

11 kV PF case - Dynamic loss evaluation

Calculation method

Workshop 1 – Part 2

Monday 14.09.2020 – Friday 18.09.2020

- Session 4
 - 11 kV Power Factory study case – dynamic iterative loss calculation method
- Session 5
 - 132 kV Power Factory study case – how the loss pattern is affected by changes in power flow direction as the traditional top-down system is challenged
- Session 6
 - Review on loss calculation procedures and tools
 - Review note D1.1 with gap analysis

Pre-recorded sessions released on Monday 14.09.2020

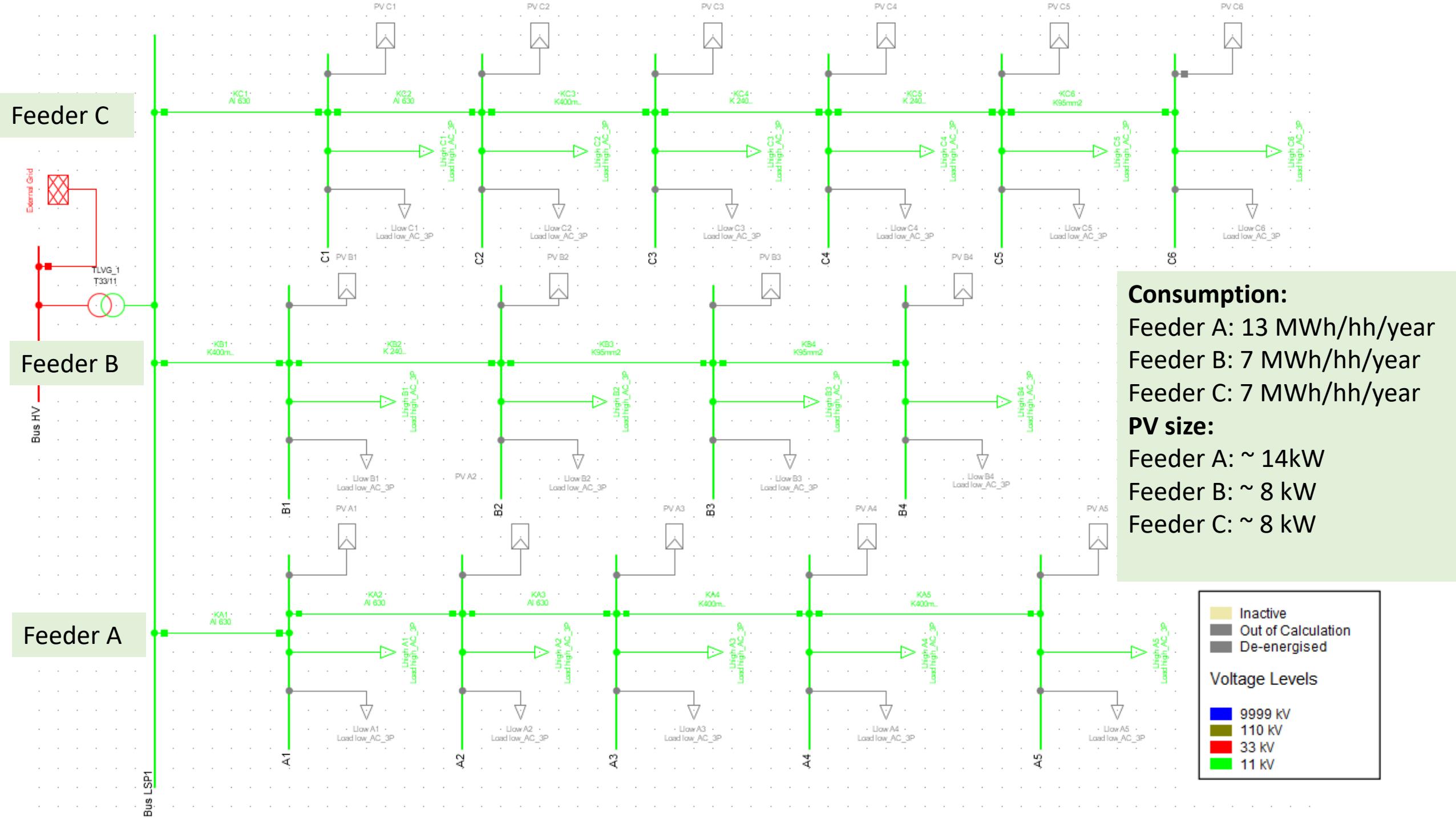
QA session: Monday 21.09.2020 (Duration TBD – Could be 2 hours)

11 kV PF case - Dynamic loss evaluation

- The dynamic model
- Building the dynamic model
- Measurement files
- Building the dynamic model
- Running the simulation
- Results

Study of the average loss profile through dynamic evaluation in Power Factory

- Loss evaluation as a dynamic study with Power Factory
- Can we build a model to help study the yearly losses?
- Can we reduce the amount of input data and number of calculations needed?



The dynamic model

- We need a model that considers both the load profiles and the PV production profiles
- We need to define which data the loads and the PV systems in the model should use as well as define the right time line

The dynamic model

Parts in the study:

- Power grid
 - The power grid could easily be simplified, looking at certain points in the grid if the grid is large
- Measurement files
 - Files containing the consumption and production data in valuable nodes with information
- Composite and common models for the loads and PV systems
 - The models are defining the communication between elements in the model and the external data in the measurement files

The dynamic model

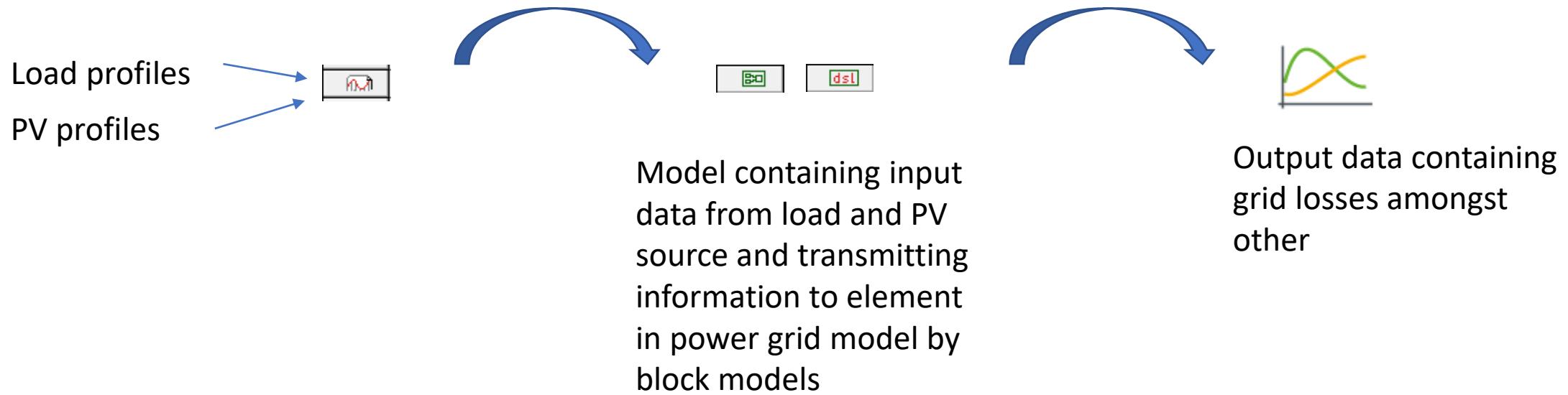
Parts in the study:

- Power grid
 - Same as previous study case
- Measurement files
 - Load profiles for the customers in the different feeders and the solar PV production profiles for the 25% of the customers having PV systems installed
- Composite and common models for the loads and PV systems
 - Power Factory block models providing the link between the modelled power grid elements and the measurement files

11 kV PF case - Dynamic loss evaluation

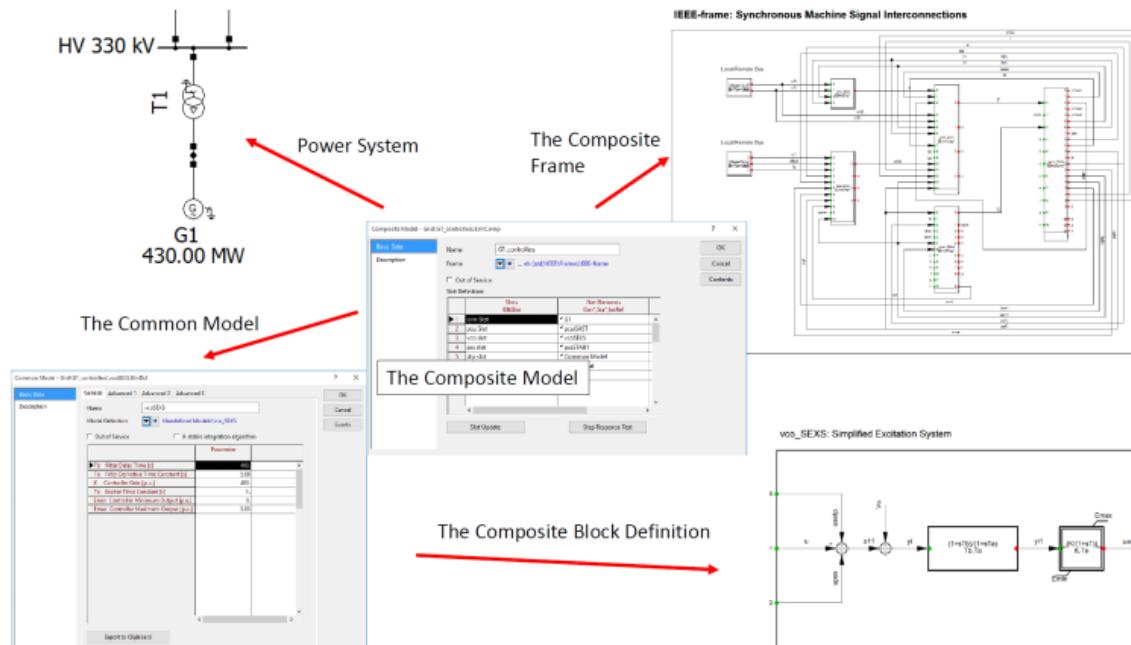
- The dynamic model
- Building the dynamic model
- Measurement files
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- Results

Building the dynamic model



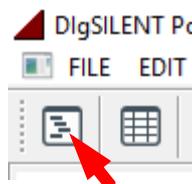
Building the dynamic model

- The **Composite Model**(*ElmComp*) connects a set of time-domain models inside a diagram (a composite frame) and creates a 'composite model'.
- The **Common Model**(*ElmDsl*) combines general time-domain models or model equations (a Block Definition) with a set of parameter values and creates an integrated time-domain model.



Building the dynamic model

- It is possible to build the models in a few different ways
- We will study one of them by combining drag & drop functions as well as the Data Manager and Network Model Manager



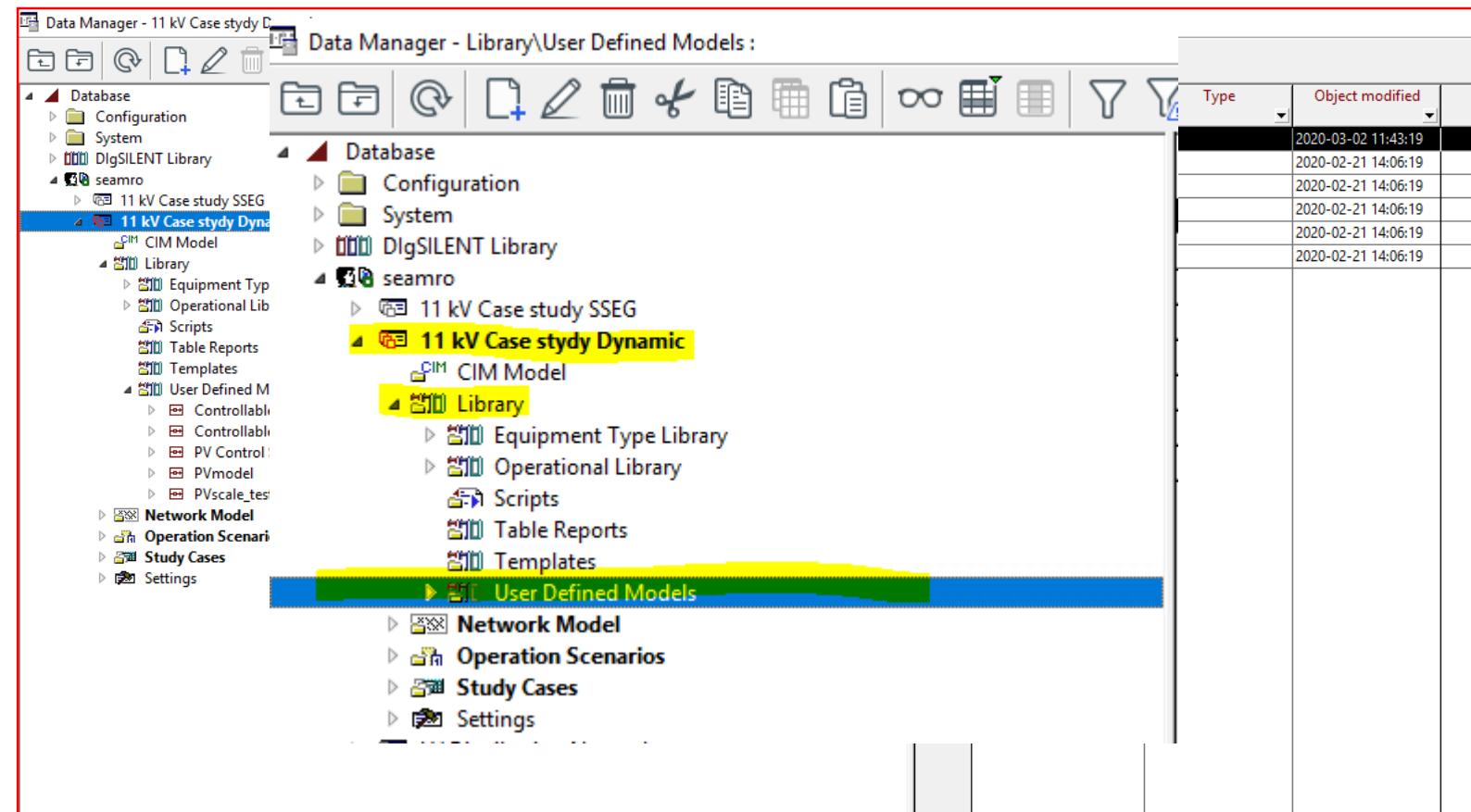
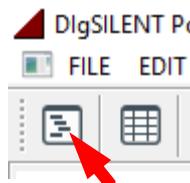
The screenshot shows the 'Data Manager - 11 kV Case study Dynamic' window. On the left is a tree view of the database structure under 'seamro' and '11 kV Case study SSEG'. On the right is a table listing various objects with columns for Name, Type, and Object modified date.

	Name	Type	Object modified
CIM	CIM Model		2020-03-02 11:43:19
Library	Library		2020-02-21 14:06:19
Network Model	Network Model		2020-02-21 14:06:19
Operation Scenarios	Operation Scenarios		2020-02-21 14:06:19
Study Cases	Study Cases		2020-02-21 14:06:19
Settings	Settings		2020-02-21 14:06:19

- Starting with the user defined models

Building the dynamic model

- It is possible to build the models in a few different ways
- We will study one of them by combining drag & drop functions as well as the Data Manager and Network Model Manager



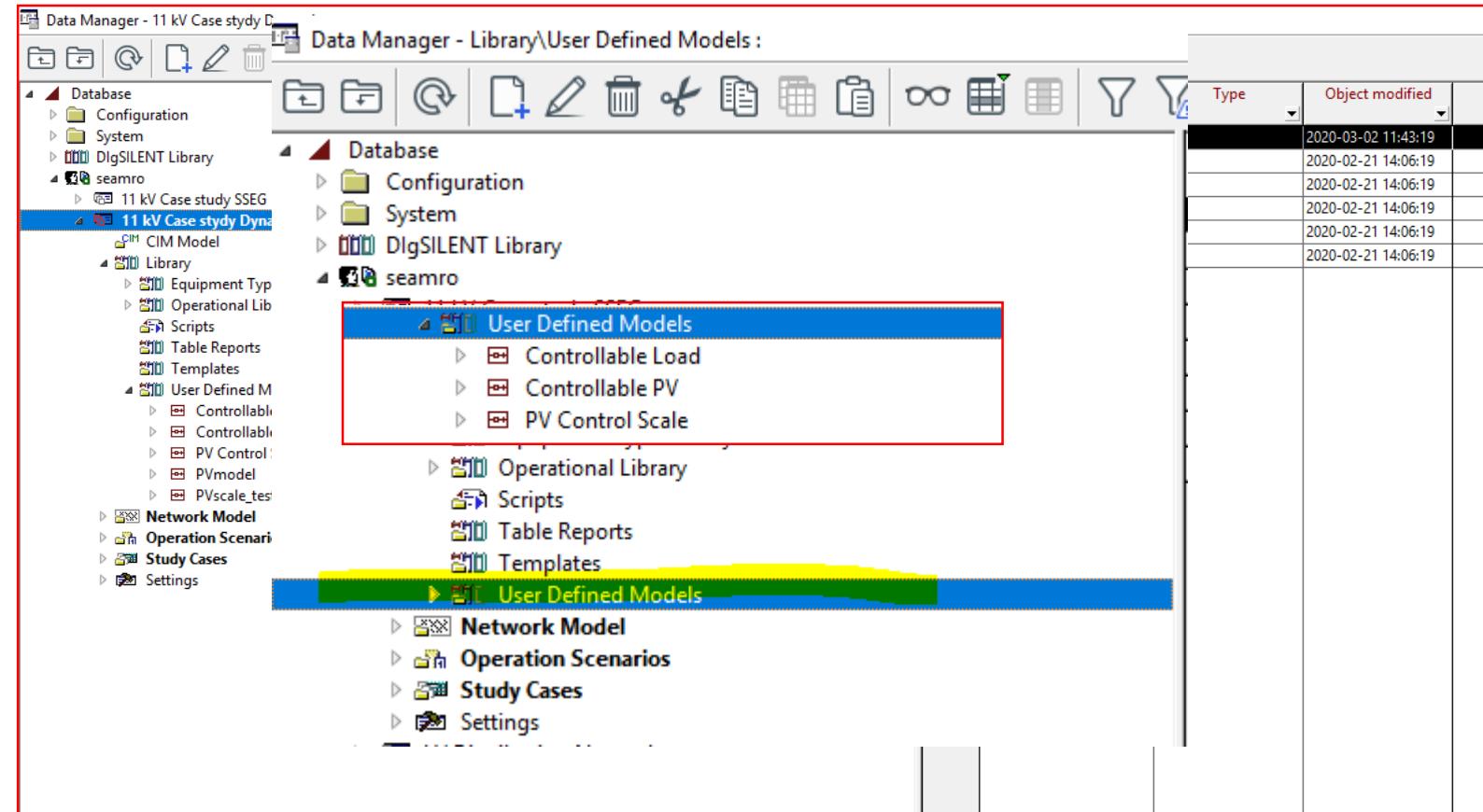
- Starting with the user defined models

Building the dynamic model

- It is possible to build the models in a few different ways
- We will study one of them by combining drag & drop functions as well as the Data Manager and Network Model Manager



- Starting with the user defined models





Building the dynamic model

Data Manager - Library\>User Defined Models:

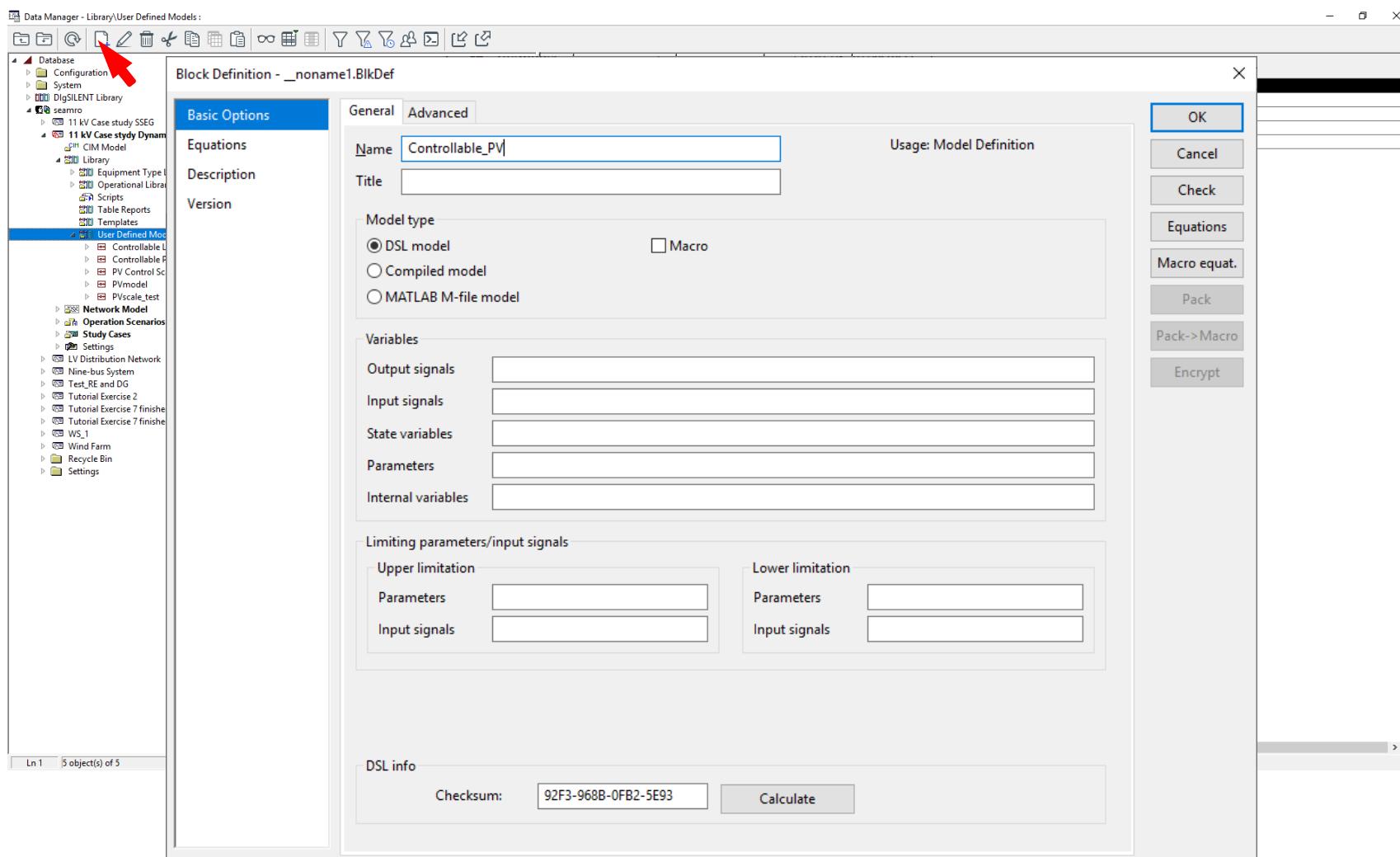
The screenshot shows the 'Data Manager - Library\User Defined Models:' window. On the left is a tree view of the library structure, with the 'User Defined Models' node selected and highlighted in blue. The main area contains a table with the following data:

	Name	Type	Object modified
1	Controllable Load		2020-03-02 12:20:52
2	Controllable PV		2020-03-02 13:54:59
3	PV Control Scale		2020-04-24 15:29:06
4	PVmodel		2020-03-10 09:19:21
5	PVscales_test		2020-04-21 16:12:48

At the bottom of the window, there is a status bar with the following information: Ln 1 | 5 object(s) of 5 | 1 object(s) selected | Drag & Drop.

