5	11.5
7	AC-110	AC-110	Base voltage defined by ENTSO-E 110 kV	AC-110	110
8	AC-115	AC-115	Base voltage defined by ENTSO-E 115 kV	AC-115	115
9	AC-12	AC-12	Base voltage defined by ENTSO-E 12 kV	AC-12	12
10	AC-120	AC-120	Base voltage defined by ENTSO-E 120 kV	AC-120	120
11	AC-124	AC-124	Base voltage defined by ENTSO-E 124 kV	AC-124	124
12	AC-125	AC-125	Base voltage defined by ENTSO-E 125 kV	AC-125	125
13	AC-13	AC-13	Base voltage 13 kV	AC-13	13
14	AC-13-8	AC-13-8	Base voltage defined by ENTSO-E 13.8 kV	AC-13-8	13.8
15	AC-130	AC-130	Base voltage 130 kV	AC-130	130
16	AC-132	AC-132	Base voltage defined by ENTSO-E 132 kV	AC-132	132
17	AC-135	AC-135	Base voltage defined by ENTSO-E 135 kV	AC-135	135
18	AC-14-4	AC-14-4	Base voltage defined by ENTSO-E 14.4 kV	AC-14-4	14.4
19	AC-15	AC-15	Base voltage defined by ENTSO-E 15 kV	AC-15	15
20	AC-15-5	AC-15-5	Base voltage 15.5 kV	AC-15-5	15.5
21	AC-15-75	AC-15-75	Base voltage defined by ENTSO-E 15.75 kV	AC-15-75	15.75
22	AC-150	AC-150	Base voltage defined by ENTSO-E 150 kV	AC-150	150

23	AC-154	AC-154	Base voltage defined by ENTSO-E 154 kV	AC-154	154
24	AC-16	AC-16	Base voltage defined by ENTSO-E 16 kV	AC-16	16
25	AC-165	AC-165	Base voltage defined by ENTSO-E 165 kV	AC-165	165
26	AC-17	AC-17	Base voltage 17 kV	AC-17	17
27	AC-18	AC-18	Base voltage 18 kV	AC-18	18
28	AC-19	AC-19	Base voltage 19 kV	AC-19	19
29	AC-19-5	AC-19-5	Base voltage 19.5 kV	AC-19-5	19.5
30	AC-193	AC-193	Base voltage defined by ENTSO-E 193 kV	AC-193	193
31	AC-20	AC-20	Base voltage defined by ENTSO-E 20 kV	AC-20	20
32	AC-200	AC-200	Base voltage defined by ENTSO-E 200 kV	AC-200	200
33	AC-21	AC-21	Base voltage defined by ENTSO-E 21 kV	AC-21	21
34	AC-22	AC-22	Base voltage 22 kV	AC-22	22
35	AC-220	AC-220	Base voltage defined by ENTSO-E 220 kV	AC-220	220
36	AC-225	AC-225	Base voltage defined by ENTSO-E 225 kV	AC-225	225
37	AC-232	AC-232	Base voltage 232 kV	AC-232	232
38	AC-24	AC-24	Base voltage 24 kV	AC-24	24
39	AC-25	AC-25	Base voltage defined by ENTSO-E 25 kV	AC-25	25
40	AC-250	AC-250	Base voltage defined by ENTSO-E 250 kV	AC-250	250
41	AC-26	AC-26	Base voltage defined by ENTSO-E 26 kV	AC-26	26
42	AC-27-5	AC-27-5	Base voltage defined by ENTSO-E 27.5 kV	AC-27-5	27.5
43	AC-275	AC-275	Base voltage defined by ENTSO-E 275 kV	AC-275	275
44	AC-285	AC-285	Base voltage defined by ENTSO-E 285 kV	AC-285	285
45	AC-3-8	AC-3-8	Base voltage defined by ENTSO-E 3.8 kV	AC-3-8	3.8
46	AC-30	AC-30	Base voltage defined by ENTSO-E 30 kV	AC-30	30
47	AC-300	AC-300	Base voltage defined by ENTSO-E 300 kV	AC-300	300
48	AC-31	AC-31	Base voltage defined by ENTSO-E 31 kV	AC-31	31
49	AC-320	AC-320	Base voltage defined by ENTSO-E 320 kV	AC-320	320
50	AC-33	AC-33	Base voltage defined by ENTSO-E 33 kV	AC-33	33
51	AC-330	AC-330	Base voltage defined by ENTSO-E 330 kV	AC-330	330
52	AC-34	AC-34	Base voltage 34 kV	AC-34	34
53	AC-35	AC-35	Base voltage defined by ENTSO-E 35 kV	AC-35	35
54	AC-350	AC-350	Base voltage defined by ENTSO-E 350 kV	AC-350	350
55	AC-36	AC-36	Base voltage defined by ENTSO-E 36 kV	AC-36	36
56	AC-380	AC-380	Base voltage defined by ENTSO-E 380 kV	AC-380	380
57	AC-400	AC-400	Base voltage defined by ENTSO-E 400 kV	AC-400	400
58	AC-450	AC-450	Base voltage defined by ENTSO-E 450 kV	AC-450	450
59	AC-5	AC-5	Base voltage defined by ENTSO-E 5 kV	AC-5	5
60	AC-500	AC-500	Base voltage defined by ENTSO-E 500 kV	AC-500	500
61	AC-6	AC-6	Base voltage defined by ENTSO-E 6 kV	AC-6	6
62	AC-6-3	AC-6-3	Base voltage defined by ENTSO-E 6.3 kV	AC-6-3	6.3
63	AC-600	AC-600	Base voltage defined by ENTSO-E 600 kV	AC-600	600

64	AC-63	AC-63	Base voltage 63 kV	AC-63	63
65	AC-70	AC-70	Base voltage defined by ENTSO-E 70 kV	AC-70	70
66	AC-750	AC-750	Base voltage defined by ENTSO-E 750 kV	AC-750	750
67	AC-9	AC-9	Base voltage 9 kV	AC-9	9

4.2.4 Boundary used

Boundary v1164 was used for model assembly.

The content of the boundary file is shown below:

Class	# of Objects	Description
BaseVoltage	67	Defines a system base voltage which is referenced.
ConnectivityNode	837	Connectivity nodes are points where terminals of AC conducting equipment are connected together with zero impedance.
GeographicalRegion	1	A geographical region of a power system network model.
Junction	837	A point where one or more conducting equipments are connected with zero resistance.
Line	837	Contains equipment beyond a substation belonging to a power transmission line.
SubGeographicalRegion	1	A subset of a geographical region of a power system network model.
Terminal	837	An AC electrical connection point to a piece of conducting equipment. Terminals are connected at physical connection points called connectivity nodes.
TopologicalNode	837	For a detailed substation model, a topological node is a set of connectivity nodes that, in the current network state, are connected together through any type of closed switches, including jumpers. Topological nodes change as the current network state changes (i.e., switches, breakers, etc. change state). For a planning model, switch statuses are not used to form topological nodes. Instead they are manually created or deleted in a model builder tool. Topological nodes maintained this way are also called "busses".
EnergySchedulingType	12	Used to define the type of generation for scheduling purposes.
FullModel	1	Header describing the full model and its contents.

4.3 Data quality checks

4.3.1 Generation Balance checks

The balances are checked against the market data.
By checking the CGMES file with the following formula
Generation = Load + losses + TSO balance.
The TSO balance is accounted by checking EquivalentInjection net value.

4.3.2 Loading and voltage violations

Continental Europe (CE):

		Undervoltage (U < 0,9)	*Overvoltage (U > 1,1)*	Flow limits violations
1	AL	1	1	0
2	AT	0	0	1
3	BA	0	0	6
4	BE	0	0	0
5	BG	0	0	0
6	CH	0	0	0
7	CZ	0	0	1
8	DE	0	0	9
9	DK	0	0	2
10	ES	3	0	4
11	FR	0	*34*	0
12	GR	7	10	0

13	HR	0	0	0
14	HU	0	*0*	0
15	IT	0	*2*	5
16	LU	0	0	0
17	ME	0	0	0
18	MK	4	0	11
19	NL	0	0	14
20	PL	0	0	0
21	PT	13	0	0
22	RO	0	0	0
23	RS	0	*1*	0
24	SI	0	0	0
25	SK	0	*0*	0

Baltics:

		Undervoltage (U < 0,9)	*Overvoltage (U > 1,1)*	Flow limits violations
1	EE	1	1	0
2	LV	0	0	0
3	LT	0	0	6

4.3.3 Losses

Continental Europe (CE):

		Installed power (MW)	*Generated Power (MW)*	Load (MW)	Losses
1	AL	2988.74	1429	1348	2.1%
2	AT	28399.7	*11169*	11469	1%
3	BA	5050.7	*3140*	1725	2.2%
4	BE	25071.16	*12504*	11906	1%
5	BG	10986.3	*6018*	5292	1.9%
6	CH	24370	*8877*	8696.52	1.5%
7	CZ	19094.6	*11532*	10246	1%
8	DE	283317	*76180*	76902	2%
9	DK	13394.14	*6492*	6070	1.5%
10	ES	130308.6	*38429*	35173	2.1%
11	FR	166760.5	*77825*	73435	1.9%
12	GR	31915	*6952*	6853	2%
13	HR	5637.15	*1976*	2191	6%
14	HU	11313.5	*4529*	5530	3.7%
15	IT	128648	*38583*	46249	1.4%
16	LU	2109	*155*	1191	5.2%
17	ME	1944	*454*	535	2.2%

18	MK	2052.1	*1189*	1174	1.3%
19	NL	42240.83	*17363.54*	16177	1.9%
20	PL	46073.81	*22818*	25601	1.4%
21	PT	25294.1	*6538*	6818	1.5 %
22	RO	20391.66	*9928*	8282	1.7%
23	RS	10183.47	*6506*	5870	2.4%
24	SI	4011.89	*2484*	1818.2	1.1%
25	SK	7734	*4054*	4642	0.70%
TOTAL			*377124.5*	375193.7	2%

Baltics:

		Installed power (MW)	*Generated Power (MW)*	Load (MW)	Losses
1	EE	2766	*496.59*	1290	1.90%
2	LV	29581.01	*9187.15*	9181.2	0.70%
3	LT	4937	*1925.7*	1769.6	1.80%

5. Merged model analysis

5.1 Model content

Network models for TYNDP 2020 will be provided in the ENTSO-E CIM CGMES data exchange format. The overall model content based on CGMES 2.4.15 classes is shown below.

Class	AL	AT	BA	BE	CH	CZ	DE	DK	ES	FR	GR	HR	HU	IT	LU	ME	MK	NL	PL	PT	RO	RS	SI	SK	Total
ACLineSegment	202	784	326	755	311	118	1591	314	1231	2225	1808	366	792	1038	45	112	155	1228	393	606	186	798	283	53	15720
BaseVoltage	2		3	8			16		15	5	5		1	24	2	2	10	14	1			5			113
Breaker		214		7			518			806				1	9			5							1346
BusbarSection	269	723	299	917	159	76	2351	251	1271	2815	2188	226	825		50	248	144	1199	369	605	128	1373		34	15245
ConformLoad	93	185	143	278	166	40		151	2241	1049	354	331	280		28		100		175	91	88	336			5598
ConformLoadGroup	93	1	1	1	15	1		1	1	1049	354	331	280		1		1		175	91	88	1			2483
ConnectivityNode	282				181						2189	226	825						369	605				34	4711
ControlArea	1	1			1		2		1	1	1	1	1			1	1		1	1	1	1		1	17
ControlAreaGeneratingUnit	1				1				1	1	1	2	1			1	1			1	4	1		2	18
CurrentLimit	1476	3214	2154	1787	2869	256	3703	794	7789	12792	16332	810	6492	6729	118	552	617	4082	9006	4658	444	6558	1872	321	95425
Disconnector		1		6	2		3	1										1							13
EnergyConsumer							1439							1157				327					157	21	3101
EquivalentBranch				18			91	22	4							2			216						353
EquivalentInjection	7	61	27	21	41	18	100	26	19	48	8	15	20	36	15	13	8	15	17	10	10	19	18	12	584
EquivalentNetwork									4							2									6
EquivalentShunt																			171						171
ExternalNetworkInjection						35	182																		217
GeneratingUnit	2	295		423	169	98	2263	163	1693	1903	308	20	424	1688	7	1	2	473	623	112	34	2	18	48	10769
GeographicalRegion	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
HydroGeneratingUnit	106	391	43	45	193	29	609		928	649	55	39	14	893	12	24	22	5	162	116	52	52	63	23	4525
HydroPowerPlant		391		45	207	29	609		928	579	55	39	14		12					116	52			23	3099
Line				672		118		314		48					45			116	376				283		1972
LinearShuntCompensator	5	54		42		8	110	85	184	393	Xxx	6	40	101			6	168	51	68	15			24	1360
LoadArea	1	1	1	1	1				1		1	1	1			1	1		1	1	1	1		1	14
LoadBreakSwitch							14																		14
LoadResponseCharacteristic	93	202	144		80		1439		2405	2005	354	331	390	1157	1	80	100		1	91	88	405		21	9387

