Topology Creator User Manual

Reference:	***Topology Creator User Manual.docx***
Date:	15/12/20

1 Introduction

The present document describes in detail the Excel spreadsheet that is used to collect the required data in order to build the topology model of the grid to be integrated.

2 Structure of the Excel spreadsheet

The Excel spreadsheet contains different tabs, each one requiring details on different elements. The following sections follow a practical example of a simple grid as a guideline to completing the spreadsheet.

2.1 Substations

Under this tab, a list of the substations present in the grid needs to be provided. Substations in the model serve as other component containers.

Property	Type	Description	Reference
Id	string	Unique identifier of the substation	

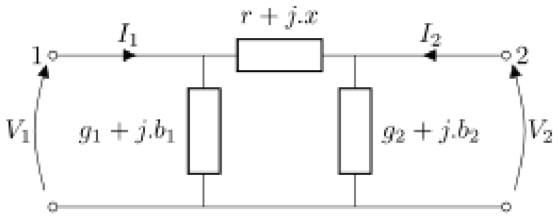
2.2 Buses

Buses are non-impedant elements used to connect equipment inside substations.

Property	Type	Description	Reference
name	string	Unique identifier of the bus	
substation	string	Substation where the bus is located	Substations.id
U	float	Nominal voltage of the bus (kV)	

2.3 Lines

Lines are used to connect buses located on different substations. They are modelled using a standard π model with distributed parameters.



Property	Type	Description	Reference
name	string	Unique identifier of the line	
Bus1	string	Source bus	Buses.name
Bus2	string	Sink bus	Buses.name
r	number	The series resistance (Ω)	
x	number	The series reactance (Ω)	
G1	number	The first side shunt conductance (S)	
B1	number	The first side shunt	

		susceptance (S)	
G2	number	The second side shunt conductance (S)	
B2	number	The second side shunt susceptance (S)	
currentLimit	number	The line maximum acceptable current (A)	

2.3.1 Hints on line modelling for distribution grids

2.3.1.1 Ideal lines

As a first step towards constructing and performing an early validation of the model, it may be interesting to proceed by modelling all lines as ideal lines (R=X=G1=B1=G2=B2=0). Electrical details can be updated in the model on a second stage.

2.3.1.2 Series resistance and reactance

Resistance depends on the temperature of the conductor. The following table contains reference values that can be used to estimate this parameter. As default value the column 20ºC may be used.

	Conductor temperature		
	20ºC	**Thermoplastics 70ºC**	**Thermoset 90ºC**
Cu	58.00	48.47	45.49
Al	35.71	29.67	27.80

Values provided in [m / (Ω·mm²)]

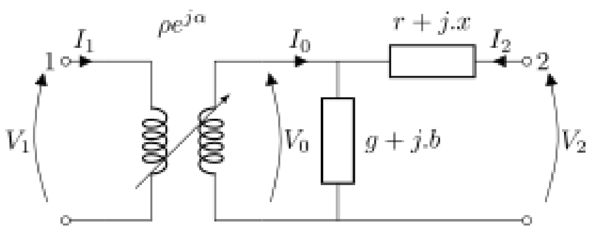
In general, reactance (x) can be considered constant, equal to 0.08 Ω/km regardless of the line type (three-phase or single-phase), conductor material (copper, aluminium) or section size. This value is accepted by IEC 60364-5-52.

2.3.1.3 Shunt conductance/susceptance

For distribution lines (length < 80km), those values are negligible (G1 = B1 = G2 = B2 = 0)

2.4 Transformers

Two-winding transformers are used to connect buses under the same substation with different nominal voltages. They are modelled using the equivalent Π model.



Property	Type	Description	Reference
name	string	Unique identifier of the transformer	
Bus1	string	Source bus	Buses.name
Bus2	string	Sink bus	Buses.name

r	number	The nominal series resistance at the side 2 of the transformer (Ω)	
x	number	The nominal series reactance at the side 2 of the transformer (Ω)	
g	number	The nominal magnetizing conductance at the side 2 of the transformer (S)	
b	number	The nominal magnetizing susceptance at the side 2 of the transformer (S)	
ratedU1	number	The rated voltage at side 1 (kV)	
ratedU2	number	The rated voltage at side 2 (kV)	

2.5 Loads

Loads represent relevant active power demand nodes in the topology model.