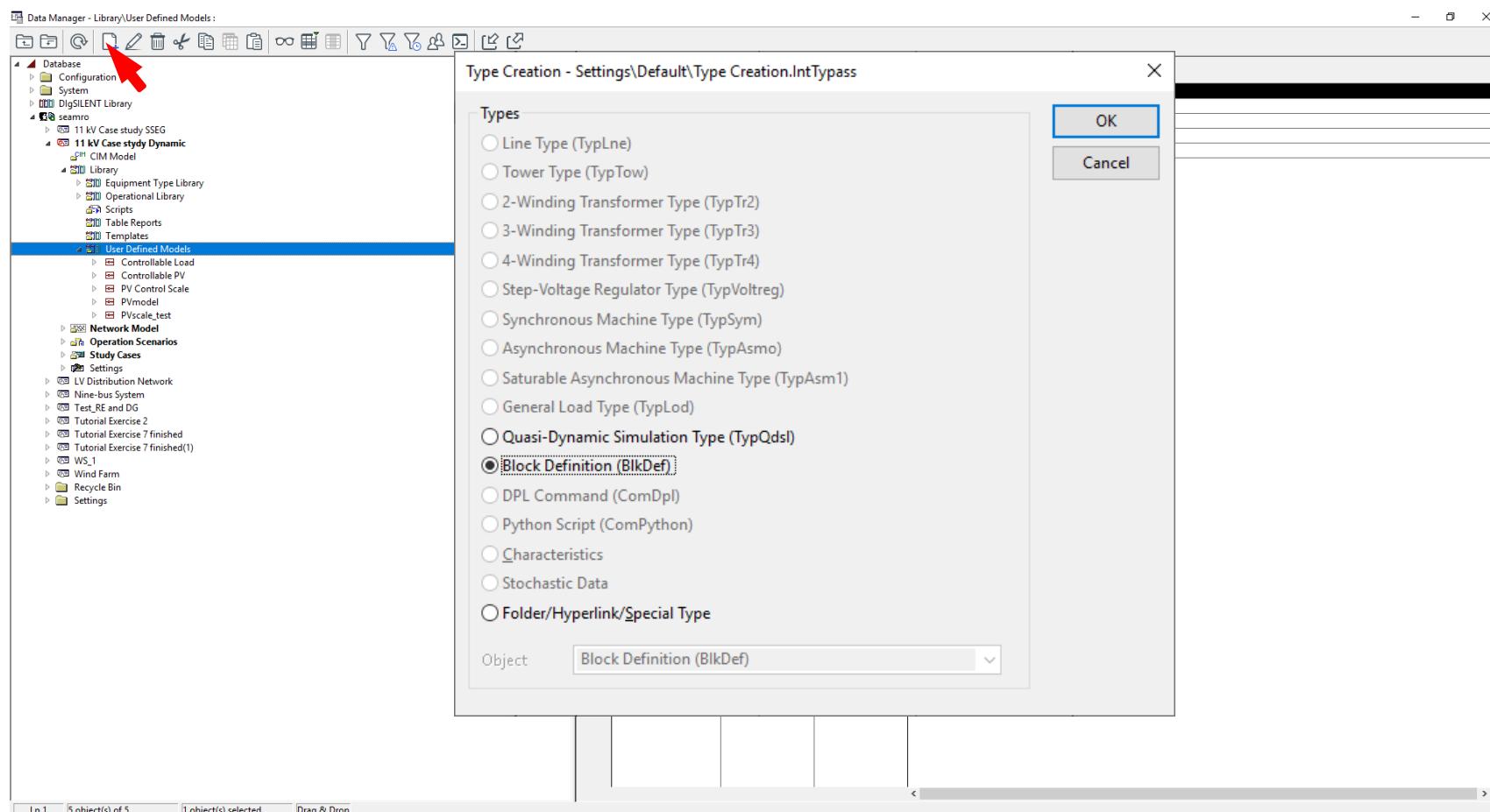


Building the dynamic model





Building the dynamic model





Building the dynamic model

Data Manager - Library\User Defined Models:

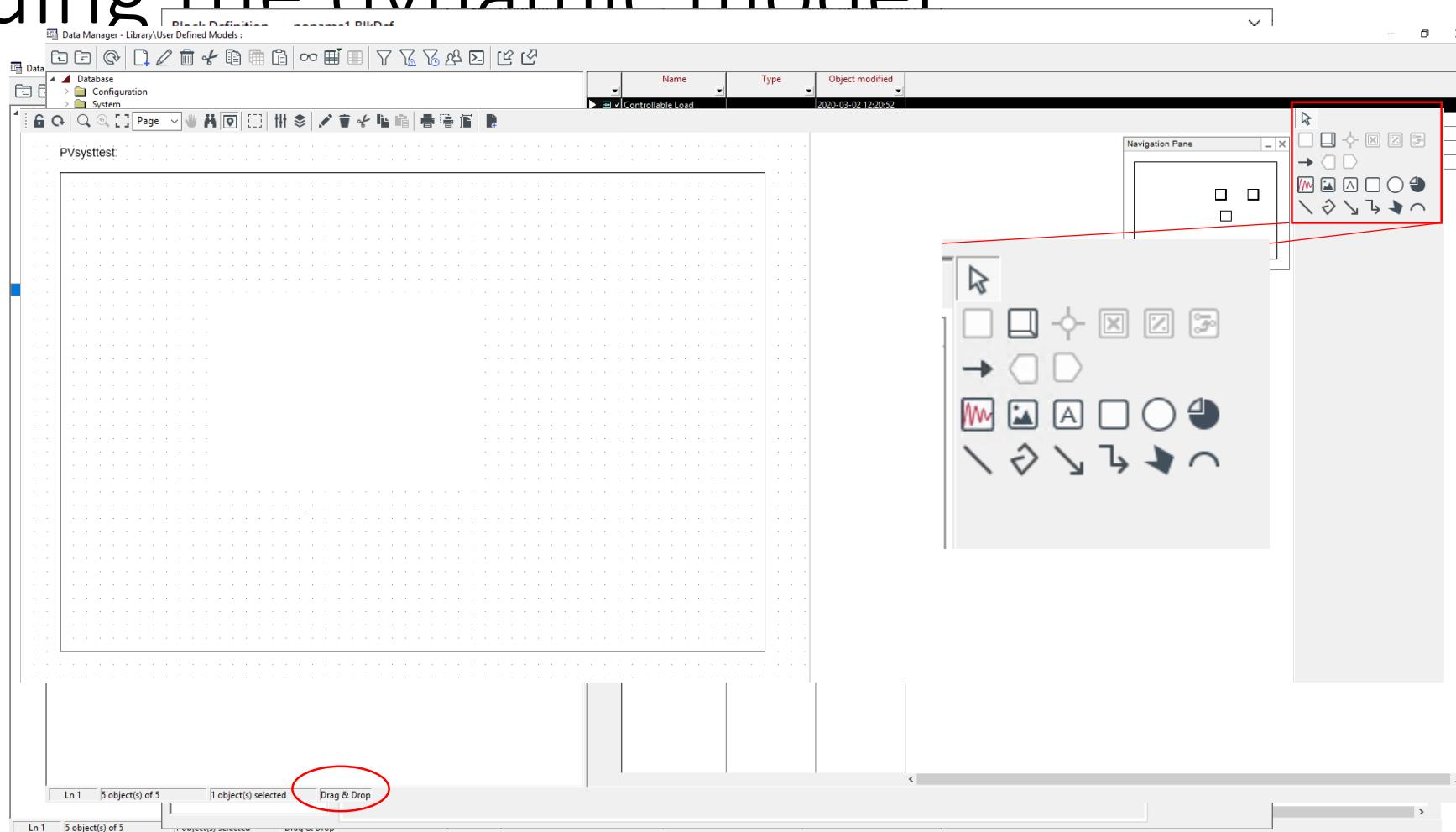
The screenshot shows the DigSILENT Data Manager interface. On the left, there is a tree view of the library structure under "User Defined Models". A red arrow points to the "New" icon (a document with a plus sign) in the toolbar at the top left. A red oval highlights the "Drag & Drop" button in the bottom toolbar. On the right, there is a table with columns for Name, Type, and Object modified.

	Name	Type	Object modified
Controllable Load			2020-03-02 12:20:51
Controllable PV			2020-03-02 13:54:51
PV Control Scale			2020-04-24 15:29:00
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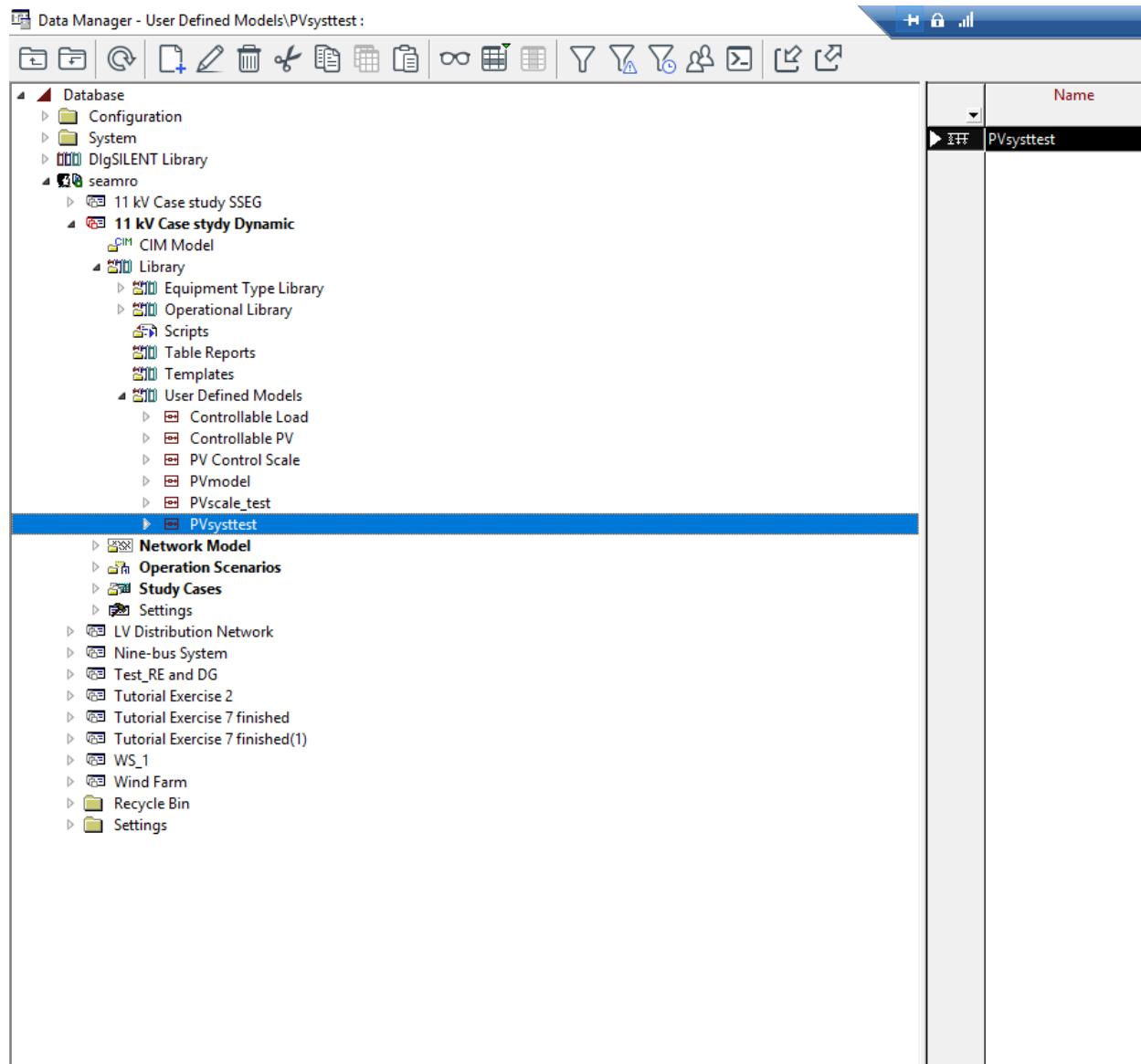
Ln 1 5 object(s) of 5 1 object(s) selected Drag & Drop



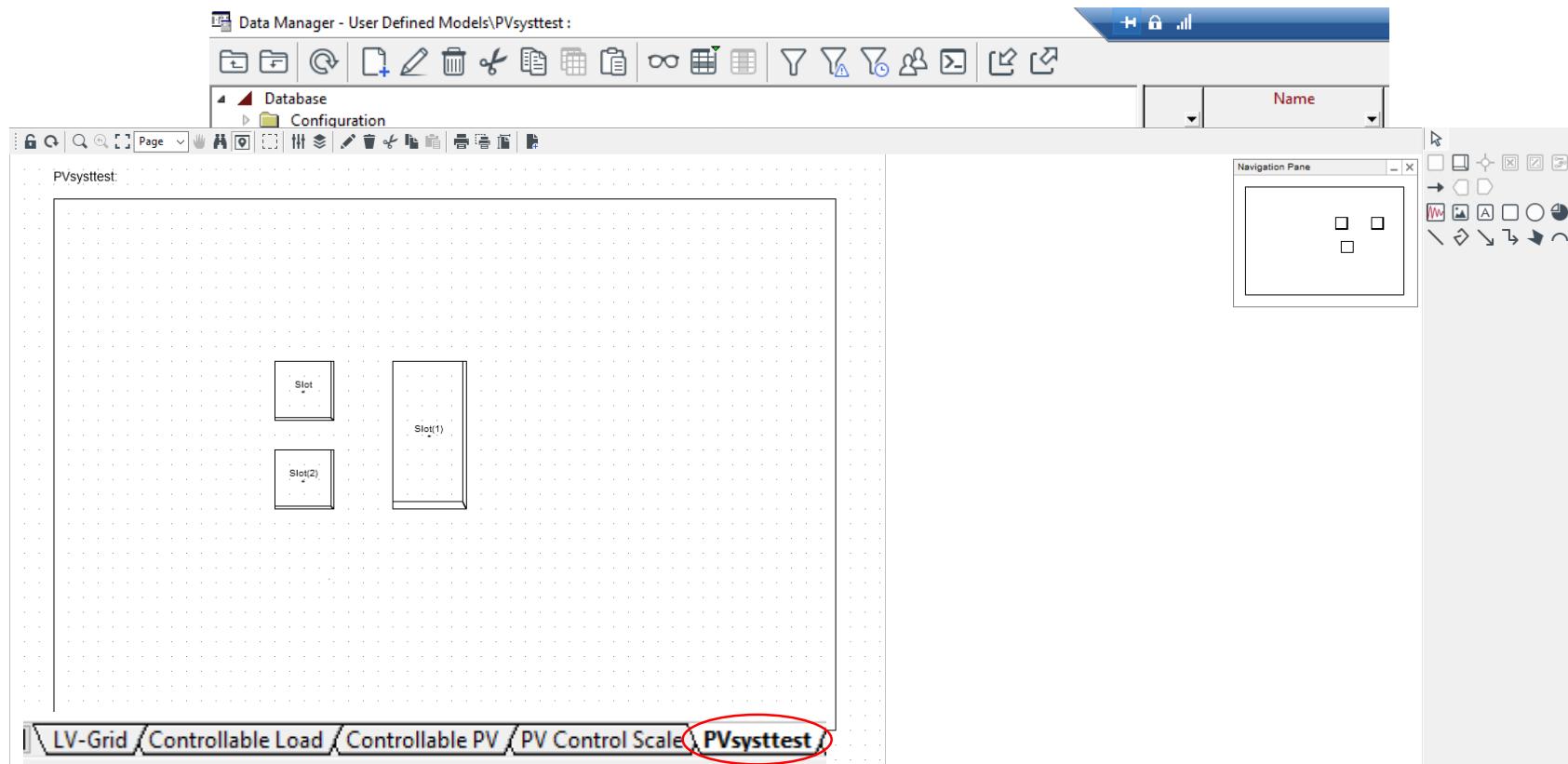
Building the dynamic model



Building the dynamic model

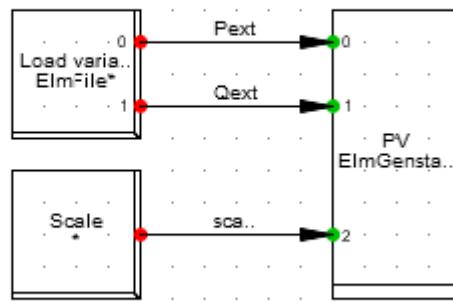


Building the dynamic model

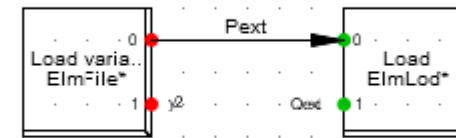
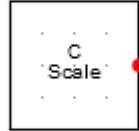


Building the dynamic model

What we want to achieve

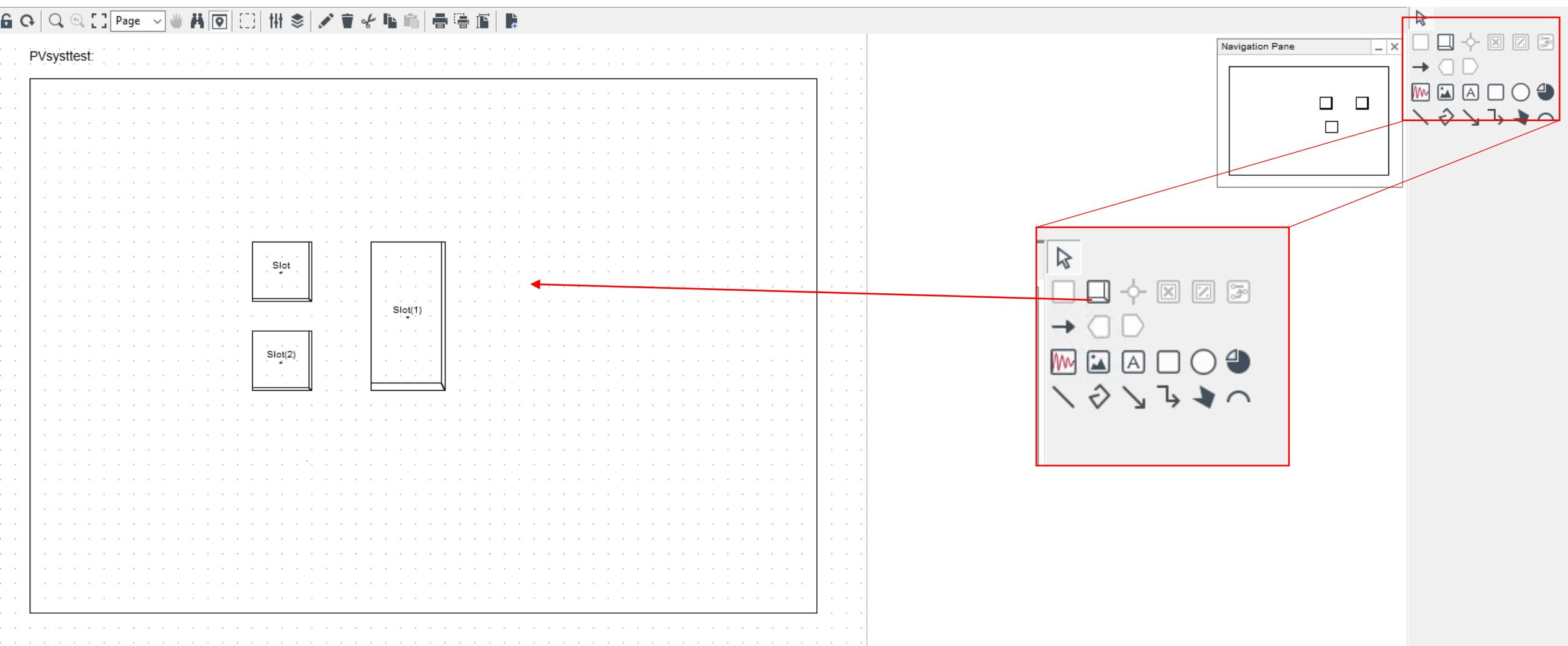


One model communicating with the PV systems, feeding the model with production data