Class	AL	AT	BA	BE	CH	CZ	DE	DK	ES	FR	GR	HR	HU	IT	LU	ME	MK	NL	PL	PT	RO	RS	SI	SK	Total
MutualCoupling																		164							164
NonConformLoad		17	1		3				164	956			110			20						69			1083
NonConformLoadGroup		1	1		3				1	956			110			1						1			833
NonlinearShuntCompensator								38																	38
NonlinearShuntCompensatorPoint								825																	825
NuclearGeneratingUnit					2	10			7	57			8					1			2		1	6	94
OperationalLimitSet	943	2018	1057	2019	3462	332	3703	1045	4494	5463	7632	1036	2989	4651	119	750		4082	3524	2487	572	4649	624	145	57796
OperationalLimitType	7	2	7	3	7	3	1	3	7	6	7	7	6	2575	3	7	7	1	3	7	7	7	3	7	2693
PhaseTapChangerAsymmetrical		115			1		1	1										4	1				2		124
																									0
PhaseTapChangerLinear				21		4													13	4					42
PhaseTapChangerSymmetrical		8			17		10		4					15											54
PhaseTapChangerTable								7		14					1			3							25
PhaseTapChangerTablePoint								155		464					33			99							751
PhaseTapChangerTabular								7		14					1			3							25
PowerTransformer	116	181	106	114	48	8	193	78	440	649	875	39	290	1285	14	110	45	653	246	335	36	820	29	1	6711
PowerTransformerEnd	270	450	212	275	96	20	513	166	1033	1298	1826	78	580	2573	28	299	108	1514	506	670	72	1958	58	3	14606
RatioTapChanger	145	58		65	29	4	55	44	149	289	256	69	95	554	11	80	10	406	231	364	36	199	24	1	3174
RatioTapChangerTable								36		232															36
RatioTapChangerTablePoint								754		1606															754
RegulatingControl	77	833	73	100	114	210	396	109	3424	3508	816	52	310	4104	13	31	42	47	217	217	94	105	8	23	14923
SeriesCompensator							4											56							60
StaticVarCompensator								1		7															8

SubGeographicalRegion	2	1	4	1065	1	1	6	3	5	7	2	1	1	20	4	2	1	18	1	14	1	1	1	1	1163
SubLoadArea	1		1		1				1		1	1	1			1	1		1	1	1	1			13
Substation	269	300	204	393	130	49	691	175	707	1313	2190	226	411	698	38	58	95	615	144	471	94	428	149	27	9875
Class	AL	AT	BA	BE	CH	CZ	DE	DK	ES	FR	GR	HR	HU	IT	LU	ME	MK	NL	PL	PT	RO	RS	SI	SK	Total
Switch									47							36	4					114			201
SynchronousMachine	114	927	73	689	373	210	4668	271	3240	3501	660	93	497	4104	23	31	36	732	1017	297	156	105	97	109	22023
TapChangerControl	19	181		47	20	4		42	153	54	138	26	54	569	1		10	69	202	150	25	199	26	1	1990
Terminal	1162	4415	1407	3800	1464	648	14727	1663	10716	16129	8826	1481	3936	10049	252	971	720	6534	3524	2953	841	5684	901	311	103114
ThermalGeneratingUnit	3	41	13	86		55	352	16	87	149	47	10	31	1152		2	10	198	81	16	51	23	7	11	2441
TieFlow		61	34				100			48									17						260
VoltageLevel	269	457	275	578	159	63	1333	244	1035	1685	2191	226	545	1904	18	145	125	967	293	574	115	1029	169	29	14428
VoltageLimit	1076		1196		2480				5084		8752	904	3300			992	576			2420	512	5592		136	33020
WindGeneratingUnit	3	91	12	135	9	18	668	91	525	743	250	24	20	371	4	3	2	159	151	53	17	27	1	5	3382
	7110,00	16256	7818	14137	12816	2350	42462	7897	50040	63199	58483	7018	23695	47449,00	881	4579	2961	22760	22279	18206	3824	30564	4795	1435	473014
Total																									

Class	EE	LT	LV	Total
ACLineSegment	339	592	338	15111
BaseVoltage	4			184
Breaker		112		2066
BusbarSection	385	560	299	17022
ConformLoad	168	392	148	5126
ConformLoadGroup	168	392	148	2127
ConnectivityNode	385	560	299	3041
ControlArea	1	1	1	154
ControlAreaGeneratingUnit	1	1	1	16
CurrentLimit	2204	4458	1230	80466
Disconnector				781
EnergyConsumer		44		3684
EquivalentBranch				2266
EquivalentInjection	8	26	12	519
EquivalentNetwork				4

EquivalentShunt				175
ExternalNetworkInjection				3924
GeneratingUnit	15	13	2	8286
GeographicalRegion	1	1	1	24
HydroGeneratingUnit		9	24	3775
HydroPowerPlant		9	24	1722
Line				2165
LinearShuntCompensator	37	15	6	1799
LoadArea	1	1	1	14
LoadBreakSwitch				14
LoadResponseCharacteristic	191	458	154	8538

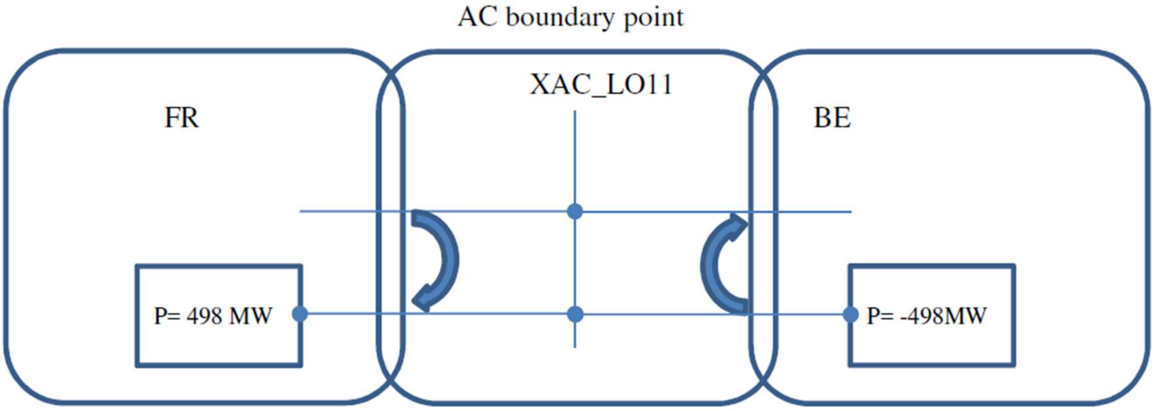
Class	EE	LT	LV	Total
MutualCoupling				164
NonConformLoad	23	66	6	959
NonConformLoadGroup	23	66	6	717
NonlinearShuntCompensator				36
NonlinearShuntCompensatorPoint				846
NuclearGeneratingUnit				85
OperationalLimitSet	1163	2120	977	
OperationalLimitType	7	7	7	2473
PhaseTapChangerAsymmetrical				46
PhaseTapChangerLinear				24
PhaseTapChangerSymmetrical				46

PhaseTapChangerTable				23
PhaseTapChangerTablePoint				691
PhaseTapChangerTabular				23
PowerTransformer	53	77	68	6621
PowerTransformerEnd	132	154	136	15310
RatioTapChanger		78	67	4030
RatioTapChangerTable				30
RatioTapChangerTablePoint				634
RegulatingControl	35	45	44	13033
SeriesCompensator				35
StaticVarCompensator				8
SubGeographicalRegion	19	8	8	115
SubLoadArea	1		1	12
Substation	264	448	299	8500
Switch				371
SynchronousMachine	36	41	40	15921
TapChangerControl	9	14		3160
Terminal	1777	2662	1323	105771
ThermalGeneratingUnit	8		7	1105
TieFlow				3434
VoltageLevel	264	448	299	15452
VoltageLimit	1540		1196	25518
WindGeneratingUnit	13	19	7	2657
Total	9229,00	12307,00	6781,00	28317,00

5.1.1 AC Lines

There are 18881 lines in the NT2025_CE model. Of these, 270 AC tie- lines between TSOs connections. When the model is merged both sides of the line segment are connected to the boundary point. The equivalent injections on the IGM are disconnected. The flows on the tie line will be as per the load flow results.

The AC tie line represented in CGMES is shown below.



XPE_PI21
XWE_LE11
XOB_MB11
XRE_PA11
XLA_GU22
XGR_IM51
XTR_PL21
XBU_KO51
XZE_KA11
XSA_RI11
XAV_AV12
XNE_BR51
XRI_CO21
XGR_HG12
XBA_KF31
XFL_KA11
XOT_LA11
XZV_BI51
XVY_MB12
XAU_M.21
XRO_SF11

XTR_BL21
XDI_ME13
XDU_SL11
XBR_AV11
XTU_DA11
XZE_HE12
XVI_KR11
XCM_ST11
XYV_SI22
XSI_MB11
XDT_DB11
XLA_GU21
XVE_GE22
XFO_PL11
XTR_KO51
XB._CA21
XS._CO21
XME_CA11
XLA_KU12
XBB_LI51
XGY_GA11
XAA_BO12
XNA_PR12
XNE_OP51
XPL_ZA51
XED_KL11
XME_DI11
XER_PE12
XCA_AL12
XST_VR11
XVD_PO21
XOR_ZU51
XPR_SI21
XVL_VE12
XKO_TI12
XGO_ME21
XVE_GE21
XKA_MA12
XAL_LG11
XZE_CI11
XGR_DA11
XST_PR52
XTR_LA11
XTU_DA21
XRE_PA12
XLI_KO21
XJA_KA12
XMA_IB51
XMO_KO11
XAR_AR21
XBI_SO21
XLA_KU21

XVK_BR51
XJO_JO21
XED_KL12
XBA_MA11
XEN_SA21
XKA_KO11
XHE_CI12
XTR_PE21
XPA_DI21
XWE_WB22
XWE_WB21
XTU_KR11
XLI_BU21
XWE_LE13
XSK_KP51
XJO_JO22
XHR_RO12
XYV_SI21
XLA_EN11
XJO_JO24
XWU_SO21
XFI_PR21
XBG_TH11
XBA_KF32
XNO_VA12
XLI_AU21
XUG_SM11
XMN_BR21
XWE_SI2B
XVA_MG11
XVI_KR12
XAU_MO22
XBE_TI13
XZU_SZ11
XNZ_SO22
XKR_LE12
XVY_MB11
XWE_KE21
XAL_PN21
XHR_ET11
XSR_LJ51
XEL_BI11
XWE_PR12
XMN_RU21
XCA_ME21
XLA_KU13
XAL_RO11
XAC_LO12
XPL_BI21
XBA_SI11
XZU_GY11
XRO_B.11

XWA_BR21
XER_SM11
XBI_SO22
XUG_ER11
XOB_PO21
XEN_VI11
XAA_BO11
XBI_NI51
XKR_ZA13
XCA_AL11
XDI_ME14
XJO_JO25
XNS_VI22
XKA_PG11
XSO_NI11
XSA_PI21
XKR_ZA14
XWI_GY21
XPR_ME21
XDO_MG11
XSA_AR11
XWE_LE12
XWE_BR12
XNE_ST51
XSJ_BR51
XAL_RO12
XQU_HE21
XPI_GI12
XCE_FR11
XBA_VI22
XEI_VO21
XKU_ZA51
XKR_LE11
XOB_RA21
XNA_PR11
XMA_MU11
XEI_MU12
XVI_VA21
XJO_JO23
XKO_LA11
XKA_KB11
XWE_BR21
XAL_PO21
XAV_MA12
XAC_LO11
XOB_RA11
XHE_AR11
XEM_EE11
XMI_NS11
XLI_PO22
XNA_GL21
XKO_LA12

XNS_VI21
XBI_PR21
XBI_LE51
XRO_GO11
XTH_DU11
XNE_GY21
XNR_DT11
XRI_AV21
XBA_VI21
XRI_VA21
XPL_BB21
XBR_VR51
XPE_AH21
XGR_TA41
XAS_SI11
XFL_KA12
XER_PE11
XVA_PR21
XPE_PT11
XBE_NA11
XPF_DJ11
XFL_BI11
XLA_TI11
XHG_MI12
XJA_KA11
XAL_PN22
XKV_GR51
XPE_SI21
XLA_KU22
XBA_FL21
XNZ_SO21
XVE_B.11
XPE_IS12
XSO_SE11
XGN_GA11
XVI_BA11
XCA_OP51
XSA_PN21
XPE_SU51
XEI_MU13
XAU_SA21
XBI_MO31
XKR_ZA12
XMO_BE21
XWE_SI2A
XEI_MU11
XTU_KR12
XBE_TI11
XSK_UR11
XHR_RO11
XMO_CH21
XSO_ST11