Property	Type	Description	Reference
name	string	Unique identifier of the load	
bus	string	Bus the load is connected to	Buses.name
P	number	Reference active power demand for this node (MW)	
Q	number	Reference reactive power demand for this node (MVAr)	

Please note that P and Q values will be updated with metered values accordingly to the corresponding analysis performed (e.g. current or forecasted power flows) during system operation. Values provided at this point will be used at system commissioning to validate the topology model.

2.6 Generators

Generators represent relevant active power injection nodes in the topology model (either RES or connections to TSO network).

Property	Type	Description	Reference
name	string	Unique identifier of the generator	
bus	string	Bus the generator is connected to	Buses.name
minP	number	Minimum generator active power output (MW). Usually negative to consider that a generator may actually consume power (e.g. TSO connections)	
maxP	number	Maximum generator active power output (MW)	
minQ	number	Minimum generator reactive	

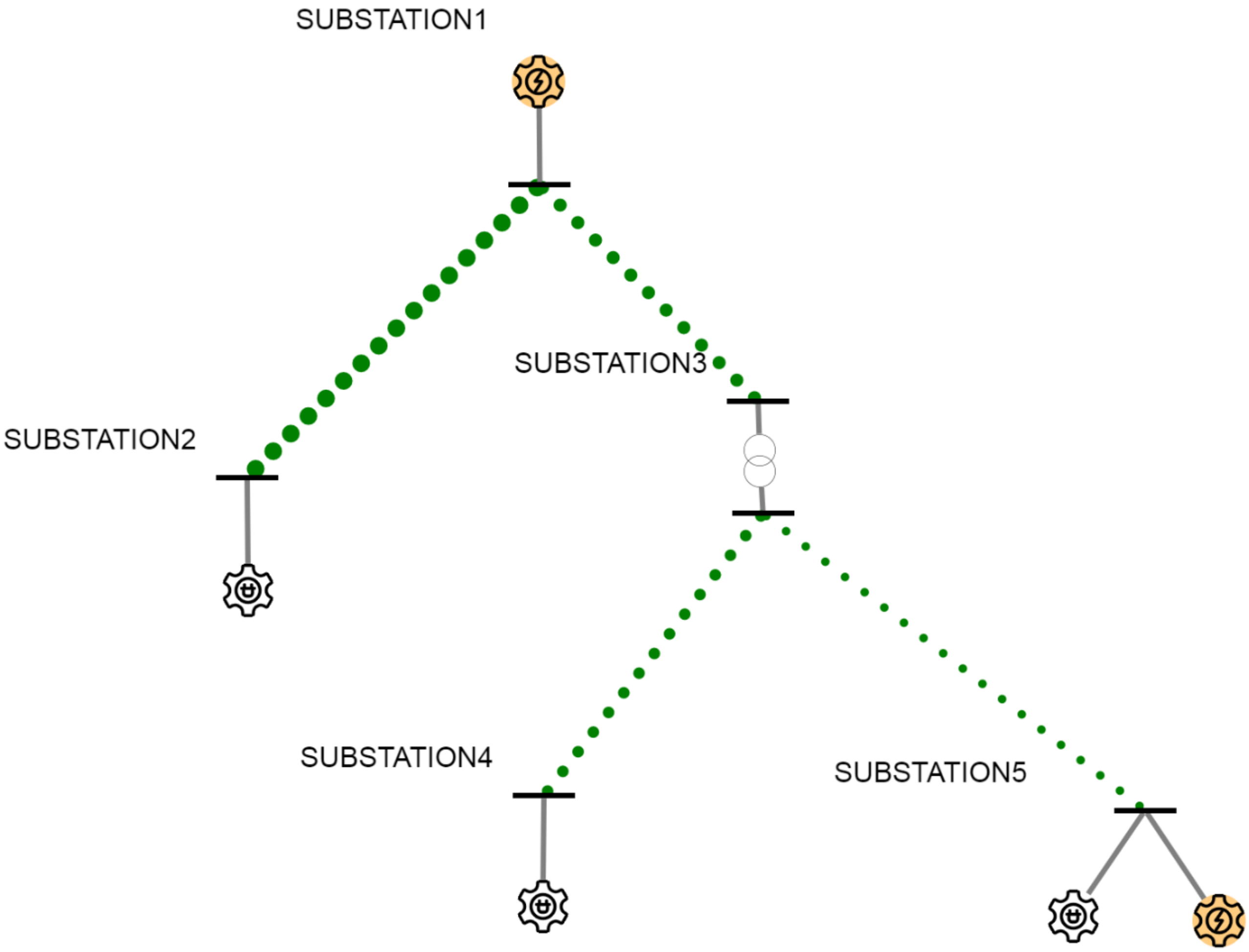
		power output (MVar)	
maxQ	number	Maximum generator reactive power output (MVar)	
targetP	number	The active power setpoint (MW)	
targetQ	number	The reactive power setpoint (MVar)	
targetV	number	The voltage setpoint (kV). Usually the nominal voltage of the bus the generator is connected to	