One model communicating with the loads, feeding the model with consumption data

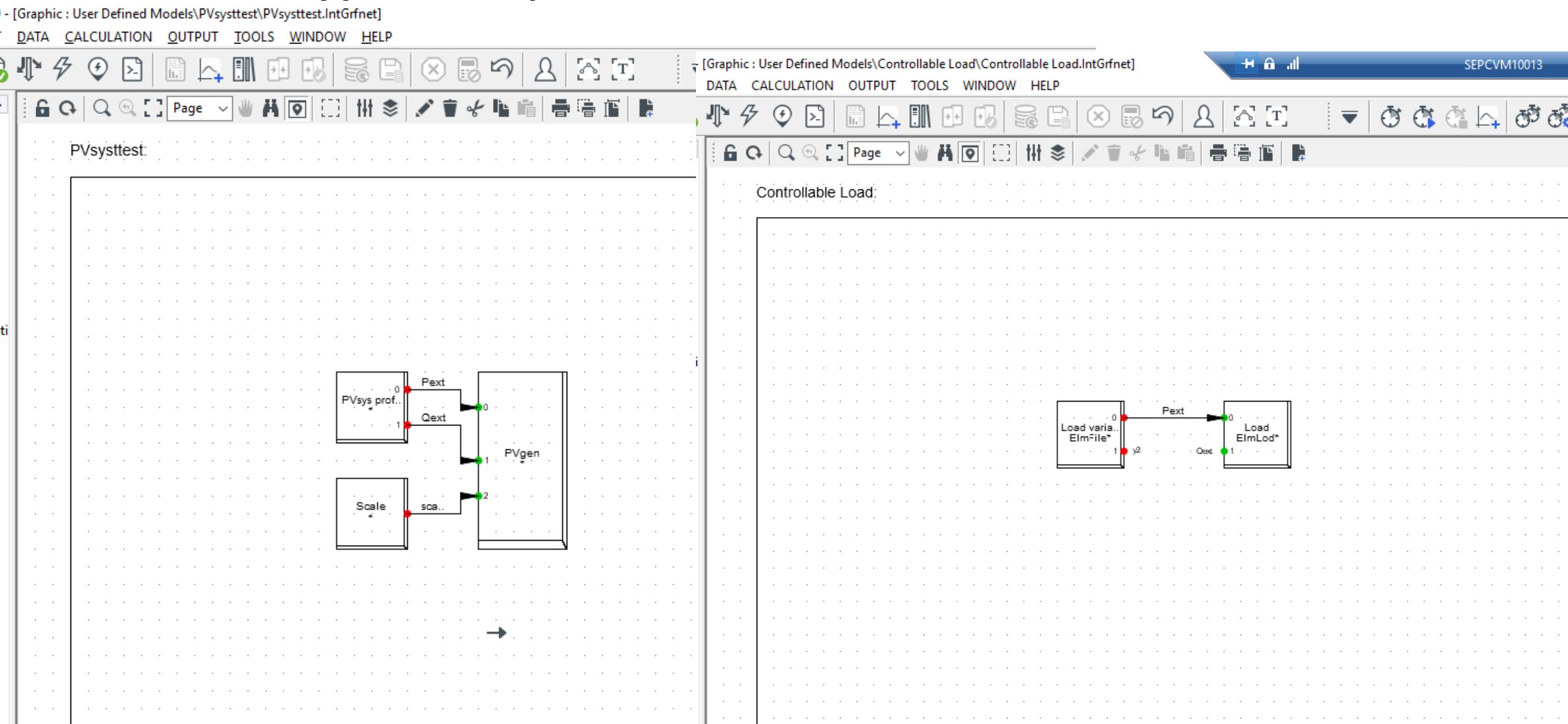
Building the dynamic model



Building the dynamic model

<p>Slot - User Defined Models\PVsysttest\PVsys profile.BlkSlot *</p> <p>Name PVsys profile</p> <p>Sequence 0,</p> <p>Block Definition <input type="button"/> <input type="button"/> ...</p> <p>Filter for</p> <p>Class Name *</p> <p>Model Name *</p> <p>Classification</p> <p><input checked="" type="checkbox"/> Linear</p> <p><input type="checkbox"/> Automatic, model will be created</p> <p><input checked="" type="checkbox"/> Local, model must be stored inside</p> <p><input type="checkbox"/> Main Slot</p> <p>Upper Limitation</p> <p>Limiting Input Signals</p> <p>Lower Limitation</p> <p>Limiting Input Signals</p> <p>Variables</p> <p>Output Signals y1,y2</p> <p>Input Signals</p>	<p>Slot - User Defined Models\PVsysttest\Slot(2).BlkSlot</p> <p>Name Scale</p> <p>Sequence 2,</p> <p>Block Definition <input type="button"/> <input type="button"/> ...</p> <p>Filter for</p> <p>Class Name *</p> <p>Model Name *</p> <p>Classification</p> <p><input checked="" type="checkbox"/> Linear</p> <p><input type="checkbox"/> Automatic, model will be created</p> <p><input checked="" type="checkbox"/> Local, model must be stored inside</p> <p><input type="checkbox"/> Main Slot</p> <p>Upper Limitation</p> <p>Limiting Input Signals</p> <p>Lower Limitation</p> <p>Limiting Input Signals</p> <p>Variables</p> <p>Output Signals scale</p> <p>Input Signals</p>	<p>Slot - User Defined Models\PVsysttest\PVgen.BlkSlot</p> <p>Name PVgen</p> <p>Sequence 1,</p> <p>Block Definition <input type="button"/> <input type="button"/> ...</p> <p>Filter for</p> <p>Class Name *</p> <p>Model Name *</p> <p>Classification</p> <p><input checked="" type="checkbox"/> Linear</p> <p><input type="checkbox"/> Automatic, model will be created</p> <p><input checked="" type="checkbox"/> Local, model must be stored inside</p> <p><input type="checkbox"/> Main Slot</p> <p>Upper Limitation</p> <p>Limiting Input Signals</p> <p>Lower Limitation</p> <p>Limiting Input Signals</p> <p>Variables</p> <p>Output Signals</p> <p>Input Signals Pext,Qext,scale</p>
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Building the dynamic model



Building the dynamic model

The image shows a screenshot of a simulation software interface, likely PVSYS, with two open dialog boxes for defining slots.

Slot - User Defined Models\Controllable Load\Load variation.BlkSlot

- Name:** Load variation
- Sequence:** 0,
- Block Definition:** (dropdown menu)
- Filter for:**
 - Class Name:** ElmFile*
 - Model Name:** *
- Classification:**
 - Linear
 - Automatic, model will be created
 - Local, model must be stored inside
 - Main Slot
- Upper Limitation:** Limiting Input Signals: [empty input field]
- Lower Limitation:** Limiting Input Signals: [empty input field]
- Variables:**
 - Output Signals:** y1,y2
 - Input Signals:** [empty input field]

Slot - User Defined Models\Controllable Load\Load.BlkSlot

- Name:** Load
- Sequence:** 1,
- Block Definition:** (dropdown menu)
- Filter for:**
 - Class Name:** ElmLod*
 - Model Name:** *
- Classification:**
 - Linear
 - Automatic, model will be created
 - Local, model must be stored inside
 - Main Slot
- Upper Limitation:** Limiting Input Signals: [empty input field]
- Lower Limitation:** Limiting Input Signals: [empty input field]
- Variables:**
 - Output Signals:** [empty input field]
 - Input Signals:** Pext,Qext

On the left, the navigation tree shows "PVsys" with nodes 0 and 1 expanded. On the right, there is a toolbar with various icons and the text "SEPCVM10013".

Building the dynamic model

The image shows a screenshot of a simulation software interface, likely PVSYS, with two dialog boxes open for defining slots.

Slot - User Defined Models\Controllable Load\Load variation.BlkSlot

- Name:** Load variation
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- Variables:**
 - Output Signals:** [empty input]
 - Input Signals:** Pext,Qext

On the left, the tree view shows nodes like PVsys, 0, and 1. On the right, there are toolbars and a status bar showing "SEPCVM10013".

Building the dynamic model

The image shows a simulation software interface with two open dialog boxes for defining slots in a user-defined model.

Slot - User Defined Models\Controllable Load\Load variation.BlkSlot

- Name:** Load variation
- Sequence:** 0,
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- Filter for:**
 - Class Name:** ElmFile*
 - Model Name:** *
- Classification:**
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- Variables:**
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 - Input Signals:** [empty input]

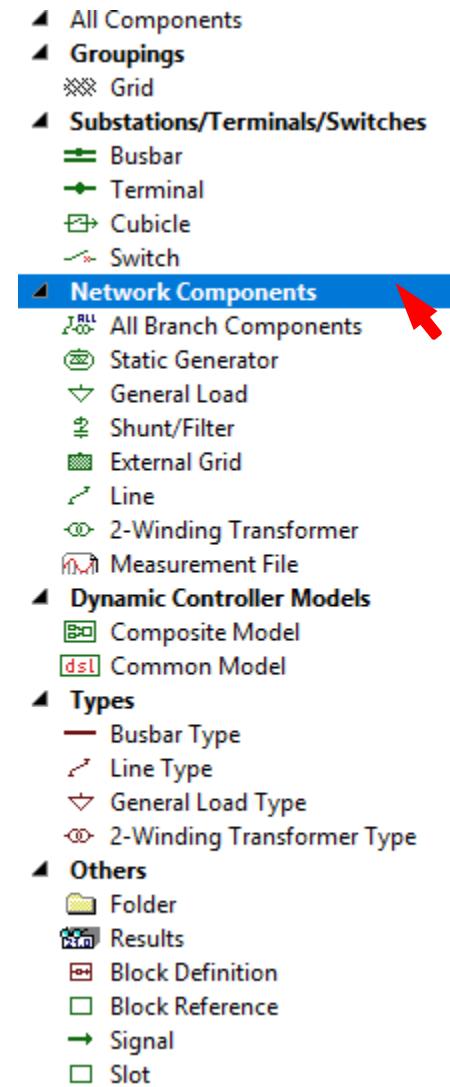
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On the left, the navigation tree shows a folder structure under PVsys. On the right, there is a toolbar with various icons and a status bar displaying "SEPCVM10013".

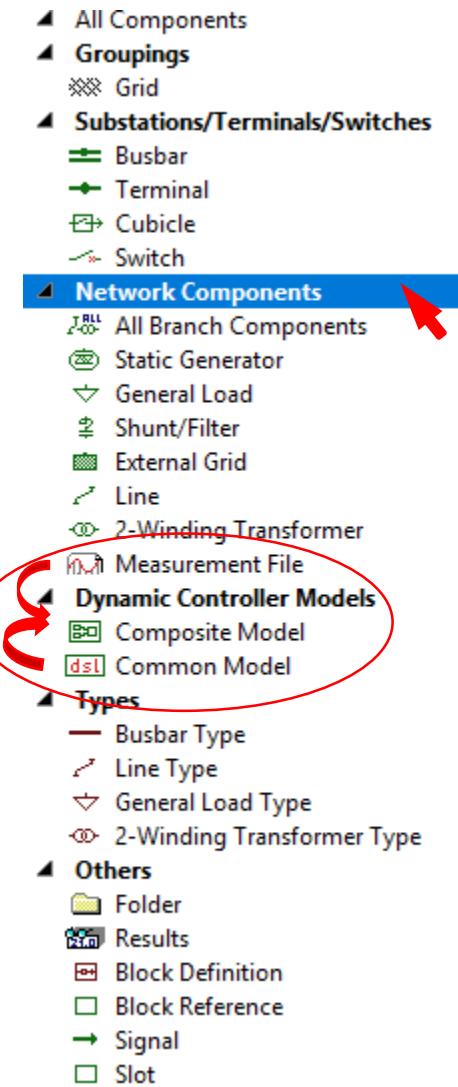
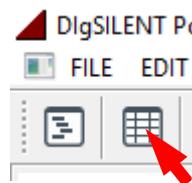
Building the dynamic model

- Now it is time to connect the user defined block models to the power grid model and its elements and the load- and PV profiles
- The profiles are to be extracted from an external system
- Then the connections between the data, block models and power grid elements are done in the Network Model Manager



Building the dynamic model

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- The dynamic model
- Building the dynamic model
- Measurement files
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Measurement file

- Text files containing all the consumption and production data
- For loss evaluation for a year typical data for certain periods can be aggregated and used to create a model over the whole year

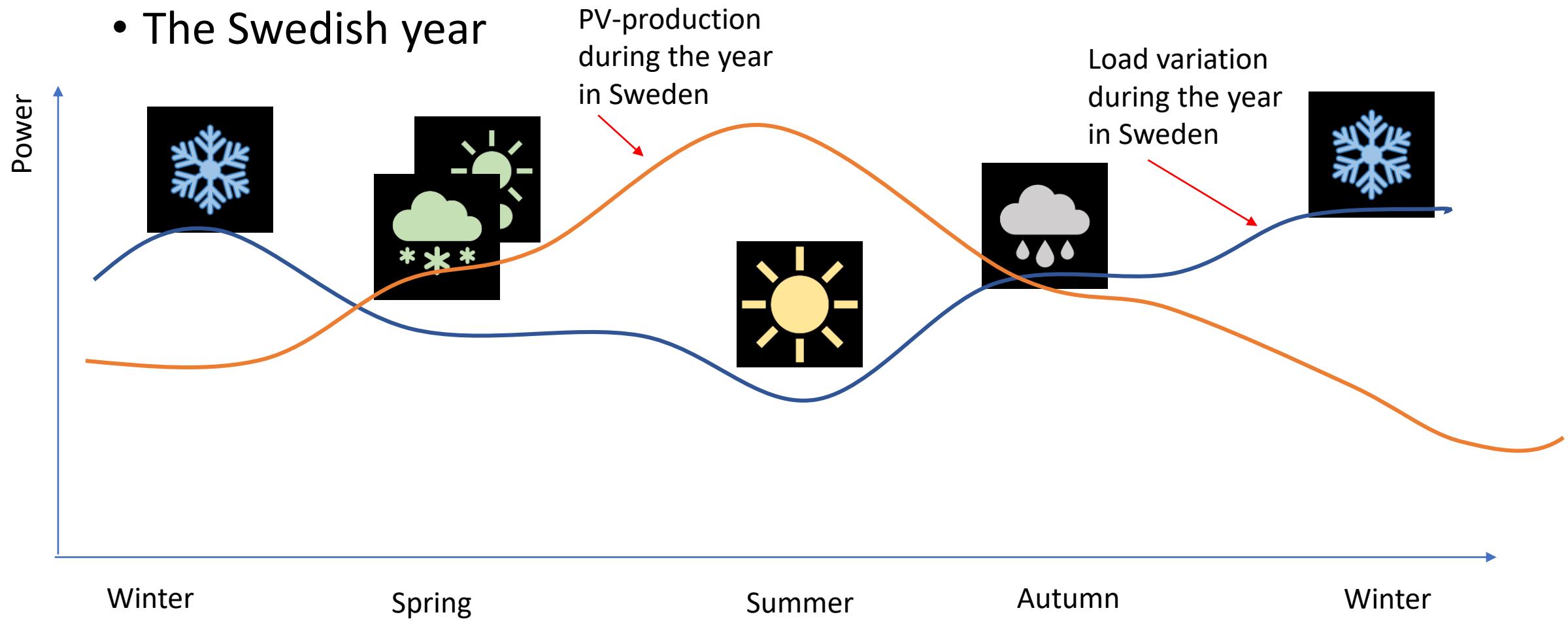
Time in
seconds

Consumption in MW

A1_high load - Anteckningar	
Arkiv	Redigera
Format	Visa
l	
0	0.54
3600	0.53
7200	0.54
10800	0.64
14400	0.63
18000	0.67
21600	0.77
25200	0.77
28800	0.72
32400	0.68
36000	0.66
39600	0.72
43200	0.65
46800	0.62
50400	0.64
54000	0.64
57600	0.73
61200	0.82
64800	0.83
68400	0.83
72000	0.80
75600	0.67
79200	0.61
82800	0.58
86400	0.54
90000	0.53
93600	0.54
97200	0.64
100800	0.63
104400	0.67
108000	0.77
111600	0.77
115200	0.72
118800	0.68
122400	0.66
126000	0.72

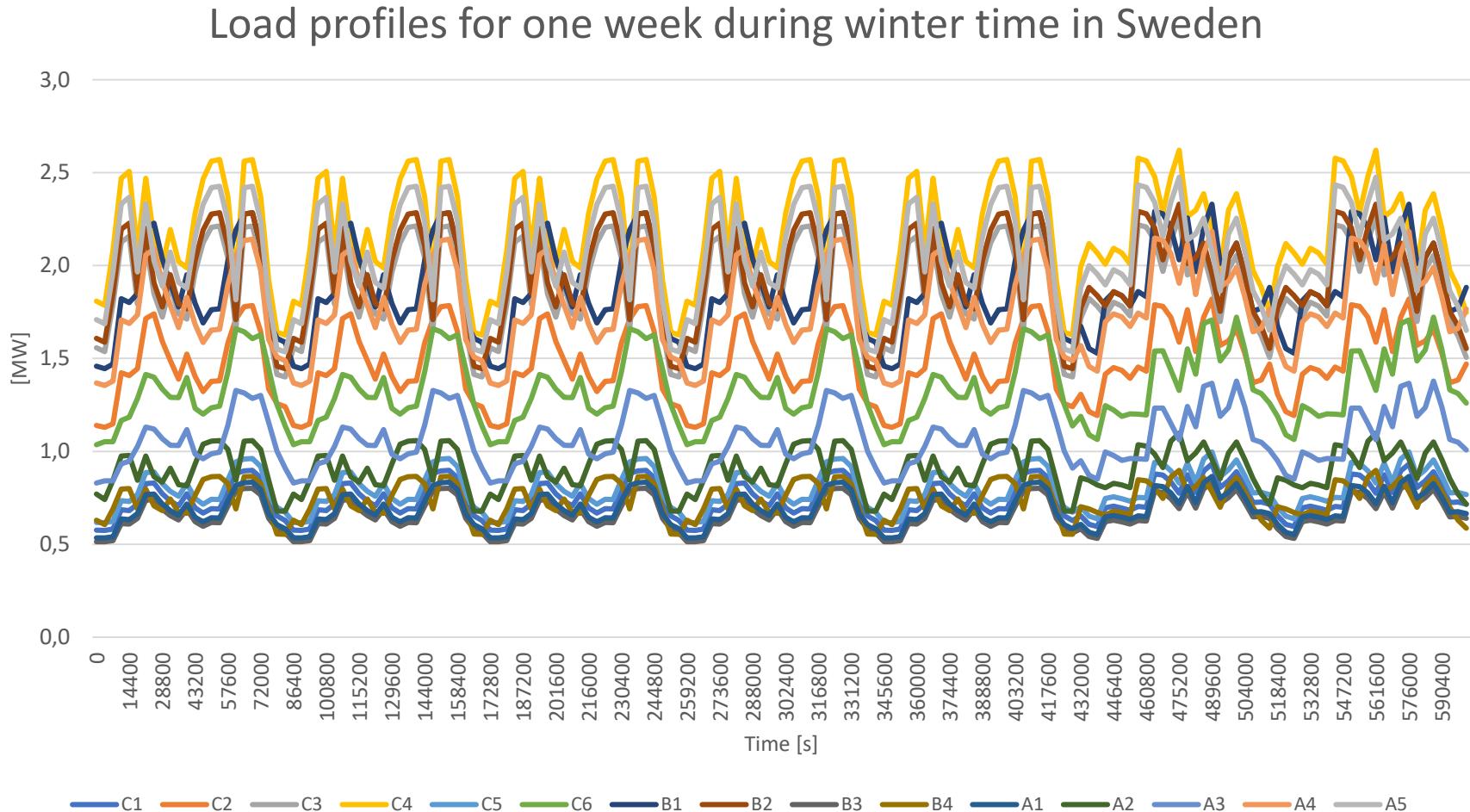
Measurement files

- The Swedish year



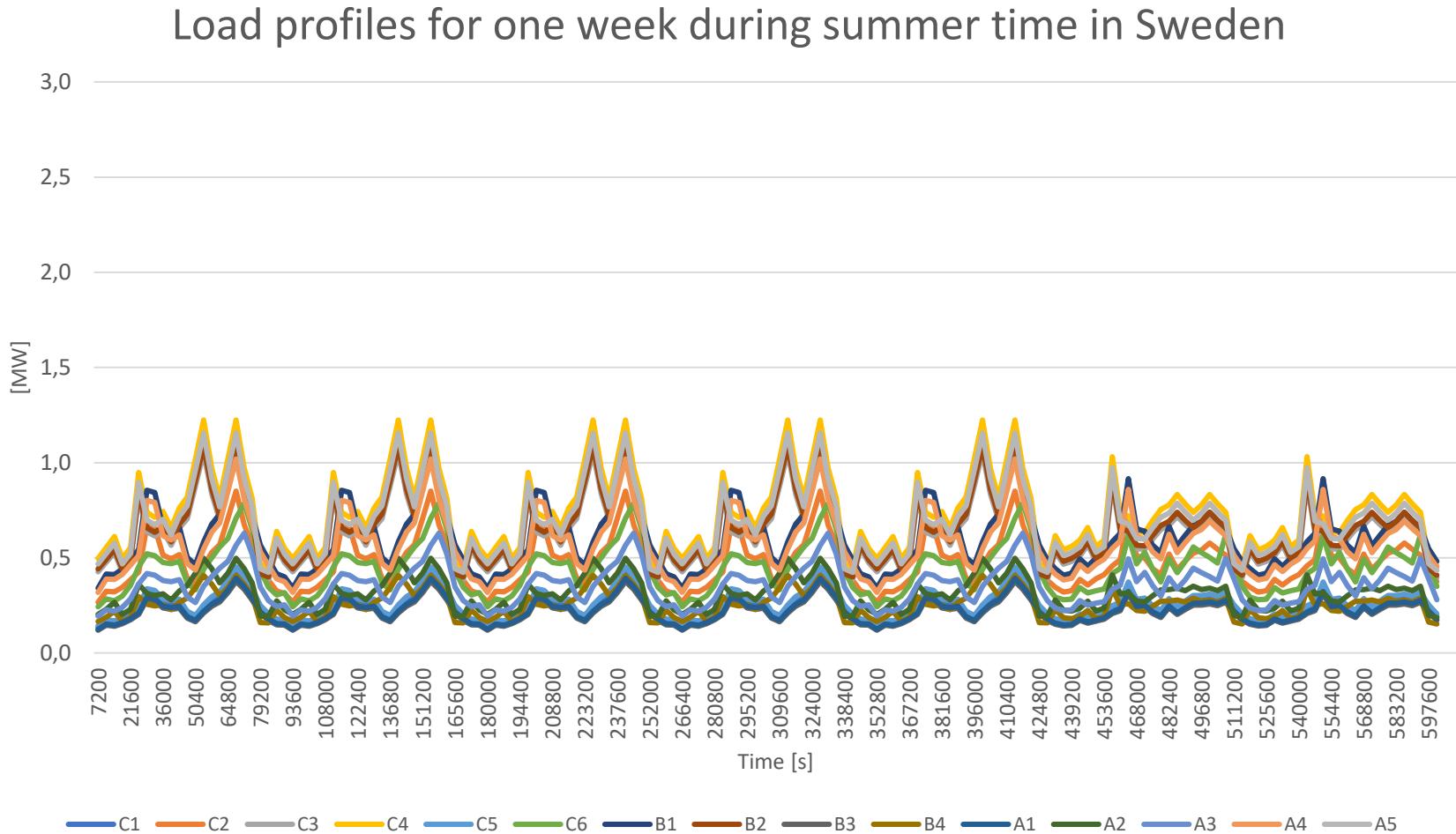
Load profiles

- Load usage data from sub station for each feeder
- Hourly data for one week
- Different profiles for summer, winter, spring and autumn