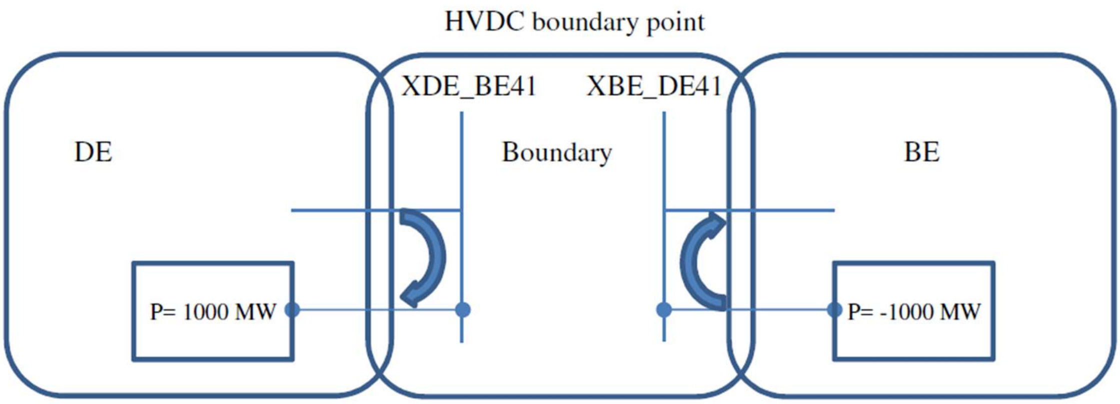
XBE_TI21
XGR_HG11
XDU_SL12
XPE_DI21
XSE_PA21
XTR_PL22
XPE_PT21
XEN_VI14
XRE_DI11
XAU_BE21
XWE_SI2C
XEN_VI13
XSO_ME11
XKR_ZA11
XSA_SU11
XNE_FO51
XPU_TV11
XGN_VD11
XKA_MA11
XKO_TI11
XNR_DT12
XLA_SI11
XPE_IS11
XPE_PT12
XMN_RU22
XPI_GI11
XTR_HN51
XRI_PE11
XST_PR51
XNO_WI11
XAS_KU11
XGR_DA21
XZE_CI21
XWE_PR11
XGO_LE11
XPR_ET11
XEN_VI12
XHG_MI11
XLA_KU11
XRA_BR51
XBA_RO21

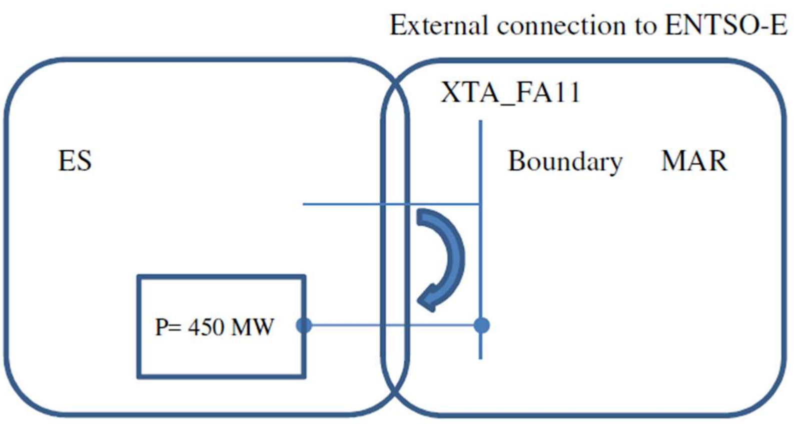
5.1.2 PST

PST in the NT2025_CE model correspond to transformers with the following associated CGMES classes:

PhaseTapChangerAsymmetrical
PhaseTapChangerLinear
PhaseTapChangerSymmetrical
PhaseTapChangerTabular

5.2 HVDC and external network connections location





The following elements are single connection X-nodes:

XGU_SI51
XPL_BI11
XGA_CU1E
XMO_ZA21
XRO_MU11
XTR_HE21
XPF_DJ12
XDI_CA1E
XBI_R21_K
XBI_R11_K
XBE_GB2B
XVG_BB11
XDI_ME12
XTI_MU21
XWB_BR21
XJO_OR11
XBA_ZA01
XAV_DW1P
XNS_BA11
XMI_HA11
XBE_DE42
XMO_TU12
XAV_DW1K
XJI_KI51
XEL_AL12
XMI_HA12
XSI_VE1I
XWB_BR11

XBR_SL51
XHW_KR1D
XTA_FA11
XTJ_K41K
XDI_CA1F
XDI_ME11
XVR_RE41
XBW_BJ1K
XED_EE1N
XMO_TE31
XSA_HO11
XWI_TO1D
XMA_SE11
XTJ_K31K
XSA_BE1S
XSA_MA1F
XGR_MA1N
XPL_PO11
XED_EE1D
XLL_BA1E
XBW_BJ1D
XTJ_K13K
XSA_LU21
XLI_OB1A
XAV_AV11
XGA_CU1F
XFG_HK12
XTJ_K23K
XVH_L11K
XAR_GA1G
XVH_L21K
XEH_GB11
XBW_BJ2K
XBW_BJ2D
XEH_GB12
XVI_KR21
XNL_GB2
XAR_GA1I
XFG_HK11
XIE_FR42
XAU_BA21
XVK_MU11
XTA_FA12
XKI_MU21
XSA_MA1E
XDR_ZR1P
XTO_CH11
XMA_SE13
XBA_MU11
XME_EX11
XAU_BA22
XNI_SI51

XGU_HU1D
XVI_KR22
XMA_SE15
XLI_OB1B
XOM_DJ51
XER_SO11
XGU_HU2D
XPA_EL9I
XLL_BA1F
XEL_AL11
XZE_HE11
XSA_GO11
XMO_TE32
XAV_MA11
XEE_FE1N
XBM_AP51
XBE_SA1S
XSL_SW11
XDE_ZA41
XBG_KN51
XSO_NI12
XFE_GR1D
XVI_PO11
XBE_GB1B
XSI_VE1S

XVR_LJ51
XSK_KB12
XSV_BA11
XVI_ZA51
XMO_ZA21
XAH_NA
XVK_IS11
XVG_BI11
XDA_TO
XBL_LI11

Number of single connected elements after merging is 115.

6. Merged model specification

NT2025_CE model is composed of 25 IGMs and one BD file. Once the assembly is done the model has been tested for convergence and the balances and losses checked.
NT2025 Baltics model is composed of 3 IGMs and one BD file.

6.1 Load flow study

6.1.1 CE Synchronous area

It is possible with the assembled model to run a load flow study with reactive limits enabled.

On this model 3 slacks are used for the CE model.

FLAMAP7 (FR)
F.20Ll (IT)
AVV_0201 (DK)

If balancing on the slack is selected for the solution, it is recommended to increase the reactive power capability on the FLAMAP7 slack to -600, 600 MVAR.

It is recommended to set the HVDC exchanges to the same values in both sides of the interconnections. The model converges in 11 iterations with the selected slacks and the recommended settings.

In case of inserting a model of the HVDC link, the balances of the EquivalentInjections indicated on both sides of the link should be maintained to keep the balances.

The results for load flow are shown below:

--
| | | | Project: |
| | | |-------------------------------
| | | 2020 | Date: 12/2020 |

--

--
| Load Flow Calculation Grid Summary |

--
AC Load Flow, balanced, positive sequence	Automatic Model Adaptation for Convergence No
Automatic tap adjustment of transformers No	Max. Acceptable Load Flow Error
Consider reactive power limits Yes	Bus Equations(HV) 1,00 kVA
	Model Equations 0,10 %

--

--
| Grid: AL System Stage: AL | Study Case: Study Case | Annex: / 1 |

--
| Grid: AL Summary |
| |
| No. of Substations 269 No. of Busbars 269 No. of Terminals 0 No. of Lines 202 |
| No. of 2-w Trfs. 78 No. of 3-w Trfs. 38 No. of syn. Machines 114 No. of asyn.Machines 0 |
| No. of Loads 93 No. of Shunts/Filters 5 No. of SVS 0 |
| |
| Generation = 1429,36 MW 98,33 Mvar 1432,74 MVA |
| External Infeed = 0,00 MW 0,00 Mvar 0,00 MVA |
| Inter Grid Flow = 56,20 MW -23,81 Mvar |
| Load P(U) = 1348,21 MW 473,49 Mvar 1428,94 MVA |
| Load P(Un) = 1348,21 MW 473,49 Mvar 1428,94 MVA |
| Load P(Un-U) = -0,00 MW 0,00 Mvar |
| Motor Load = 0,00 MW 0,00 Mvar 0,00 MVA |
| Grid Losses = 24,95 MW -351,35 Mvar |
| Line Charging = -648,31 Mvar |
| Compensation ind. = 0,00 Mvar |
| Compensation cap. = 0,00 Mvar |
| |
| Installed Capacity = 2651,52 MW |
| Spinning Reserve = 883,42 MW |
| |

| Total Power Factor: |
| Generation = 1,00 [-] |
|---
|

| Grid: AL System Stage: AL | Study Case: Study Case | Annex: / 2
|

| Load/Motor = 0,94 / 0,00 [-] |

| Inter Grid Flow to |
| GR = -49,24 MW 6,41 Mvar |
| MK = -94,02 MW -20,15 Mvar |
| ME = 62,62 MW -20,02 Mvar |
| RS = 136,84 MW 9,96 Mvar |
| Total = 56,20 MW -23,81 Mvar |
|---
|

```
----------------------------------------------------------------------------------------------------------------------------
--
| Grid: AT                System Stage: AT            | Study Case: Study Case              | Annex:               / 3
|
----------------------------------------------------------------------------------------------------------------------------
--
| Grid: AT                Summary                                                                     |
|                                                                                             |
| No. of Substations     457       No. of Busbars       723       No. of Terminals     0         No. of Lines
784   |
| No. of 2-w Trfs.      93        No. of 3-w Trfs.      88        No. of syn. Machines  927       No. of
asyn.Machines  0     |
| No. of Loads          202       No. of Shunts/Filters 54        No. of SVS            0                          |
|                                                                                             |
| Generation          =  11167,90  MW       -347,30   Mvar    11173,30  MVA
|
| External Infeed       =       0,00  MW          0,00   Mvar        0,00  MVA                                 |
| Inter Grid Flow       =   -421,05  MW       -115,14   Mvar                                             |
| Load P(U)           =  11467,66  MW        982,15   Mvar    11509,64  MVA
|
| Load P(Un)           =  11467,66  MW        982,15   Mvar    11509,64  MVA
|
| Load P(Un-U)          =       0,00  MW         -0,00   Mvar                                           |
| Motor Load            =       0,06  MW        166,72   Mvar      166,72  MVA                                 |
| Grid Losses           =    121,22  MW       -2763,61   Mvar                                           |
| Line Charging         =                    -3915,36   Mvar                                         |
| Compensation ind.     =                      1494,58   Mvar                                      |
| Compensation cap.     =                      -112,00   Mvar                                      |
|                                                                                             |
| Installed Capacity    =  43068,88  MW                                                       |
| Spinning Reserve      =  17231,81  MW                                                       |
|                                                                                             |
| Total Power Factor:                                                                   |
|   Generation          =       1,00  [-]                                                |
|-----------------------------------------------------------------------------------------------------------------------------
|
----------------------------------------------------------------------------------------------------------------------------
--
| Grid: AT                System Stage: AT            | Study Case: Study Case              | Annex:               / 4
|
----------------------------------------------------------------------------------------------------------------------------
--
|   Load/Motor          =  1,00 / 0,00  [-]                                                     |
----------------------------------------------------------------------------------------------------------------------------
--
| Inter Grid Flow to                                                                    |
|   DE               =  -1455,45  MW        -478,17   Mvar                                   |
|   IT               =    863,16  MW       -100,88   Mvar                                   |
|   CZ               =   -520,66  MW        173,68   Mvar                                   |
|   HU               =     -80,10  MW        -30,05   Mvar                                   |
|   CH               =    865,91  MW        108,30   Mvar                                   |
|   SI               =    -93,91  MW       211,97   Mvar                                   |
```

| Total = -421,05 MW -115,14 Mvar |
|---
|

```
--------------------------------------------------------------------------------------------------------------------------------
--
| Grid: BA                 System Stage: BA            | Study Case: Study Case              | Annex:                / 5
|
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--
| Grid: BA                 Summary                                                                              |
|                                                                                                          |
| No. of Substations     275        No. of Busbars        299        No. of Terminals      0         No. of Lines
324   |
| No. of 2-w Trfs.       106        No. of 3-w Trfs.       0          No. of syn. Machines  73         No. of
asyn.Machines  0      |
| No. of Loads           144        No. of Shunts/Filters 0          No. of SVS            0                         |
|                                                                                                          |
| Generation          =    3139,71  MW        -32,33   Mvar     3139,88  MVA                                       |
| External Infeed       =       0,00  MW           0,00   Mvar        0,00  MVA                                  |
| Inter Grid Flow       =    1356,31  MW        -335,78   Mvar                                                  |
| Load P(U)           =    1724,51  MW         565,23   Mvar      1814,78  MVA
|
| Load P(Un)            =    1724,51  MW         565,23   Mvar      1814,78  MVA
|
| Load P(Un-U)          =       -0,00  MW           0,00   Mvar                                                 |
| Motor Load            =       0,00  MW           0,00   Mvar        0,00  MVA                                   |
| Grid Losses           =      58,89  MW        -261,78   Mvar                                                   |
| Line Charging         =                       -923,48   Mvar                                             |
| Compensation ind.     =                           0,00   Mvar                                            |
| Compensation cap.     =                           0,00   Mvar                                            |
|                                                                                                          |
| Installed Capacity    =    2312,15  MW                                                                   |
| Spinning Reserve      =      525,34  MW                                                                  |
|                                                                                                          |
| Total Power Factor:                                                                                |
|   Generation          =         1,00  [-]                                                                 |
|---------------------------------------------------------------------------------------------------------------------------------
|
--------------------------------------------------------------------------------------------------------------------------------
--
| Grid: BA                 System Stage: BA            | Study Case: Study Case              | Annex:                / 6
|
--------------------------------------------------------------------------------------------------------------------------------
--
|   Load/Motor          =  0,95 / 0,00  [-]                                                                  |
--------------------------------------------------------------------------------------------------------------------------------
--
| Inter Grid Flow to                                                                                      |
|   HR                =   1253,15  MW        -201,47   Mvar                                             |
|   RS                =    176,39  MW        -112,77   Mvar                                            |
|   ME                =    -73,22  MW         -21,54   Mvar                                            |
|   Total             =   1356,31  MW        -335,78   Mvar                                             |
|---------------------------------------------------------------------------------------------------------------------------------
|
```