Please note that targetP and targetQ values will be updated with metered values accordingly to the corresponding analysis performed (e.g. current or forecasted power flows) during system operation. Values provided at this point will be used at system commissioning to validate the topology model.

3 EXAMPLE

This section contains the complete description of the small grid shown in the figure. The grid is composed of 5 substation with the following relevant particularities:

- TSO connection is located at SUBSTATION1. This is modelled as a generator that feeds power at 20kV (HV/MV transformer is not present in order to simplify the model)
- SUBSTATION3 contains a 20kV/12.5kV transformer. SUBSTATION4 and SUBSTATION5 are supplied with 12.5kV
- Loads are present at SUBSTATION2, SUBSTATION3 and SUBSTATION4
- A PV generation unit is present at SUBSTATION5



3.1 Substations

ID
SUBSTATION1
SUBSTATION2
SUBSTATION3
SUBSTATION4
SUBSTATION5

3.2 Buses

NAME	SUBSTATION	U
S1B1	SUBSTATION1	20.00
S2B1	SUBSTATION2	20.00
S3B1	SUBSTATION3	20.00
S3B2	SUBSTATION3	12.50
S4B1	SUBSTATION4	12.50
S5B1	SUBSTATION5	12.50

SUBSTATION3 contains 2 different buses (S3B1 and S3B2) at different voltage levels.

3.3 Lines

NAME	BUS1	BUS2	R	X	G1	B1	G2	B2	CURRENTLIMIT
L1_2	S1B1	S2B1	0.93	0.80	0.00	0.00	0.00	0.00	40.00
L1_3	S1B1	S3B1	0.93	0.80	0.00	0.00	0.00	0.00	40.00
L3_4	S3B2	S4B1	0.93	0.80	0.00	0.00	0.00	0.00	40.00
L3_5	S3B2	S5B1	0.93	0.80	0.00	0.00	0.00	0.00	40.00

Assuming all lines have the following properties:

- Aluminium
- Section of 300mm^2
- Length of 10km

Calculation of R

From the reference table, Aluminium conductor at 20ºC has 35.71 m / (Ω·mm^2). Resistance is therefore calculated as:

$$R = LENGTH / (SECTION \cdot 35.71) = 10000 / (300 \cdot 35.71) = 0.93\ \Omega$$

Calculation of X

Value for reactance is considered equal to 0.08 Ω/km. Reactance is therefore calculated as:

$$X = LENGTH \cdot 0.08 = 10 \cdot 0.08 = 0.8$$

Calculation of G1, B1, G2, B2

Since length is lower than 80 km, it can be assumed that G1=B1=G2=B2=0

3.4 Transformers

NAME	BUS1	BUS2	R	X	G	B	RATEDU1	RATEDU2
TRAFO3	S3B1	S3B2	0.00	0.00	0.00	0.00	20.00	12.50

In this case, transformers details are assumed to be unknown, and the transformer has been modelled as an ideal transformer (R=X=G=B=0)

3.5 Loads

NAME	BUS	P	Q
LOAD2	S2B1	7.00	0.05
LOAD4	S4B1	3.00	0.05
LOAD5	S5B1	2.00	0.05

3.6 Generators

NAME	BUS	MINP	MAXP	TARGETP	TARGETV	TARGETQ	MINQ	MAXQ
TSO	S1B1	-100.00	100.00	11	20	1	-100.00	100.00
PV5	S5B1	0.00	2.00	1	12.5	0.3	-100.00	100.00