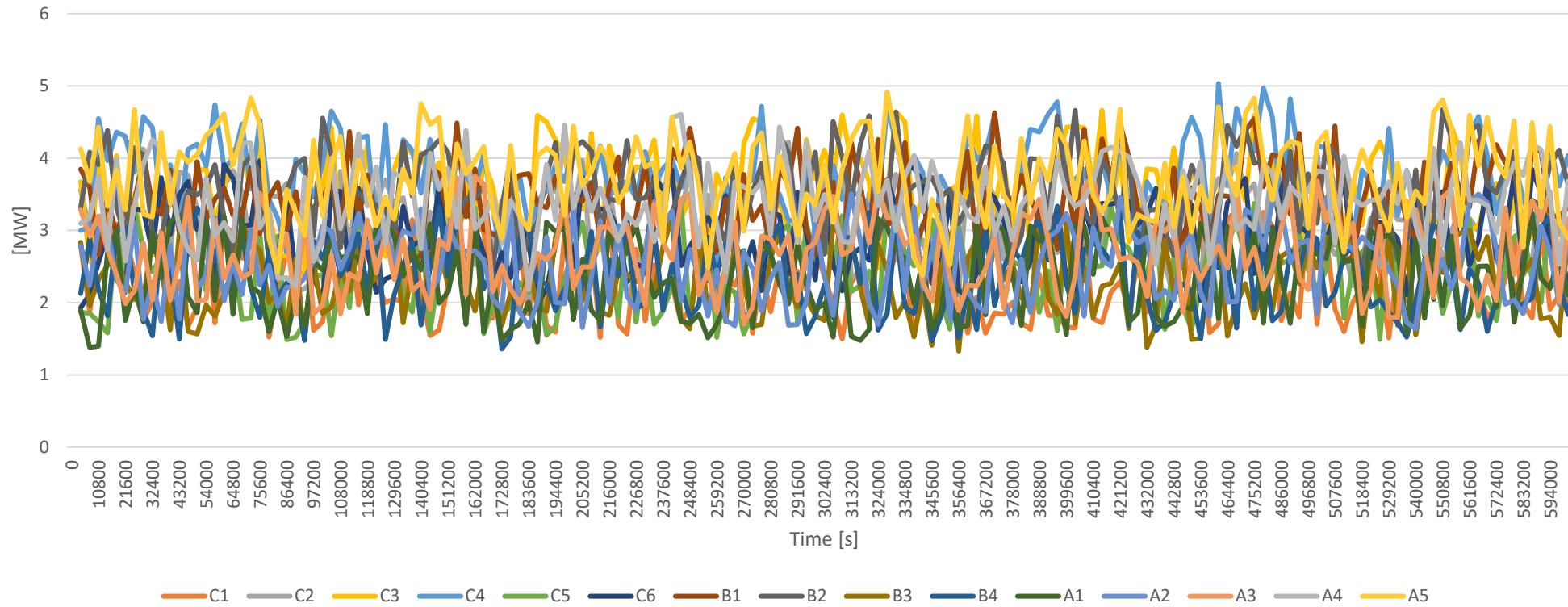
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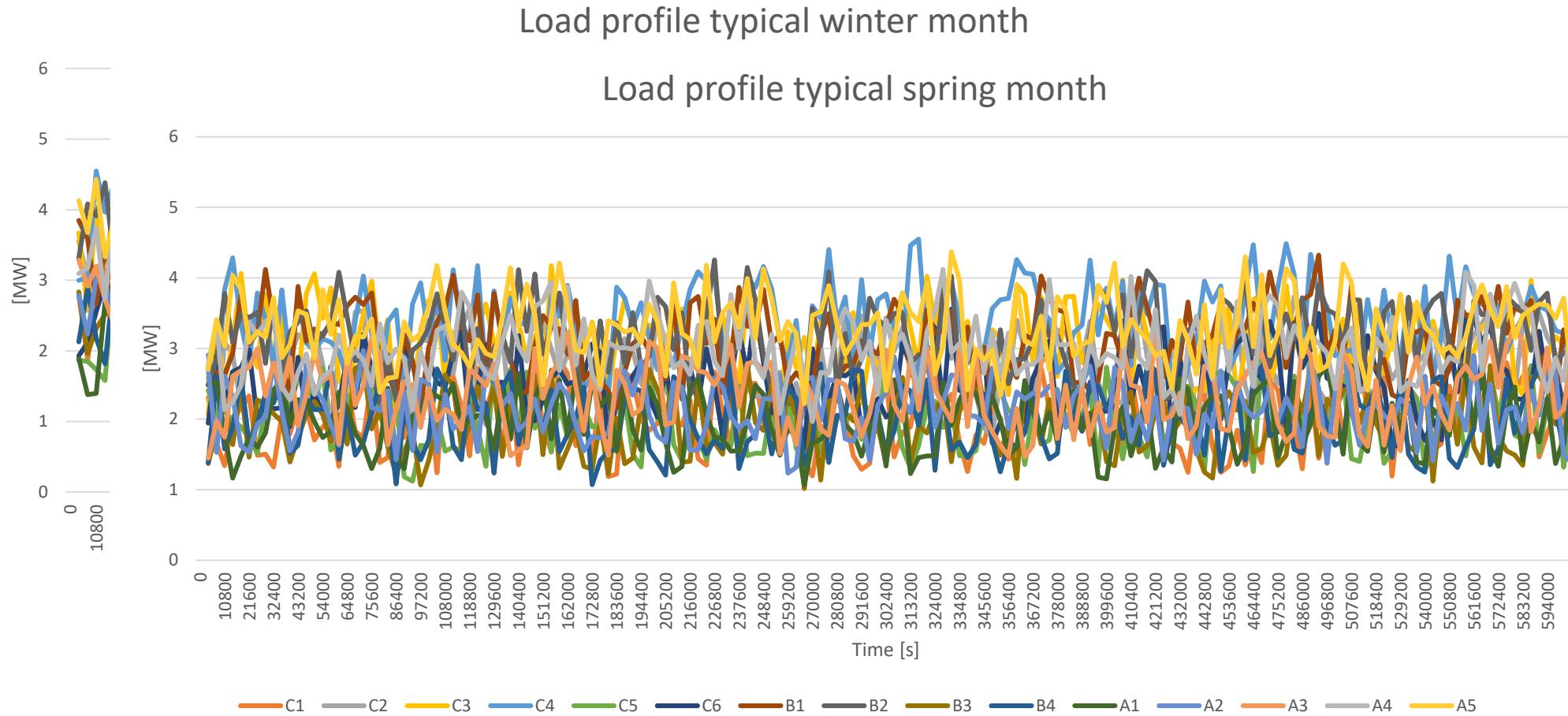