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--
| Grid: BE                System Stage: BE            | Study Case: Study Case            | Annex:                / 7  |
--------------------------------------------------------------------------------------------------------------------------
--
| Grid: BE                Summary                                                                          |
|                                                                                          |
| No. of Substations    578       No. of Busbars       729       No. of Terminals      94        No. of Lines
755   |
| No. of 2-w Trfs.      67        No. of 3-w Trfs.      47        No. of syn. Machines  689        No. of
asyn.Machines  0      |
| No. of Loads          278       No. of Shunts/Filters 42        No. of SVS            0                     |
|                                                                                          |
| Generation          =  12504,37  MW       -2122,27   Mvar    12683,19  MVA
|
| External Infeed      =     0,00  MW          0,00   Mvar        0,00  MVA                       |
| Inter Grid Flow      =    484,91  MW        699,79   Mvar                                    |
| Load P(U)           =  11906,09  MW       1296,63   Mvar    11976,49  MVA
|
| Load P(Un)           =  11906,09  MW       1296,63   Mvar    11976,49  MVA
|
| Load P(Un-U)          =      0,00  MW         -0,00   Mvar                                 |
| Motor Load           =     0,00  MW          0,00   Mvar        0,00  MVA                       |
| Grid Losses          =    113,36  MW       -3926,05   Mvar                                 |
| Line Charging        =                    -5614,73   Mvar                            |
| Compensation ind.     =                     1909,36   Mvar                              |
| Compensation cap.     =                    -2101,99   Mvar                              |
|                                                                                          |
| Installed Capacity    =  25295,00  MW                                                    |
| Spinning Reserve      =   12566,79  MW                                                    |
|                                                                                          |
| Total Power Factor:                                                                      |
|   Generation          =       0,99  [-]                                                  |
|---------------------------------------------------------------------------------------------------------------------------
|
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--
| Grid: BE                System Stage: BE            | Study Case: Study Case            | Annex:                / 8  |
--------------------------------------------------------------------------------------------------------------------------
--
|   Load/Motor          =  0,99 / 0,00  [-]                                                 |
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--
| Inter Grid Flow to                                                                      |
|   FR               =    2045,97  MW       -160,34   Mvar                                  |
|   NL               =  -1401,05  MW        737,95   Mvar                                  |
|   LU               =   -262,01  MW         58,90   Mvar                                  |
|   EU               =    102,00  MW         63,28   Mvar                                  |
|   Total            =    484,91  MW        699,79   Mvar                                  |
|---------------------------------------------------------------------------------------------------------------------------
|
```

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-------------------------------------------------------------------------------------------------------------------------------
--
| Grid: BG              System Stage: BG           | Study Case: Study Case           | Annex:              / 9
|
-------------------------------------------------------------------------------------------------------------------------------
--
| Grid: BG              Summary                                                                  |
|                                                                                  |
| No. of Substations    692       No. of Busbars       797       No. of Terminals     0        No. of Lines
862   |
| No. of 2-w Trfs.      248       No. of 3-w Trfs.      0        No. of syn. Machines  185       No. of
asyn.Machines  0      |
| No. of Loads          625       No. of Shunts/Filters 33        No. of SVS           0                       |
|                                                                                  |
| Generation          =   6018,09  MW        547,55   Mvar     6042,95  MVA                        |
| External Infeed      =      0,00  MW          0,00   Mvar       0,00  MVA                        |
| Inter Grid Flow      =    600,55  MW         76,67   Mvar                                       |
| Load P(U)           =   5292,22  MW       1583,62   Mvar     5524,08  MVA
|
| Load P(Un)           =   5292,22  MW       1583,62   Mvar     5524,08  MVA
|
| Load P(Un-U)          =      0,00  MW          0,00   Mvar                                       |
| Motor Load           =      0,00  MW          0,00   Mvar       0,00  MVA                        |
| Grid Losses          =    125,32  MW      -1112,74   Mvar                                       |
| Line Charging        =                    -2792,60   Mvar                                  |
| Compensation ind.     =                        0,00   Mvar                                  |
| Compensation cap.     =                        0,00   Mvar                                  |
|                                                                                  |
| Installed Capacity    =   9830,03  MW                                                    |
| Spinning Reserve      =   2362,61  MW                                                    |
|                                                                                  |
| Total Power Factor:                                                                  |
|   Generation         =       1,00  [-]                                                  |
|-------------------------------------------------------------------------------------------------------------------------------
|
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--
| Grid: BG              System Stage: BG           | Study Case: Study Case           | Annex:              / 10
|
-------------------------------------------------------------------------------------------------------------------------------
--
|   Load/Motor         = 0,96 / 0,00  [-]                                                  |
-------------------------------------------------------------------------------------------------------------------------------
--
| Inter Grid Flow to                                                                  |
|   MK              =      6,25  MW         24,76   Mvar                                  |
|   RS              =    201,37  MW        -18,60   Mvar                                  |
|   EU              =    900,00  MW         -0,00   Mvar                                  |
|   GR              =    243,06  MW        -41,17   Mvar                                  |
|   RO              =   -750,13  MW        111,68   Mvar                                  |
|   Total           =    600,55  MW         76,67   Mvar                                  |
```

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|

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| Grid: CH System Stage: CH | Study Case: Study Case | Annex: / 11
|

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| Grid: CH Summary |
| |
| No. of Substations 159 No. of Busbars 159 No. of Terminals 22 No. of Lines
311 |
| No. of 2-w Trfs. 48 No. of 3-w Trfs. 0 No. of syn. Machines 373 No. of
asyn.Machines 0 |
| No. of Loads 169 No. of Shunts/Filters 0 No. of SVS 0 |
| |
| Generation = 8877,39 MW -696,21 Mvar 8904,65 MVA
|
| External Infeed = 0,00 MW 0,00 Mvar 0,00 MVA |
| Inter Grid Flow = 56,11 MW -1241,10 Mvar |
| Load P(U) = 8696,48 MW 1771,25 Mvar 8875,02 MVA
|
| Load P(Un) = 8696,48 MW 1771,25 Mvar 8875,02 MVA
|
| Load P(Un-U) = 0,00 MW 0,00 Mvar |
| Motor Load = 0,00 MW 0,00 Mvar 0,00 MVA |
| Grid Losses = 124,80 MW -1226,35 Mvar |
| Line Charging = -2631,98 Mvar |
| Compensation ind. = 0,00 Mvar |
| Compensation cap. = 0,00 Mvar |
| |
| Installed Capacity = 19471,50 MW |
| Spinning Reserve = 7579,61 MW |
| |
| Total Power Factor: |
| Generation = 1,00 [-] |
|---
|

--
| Grid: CH System Stage: CH | Study Case: Study Case | Annex: / 12
|

--
| Load/Motor = 0,98 / 0,00 [-] |

--
| Inter Grid Flow to |
| IT = 4484,76 MW -445,20 Mvar |
| DE = -1589,62 MW -846,67 Mvar |
| EU = 50,00 MW -0,02 Mvar |
| FR = -2023,11 MW 159,08 Mvar |
| AT = -865,91 MW -108,30 Mvar |
| Total = 56,11 MW -1241,10 Mvar |

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| Grid: CZ             System Stage: CZ          | Study Case: Study Case          | Annex:            / 13
|
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--
| Grid: CZ             Summary                                                        |
|                                                                           |
| No. of Substations    63      No. of Busbars      76      No. of Terminals    0       No. of Lines
118   |
| No. of 2-w Trfs.      4       No. of 3-w Trfs.     4       No. of syn. Machines  210      No. of
asyn.Machines  0     |
| No. of Loads          40      No. of Shunts/Filters 13      No. of SVS          0                      |
|                                                                           |
| Generation         =  11532,10  MW       -21,41   Mvar    11532,12  MVA
|
| External Infeed      =      0,00  MW          0,00   Mvar       0,00  MVA                      |
| Inter Grid Flow      =   1189,48  MW       -837,66   Mvar                                     |
| Load P(U)          =  10246,07  MW       1602,00   Mvar    10370,55  MVA
|
| Load P(Un)          =  10246,07  MW       1602,00   Mvar    10370,55  MVA
|
| Load P(Un-U)         =      0,00  MW          0,00   Mvar                                      |
| Motor Load          =      0,00  MW          0,00   Mvar       0,00  MVA                      |
| Grid Losses         =     96,56  MW      -1905,29   Mvar                                     |
| Line Charging        =                  -2928,76   Mvar                                     |
| Compensation ind.     =                   1119,55   Mvar                                     |
| Compensation cap.     =                      0,00   Mvar                                     |
|                                                                           |
| Installed Capacity    =  22230,28  MW                                                     |
| Spinning Reserve      =   7562,50  MW                                                     |
|                                                                           |
| Total Power Factor:                                                           |
|   Generation        =        1,00  [-]                                                 |
|-------------------------------------------------------------------------------------------------------------------------------
|
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--
| Grid: CZ             System Stage: CZ          | Study Case: Study Case          | Annex:            / 14
|
-------------------------------------------------------------------------------------------------------------------------------
--
|   Load/Motor        = 0,99 / 0,00  [-]                                              |
-------------------------------------------------------------------------------------------------------------------------------
--
| Inter Grid Flow to                                                            |
|   AT              =    520,66  MW       -173,68   Mvar                              |
|   PL              =     59,04  MW       -193,25   Mvar                              |
|   SK              =    523,43  MW       -167,90   Mvar                              |
|   DE              =     86,34  MW       -302,84   Mvar                              |
|   Total           =   1189,48  MW       -837,66   Mvar                              |
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| Grid: DE              System Stage: DE          | Study Case: Study Case            | Annex:              / 15
|
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--
| Grid: DE              Summary                                                                |
|                                                                                        |
| No. of Substations    1333       No. of Busbars       2351       No. of Terminals    91        No. of Lines
1591  |
| No. of 2-w Trfs.      66        No. of 3-w Trfs.       127        No. of syn. Machines  4667       No. of
asyn.Machines  0     |
| No. of Loads         1439       No. of Shunts/Filters 110        No. of SVS           4                  |
|                                                                                        |
| Generation          =  76179,67  MW       -2361,12   Mvar    76216,25  MVA
|
| External Infeed      =       0,00  MW       -1860,18   Mvar     1860,18  MVA
|
| Inter Grid Flow      =  -2390,45  MW        2569,00   Mvar                                   |
| Load P(U)           =  76901,53  MW          26,10   Mvar    76901,53  MVA
|
| Load P(Un)           =  76901,53  MW          26,10   Mvar    76901,53  MVA
|
| Load P(Un-U)         =       0,00  MW           0,00   Mvar                                  |
| Motor Load           =       0,00  MW           0,00   Mvar        0,00  MVA                      |
| Grid Losses         =   1668,59  MW      -10117,79   Mvar                                  |
| Line Charging        =                    -27896,54   Mvar                            |
| Compensation ind.    =                      3954,71   Mvar                            |
| Compensation cap.    =                      -653,31   Mvar                            |
|                                                                                        |
| Installed Capacity    = 294076,23  MW                                                  |
| Spinning Reserve      = 207123,95  MW                                                  |
|                                                                                        |
| Total Power Factor:                                                              |
|   Generation         =        1,00  [-]                                            |
|--------------------------------------------------------------------------------------------------------------------------
|
--------------------------------------------------------------------------------------------------------------------------
--
| Grid: DE              System Stage: DE          | Study Case: Study Case            | Annex:              / 16
|
--------------------------------------------------------------------------------------------------------------------------
--
|   Load/Motor         =  1,00 / 0,00  [-]                                             |
--------------------------------------------------------------------------------------------------------------------------
--
| Inter Grid Flow to                                                              |
|   AT               =   1455,45  MW        478,17   Mvar                               |
|   CH               =   1589,62  MW        846,67   Mvar                               |
|   NL               =   -207,54  MW        427,36   Mvar                               |
|   FR              =  -1755,70  MW        324,33   Mvar                               |
|   CZ               =    -86,34  MW       302,84   Mvar                               |
```