Load profiles-aggregated to a month for the different seasons

Load profile typical winter month

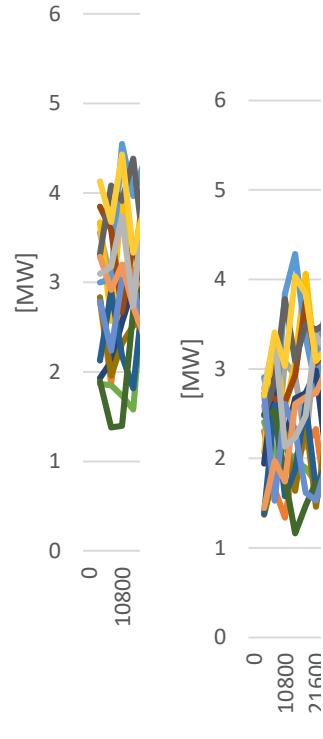


Load profiles-aggregated to a month for the different seasons

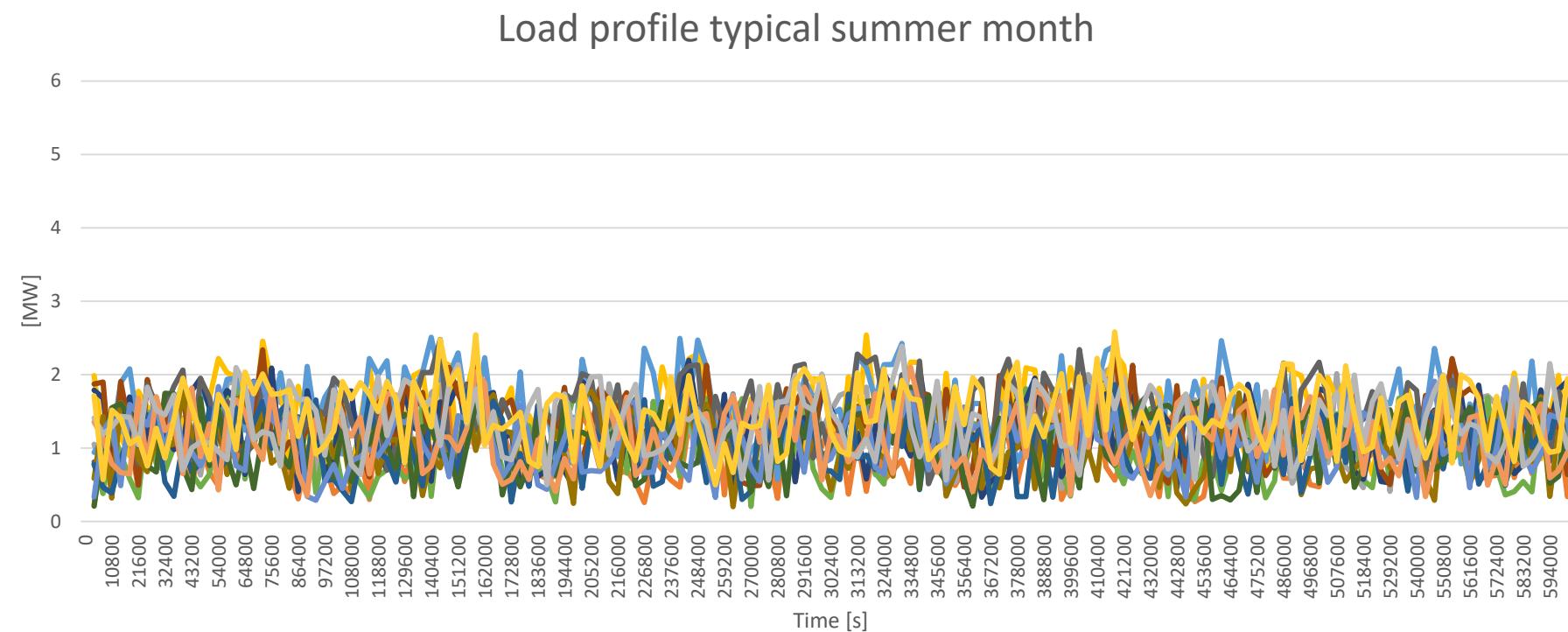


Load profiles-aggregated to a month for the different seasons

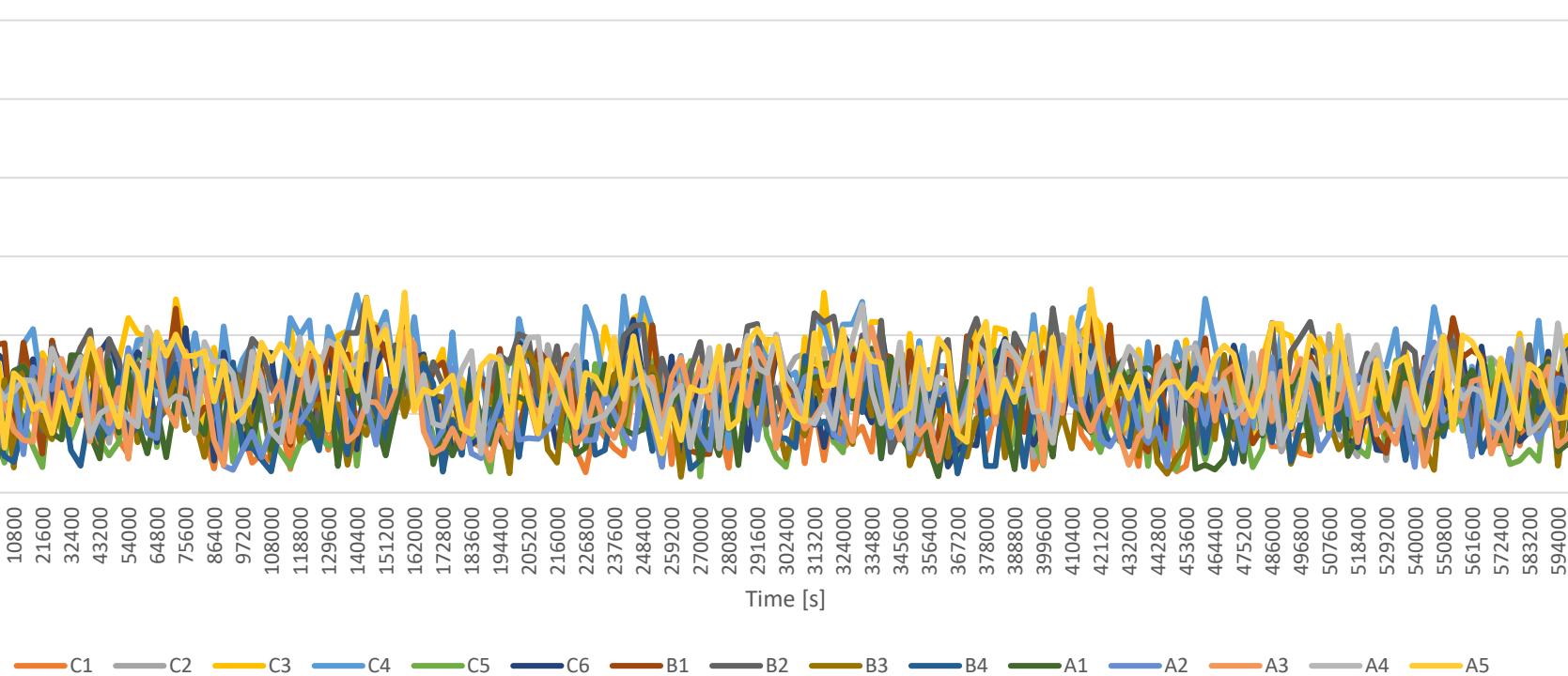
Load profile typical winter month



Load profile typical spring month

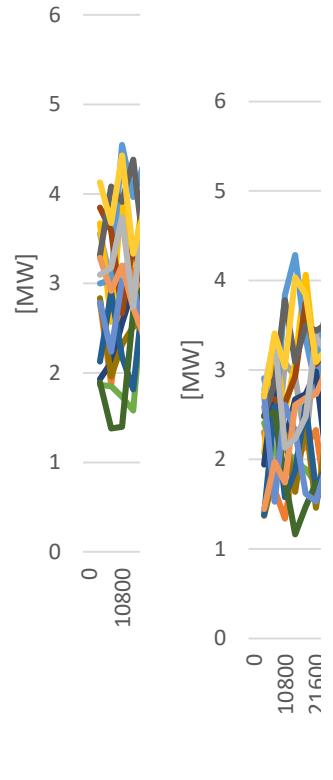


Load profile typical summer month

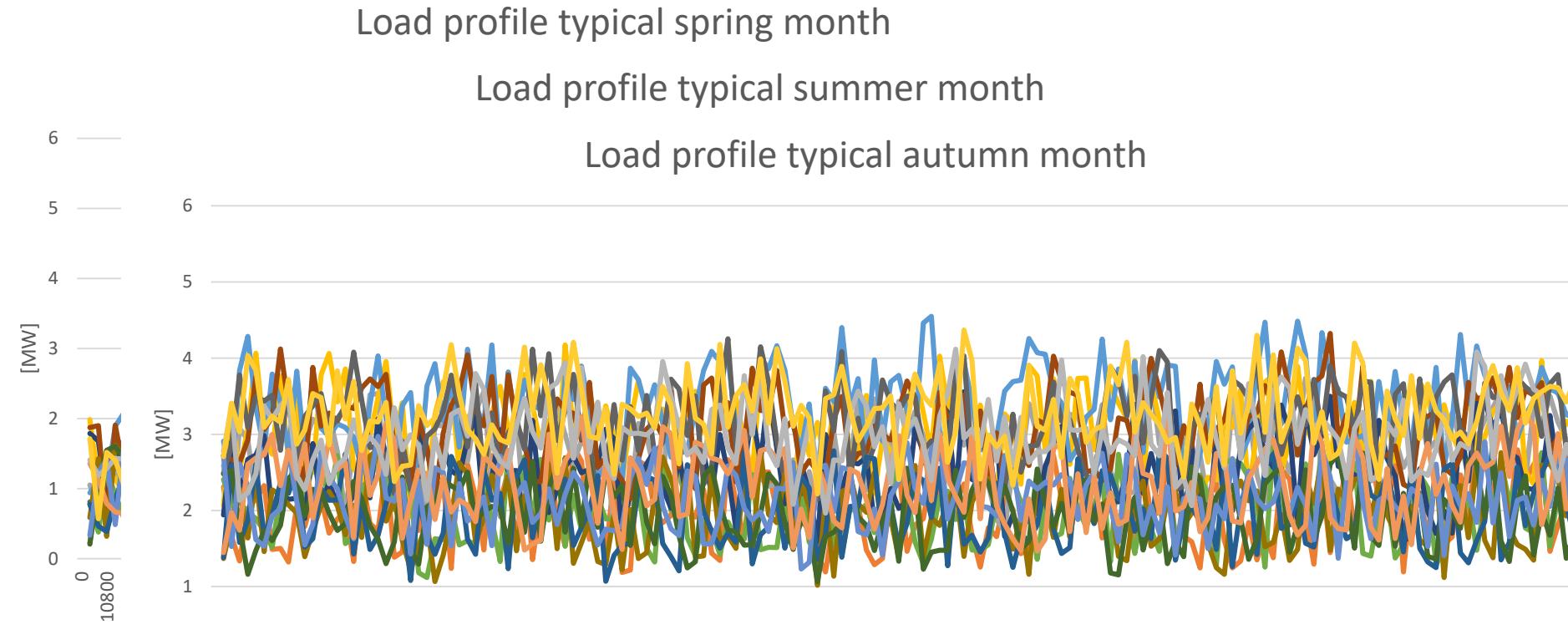


Load profiles-aggregated to a month for the different seasons

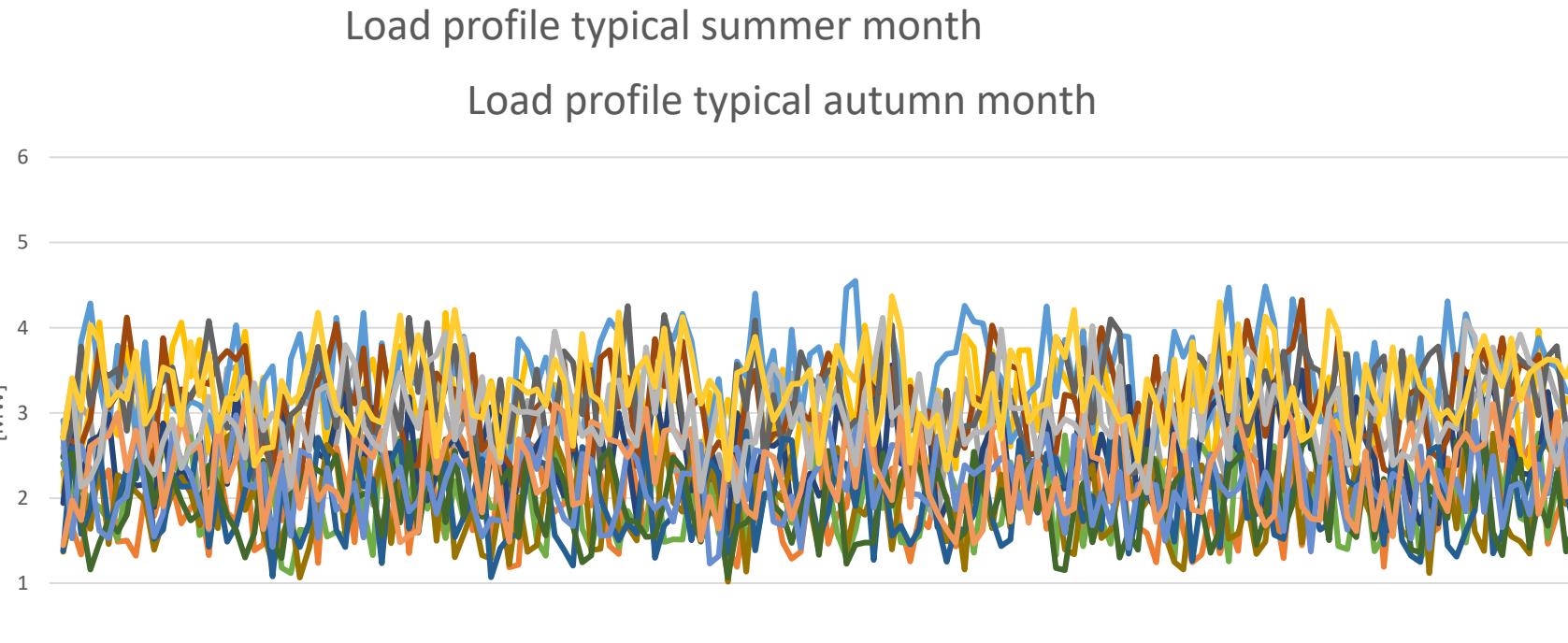
Load profile typical winter month



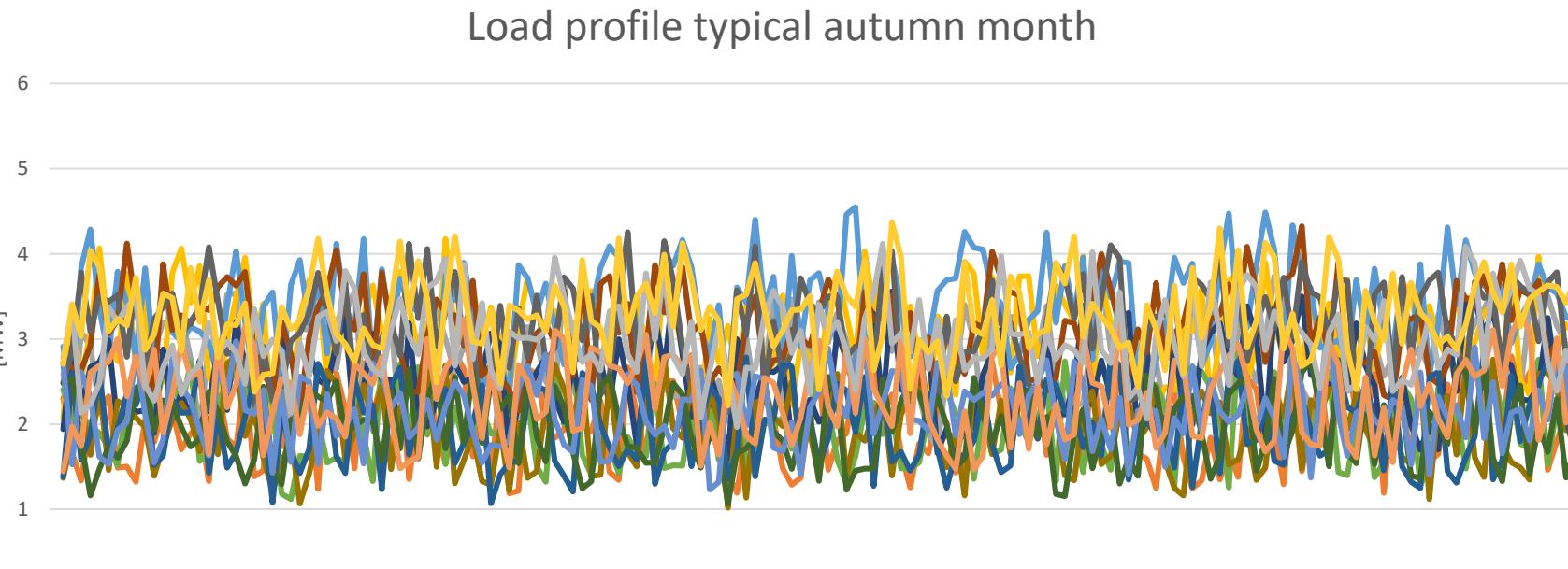
Load profile typical spring month



Load profile typical summer month

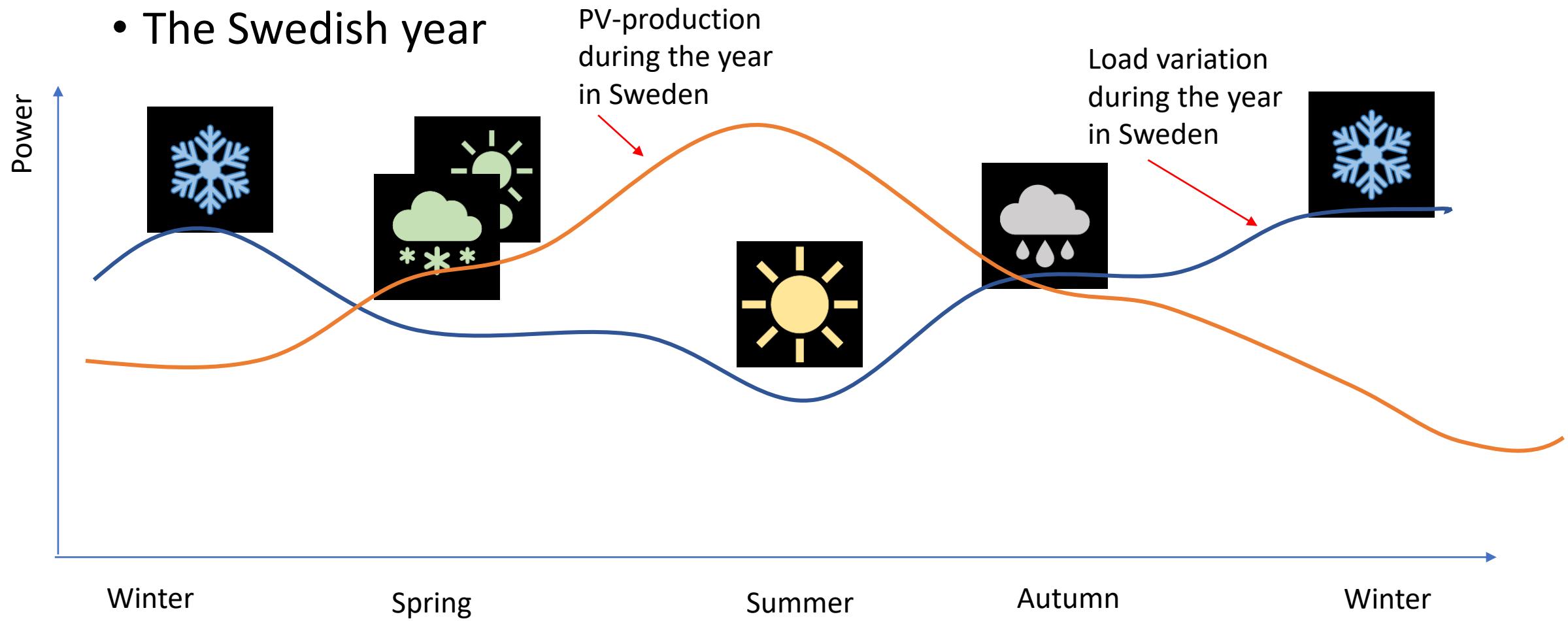


Load profile typical autumn month



Measurement files

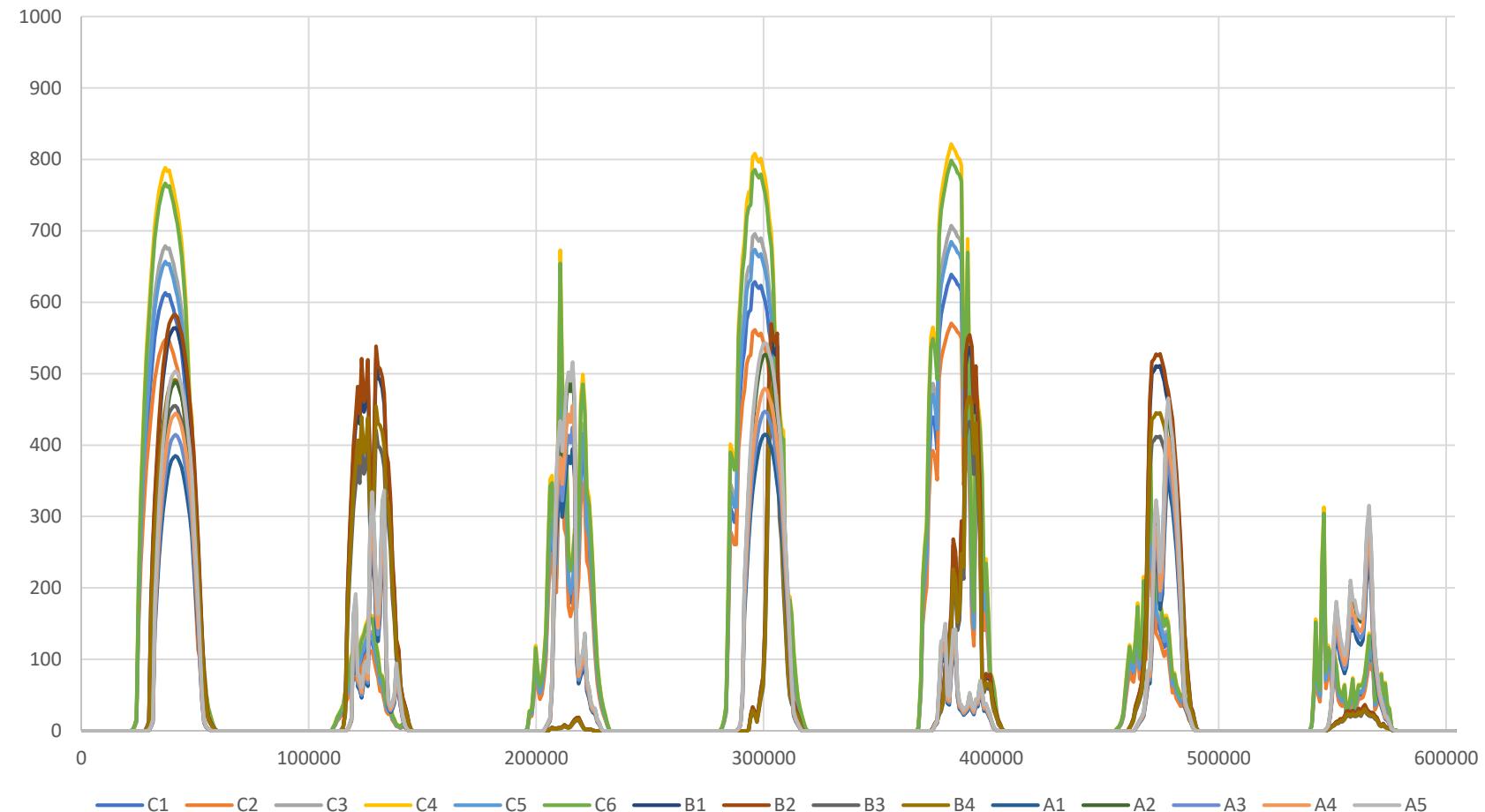
- The Swedish year



PV profiles

- PV production data from real PV system in Hova, Sweden
- Hourly data for one week aggregated for our customers in the three feeders in the study case
- Different profiles for summer, winter, spring and autumn

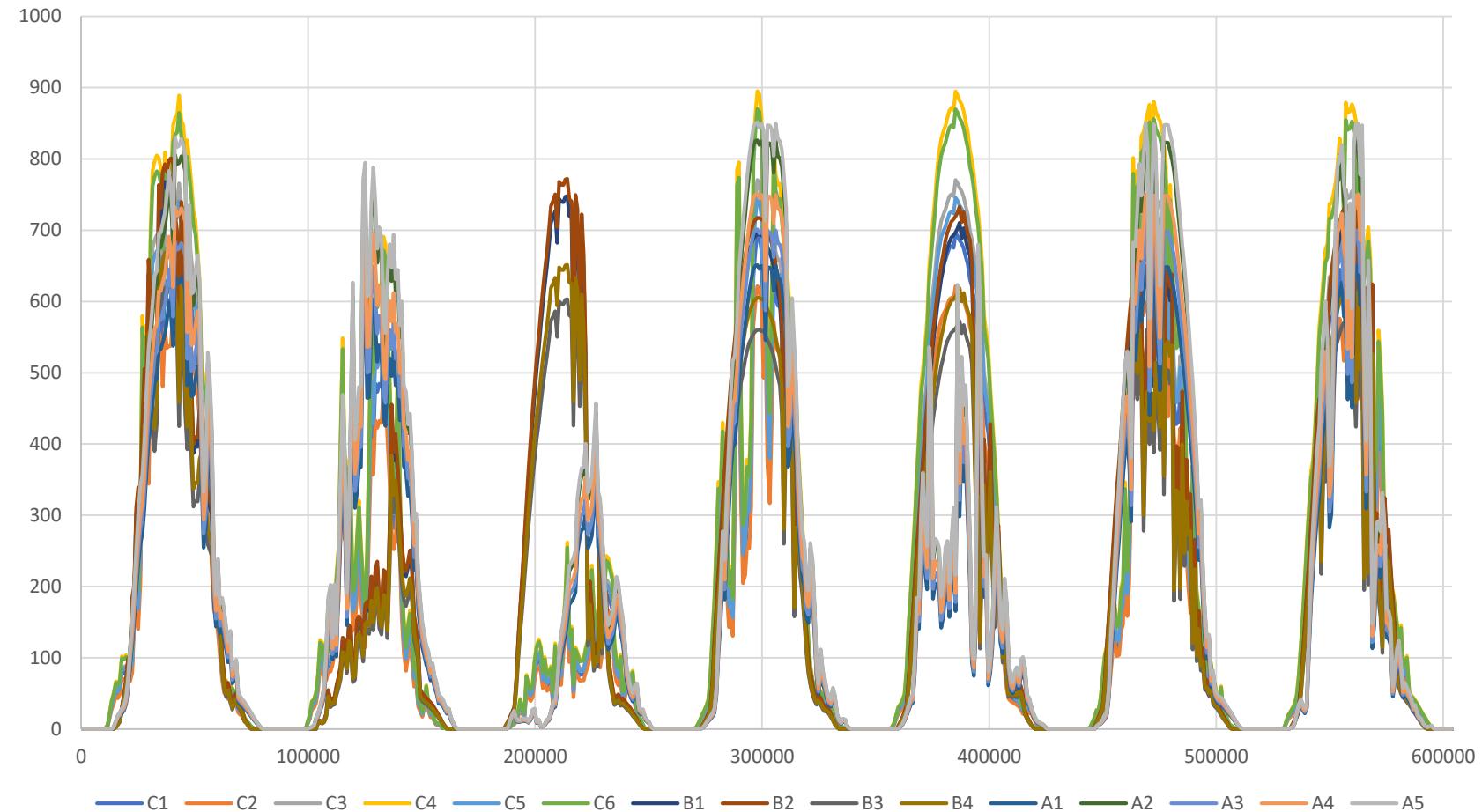
PV profiles for one week during winter time in Sweden



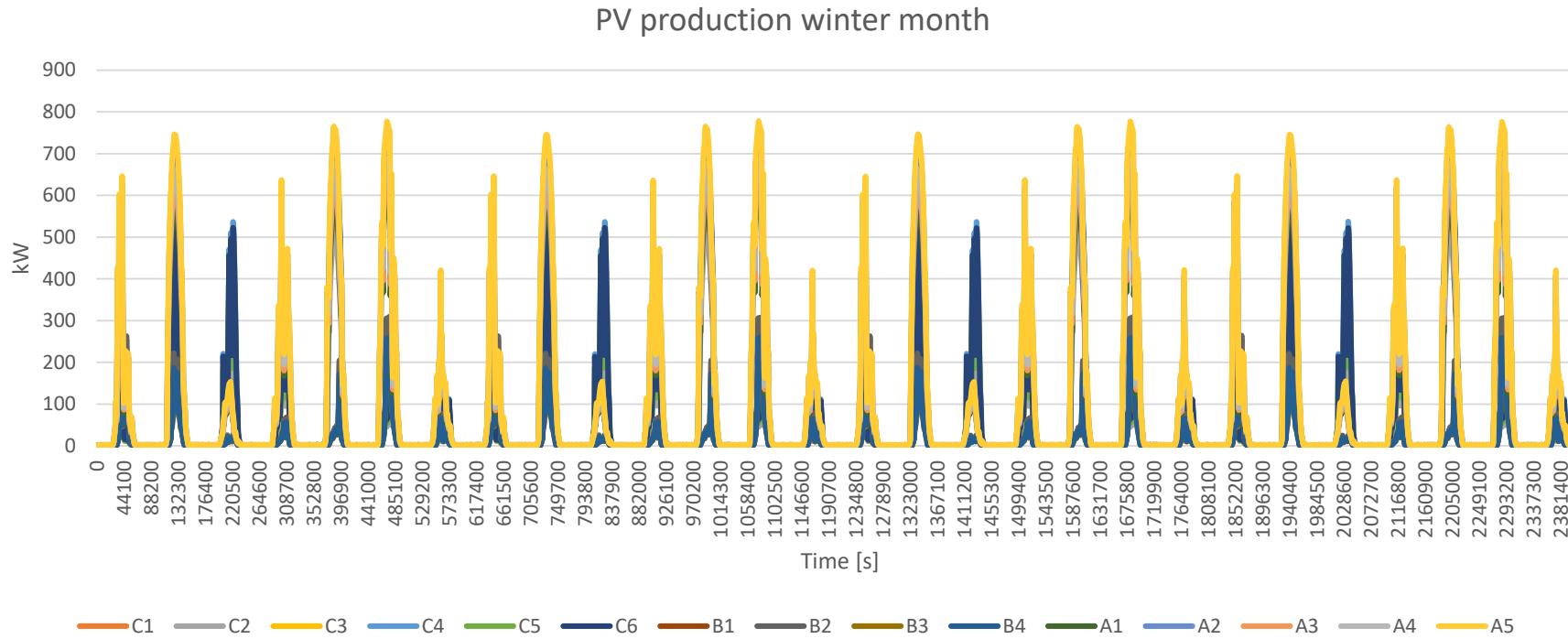
PV profiles

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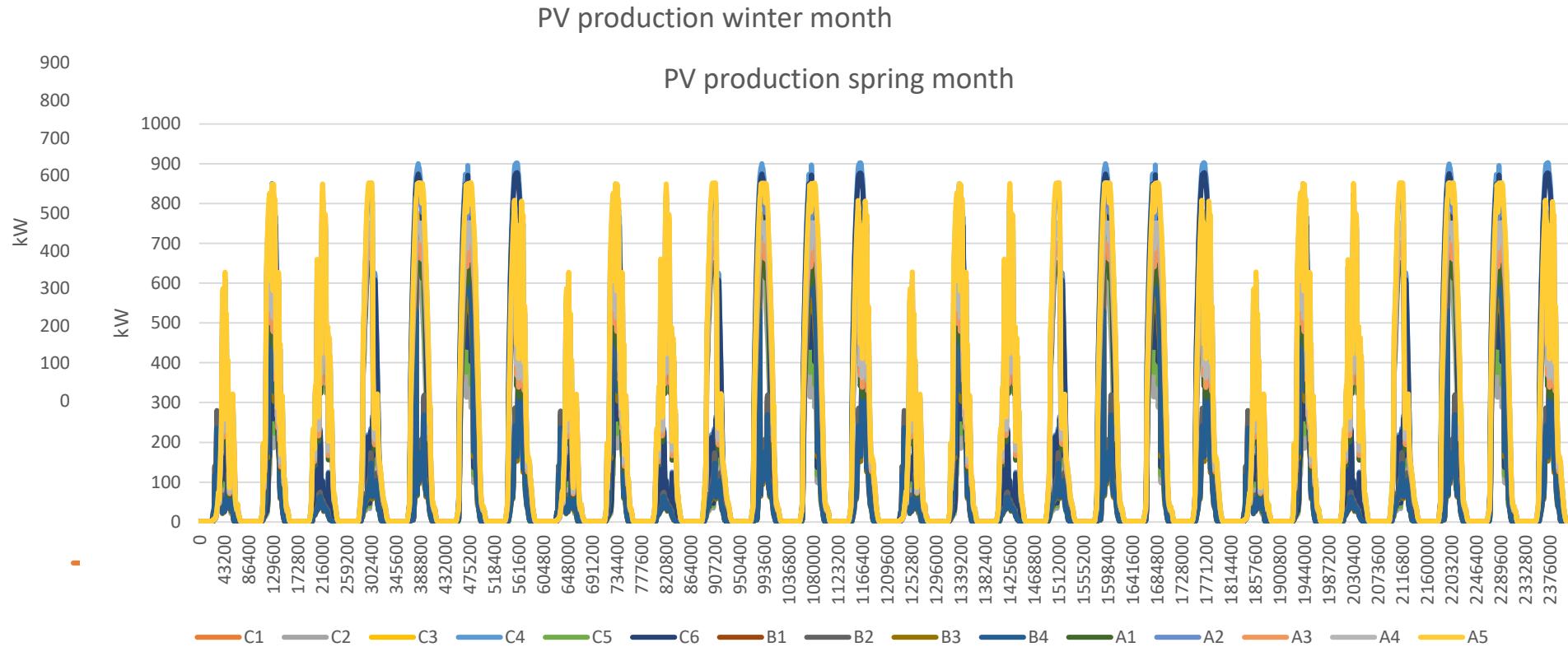
PV profiles for one week during summer time in Sweden



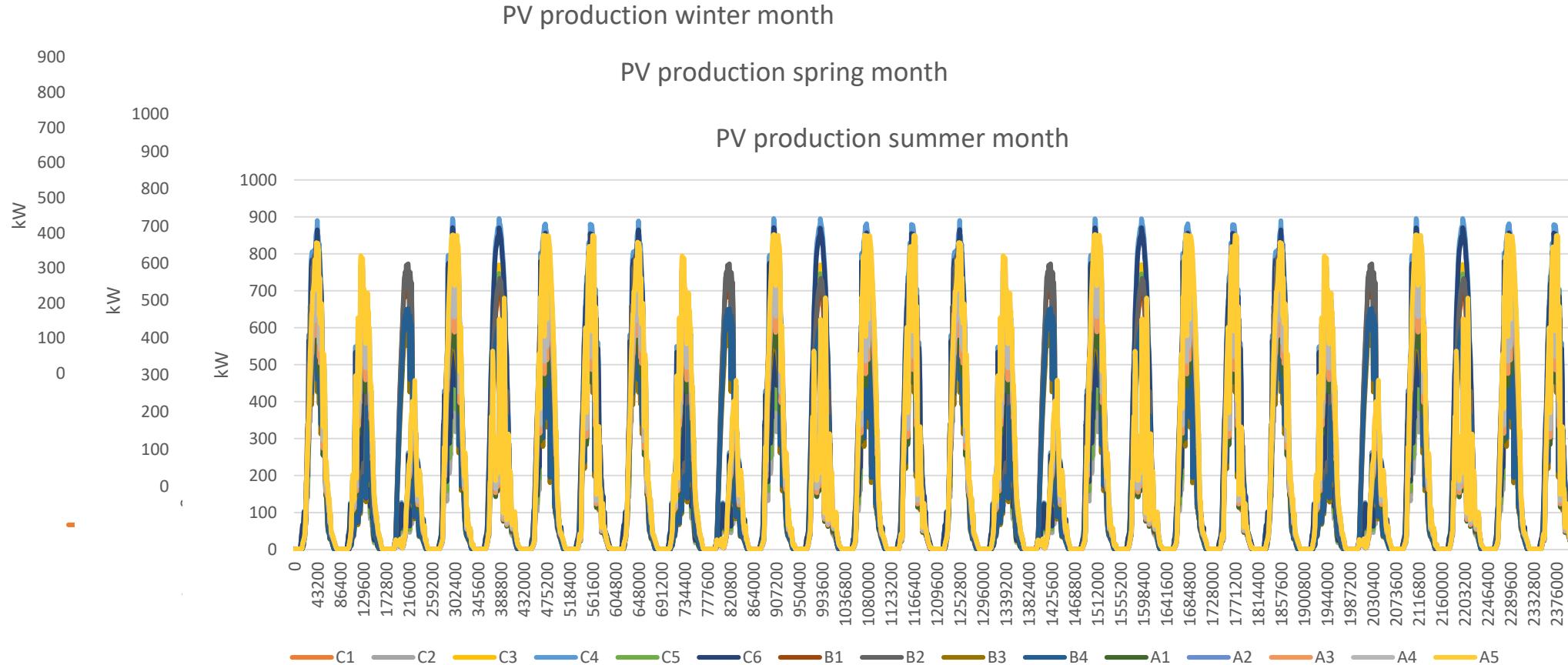
PV profiles-aggregated to a month for the different seasons