```
|  LU              =   1137,68  MW         204,61   Mvar                                                   |
|  EU              =  -3517,00  MW          -67,41   Mvar                                                  |
|  DK              =  -2947,28  MW          -58,46   Mvar                                                  |
|  PL              =   1940,66  MW          110,89   Mvar                                                  |
|  Total           =  -2390,45  MW         2569,00   Mvar                                                  |
|-------------------------------------------------------------------------------------------------------------
|
```

--
| Grid: DK System Stage: DK | Study Case: Study Case | Annex: /
17 |

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| Grid: DK Summary |
| |
| No. of Substations 244 No. of Busbars 251 No. of Terminals 7 No. of Lines
309 |
| No. of 2-w Trfs. 68 No. of 3-w Trfs. 10 No. of syn. Machines 271 No. of
asyn.Machines 0 |
| No. of Loads 151 No. of Shunts/Filters 123 No. of SVS 1 |
| |
| Generation = 6490,12 MW -773,51 Mvar 6536,05 MVA
|
| External Infeed = 0,00 MW 0,00 Mvar 0,00 MVA |
| Inter Grid Flow = 320,30 MW 58,46 Mvar |
| Load P(U) = 6070,00 MW 1875,20 Mvar 6353,05 MVA
|
| Load P(Un) = 6070,00 MW 1875,20 Mvar 6353,05 MVA
|
| Load P(Un-U) = -0,00 MW -0,00 Mvar |
| Motor Load = 0,00 MW 0,00 Mvar 0,00 MVA |
| Grid Losses = 99,82 MW -5818,36 Mvar |
| Line Charging = -6958,19 Mvar |
| Compensation ind. = 3615,84 Mvar |
| Compensation cap. = -504,66 Mvar |
| |
| Installed Capacity = 14448,75 MW |
| Spinning Reserve = 6904,02 MW |
| |
| Total Power Factor: |
| Generation = 0,99 [-] |
|---
|

--
| Grid: DK System Stage: DK | Study Case: Study Case | Annex: /
18 |

--
| Load/Motor = 0,96 / 0,00 [-] |

--
| Inter Grid Flow to |
| EU = -2626,98 MW -0,00 Mvar |
| DE = 2947,28 MW 58,46 Mvar |
| Total = 320,30 MW 58,46 Mvar |
|---
|

--
| Grid: ES System Stage: ES | Study Case: Study Case | Annex: / 19 |

--
| Grid: ES Summary |
| |
| No. of Substations 1035 No. of Busbars 1271 No. of Terminals 0 No. of Lines
1231 |
| No. of 2-w Trfs. 287 No. of 3-w Trfs. 153 No. of syn. Machines 3240 No. of
asyn.Machines 0 |
| No. of Loads 2405 No. of Shunts/Filters 184 No. of SVS 0 |
| |
| Generation = 38429,25 MW -156,36 Mvar 38429,56 MVA
|
| External Infeed = 0,00 MW 0,00 Mvar 0,00 MVA |
| Inter Grid Flow = 2516,41 MW 185,43 Mvar |
| Load P(U) = 35173,08 MW 1110,89 Mvar 35190,61 MVA
|
| Load P(Un) = 35173,08 MW 1110,89 Mvar 35190,61 MVA
|
| Load P(Un-U) = -0,00 MW -0,00 Mvar |
| Motor Load = 0,00 MW 0,00 Mvar 0,00 MVA |
| Grid Losses = 739,76 MW -12462,92 Mvar |
| Line Charging = -20404,94 Mvar |
| Compensation ind. = 11075,19 Mvar |
| Compensation cap. = -64,95 Mvar |
| |
| Installed Capacity = 95326,51 MW |
| Spinning Reserve = 59716,91 MW |
| |
| Total Power Factor: |
| Generation = 1,00 [-] |
|--
|

--
| Grid: ES System Stage: ES | Study Case: Study Case | Annex: / 20 |

--
| Load/Motor = 1,00 / 0,00 [-] |

--
| Inter Grid Flow to |
| PT = 433,70 MW 619,20 Mvar |
| FR = 2090,71 MW -425,77 Mvar |
| EU = -8,00 MW -8,00 Mvar |
| Total = 2516,41 MW 185,43 Mvar |
|--
|

| Grid: EU System Stage: EU | Study Case: Study Case | Annex: / 21
|

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| Grid: EU Summary |
| |
| No. of Substations 0 No. of Busbars 837 No. of Terminals 0 No. of Lines 0
|
| No. of 2-w Trfs. 0 No. of 3-w Trfs. 0 No. of syn. Machines 0 No. of asyn.Machines 0 |
| No. of Loads 0 No. of Shunts/Filters 0 No. of SVS 0 |
| |
| Generation = 0,00 MW 0,00 Mvar 0,00 MVA |
| External Infeed = 4653,00 MW -1236,55 Mvar 4814,51 MVA
|
| Inter Grid Flow = 4653,00 MW -1236,55 Mvar |
| Load P(U) = 0,00 MW 0,00 Mvar 0,00 MVA |
| Load P(Un) = 0,00 MW 0,00 Mvar 0,00 MVA |
| Load P(Un-U) = 0,00 MW 0,00 Mvar |
| Motor Load = 0,00 MW 0,00 Mvar 0,00 MVA |
| Grid Losses = 0,00 MW 0,00 Mvar |
| Line Charging = 0,00 Mvar |
| Compensation ind. = 0,00 Mvar |
| Compensation cap. = 0,00 Mvar |
| |
| Installed Capacity = 0,00 MW |
| Spinning Reserve = 0,00 MW |
| |
| Total Power Factor: |
| Generation = 0,00 [-] |
|---
|

--
| Grid: EU System Stage: EU | Study Case: Study Case | Annex: / 22
|

--
| Load/Motor = 0,00 / 0,00 [-] |

--
| Inter Grid Flow to |
| CH = -50,00 MW 0,02 Mvar |
| FR = -726,99 MW -938,12 Mvar |
| DE = 3517,00 MW 67,41 Mvar |
| NL = 700,00 MW -0,11 Mvar |
| PL = 1100,00 MW -0,00 Mvar |
| RO = -150,00 MW 50,00 Mvar |
| SK = -244,00 MW -0,00 Mvar |
| ES = 8,00 MW 8,00 Mvar |
| BE = -102,00 MW -63,28 Mvar |
| DK = 2626,98 MW 0,00 Mvar |