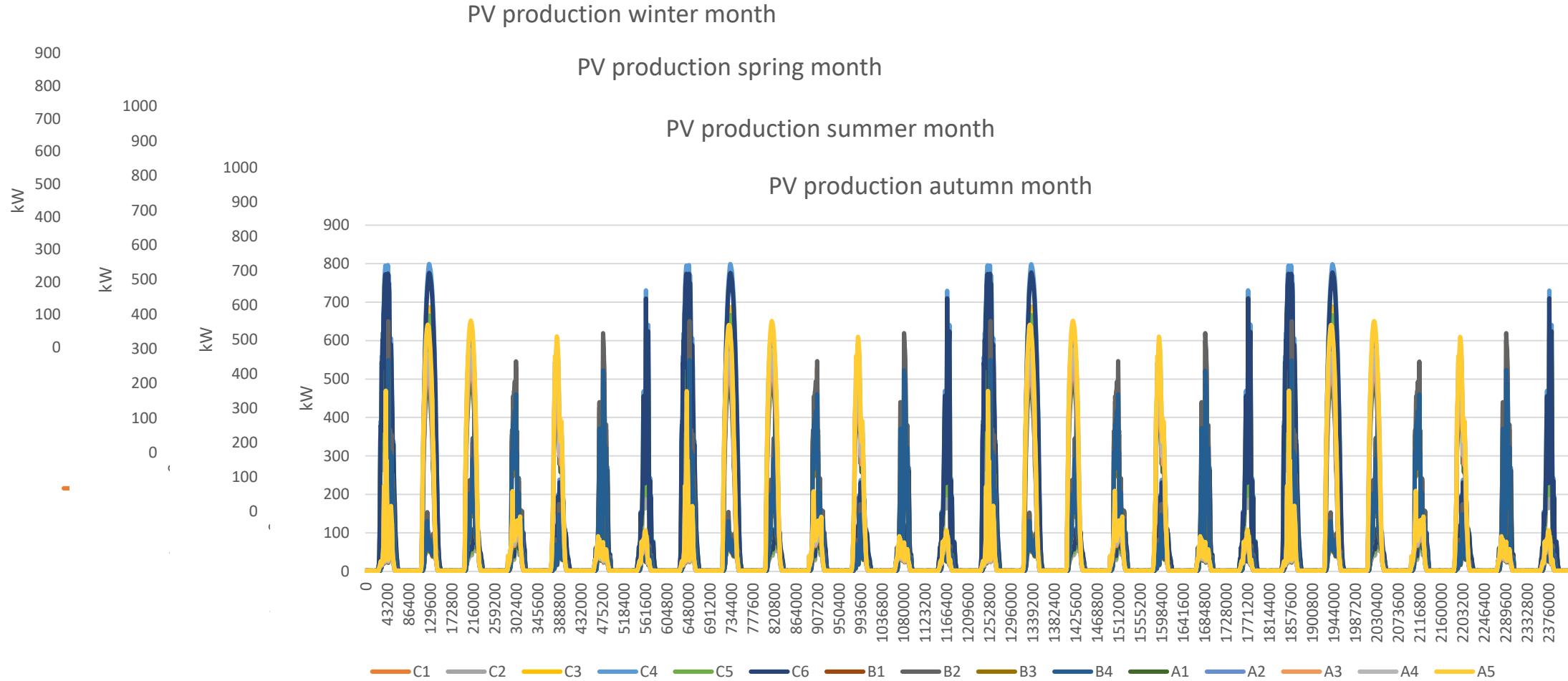
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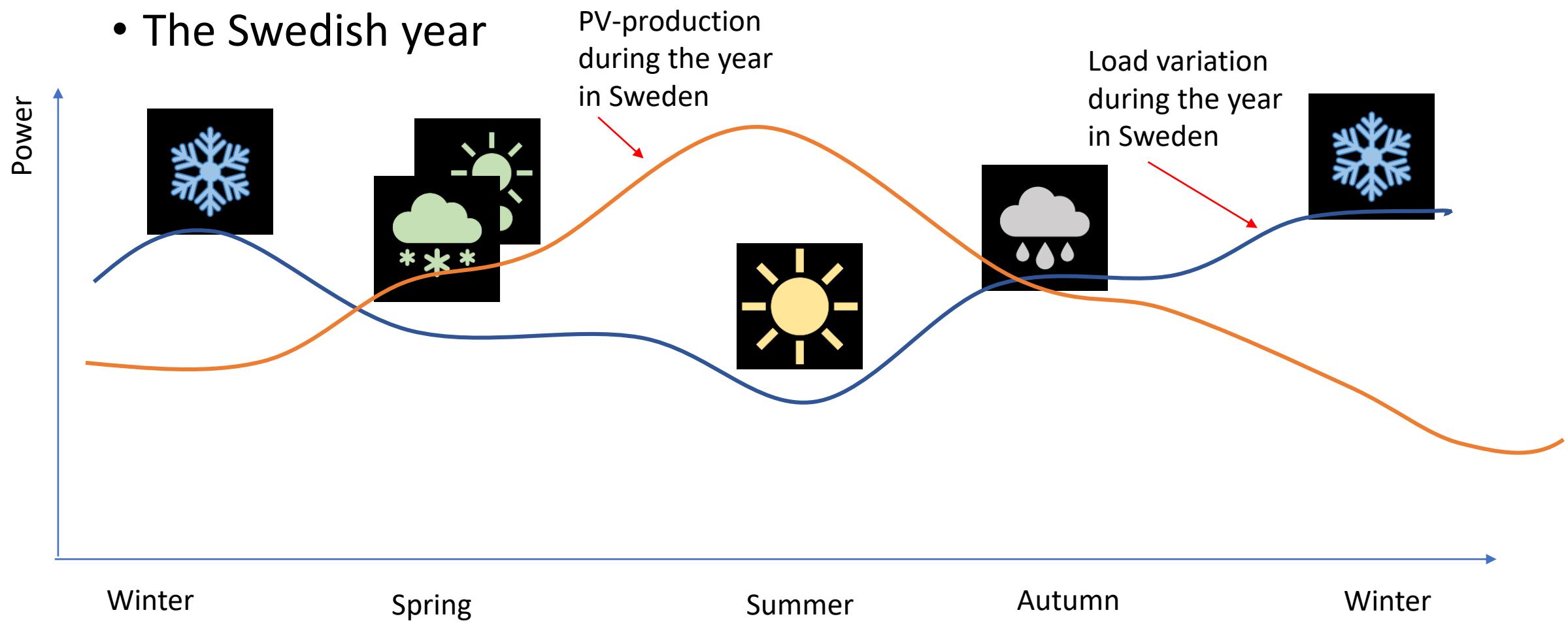


PV profiles-aggregated to a month for the different seasons

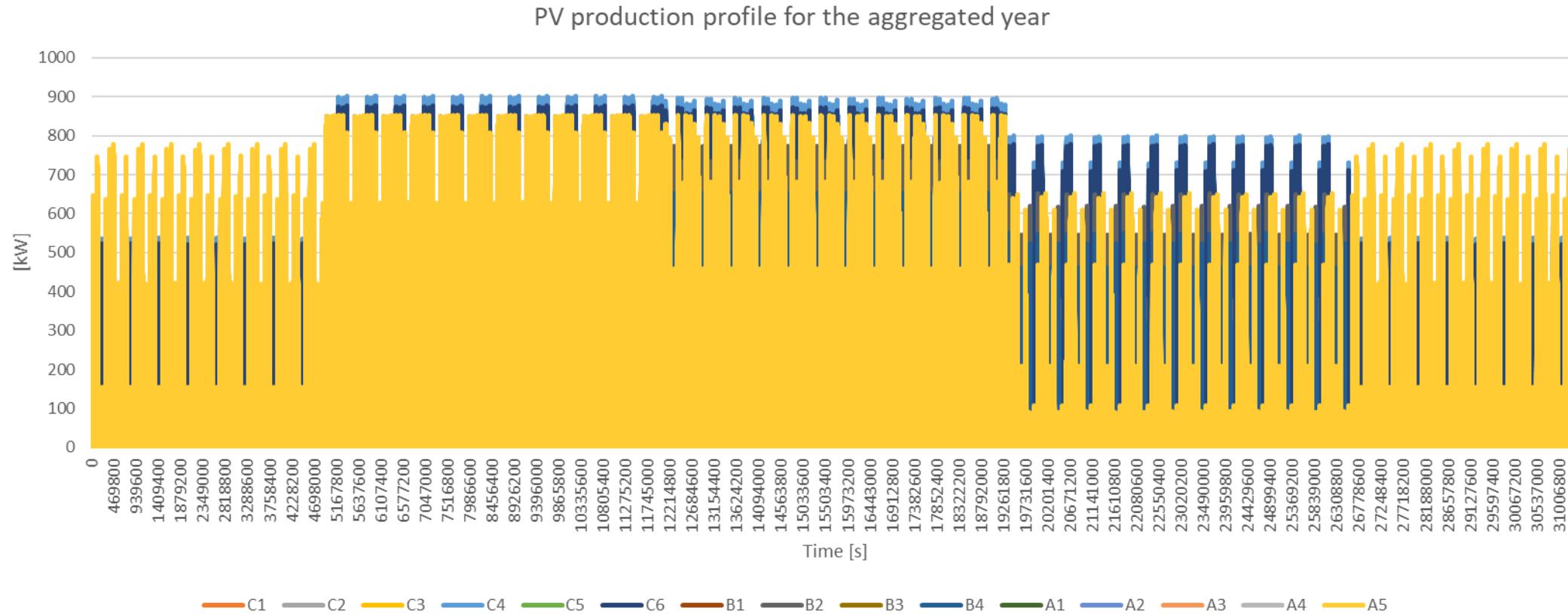


Measurement file

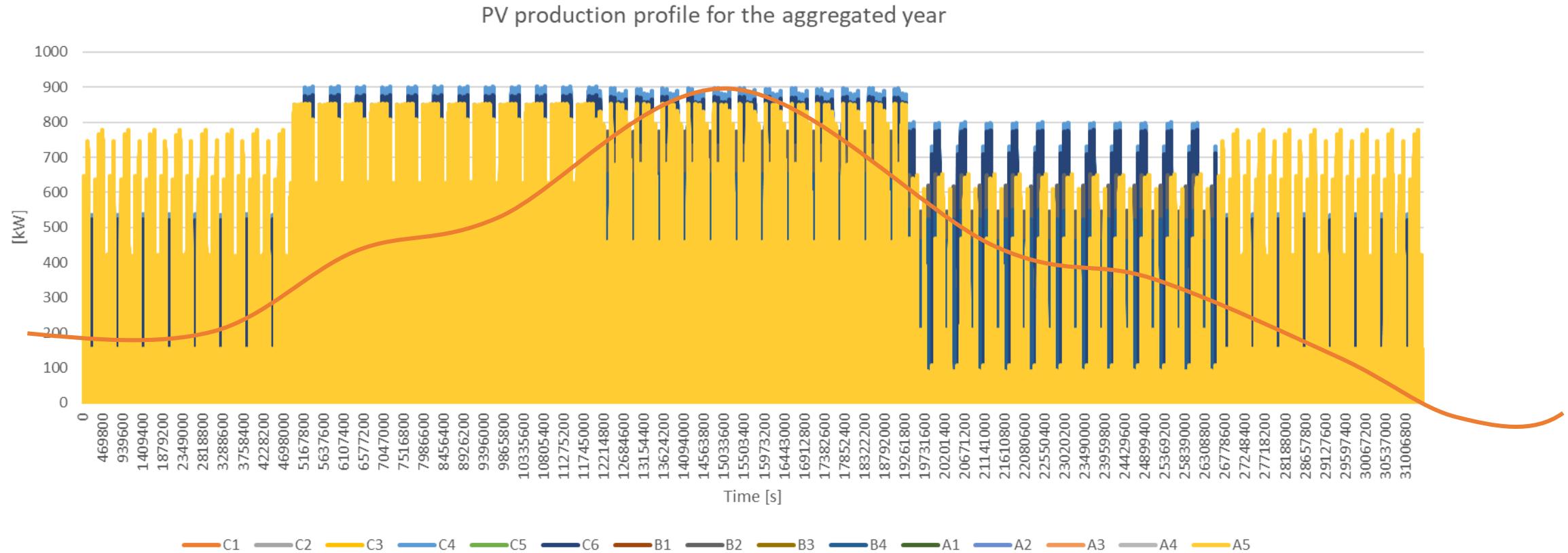
- The Swedish year



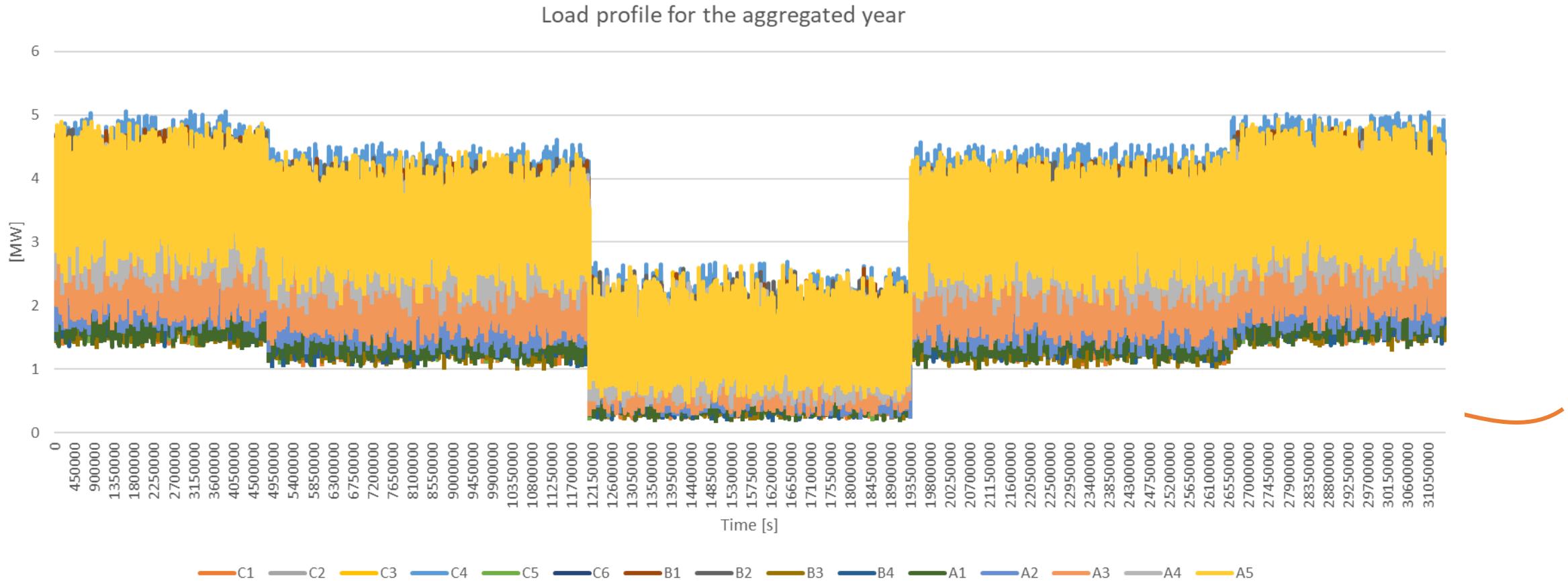
Measurement file – yearly profiles



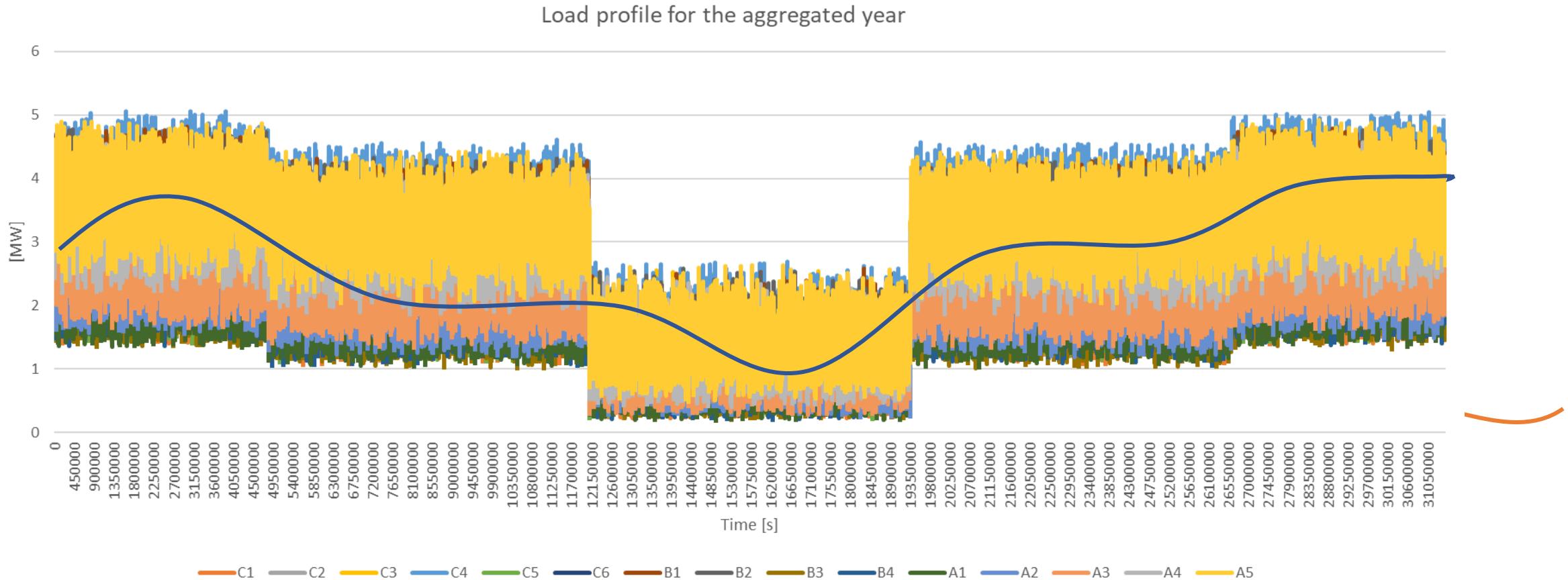
Measurement file – yearly profiles



Measurement file – yearly profiles



Measurement file – yearly profiles

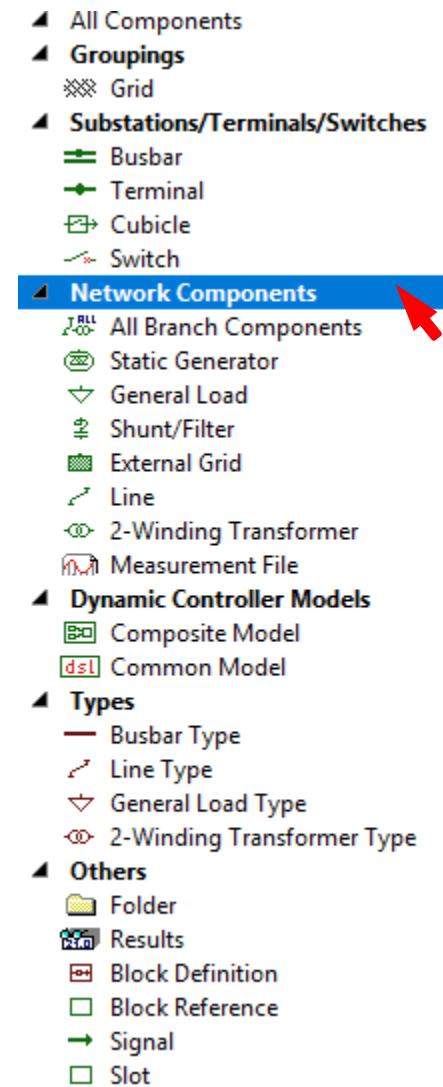
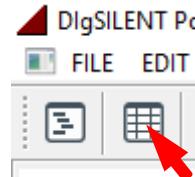


11 kV PF case - Dynamic loss evaluation

- The dynamic model
- Building the dynamic model
- Measurement files
- Building the dynamic model
- Running the simulation
- Results

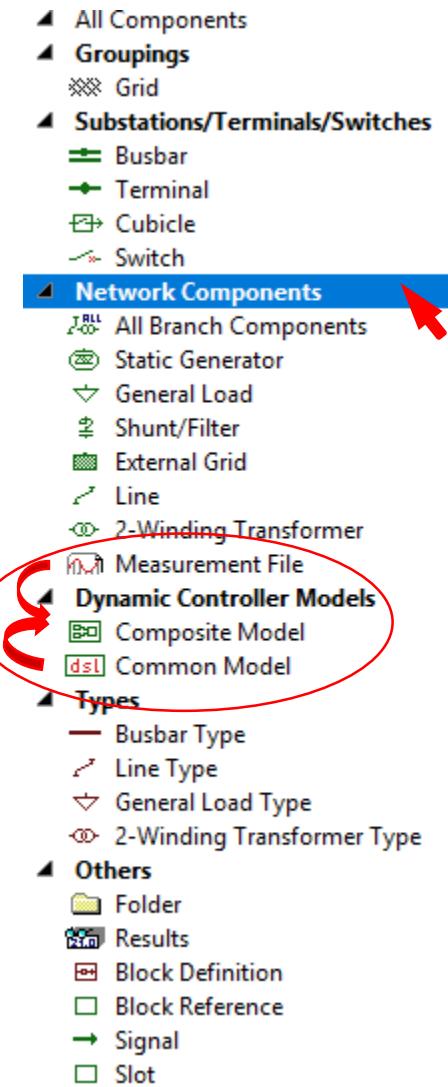
Building the dynamic model

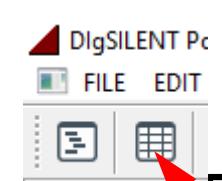
- Now its time to connect the load and PV profiles to the block models and the power grid model elements, using the Network Model Manager



Building the dynamic model

- Now its time to connect the load and PV profiles to the block models and the power grid model elements, using the Network Model Manager





Building the dynamic model

Network Model Manager: *.ElmComp						
Filter: -- None --						
	Name	Grid	Frame BlkDef	Out of Service	Slots BlkSlot	Net Elel Elm*, Sta*
	A1_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A1_yl ...
	A1low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A1_lowlo...
	A2_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A2_yl ...
	A2low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A2_lowlo...
	A3_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A3_yl ...
	A3low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A3_lowlo...
	A4_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A4_yl ...
	A4low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A4_lowlo...
	A5_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A5_yl ...
	A5low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A5_lowlo...
	B1_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B1_yl ...
	B1low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B1_lowlo...
	B2_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B2_yl ...
	B2low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B2_lowlo...
	B3_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B3_yl ...
	B3low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B3_lowlo...
	B4_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B4_yl ...
	B4low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B4_lowlo...
	C1_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C1_yl ...
	C1low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C1_lowlo...
	C2_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C2_yl ...
	C2low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C2_lowlo...
	C3_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C3_yl ...
	C3low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C3_lowlo...
	C4_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C4_yl ...
	C4low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C4_lowlo...
	C5_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C5_yl ...
	C5low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C5_lowlo...
	C6_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C6_yl ...
	C6low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C6_lowlo...
	PVA1_y	LV-Grid	Controllable PV	<input type="checkbox"/>	Load variation	PVA1y ...

The dynamic model - PV variation

Network Model Manager: *.ElmComp

Filter: -- None --

	Name	Grid	Frame BlkDef	Out of Service	Slots BlkSlot	Net Elr
▶	A1_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A1.
▶	A1low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A1.
▶	A2_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A2.
▶	A2low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A2.
▶	A3_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A3.
▶	A3low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A3.
▶	A4_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A4.
▶	A4low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A4.
▶	A5_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A5.
▶	A5low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A5.
▶	B1_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B1.
▶	B1low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B1.
▶	B2_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B2.
▶	B2low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B2.
▶	B3_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B3.
▶	B3low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B3.
▶	B4_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B4.
▶	B4low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B4.
▶	C1_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C1.
▶	C1low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C1.
▶	C2_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C2.
▶	C2low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C2.
▶	C3_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C3.
▶	C3low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C3.
▶	C4_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C4.
▶	C4low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C4.
▶	C5_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C5.
▶	C5low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C5.
▶	C6_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C6.
▶	C6low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C6.
▶	PVA1_y	LV-Grid	Controllable PV	<input checked="" type="checkbox"/>	Load variation	PV.
▶	PVA1high	LV-Grid	Controllable PV	<input type="checkbox"/>	Load variation	PV.
▶	PVA2_y	LV-Grid	Controllable PV	<input type="checkbox"/>	Load variation	PV.

The dynamic model - PV variation

Network Model Manager: *.ElmComp

Filter: -- None --

	Name	Grid	Frame BlkDef	Out of Service	Slots BlkSlot	Net Elr
▶	A1_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A1.
▶	A1low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A1.
▶	A2_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A2.
▶	A2low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A2.
▶	A3_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A3.
▶	A3low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A3.
▶	A4_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A4.
▶	A4low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A4.
▶	A5_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A5.
▶	A5low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A5.
▶	B1_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B1.
▶	B1low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B1.
▶	B2_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B2.
▶	B2low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B2.
▶	B3_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B3.
▶	B3low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B3.
▶	B4_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B4.
▶	B4low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	B4.
▶	C1_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C1.
▶	C1low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C1.
▶	C2_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C2.
▶	C2low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C2.
▶	C3_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C3.
▶	C3low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C3.
▶	C4_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C4.
▶	C4low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C4.
▶	C5_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C5.
▶	C5low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C5.
▶	C6_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C6.
▶	C6low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	C6.
▶	PVA1_y	LV-Grid	Controllable PV	<input type="checkbox"/>	Load variation	PV.
▶	PVA1high	LV-Grid	Controllable PV	<input checked="" type="checkbox"/>	Load variation	PV.
▶	PVA2_y	LV-Grid	Controllable PV	<input type="checkbox"/>	Load variation	PV.