```
|  BG          =   -900,00  MW          0,00   Mvar                                   |
|  GR          =   -160,00  MW        -36,37   Mvar                                   |
|  HR          =     50,00  MW         -1,02   Mvar                                   |
|  IT          =   -566,00  MW          0,00   Mvar                                   |
|  HU          =   -450,00  MW       -257,38   Mvar                                   |
|  LU          =      0,00  MW        -65,71   Mvar                                   |
|  Total       =   4653,00  MW      -1236,55   Mvar                                   |
|----------------------------------------------------------------------------------------------------------------------------
|
```

| Grid: FR System Stage: FR | Study Case: Study Case | Annex: / 23 |

--
| Grid: FR Summary |
| |
| No. of Substations 1685 No. of Busbars 2815 No. of Terminals 0 No. of Lines 2225 |
| No. of 2-w Trfs. 649 No. of 3-w Trfs. 0 No. of syn. Machines 3501 No. of asyn.Machines 0 |
| No. of Loads 2005 No. of Shunts/Filters 393 No. of SVS 7 |
| |
| Generation = 77924,53 MW -612,21 Mvar 77926,93 MVA |
| External Infeed = 0,00 MW 0,00 Mvar 0,00 MVA |
| Inter Grid Flow = 3171,24 MW 1205,83 Mvar |
| Load P(U) = 73435,15 MW 5057,99 Mvar 73609,13 MVA |
| Load P(Un) = 73435,15 MW 5057,99 Mvar 73609,13 MVA |
| Load P(Un-U) = 0,00 MW -0,00 Mvar |
| Motor Load = 0,00 MW 0,00 Mvar 0,00 MVA |
| Grid Losses = 1318,14 MW -11125,87 Mvar |
| Line Charging = -28437,38 Mvar |
| Compensation ind. = 7939,91 Mvar |
| Compensation cap. = -3690,08 Mvar |
| |
| Installed Capacity = 175873,81 MW |
| Spinning Reserve = 89741,43 MW |
| |
| Total Power Factor: |
| Generation = 1,00 [-] |
|--
|--
--
| Grid: FR System Stage: FR | Study Case: Study Case | Annex: / 24 |

--
| Load/Motor = 1,00 / 0,00 [-] |

--
| Inter Grid Flow to |
| BE = -2045,97 MW 160,34 Mvar |
| ES = -2090,71 MW 425,77 Mvar |
| CH = 2023,11 MW -159,08 Mvar |
| IT = 2693,14 MW 169,49 Mvar |
| EU = 726,99 MW 938,12 Mvar |
| DE = 1755,70 MW -324,33 Mvar |
| LU = 108,98 MW -4,48 Mvar |
| Total = 3171,24 MW 1205,83 Mvar |
|--
|

| Grid: GR System Stage: GR | Study Case: Study Case | Annex: / 25
|

--
| Grid: GR Summary |
| |
| No. of Substations 2191 No. of Busbars 2188 No. of Terminals 1 No. of Lines 1808 |
| No. of 2-w Trfs. 799 No. of 3-w Trfs. 76 No. of syn. Machines 660 No. of asyn.Machines 0 |
| No. of Loads 354 No. of Shunts/Filters 174 No. of SVS 0 |
| |
| Generation = 6951,73 MW -270,90 Mvar 6957,01 MVA
|
| External Infeed = 0,00 MW 0,00 Mvar 0,00 MVA |
| Inter Grid Flow = -35,78 MW 11,17 Mvar |
| Load P(U) = 6853,44 MW 3421,63 Mvar 7660,11 MVA
|
| Load P(Un) = 6853,44 MW 3421,63 Mvar 7660,11 MVA
|
| Load P(Un-U) = 0,00 MW -0,00 Mvar |
| Motor Load = 0,00 MW 0,00 Mvar 0,00 MVA |
| Grid Losses = 134,07 MW -6542,34 Mvar |
| Line Charging = -8307,34 Mvar |
| Compensation ind. = 3314,56 Mvar |
| Compensation cap. = -475,92 Mvar |
| |
| Installed Capacity = 16111,73 MW |
| Spinning Reserve = 17243,60 MW |
| |
| Total Power Factor: |
| Generation = 1,00 [-] |
|--
|

--
| Grid: GR System Stage: GR | Study Case: Study Case | Annex: / 26
|

--
| Load/Motor = 0,89 / 0,00 [-] |

--
| Inter Grid Flow to |
| BG = -243,06 MW 41,17 Mvar |
| AL = 49,24 MW -6,41 Mvar |
| EU = 160,00 MW 36,37 Mvar |
| MK = -1,96 MW -59,96 Mvar |
| Total = -35,78 MW 11,17 Mvar |
|--
|

| Grid: HR System Stage: HR | Study Case: Study Case | Annex: / 27
|

--
| Grid: HR Summary |
| |
| No. of Substations 226 No. of Busbars 226 No. of Terminals 0 No. of Lines
366 |
| No. of 2-w Trfs. 39 No. of 3-w Trfs. 0 No. of syn. Machines 93 No. of
asyn.Machines 0 |
| No. of Loads 331 No. of Shunts/Filters 6 No. of SVS 0 |
| |
| Generation = 1975,72 MW -158,74 Mvar 1982,09 MVA
|
| External Infeed = 0,00 MW 0,00 Mvar 0,00 MVA |
| Inter Grid Flow = -322,94 MW 1,67 Mvar |
| Load P(U) = 2191,00 MW 358,57 Mvar 2220,15 MVA
|
| Load P(Un) = 2191,00 MW 358,57 Mvar 2220,15 MVA
|
| Load P(Un-U) = 0,00 MW 0,00 Mvar |
| Motor Load = 0,00 MW 0,00 Mvar 0,00 MVA |
| Grid Losses = 107,65 MW -518,98 Mvar |
| Line Charging = -1267,15 Mvar |
| Compensation ind. = 0,00 Mvar |
| Compensation cap. = 0,00 Mvar |
| |
| Installed Capacity = 5684,99 MW |
| Spinning Reserve = 3205,43 MW |
| |
| Total Power Factor: |
| Generation = 1,00 [-] |
|---
|

--
| Grid: HR System Stage: HR | Study Case: Study Case | Annex: / 28
|

--
| Load/Motor = 0,99 / 0,00 [-] |

--
| Inter Grid Flow to |
| BA = -1253,15 MW 201,47 Mvar |
| SI = 802,74 MW -18,50 Mvar |
| HU = 704,65 MW -228,71 Mvar |
| RS = -527,18 MW 46,39 Mvar |
| EU = -50,00 MW 1,02 Mvar |
| Total = -322,94 MW 1,67 Mvar |
|---

| Grid: HU System Stage: HU | Study Case: Study Case | Annex: / 29 |

| Grid: HU Summary |
|
| No. of Substations 545 No. of Busbars 825 No. of Terminals 0 No. of Lines 792 |
| No. of 2-w Trfs. 290 No. of 3-w Trfs. 0 No. of syn. Machines 497 No. of asyn.Machines 0 |
| No. of Loads 390 No. of Shunts/Filters 40 No. of SVS 0 |
|
| Generation = 4528,60 MW 273,20 Mvar 4536,83 MVA |
| External Infeed = 0,00 MW 0,00 Mvar 0,00 MVA |
| Inter Grid Flow = -1143,49 MW 684,75 Mvar |
| Load P(U) = 5530,28 MW 1064,91 Mvar 5631,88 MVA |
| Load P(Un) = 5530,28 MW 1064,91 Mvar 5631,88 MVA |
| Load P(Un-U) = -0,00 MW 0,00 Mvar |
| Motor Load = 0,00 MW 0,00 Mvar 0,00 MVA |
| Grid Losses = 141,80 MW -1476,46 Mvar |
| Line Charging = -2994,80 Mvar |
| Compensation ind. = 0,00 Mvar |
| Compensation cap. = 0,00 Mvar |
|
| Installed Capacity = 12337,87 MW |
| Spinning Reserve = 6784,90 MW |
|
| Total Power Factor: |
Generation = 1,00 [-]
Grid: HU System Stage: HU	Study Case: Study Case	Annex: / 30

| Load/Motor = 0,98 / 0,00 [-] |

| Inter Grid Flow to |
| SK = 312,36 MW -70,14 Mvar |
| AT = 80,10 MW 30,05 Mvar |
| SI = -60,70 MW 58,62 Mvar |
| HR = -704,65 MW 228,71 Mvar |
| EU = 450,00 MW 257,38 Mvar |
| RO = -800,02 MW 121,79 Mvar |
| RS = -420,59 MW 58,35 Mvar |
Total = -1143,49 MW 684,75 Mvar

| Grid: IT System Stage: IT | Study Case: Study Case | Annex: / 31 |

--
| Grid: IT Summary |
| |
| No. of Substations 1904 No. of Busbars 1904 No. of Terminals 0 No. of Lines 1038 |
| No. of 2-w Trfs. 1282 No. of 3-w Trfs. 3 No. of syn. Machines 4104 No. of asyn.Machines 0 |
| No. of Loads 1157 No. of Shunts/Filters 101 No. of SVS 0 |
| |
| Generation = 38583,09 MW -1110,36 Mvar 38599,06 MVA |
| External Infeed = 0,00 MW 0,00 Mvar 0,00 MVA |
| Inter Grid Flow = -8129,40 MW 231,23 Mvar |
| Load P(U) = 46249,46 MW 3580,25 Mvar 46387,83 MVA |
| Load P(Un) = 46249,46 MW 3580,25 Mvar 46387,83 MVA |
| Load P(Un-U) = -0,00 MW -0,00 Mvar |
| Motor Load = 0,00 MW 0,00 Mvar 0,00 MVA |
| Grid Losses = 463,03 MW -5909,44 Mvar |
| Line Charging = -13758,60 Mvar |
| Compensation ind. = 2031,70 Mvar |
| Compensation cap. = -1044,10 Mvar |
| |
| Installed Capacity = 123439,81 MW |
| Spinning Reserve = 80817,17 MW |
| |
| Total Power Factor: |
| Generation = 1,00 [-] |
|---
|

--
| Grid: IT System Stage: IT | Study Case: Study Case | Annex: / 32 |

--
| Load/Motor = 1,00 / 0,00 [-] |

--
| Inter Grid Flow to |
| AT = -863,16 MW 100,88 Mvar |
| CH = -4484,76 MW 445,20 Mvar |
| FR = -2693,14 MW -169,49 Mvar |
| SI = -987,34 MW 76,09 Mvar |
| EU = 566,00 MW -0,00 Mvar |
| ME = 333,01 MW -221,45 Mvar |
| Total = -8129,40 MW 231,23 Mvar |
|---
|

--
| Grid: LU System Stage: LU | Study Case: Study Case | Annex: / 33
|

--
| Grid: LU Summary |
| |
| No. of Substations 37 No. of Busbars 46 No. of Terminals 0 No. of Lines
45 |
| No. of 2-w Trfs. 14 No. of 3-w Trfs. 0 No. of syn. Machines 23 No. of
asyn.Machines 0 |
| No. of Loads 28 No. of Shunts/Filters 0 No. of SVS 0 |
| |
| Generation = 155,24 MW -222,86 Mvar 271,60 MVA |
| External Infeed = 0,00 MW 0,00 Mvar 0,00 MVA |
| Inter Grid Flow = -984,65 MW -193,33 Mvar |
| Load P(U) = 1127,97 MW 70,01 Mvar 1130,14 MVA |
| Load P(Un) = 1127,97 MW 70,01 Mvar 1130,14 MVA
|
| Load P(Un-U) = -0,00 MW -0,00 Mvar |
| Motor Load = 0,00 MW 0,00 Mvar 0,00 MVA |
| Grid Losses = 11,93 MW -99,54 Mvar |
| Line Charging = -196,98 Mvar |
| Compensation ind. = 0,00 Mvar |
| Compensation cap. = 0,00 Mvar |
| |
| Installed Capacity = 2119,50 MW |
| Spinning Reserve = 1954,26 MW |
| |
| Total Power Factor: |
| Generation = 0,57 [-] |
|---
|

--
| Grid: LU System Stage: LU | Study Case: Study Case | Annex: / 34
|

--
| Load/Motor = 1,00 / 0,00 [-] |

--
| Inter Grid Flow to |
| EU = -0,00 MW 65,71 Mvar |
| BE = 262,01 MW -58,90 Mvar |
| DE = -1137,68 MW -204,61 Mvar |
| FR = -108,98 MW 4,48 Mvar |
| Total = -984,65 MW -193,33 Mvar |
|---
|

| Grid: ME System Stage: ME | Study Case: Study Case | Annex: /
35 |

--
| Grid: ME Summary |
| |
| No. of Substations 145 No. of Busbars 248 No. of Terminals 0 No. of Lines
112 |
| No. of 2-w Trfs. 31 No. of 3-w Trfs. 79 No. of syn. Machines 31 No. of
asyn.Machines 0 |
| No. of Loads 80 No. of Shunts/Filters 0 No. of SVS 0 |
| |
| Generation = 453,91 MW 73,07 Mvar 459,75 MVA |
| External Infeed = 0,00 MW 0,00 Mvar 0,00 MVA |
| Inter Grid Flow = -91,40 MW 213,29 Mvar |
| Load P(U) = 534,85 MW 176,52 Mvar 563,22 MVA |
| Load P(Un) = 534,85 MW 176,52 Mvar 563,22 MVA |
| Load P(Un-U) = -0,00 MW -0,00 Mvar |
| Motor Load = 0,00 MW 0,00 Mvar 0,00 MVA |
| Grid Losses = 10,46 MW -316,74 Mvar |
| Line Charging = -446,18 Mvar |
| Compensation ind. = 0,00 Mvar |
| Compensation cap. = 0,00 Mvar |
| |
| Installed Capacity = 1742,28 MW |
| Spinning Reserve = 1227,59 MW |
| |
| Total Power Factor: |
| Generation = 0,99 [-] |
|--
|

--
| Grid: ME System Stage: ME | Study Case: Study Case | Annex: /
36 |

--
| Load/Motor = 0,95 / 0,00 [-] |

--
| Inter Grid Flow to |
| BA = 73,22 MW 21,54 Mvar |
| AL = -62,62 MW 20,02 Mvar |
| RS = 231,01 MW -49,72 Mvar |
| IT = -333,01 MW 221,45 Mvar |
| Total = -91,40 MW 213,29 Mvar |
|--
|

| Grid: MK System Stage: MK | Study Case: Study Case | Annex: / 37 |

| Grid: MK Summary |
|
| No. of Substations 125 No. of Busbars 144 No. of Terminals 0 No. of Lines 155 |
| No. of 2-w Trfs. 27 No. of 3-w Trfs. 18 No. of syn. Machines 36 No. of asyn.Machines 0 |
| No. of Loads 100 No. of Shunts/Filters 6 No. of SVS 0 |
|
| Generation = 1189,41 MW 44,89 Mvar 1190,26 MVA |
| External Infeed = 0,00 MW 0,00 Mvar 0,00 MVA |
| Inter Grid Flow = 0,06 MW -47,22 Mvar |
| Load P(U) = 1174,10 MW 402,41 Mvar 1241,15 MVA |
| Load P(Un) = 1174,10 MW 402,41 Mvar 1241,15 MVA |
| Load P(Un-U) = 0,00 MW 0,00 Mvar |
| Motor Load = 0,00 MW 0,00 Mvar 0,00 MVA |
| Grid Losses = 15,25 MW -310,30 Mvar |
| Line Charging = -487,12 Mvar |
| Compensation ind. = 0,00 Mvar |
| Compensation cap. = 0,00 Mvar |
|
| Installed Capacity = 1008,50 MW |
| Spinning Reserve = 265,39 MW |
|
| Total Power Factor: |
Generation = 1,00 [-]

| Grid: MK System Stage: MK | Study Case: Study Case | Annex: / 38 |

| Load/Motor = 0,95 / 0,00 [-] |

| Inter Grid Flow to |
| GR = 1,96 MW 59,96 Mvar |
| BG = -6,25 MW -24,76 Mvar |
| RS = -89,68 MW -102,57 Mvar |
| AL = 94,02 MW 20,15 Mvar |
Total = 0,06 MW -47,22 Mvar

| Grid: NL System Stage: NL | Study Case: Study Case | Annex: / 39
|

--
| Grid: NL Summary |
| |
| No. of Substations 967 No. of Busbars 705 No. of Terminals 953 No. of Lines
1228 |
| No. of 2-w Trfs. 445 No. of 3-w Trfs. 208 No. of syn. Machines 732 No. of
asyn.Machines 0 |
| No. of Loads 327 No. of Shunts/Filters 168 No. of SVS 0 |
| |
| Generation = 17363,54 MW -2310,48 Mvar 17516,59 MVA
|
| External Infeed = 0,00 MW 0,00 Mvar 0,00 MVA |
| Inter Grid Flow = 908,59 MW -1165,20 Mvar |
| Load P(U) = 16177,00 MW 4897,99 Mvar 16902,24 MVA
|
| Load P(Un) = 16177,00 MW 4897,99 Mvar 16902,24 MVA
|
| Load P(Un-U) = -0,00 MW -0,00 Mvar |
| Motor Load = 0,00 MW 0,00 Mvar 0,00 MVA |
| Grid Losses = 277,95 MW -6118,88 Mvar |
| Line Charging = -10887,15 Mvar |
| Compensation ind. = 4074,92 Mvar |
| Compensation cap. = -3999,30 Mvar |
| |
| Installed Capacity = 532844,57 MW |
| Spinning Reserve = 24877,26 MW |
| |
| Total Power Factor: |
| Generation = 0,99 [-] |
|---
|

--
| Grid: NL System Stage: NL | Study Case: Study Case | Annex: / 40
|

--
| Load/Motor = 0,96 / 0,00 [-] |

--
| Inter Grid Flow to |
| DE = 207,54 MW -427,36 Mvar |
| BE = 1401,05 MW -737,95 Mvar |
| EU = -700,00 MW 0,11 Mvar |
| Total = 908,59 MW -1165,20 Mvar |
|---
|

| Grid: PL System Stage: PL | Study Case: Study Case | Annex: / 41 |

--
| Grid: PL Summary |
| |
| No. of Substations 293 No. of Busbars 369 No. of Terminals 0 No. of Lines
393 |
| No. of 2-w Trfs. 232 No. of 3-w Trfs. 14 No. of syn. Machines 1017 No. of
asyn.Machines 0 |
| No. of Loads 175 No. of Shunts/Filters 51 No. of SVS 0 |
| |
| Generation = 22818,15 MW 1325,96 Mvar 22856,64 MVA
|
| External Infeed = -0,00 MW 1855,26 Mvar 1855,26 MVA
|
| Inter Grid Flow = -3073,98 MW 94,84 Mvar |
| Load P(U) = 25600,74 MW 5418,90 Mvar 26167,97 MVA
|
| Load P(Un) = 25600,74 MW 5418,90 Mvar 26167,97 MVA
|
| Load P(Un-U) = -0,00 MW -0,00 Mvar |
| Motor Load = 0,00 MW 0,00 Mvar 0,00 MVA |
| Grid Losses = 291,39 MW -3039,12 Mvar |
| Line Charging = -6663,66 Mvar |
| Compensation ind. = 824,08 Mvar |
| Compensation cap. = -117,48 Mvar |
| |
| Installed Capacity = 52280,55 MW |
| Spinning Reserve = 23255,65 MW |
| |
| Total Power Factor: |
| Generation = 1,00 [-] |
|--
|

--
| Grid: PL System Stage: PL | Study Case: Study Case | Annex: / 42 |

--
| Load/Motor = 0,98 / 0,00 [-] |

--
| Inter Grid Flow to |
| CZ = -59,04 MW 193,25 Mvar |
| EU = -1100,00 MW 0,00 Mvar |
| DE = -1940,66 MW -110,89 Mvar |
| SK = 25,72 MW 12,48 Mvar |
| Total = -3073,98 MW 94,84 Mvar |
|--
|

| Grid: PT System Stage: PT | Study Case: Study Case | Annex: / 43 |

--
| Grid: PT Summary |
| |
| No. of Substations 574 No. of Busbars 605 No. of Terminals 0 No. of Lines
606 |
| No. of 2-w Trfs. 335 No. of 3-w Trfs. 0 No. of syn. Machines 297 No. of
asyn.Machines 0 |
| No. of Loads 91 No. of Shunts/Filters 68 No. of SVS 0 |
| |
| Generation = 6538,09 MW -1200,58 Mvar 6647,40 MVA
|
| External Infeed = 0,00 MW 0,00 Mvar 0,00 MVA |
| Inter Grid Flow = -433,70 MW -619,20 Mvar |
| Load P(U) = 6817,70 MW 1187,70 Mvar 6920,38 MVA
|
| Load P(Un) = 6817,70 MW 1187,70 Mvar 6920,38 MVA
|
| Load P(Un-U) = -0,00 MW -0,00 Mvar |
| Motor Load = 0,00 MW 0,00 Mvar 0,00 MVA |
| Grid Losses = 154,09 MW -1559,36 Mvar |
| Line Charging = -3184,02 Mvar |
| Compensation ind. = 0,00 Mvar |
| Compensation cap. = -209,72 Mvar |
| |
| Installed Capacity = 27061,90 MW |
| Spinning Reserve = 18756,01 MW |
| |
| Total Power Factor: |
| Generation = 0,98 [-] |
|---
|

--
| Grid: PT System Stage: PT | Study Case: Study Case | Annex: / 44 |

--
| Load/Motor = 0,99 / 0,00 [-] |

--
| Inter Grid Flow to |
| ES = -433,70 MW -619,20 Mvar |
| Total = -433,70 MW -619,20 Mvar |
|---
|

| Grid: RO System Stage: RO | Study Case: Study Case | Annex: / 45
|

--
| Grid: RO Summary |
| |
| No. of Substations 115 No. of Busbars 128 No. of Terminals 0 No. of Lines 186 |
| No. of 2-w Trfs. 36 No. of 3-w Trfs. 0 No. of syn. Machines 156 No. of asyn.Machines 0 |
| No. of Loads 88 No. of Shunts/Filters 15 No. of SVS 0 |
| |
| Generation = 9928,23 MW -701,08 Mvar 9952,95 MVA
|
| External Infeed = 0,00 MW 0,00 Mvar 0,00 MVA |
| Inter Grid Flow = 1507,42 MW -310,07 Mvar |
| Load P(U) = 8281,99 MW 2598,27 Mvar 8680,00 MVA
|
| Load P(Un) = 8281,99 MW 2598,27 Mvar 8680,00 MVA
|
| Load P(Un-U) = 0,00 MW 0,00 Mvar |
| Motor Load = 0,00 MW 0,00 Mvar 0,00 MVA |
| Grid Losses = 138,81 MW -2989,28 Mvar |
| Line Charging = -4281,21 Mvar |
| Compensation ind. = 0,00 Mvar |
| Compensation cap. = 0,00 Mvar |
| |
| Installed Capacity = 19431,50 MW |
| Spinning Reserve = 7666,24 MW |
| |
| Total Power Factor: |
| Generation = 1,00 [-] |
|---

--
| Grid: RO System Stage: RO | Study Case: Study Case | Annex: / 46
|

--
| Load/Motor = 0,95 / 0,00 [-] |

--
| Inter Grid Flow to |
| RS = -192,72 MW -26,60 Mvar |
| EU = 150,00 MW -50,00 Mvar |
| BG = 750,13 MW -111,68 Mvar |
| HU = 800,02 MW -121,79 Mvar |
| Total = 1507,42 MW -310,07 Mvar |
|---
|

| Grid: RS   System Stage: RS | Study Case: Study Case | Annex: / 47
|
| Grid: RS   Summary |
| |
| No. of Substations   1029   No. of Busbars   1373   No. of Terminals   0   No. of Lines
798 |
| No. of 2-w Trfs.   502   No. of 3-w Trfs.   318   No. of syn. Machines 105   No. of
asyn.Machines 0 |
| No. of Loads   405   No. of Shunts/Filters 0   No. of SVS   0 |
| |
| Generation   =   6505,97 MW   1435,03   Mvar   6662,35 MVA
|
| External Infeed   =   0,00 MW   0,00   Mvar   0,00 MVA |
| Inter Grid Flow   =   484,56 MW   195,56   Mvar |
| Load P(U)   =   5869,78 MW   1313,06   Mvar   6014,85 MVA
|
| Load P(Un)   =   5869,78 MW   1313,06   Mvar   6014,85 MVA
|
| Load P(Un-U)   =   -0,00 MW   -0,00   Mvar |
| Motor Load   =   0,00 MW   0,00   Mvar   0,00 MVA |
| Grid Losses   =   151,63 MW   -73,59   Mvar |
| Line Charging   =   -1956,19   Mvar |
| Compensation ind.   =   0,00   Mvar |
| Compensation cap.   =   0,00   Mvar |
| |
| Installed Capacity   =   8546,36 MW |
| Spinning Reserve   =   3677,50 MW |
| |
| Total Power Factor: |
| Generation   =   0,98 [-] |
|--

| Grid: RS   System Stage: RS | Study Case: Study Case | Annex: / 48
|

--
| Load/Motor   = 0,98 / 0,00 [-] |

--
| Inter Grid Flow to |
| BA   =   -176,39 MW   112,77   Mvar |
| HR   =   527,18 MW   -46,39   Mvar |
| AL   =   -136,84 MW   -9,96   Mvar |
| RO   =   192,72 MW   26,60   Mvar |
| ME   =   -231,01 MW   49,72   Mvar |
| HU   =   420,59 MW   -58,35   Mvar |
| MK   =   89,68 MW   102,57   Mvar |
| BG   =   -201,37 MW   18,60   Mvar |
| Total   =   484,56 MW   195,56   Mvar |
|--
|

```
| Grid: SI              System Stage: SI          | Study Case: Study Case          | Annex:              / 49 |
----------------------------------------------------------------------------------------------------------------------
--
| Grid: SI              Summary                                                                |
|                                                                                     |
| No. of Substations    169       No. of Busbars       175       No. of Terminals     0        No. of Lines
283   |
| No. of 2-w Trfs.      29        No. of 3-w Trfs.      0        No. of syn. Machines  97       No. of
asyn.Machines  0     |
| No. of Loads          157       No. of Shunts/Filters 3        No. of SVS           1                       |
|                                                                                     |
| Generation          =   2484,20  MW       -350,39   Mvar     2508,79  MVA
|
| External Infeed      =      0,00  MW          0,00   Mvar       0,00  MVA                        |
| Inter Grid Flow      =    339,21  MW       -328,19   Mvar                                      |
| Load P(U)           =   2108,25  MW        315,50   Mvar     2131,72  MVA
|
| Load P(Un)           =   2108,25  MW        315,50   Mvar     2131,72  MVA
|
| Load P(Un-U)         =     -0,00  MW         -0,00   Mvar                                       |
| Motor Load           =      0,00  MW          0,00   Mvar       0,00  MVA                        |
| Grid Losses          =     36,74  MW       -295,86   Mvar                                       |
| Line Charging        =                    -700,35   Mvar                                     |
| Compensation ind.    =                      47,12   Mvar                                     |
| Compensation cap.    =                     -88,97   Mvar                                     |
|                                                                                     |
| Installed Capacity   =   4108,34  MW                                                         |
| Spinning Reserve     =    1527,69  MW                                                        |
|                                                                                     |
| Total Power Factor:                                                                  |
|   Generation         =        0,99  [-]                                                      |
|---------------------------------------------------------------------------------------------------------------------
----------------------------------------------------------------------------------------------------------------------
--
| Grid: SI              System Stage: SI          | Study Case: Study Case          | Annex:              / 50 |
----------------------------------------------------------------------------------------------------------------------
--
|   Load/Motor         =  0,99 / 0,00  [-]                                                     |
----------------------------------------------------------------------------------------------------------------------
--
| Inter Grid Flow to                                                                   |
|   HU                 =     60,70  MW        -58,62   Mvar                                    |
|   HR                 =   -802,74  MW         18,50   Mvar                                    |
|   IT                 =    987,34  MW        -76,09   Mvar                                    |
|   AT                 =     93,91  MW       -211,97   Mvar                                    |
|   Total              =    339,21  MW       -328,19   Mvar                                    |
|---------------------------------------------------------------------------------------------------------------------
|
```

| Grid: SK System Stage: SK | Study Case: Study Case | Annex: / 51
|

--
| Grid: SK Summary |
| |
| No. of Substations 29 No. of Busbars 34 No. of Terminals 0 No. of Lines
53 |
| No. of 2-w Trfs. 0 No. of 3-w Trfs. 1 No. of syn. Machines 109 No. of
asyn.Machines 0 |
| No. of Loads 21 No. of Shunts/Filters 24 No. of SVS 0 |
| |
| Generation = 4053,52 MW 104,84 Mvar 4054,88 MVA |
| External Infeed = 0,00 MW 0,00 Mvar 0,00 MVA |
| Inter Grid Flow = -617,51 MW 225,56 Mvar |
| Load P(U) = 4642,00 MW 1083,00 Mvar 4766,66 MVA
|
| Load P(Un) = 4642,00 MW 1083,00 Mvar 4766,66 MVA
|
| Load P(Un-U) = 0,00 MW 0,00 Mvar |
| Motor Load = 0,00 MW 0,00 Mvar 0,00 MVA |
| Grid Losses = 29,04 MW -1203,72 Mvar |
| Line Charging = -1540,66 Mvar |
| Compensation ind. = 0,00 Mvar |
| Compensation cap. = 0,00 Mvar |
| |
| Installed Capacity = 6141,00 MW |
| Spinning Reserve = 2087,48 MW |
| |
| Total Power Factor: |
| Generation = 1,00 [-] |
|--
|

--
| Grid: SK System Stage: SK | Study Case: Study Case | Annex: / 52
|

--
| Load/Motor = 0,97 / 0,00 [-] |

--
| Inter Grid Flow to |
| HU = -312,36 MW 70,14 Mvar |
| PL = -25,72 MW -12,48 Mvar |
| CZ = -523,43 MW 167,90 Mvar |
| EU = 244,00 MW 0,00 Mvar |
| Total = -617,51 MW 225,56 Mvar |
|--
|

The number of overloaded lines (loading over 100% rated thermal capacity) for this snapshot is 30.

6.1.2 Baltics Synchronous area

It is possible with the assembled model to run a load flow study with reactive limits enabled.

On this model 3 slacks are used for the Baltics model.

4884_1 LV
5820_1(1) LT
7013_9 EE

It is recommended to set the HVDC exchanges to the same values in both sides of the interconnections. The model converges in 11 iterations with the selected slacks and the recommended settings.

In case of inserting a model of the HVDC link, the balances of the EquivalentInjections indicated on both sides of the link should be maintained to keep the balances.

The results for load flow are shown below:

--
| Load Flow Calculation   Grid Summary |

--
| AC Load Flow, balanced, positive sequence | Automatic Model Adaptation for Convergence
No |
| Automatic tap adjustment of transformers   No | Max. Acceptable Load Flow Error
|
| Consider reactive power limits   Yes | Bus Equations(HV)   1,00 kVA
|
| | Model Equations   0,10 % |

--

--
| Grid: EE00   System Stage: EE00 | Study Case: Study Case | Annex: /
1 |

--
| Grid: EE00   Summary |
| |
| No. of Substations   264   No. of Busbars   385   No. of Terminals   0   No. of Lines
334 |
| No. of 2-w Trfs.   27   No. of 3-w Trfs.   26   No. of syn. Machines 36   No. of
asyn.Machines 0 |
| No. of Loads   191   No. of Shunts/Filters 37   No. of SVS   0 |
| |
| Generation   =   1308,35 MW   118,88   Mvar   1313,74 MVA |
| External Infeed   =   0,00 MW   0,00   Mvar   0,00 MVA |
| Inter Grid Flow   =   -27,16 MW   -71,13   Mvar |
| Load P(U)   =   1234,21 MW   234,98   Mvar   1256,38 MVA
|
| Load P(Un)   =   1234,21 MW   234,98   Mvar   1256,38 MVA
|
| Load P(Un-U)   =   -0,00 MW   -0,00   Mvar |
| Motor Load   =   0,00 MW   0,00   Mvar   0,00 MVA |
| Grid Losses   =   101,30 MW   -603,50   Mvar |
| Line Charging   =   -1221,27   Mvar |
| Compensation ind.   =   871,30   Mvar |
| Compensation cap.   =   -312,77   Mvar |
| |
| Installed Capacity   =   2364,98 MW |
| Spinning Reserve   =   516,85 MW |
| |
| Total Power Factor: |
| Generation   =   1,00 [-] |
| Load/Motor   = 0,98 / 0,00 [-] |
|--
|

--
| Grid: EE00 System Stage: EE00 | Study Case: Study Case | Annex: /
2 |

--

--
| Inter Grid Flow to |
| LV00 = 540,84 MW -71,13 Mvar |
| EU = -568,00 MW -0,00 Mvar |
| Total = -27,16 MW -71,13 Mvar |
|--
|

--
| Load Flow Calculation Grid Summary |

--
| AC Load Flow, balanced, positive sequence | Automatic Model Adaptation for Convergence
No |
| Automatic tap adjustment of transformers No | Max. Acceptable Load Flow Error
|
| Consider reactive power limits Yes | Bus Equations(HV) 1,00 kVA
|
| | Model Equations 0,10 % |

--

--
| Grid: EU System Stage: EU | Study Case: Study Case | Annex: / 3
|

--
| Grid: EU Summary |
| |
| No. of Substations 0 No. of Busbars 837 No. of Terminals 0 No. of Lines 0
|
| No. of 2-w Trfs. 0 No. of 3-w Trfs. 0 No. of syn. Machines 0 No. of
asyn.Machines 0 |
| No. of Loads 0 No. of Shunts/Filters 0 No. of SVS 0 |
| |
| Generation = 0,00 MW 0,00 Mvar 0,00 MVA |
| External Infeed = 1065,00 MW -0,00 Mvar 1065,00 MVA
|
| Inter Grid Flow = 1065,00 MW 0,00 Mvar |
| Load P(U) = 0,00 MW 0,00 Mvar 0,00 MVA |
| Load P(Un) = 0,00 MW 0,00 Mvar 0,00 MVA |
| Load P(Un-U) = 0,00 MW 0,00 Mvar |
| Motor Load = 0,00 MW 0,00 Mvar 0,00 MVA |
| Grid Losses = 0,00 MW 0,00 Mvar |

| Line Charging = 0,00 Mvar |
| Compensation ind. = 0,00 Mvar |
| Compensation cap. = 0,00 Mvar |
| |
| Installed Capacity = 0,00 MW |
| Spinning Reserve = 0,00 MW |
| |
| Total Power Factor: |
| Generation = 0,00 [-] |
| Load/Motor = 0,00 / 0,00 [-] |
|---
|

--
| Grid: EU System Stage: EU | Study Case: Study Case | Annex: / 4
|

--

--
| Inter Grid Flow to |
| EE00 = 568,00 MW 0,00 Mvar |
| LT00 = 497,00 MW 0,00 Mvar |
| Total = 1065,00 MW 0,00 Mvar |
|---
|

--
| Load Flow Calculation Grid Summary |

--
| AC Load Flow, balanced, positive sequence | Automatic Model Adaptation for Convergence
No |
| Automatic tap adjustment of transformers No | Max. Acceptable Load Flow Error
|
| Consider reactive power limits Yes | Bus Equations(HV) 1,00 kVA
|
| | Model Equations 0,10 % |

--

--
| Grid: LT00 System Stage: LT00 | Study Case: Study Case | Annex: /
5 |

--
| Grid: LT00 Summary |
| |
| No. of Substations 448 No. of Busbars 560 No. of Terminals 0 No. of Lines
592 |

| No. of 2-w Trfs. 77 No. of 3-w Trfs. 0 No. of syn. Machines 41 No. of asyn.Machines 0 |
| No. of Loads 458 No. of Shunts/Filters 15 No. of SVS 0 |
| |
| Generation = 772,95 MW -121,09 Mvar 782,37 MVA |
| External Infeed = 0,00 MW 0,00 Mvar 0,00 MVA |
| Inter Grid Flow = -1162,21 MW 72,88 Mvar |
| Load P(U) = 1908,99 MW 496,82 Mvar 1972,58 MVA |
| Load P(Un) = 1908,99 MW 496,82 Mvar 1972,58 MVA |
| Load P(Un-U) = -0,00 MW -0,00 Mvar |
| Motor Load = 0,00 MW 0,00 Mvar 0,00 MVA |
| Grid Losses = 26,16 MW -1029,98 Mvar |
| Line Charging = -1229,38 Mvar |
| Compensation ind. = 339,19 Mvar |
| Compensation cap. = 0,00 Mvar |
| |
| Installed Capacity = 2893,03 MW |
| Spinning Reserve = 1682,05 MW |
| |
| Total Power Factor: |
| Generation = 0,99 [-] |
Load/Motor = 0,97 / 0,00 [-]

| Grid: LT00 System Stage: LT00 | Study Case: Study Case | Annex: / 6 |

| Inter Grid Flow to |
| LV00 = -665,21 MW 72,88 Mvar |
| EU = -497,00 MW -0,00 Mvar |
Total = -1162,21 MW 72,88 Mvar