The dynamic model - PV variation

Network Model Manager: *.ElmComp

Filter: -- None --

All Components Groupings Grid Substation Busbar Terminal Cubic Switch Network All Branches Static Gener Shunt External Line 2-Wire Measurement Dynamic Components Communication Model (*.ElmComp) Types Busbar Line Terminal General 2-Wire Others Folder Result Block Block Signal Slot

Composite Model - LV-Grid\PVA1_y.ElmComp

Basic Data Name PVA1_y Frame User Defined Models\Controllable PV OK Cancel Out of Service

Slot Definition:

	Slots BlkSlot	Net Elements Elm*,Sta*,IntRef
1 Load variation	PVA1y	
2 PV	PV A1	
3 Scale	PVA1 Scale	

Slot Update Step Response Test

Relevant measurement file

Intended PV system

Scaling factor

IPVAT_y LV-Grid Controllable PV Load variation PV
PVA1high LV-Grid Controllable PV Load variation PV
PVA2_y LV-Grid Controllable PV Load variation PV

The dynamic model – load variation

	Name	Grid	Frame BlkDef	Out of Service	Slots BlkSlot	Net Elements Elm*,Sta*,IntRef
*	A1_yl	LV-Grid	Controllable Load	<input checked="" type="checkbox"/>	Load variation	A1_yl ...
	A1low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A1_lowload ...
	A2_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A2_yl ...
	A2low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A2_lowload ...
	A3_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A3_yl ...
	A3low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A3_lowload ...
	A4_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A4_yl ...
	A4low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A4_lowload ...
	A5_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A5_yl ...
	A5low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A5_lowload ...
	B1_yl	Composite Model - LV-Grid\A1_yl.ElmComp *				
	B1low					
	B2_yl					
	B2low					
	B3_yl					
	B3low					
	B4_yl					
	B4low					
	C1_yl					
	C1low					
	C2_yl					
	C2low					
	C3_yl					
	C3low					
	C4_yl					
	C4low					
	C5_yl					
	C5low					
	C6_yl					
	C6low					
	PVA1_y					
	PVA1hi					
	PVA2_y					
	PVA2hi					
	DVAR2_y	LV-Grid	Controllable DVM	<input type="checkbox"/>	Load variation	DVAR2_y

Composite Model - LV-Grid\A1_yl.ElmComp *

Basic Data

Name: A1_yl

Description: ...efined Models\Controllable Load

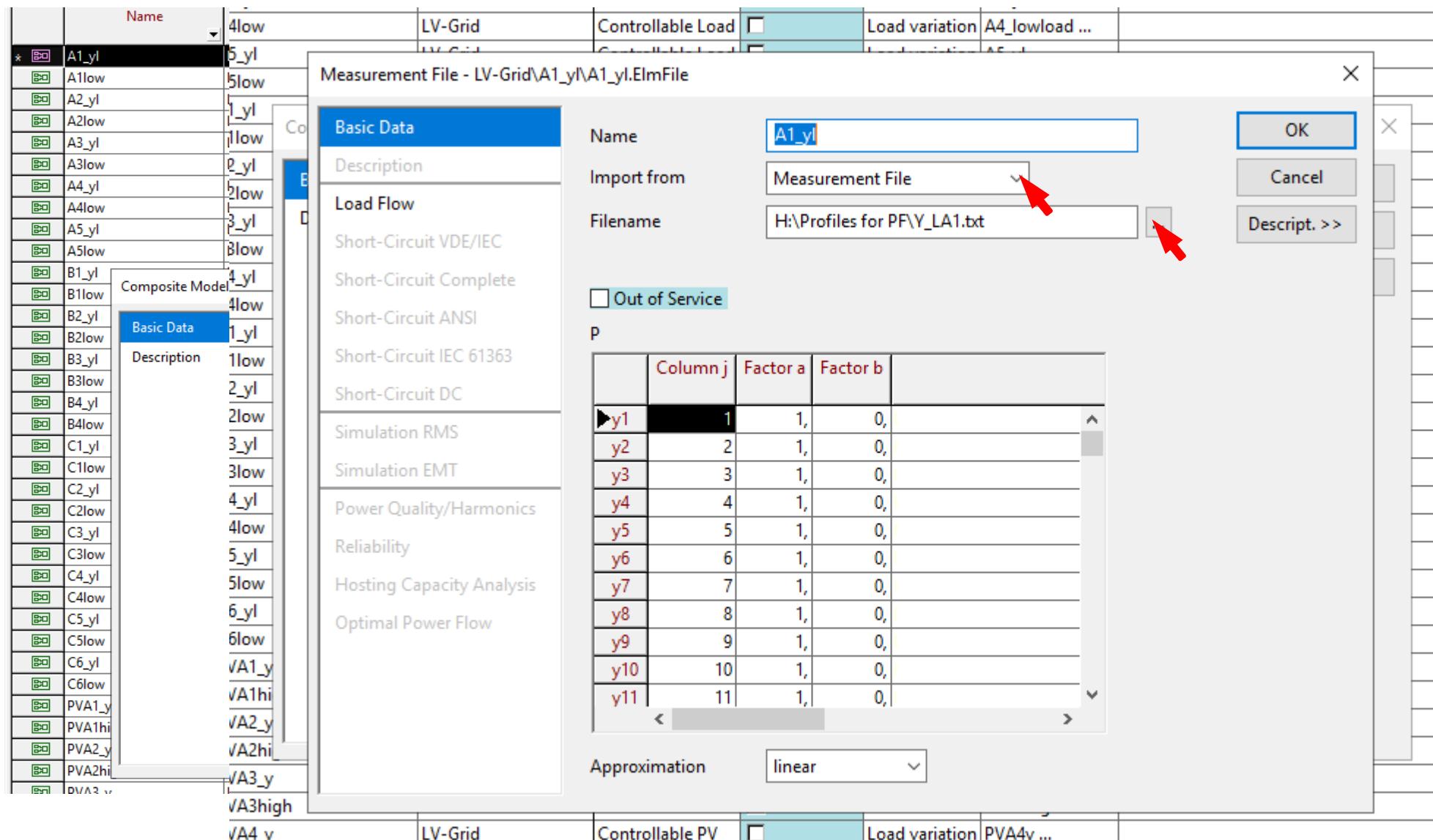
Out of Service

Slot Definition:

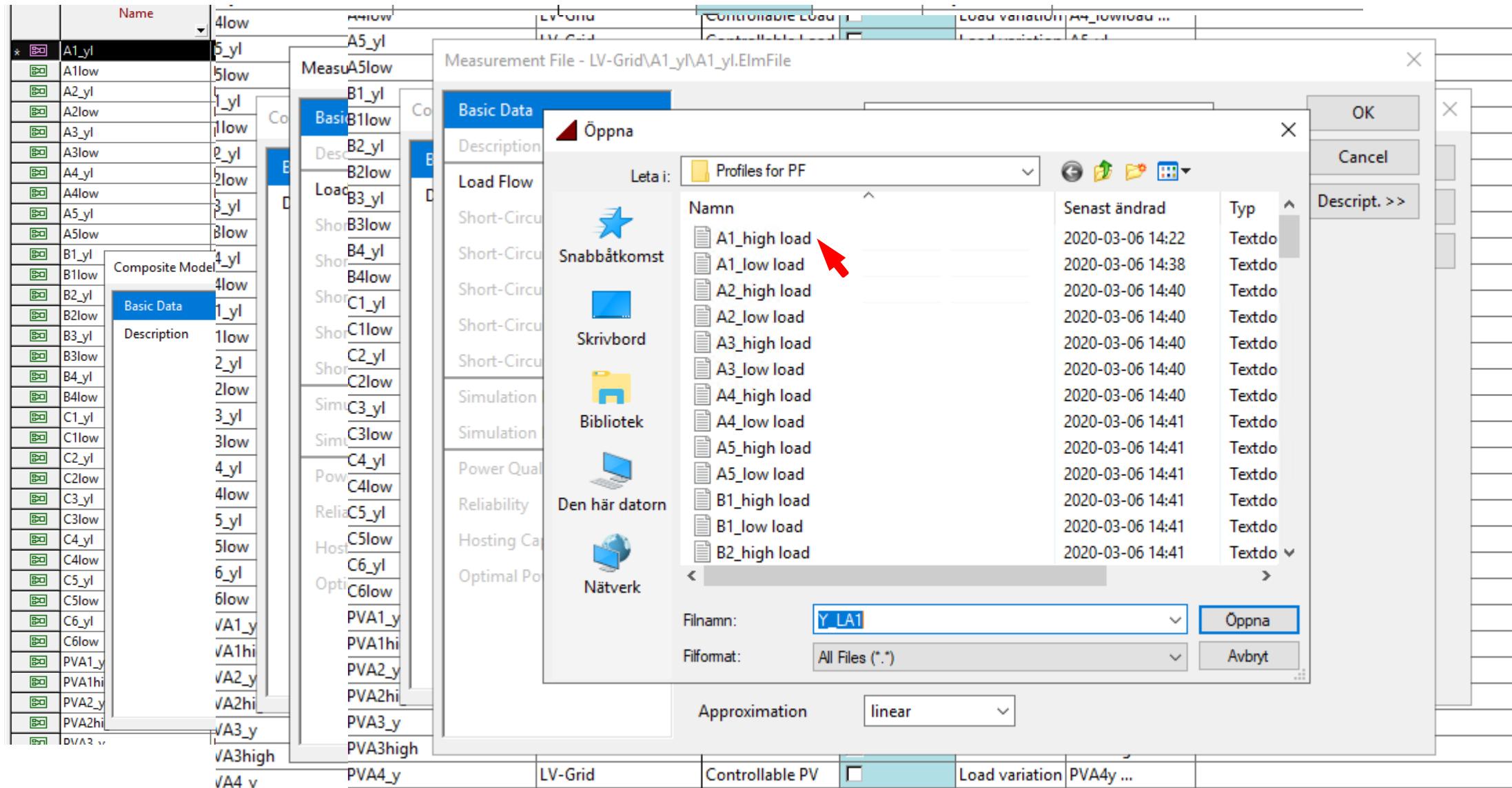
	Slots BlkSlot	Net Elements Elm*,Sta*,IntRef
1	Load variation	
2	Load	

Slot Update Step Response Test

The dynamic model – load variation



The dynamic model – load variation



The dynamic model – load variation

	Name	Grid	Frame BlkDef	Out of Service	Slots BlkSlot	Net Elements Elm*,Sta*,IntRef
*	A1_yl	LV-Grid	Controllable Load	<input checked="" type="checkbox"/>	Load variation	A1_yl ...
	A1low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A1_lowload ...
	A2_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A2_yl ...
	A2low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A2_lowload ...
	A3_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A3_yl ...
	A3low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A3_lowload ...
	A4_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A4_yl ...
	A4low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A4_lowload ...
	A5_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A5_yl ...
	A5low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A5_lowload ...
	B1_yl	Composite Model - LV-Grid\A1_yl.ElmComp *				
	B1low					
	B2_yl					
	B2low					
	B3_yl					
	B3low					
	B4_yl					
	B4low					
	C1_yl					
	C1low					
	C2_yl					
	C2low					
	C3_yl					
	C3low					
	C4_yl					
	C4low					
	C5_yl					
	C5low					
	C6_yl					
	C6low					
	PVA1_y					
	PVA1hi					
	PVA2_y					
	PVA2hi					
	DVAR2_y					
	LV-Grid					
	Controllable DVI					
	Load variation DVI					

Basic Data

Name: A1_yl

Description: ... efined Models\Controllable Load

Out of Service

Slot Definition:

	Slots BlkSlot	Net Elements Elm*,Sta*,IntRef
1	Load variation	A1_yl
2	Load	

Slot Update Step Response Test

The dynamic model – load variation

	Name	Grid	Frame BlkDef	Out of Service	Slots BlkSlot	Net Elements Elm*,Sta*,IntRef
*	A1_yl	LV-Grid	Controllable Load	<input checked="" type="checkbox"/>	Load variation	A1_yl ...
	A1low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A1_lowload ...
	A2_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A2_yl ...
	A2low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A2_lowload ...
	A3_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A3_yl ...
	A3low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A3_lowload ...
	A4_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A4_yl ...
	A4low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A4_lowload ...
	A5_yl	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A5_yl ...
	A5low	LV-Grid	Controllable Load	<input type="checkbox"/>	Load variation	A5_lowload ...
	B1_yl	Composite Model - LV-Grid\A1_yl.ElmComp *				
	B1low					
	B2_yl					
	B2low					
	B3_yl					
	B3low					
	B4_yl					
	B4low					
	C1_yl					
	C1low					
	C2_yl					
	C2low					
	C3_yl					
	C3low					
	C4_yl					
	C4low					
	C5_yl					
	C5low					
	C6_yl					
	C6low					
	PVA1_y					
	PVA1hi					
	PVA2_y					
	PVA2hi					
	DVAR1_y					
	DVAR1hi					
	DVAR2_y					
	DVAR2hi					

Basic Data

Name: A1_yl

Description: ...efined Models\Controllable Load

Out of Service

Slot Definition:

	Slots BlkSlot	Net Elements Elm*,Sta*,IntRef
1	Load variation	A1_yl
2	Load	

Slot Update Step Response Test

The dynamic model – load variation

Screenshot of a software interface showing a list of network objects and a detailed table of load variations.

The top navigation bar includes: Name, Grid, Frame BlkDef, Out of Service, Slots BlkSlot, and Net Elements Elm*, Sta*, IntRef.

A message box says: Please Select 'ElmLod*', 'ElmDsl' - Network Model\Network Data\LV-Grid :

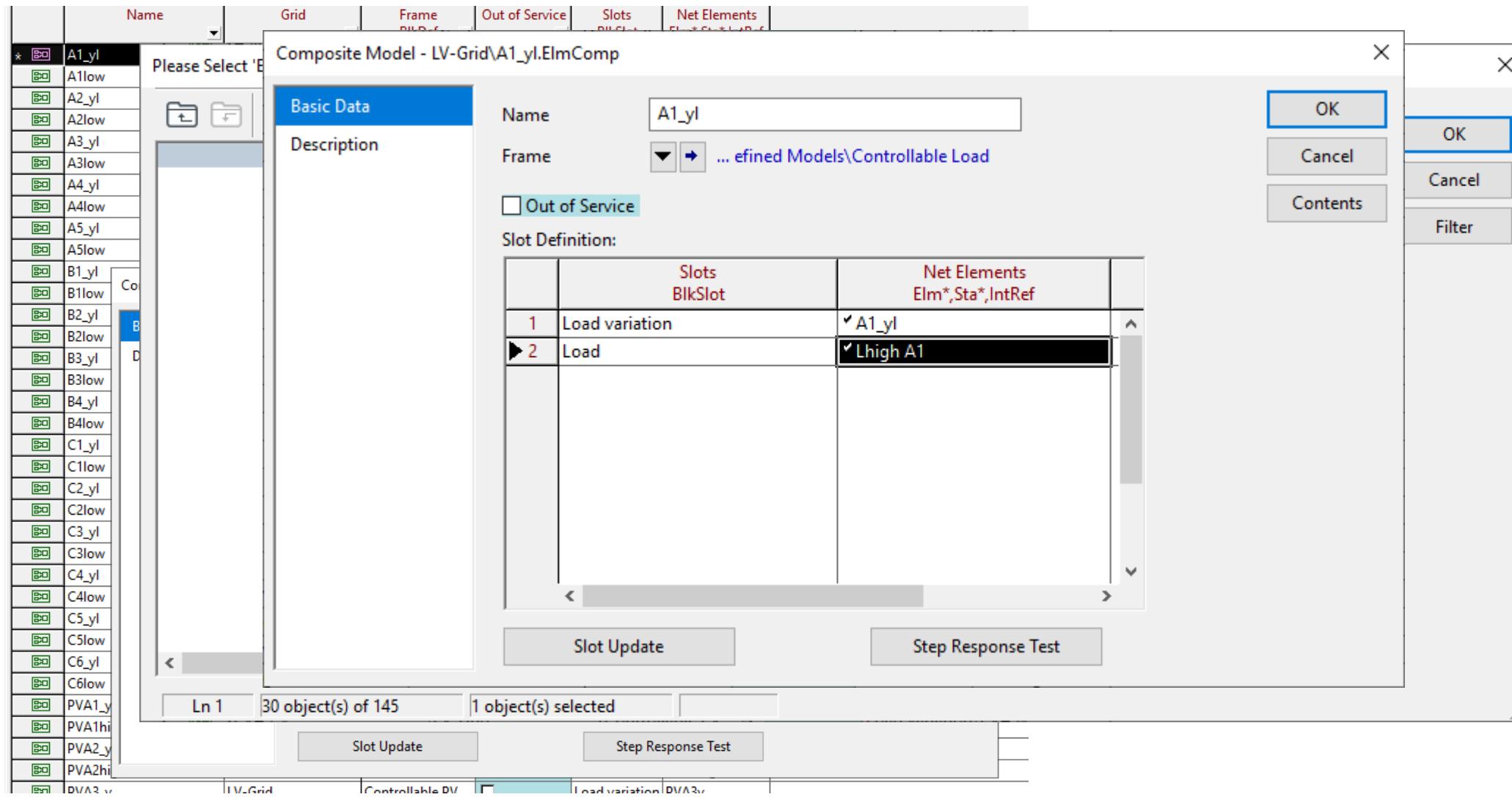
The left sidebar lists nodes categorized by location (A1_yl, A2_yl, A3_yl, A4_yl, A5_yl, B1_yl, B2_yl, B3_yl, B4_yl, C1_yl, C2_yl, C3_yl, C4_yl, C5_yl, C6_yl) and types (low, high).

The main area displays a table titled "LV-Grid" with the following columns: Name, Type, Out of Service, Object modified, and a status column (checkbox). The table shows 30 objects of 145, with 1 object selected. The selected row is highlighted with a red circle around the "Name" column.

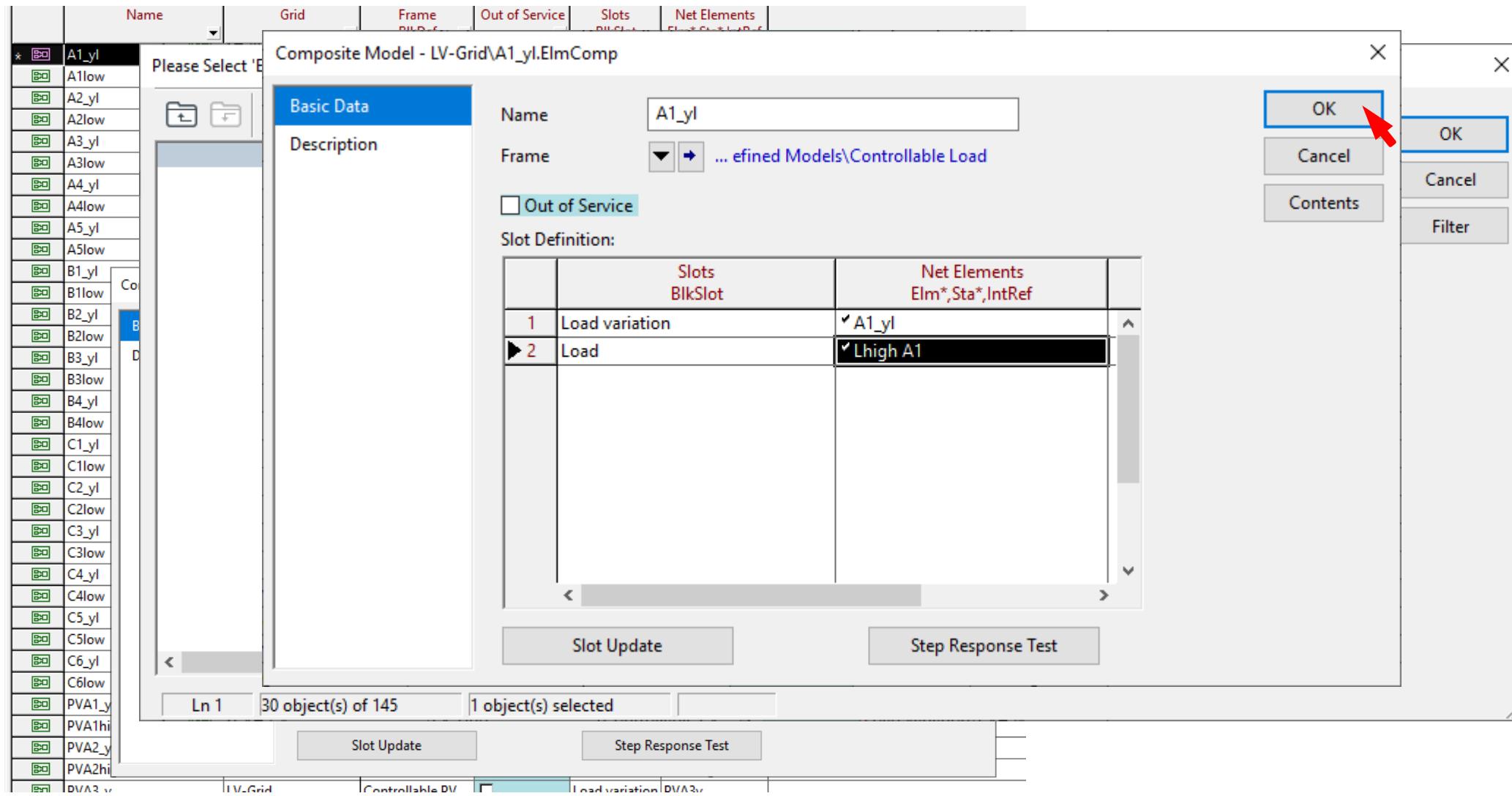
Name	Type	Out of Service	Object modified	
Lhigh A1	Load high_AC_3P(1)	<input type="checkbox"/>	2020-03-02 11:31:29	
Lhigh A2	Load high_AC_3P(1)	<input type="checkbox"/>	2020-03-02 11:31:29	
Lhigh A3	Load high_AC_3P(1)	<input type="checkbox"/>	2020-03-02 11:31:29	
Lhigh A4	Load high_AC_3P(1)	<input type="checkbox"/>	2020-03-02 11:31:29	
Lhigh A5	Load high_AC_3P(1)	<input type="checkbox"/>	2020-03-02 11:31:29	
Lhigh B1	Load high_AC_3P(1)	<input type="checkbox"/>	2020-03-02 11:31:29	
Lhigh B2	Load high_AC_3P(1)	<input type="checkbox"/>	2020-03-02 11:31:29	
Lhigh B3	Load high_AC_3P(1)	<input type="checkbox"/>	2020-03-02 11:31:21	
Lhigh B4	Load high_AC_3P(1)	<input type="checkbox"/>	2020-03-02 11:31:31	
Lhigh C1	Load high_AC_3P(1)	<input type="checkbox"/>	2020-03-02 12:09:56	
Lhigh C2	Load high_AC_3P(1)	<input type="checkbox"/>	2020-03-02 11:31:31	
Lhigh C3	Load high_AC_3P(1)	<input type="checkbox"/>	2020-03-02 11:31:31	
Lhigh C4	Load high_AC_3P(1)	<input type="checkbox"/>	2020-03-02 11:31:31	
Lhigh C5	Load high_AC_3P(1)	<input type="checkbox"/>	2020-03-02 11:31:31	
Lhigh C6	Load high_AC_3P(1)	<input type="checkbox"/>	2020-03-02 11:31:31	
Llow A1	Load low_AC_3P(1)	<input checked="" type="checkbox"/>	2020-03-02 11:31:09	
Llow A2	Load low_AC_3P(1)	<input checked="" type="checkbox"/>	2020-03-02 11:31:09	

Buttons at the bottom include: Slot Update, Step Response Test, OK, Cancel, and Filter.