```
-----------------------------------------------------------------------------------------------------------------------------
--
| Load Flow Calculation                                                                                  Grid Summary |
-----------------------------------------------------------------------------------------------------------------------------
--
|    AC Load Flow, balanced, positive sequence            |   Automatic Model Adaptation for Convergence
No       |
|    Automatic tap adjustment of transformers       No    |   Max. Acceptable Load Flow Error
|
|    Consider reactive power limits               Yes   |      Bus Equations(HV)                         1,00 kVA
|
|                                              |     Model Equations                       0,10 %    |
-----------------------------------------------------------------------------------------------------------------------------
--
-----------------------------------------------------------------------------------------------------------------------------
--
| Grid: LV00            System Stage: LV00         | Study Case: Study Case            | Annex:               /
7  |
-----------------------------------------------------------------------------------------------------------------------------
--
| Grid: LV00            Summary                                                                  |
|                                                                                   |
| No. of Substations    299       No. of Busbars       299       No. of Terminals     0        No. of Lines
338   |
| No. of 2-w Trfs.      68        No. of 3-w Trfs.      0        No. of syn. Machines  40       No. of
asyn.Machines  0      |
| No. of Loads          154       No. of Shunts/Filters 6         No. of SVS          0                          |
|                                                                                   |
| Generation          =    1263,00  MW        -402,90   Mvar      1325,71  MVA
|
| External Infeed      =       0,00  MW          0,00   Mvar        0,00  MVA                              |
| Inter Grid Flow      =     124,37  MW          -1,75   Mvar                                         |
| Load P(U)           =    1109,00  MW         438,89   Mvar      1192,69  MVA
|
| Load P(Un)           =    1109,00  MW         438,89   Mvar      1192,69  MVA
|
| Load P(Un-U)          =       0,00  MW          -0,00   Mvar                                         |
| Motor Load           =      0,00  MW           0,00   Mvar       0,00  MVA                              |
| Grid Losses          =      29,63  MW        -840,04   Mvar                                          |
| Line Charging         =                     -1129,21   Mvar                                    |
| Compensation ind.     =                          0,00   Mvar                                    |
| Compensation cap.     =                          0,00   Mvar                                    |
|                                                                                   |
| Installed Capacity    =    4350,55  MW                                                      |
| Spinning Reserve      =     123,00  MW                                                      |
|                                                                                   |
| Total Power Factor:                                                                     |
|   Generation          =        0,95  [-]                                                    |
|   Load/Motor          =  0,93 / 0,00  [-]                                                    |
|-----------------------------------------------------------------------------------------------------------------------------
|
```

--
| Grid: LV00 System Stage: LV00 | Study Case: Study Case | Annex: /
8 |

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--
| Inter Grid Flow to |
| LT00 = 665,21 MW -72,88 Mvar |
| EE00 = -540,84 MW 71,13 Mvar |
| Total = 124,37 MW -1,75 Mvar |
|---
|

The number of overloaded lines (loading over 100% rated thermal capacity) for this snapshot is 18.

6.2 Contingency analysis

It is possible to run a N-1 contingency analysis for all lines.

6.2.1 CE Synchronous area

The results show there are 57 elements with an overload exceeding 100%.

6.2.2 Baltics Synchronous area

The results are shown below:
The results show there are 25 elements with an overload exceeding 100%.

6.3 Short circuit study

The information for all generators is not present in the NT2025_CE model.

It is possible with the assembled model to run a 3-phase short circuit study, with standard values for each generation type.

6.4 Other studies

In case of use of the model for other studies, the dynamic data is not part of the NT2025_CE model. As all generating units are categorized and the rated power is available, it would be possible for the user to insert a dynamic model for a particular grid and insert dynamic data for the rest of the generators.

7. References

[1] TYNDP 2020

https://tyndp.entsoe.eu/

[2] Common Information Model
https://www.entsoe.eu/digital/common-information-model/

8. Notes

[1] CE and Baltics are connected through a AC X-node. However, the main exchanges are managed through an HVDC line. For the integrity of the studies, CE and Baltics should be considered two separate Synchronous areas.

[2] LU loads have been modelled as voltage dependent. It is recommended to disable the load voltage dependency on the solution.

[3] Tie lines between BA and HR.

There are for instances for boundary node XMO_ZA21. The correct boundary node is XMO_ZA21 as described below.

Attribute	Type	Value
ID	ID	_5d7285b0-73d6-4090-9e84-21a39845a17a
PATH	PATH	EU/ENTSO-E/Mostar-Zakucac/XMO_ZA21
IdentifiedObject.name	String	XMO_ZA21
IdentifiedObject.description	String	XMO_ZA21; overheadLine; 220 kV; BA-HR; Mostar - Zakucac
IdentifiedObject.mRID	String	
IdentifiedObject.shortName	String	XMO_ZA21
IdentifiedObject.energyIdentCodeEic	String	
TopologicalNode.ConnectivityNodeContainer	ConnectivityNodeContainer (Line)	Mostar-Zakucac
TopologicalNode.BaseVoltage	BaseVoltage	AC-220
TopologicalNode.ReportingGroup	ReportingGroup	
TopologicalNode.fromEndIsoCode	String	BA
TopologicalNode.fromEndName	String	Mostar
TopologicalNode.fromEndNameTso	String	NOS BiH
TopologicalNode.toEndIsoCode	String	HR
TopologicalNode.toEndName	String	Zakucac
TopologicalNode.toEndNameTso	String	HOPS
TopologicalNode.boundaryPoint	Boolean	true

Connect BA line XMO_ZA21_WRPJAB2_1_220 to XMO_ZA21 above and substation 56 in BA grid.

Attribute	Type	Value
PATH	PATH	XMO_ZA21_WRPJAB2_1_220
IdentifiedObject.name	String	XMO_ZA21_WRPJAB2_1_220
IdentifiedObject.description	String	_AC_13204_133220_CKT_1-MeteredEnd:13204
ConductingEquipment.BaseVoltage	BaseVoltage	_7891a026ba2c42098556665efd13ba94
ACLineSegment.r	Resistance	5.159924
ACLineSegment.x	Reactance	28.121851
ACLineSegment.bch	Susceptance	0.000167768609
Equipment.aggregate	Boolean	true
Conductor.length	Length	64.5

Ratings:

	name	description	value
XMO_ZA21_WRPJAB2_1_220/_T_AC_13204_133220/_OLS1_13204_133220_1/_CL_PATL_13204_133220_1	_CL_PATL_13204_133220_1	RateA	789.920166
XMO_ZA21_WRPJAB2_1_220/_T_AC_13204_133220/_OLS2_13204_133220_1/_CL_PATL_13204_133220_1	_CL_PATL_13204_133220_1	RateA	789.920166

There are two instances for XVR_LJ51.
The correct boundary node is XVR_LJ51 as described below.

Attribute	Type	Value
ID	ID	_30c84067-ee6b-465f-bdd9-8a9cd8f
PATH	PATH	EU/ENTSO-E/Vrgorac-Ljubuski/XVR_LJ51
IdentifiedObject.name	String	XVR_LJ51
IdentifiedObject.description	String	XVR_LJ51; overheadLine; 110 kV; BA-HR; TS VRGORAC - TS LJUBUSKI
IdentifiedObject.shortName	String	XVR_LJ51
TopologicalNode.ConnectivityNodeContainer	ConnectivityNodeContainer (Line)	Vrgorac-Ljubuski
TopologicalNode.BaseVoltage	BaseVoltage	AC-110
TopologicalNode.fromEndIsoCode	String	BA
TopologicalNode.fromEndName	String	TS LJUBUSKI
TopologicalNode.fromEndNameTso	String	NOS BiH
TopologicalNode.toEndIsoCode	String	HR
TopologicalNode.toEndName	String	TS VRGORAC
TopologicalNode.toEndNameTso	String	HOPS
TopologicalNode.boundaryPoint	Boolean	true

Connect BA line XVR_LJ51_WLJUBU5_1_110 to XVR_LJ51 above and Substation 69 in BA grid.

Attribute	Type	Value
PATH	PATH	XVR_LJ51_WLJUBU5_1_110
IdentifiedObject.name	String	XVR_LJ51_WLJUBU5_1_110
IdentifiedObject.description	String	_AC_13535_138100_CKT_1-MeteredEnd:138100
ConductingEquipment.BaseVoltage	BaseVoltage	_b8e17237e0ca4fca9e4e285b80ab30d0
ACLineSegment.r	Resistance	1.37456
ACLineSegment.x	Reactance	4.55536
ACLineSegment.bch	Susceptance	3.2396696E-05
Equipment.aggregate	Boolean	true
Conductor.length	Length	11.36

Attribute	Type	Value
ID	ID	_f03f92e8-dec5-eacf-0848-a39c9ca5f43d
PATH	PATH	AC-110/XVR_LJ51_WLJUBU5_1_110/_T_AC_13535_138100/_OLS1_13535_138100_1/_CL_PATL_13535_138100_1
IdentifiedObject.name	String	_CL_PATL_13535_138100_1
IdentifiedObject.description	String	RateA
CurrentLimit.value	CurrentFlow	645.5826
OperationalLimit.OperationalLimitSet	OperationalLimitSet	_OLS1_13535_138100_1
OperationalLimit.OperationalLimitType	OperationalLimitType	PATL

[4] Mismatches on X-nodes correction.

XCA_ME21 CH\Mese (-50+j -0 MVA) IT_19358fed-5a1b-40f7-9064-144596b(0+j 0MVA)XCA_ME21; overheadLine; 220 kV; CH-IT; Castasegna – Mese

Set XCA_ME21 EquivalentInjections to 0 MW.

XBW_BJ1D DE\RAND 380 1D (0+j 67 MVA)
XBW_BJ1D; highVoltageDirectCurrent; 380 kV; DE-DK; Bentwisch – Bjaeverskov

XBW_BJ1K DK\BoundaryInjectionEq(20) (-585+j -0MVA)
XBW_BJ1K; highVoltageDirectCurrent; 400 kV; DK-DE; Bjaeverskov – Bentwisch

Set XBW_BJD and XBW_BJ1K EquivalentInjections to -585 and 585 MW.