The dynamic model – load variation



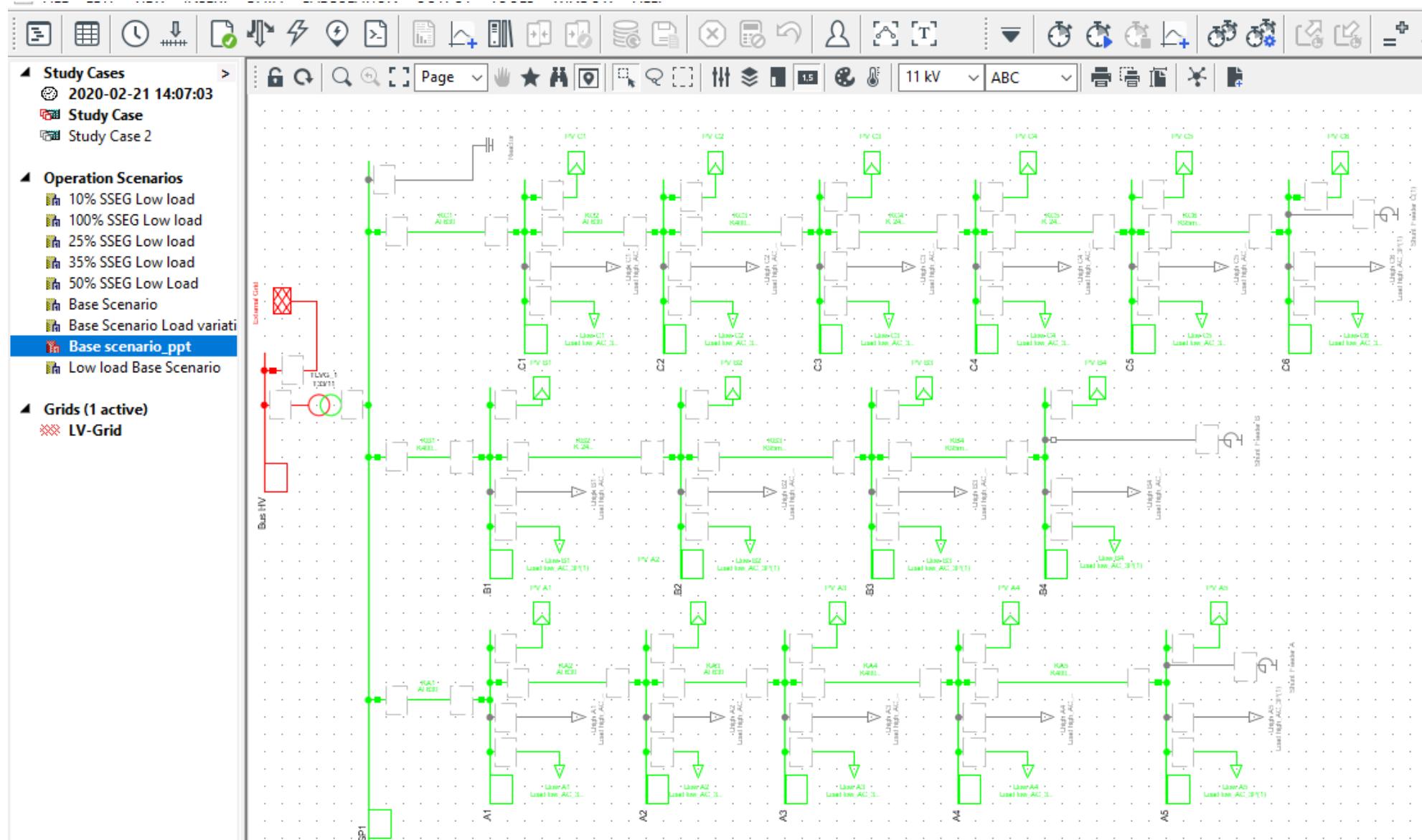
The dynamic model – load variation



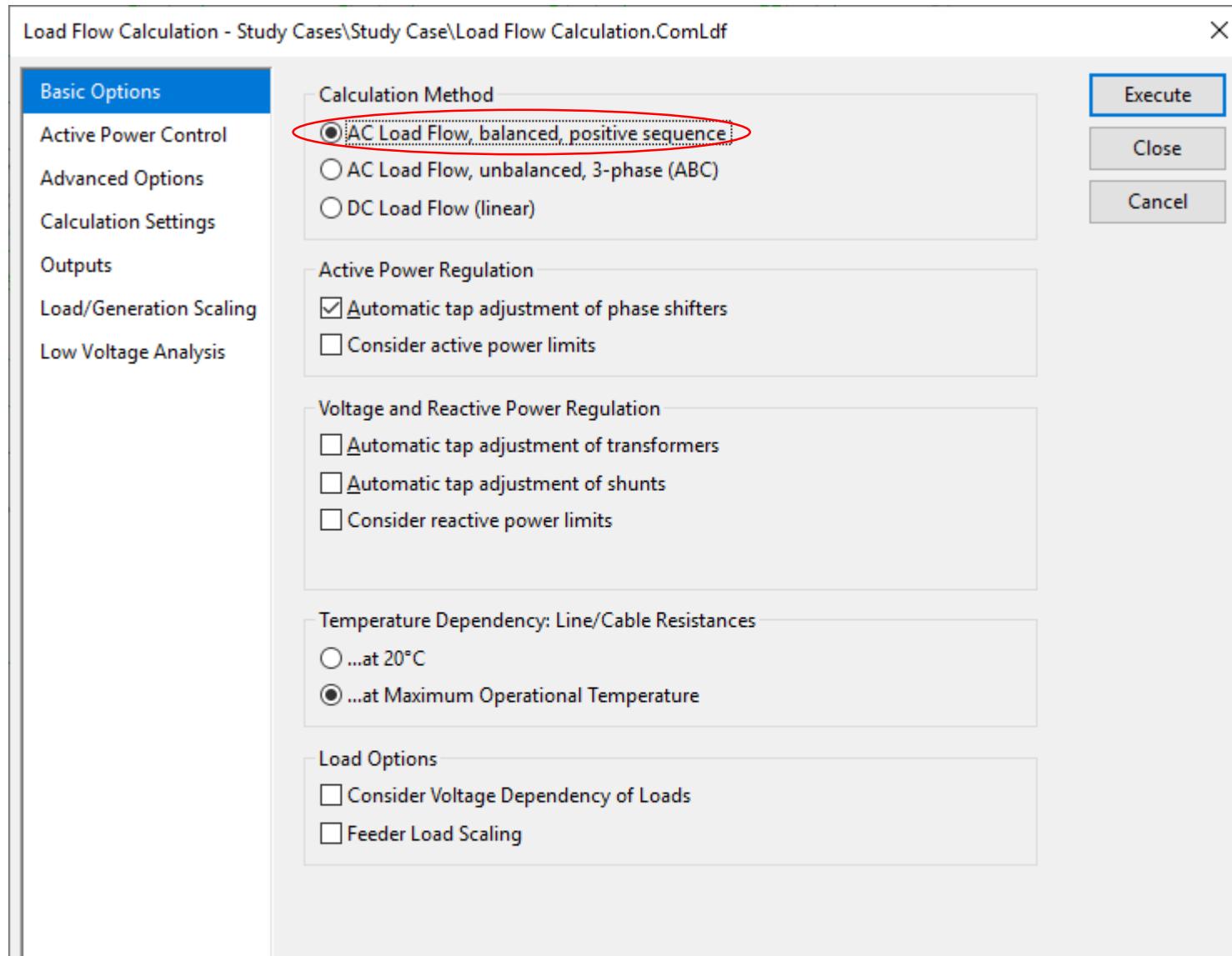
11 kV PF case - Dynamic loss evaluation

- The dynamic model
- Building the dynamic model
- Measurement files
- Building the dynamic model
- Running the simulation
- Results

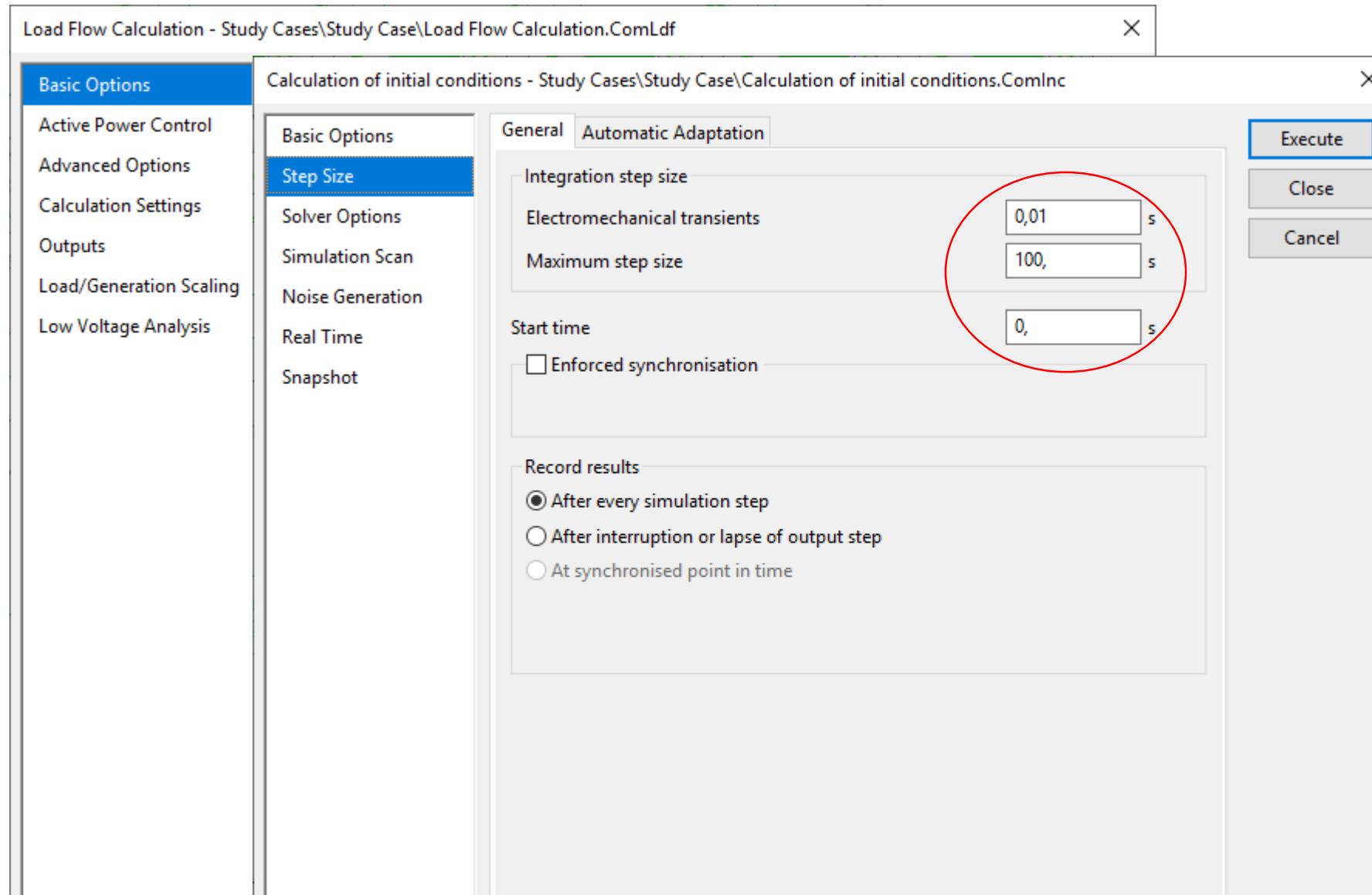
The dynamic model - time to run



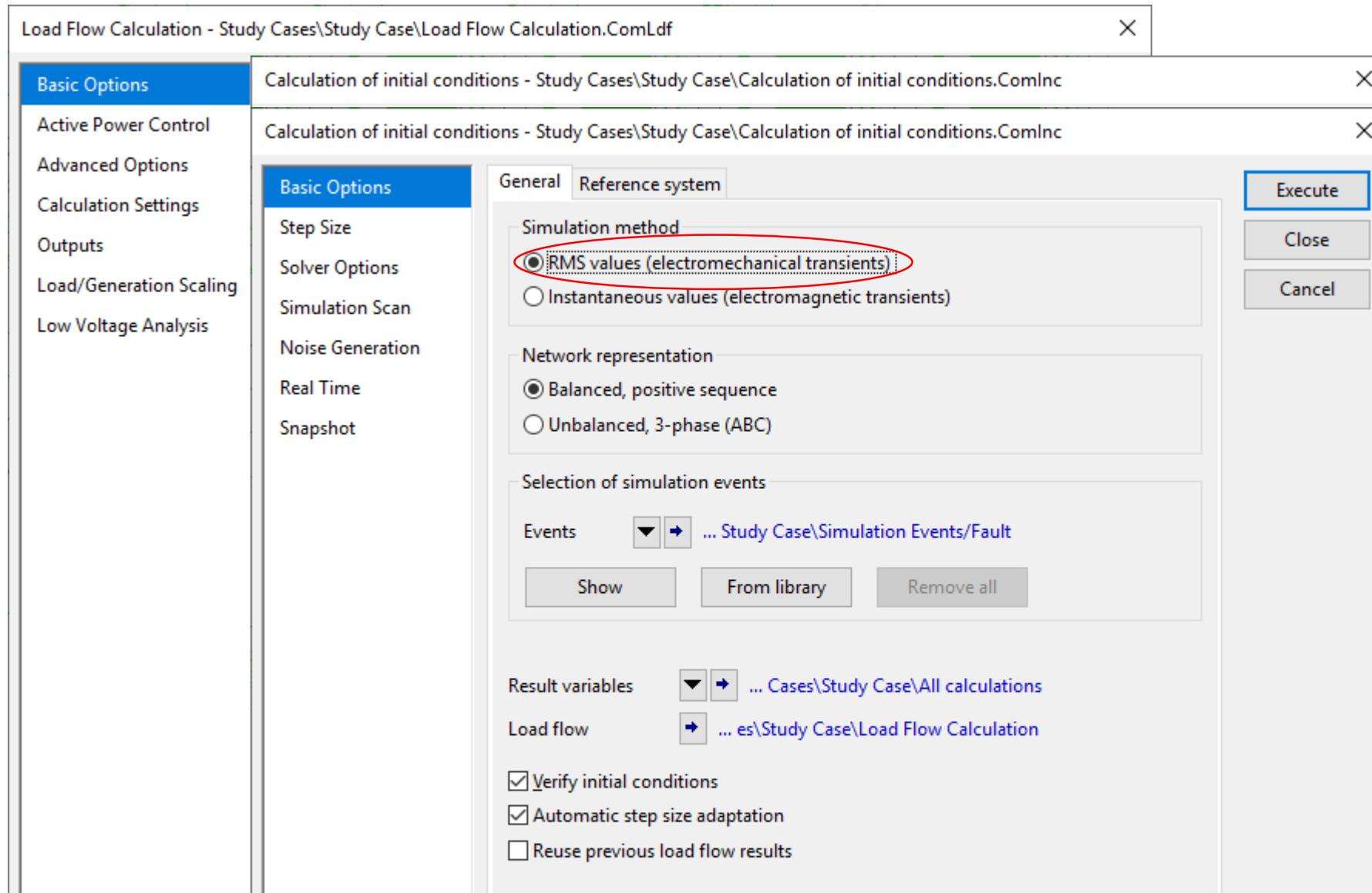
The dynamic model – time to run



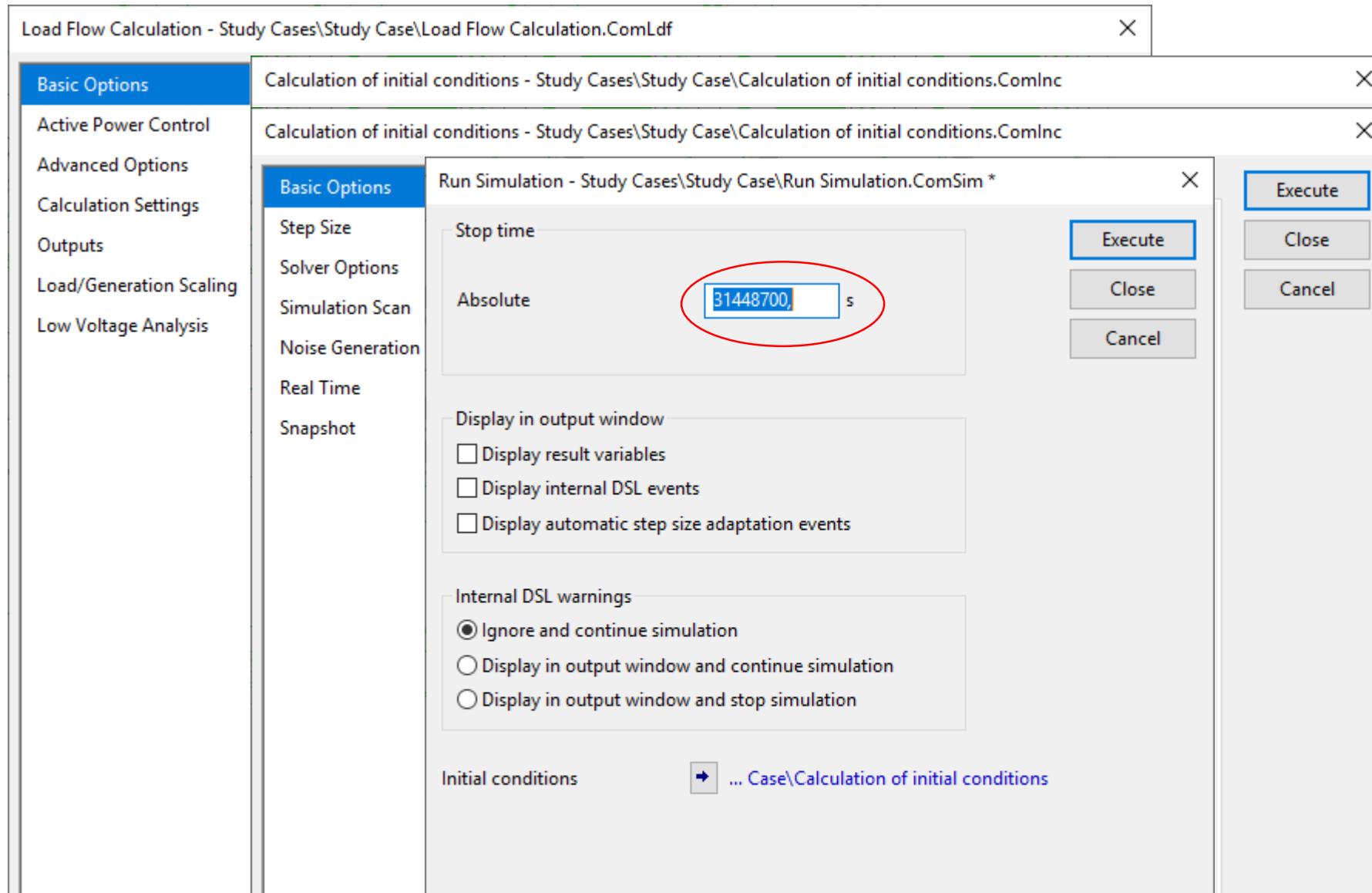
The dynamic model – time to run



The dynamic model – time to run



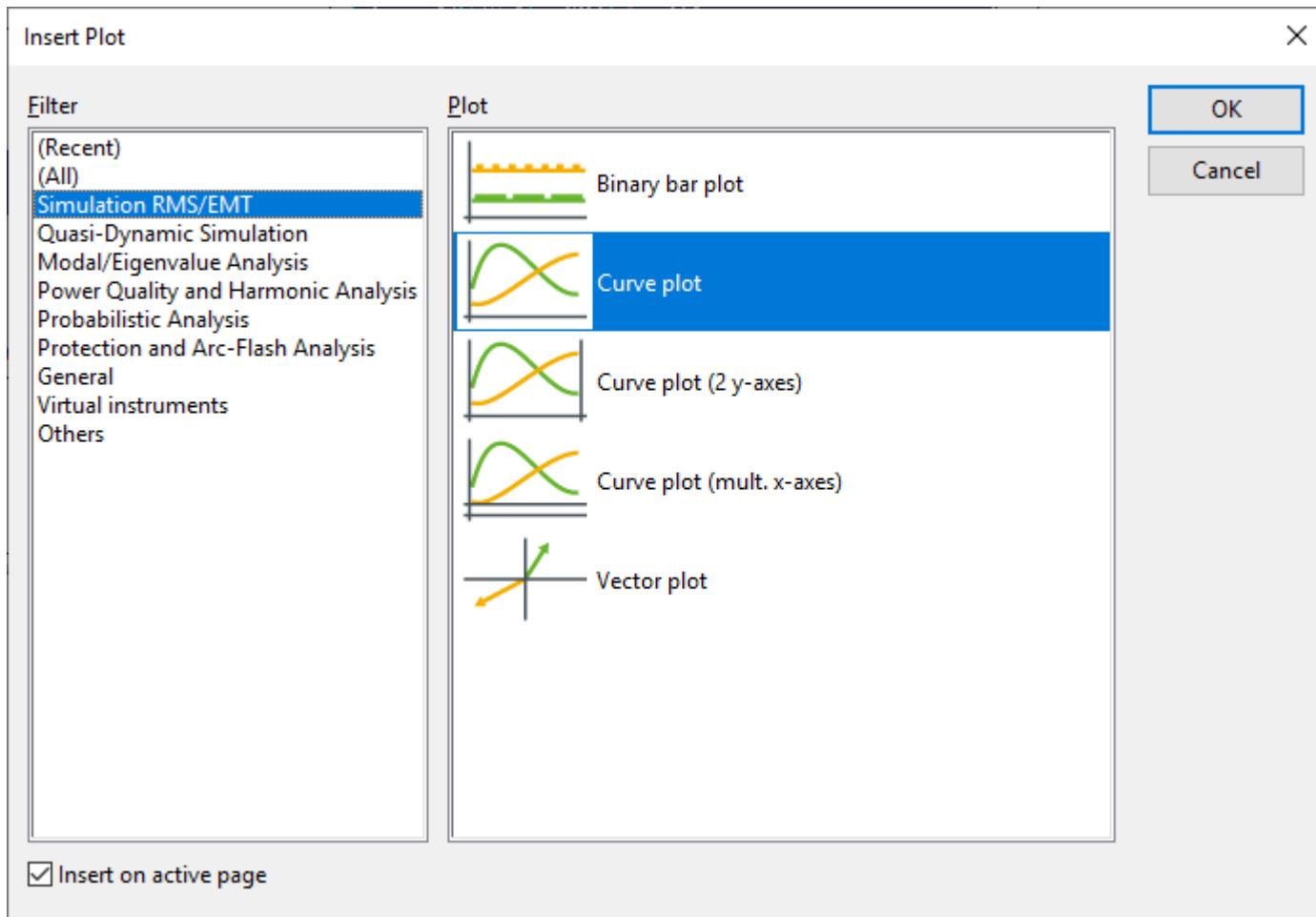
The dynamic model – time to run

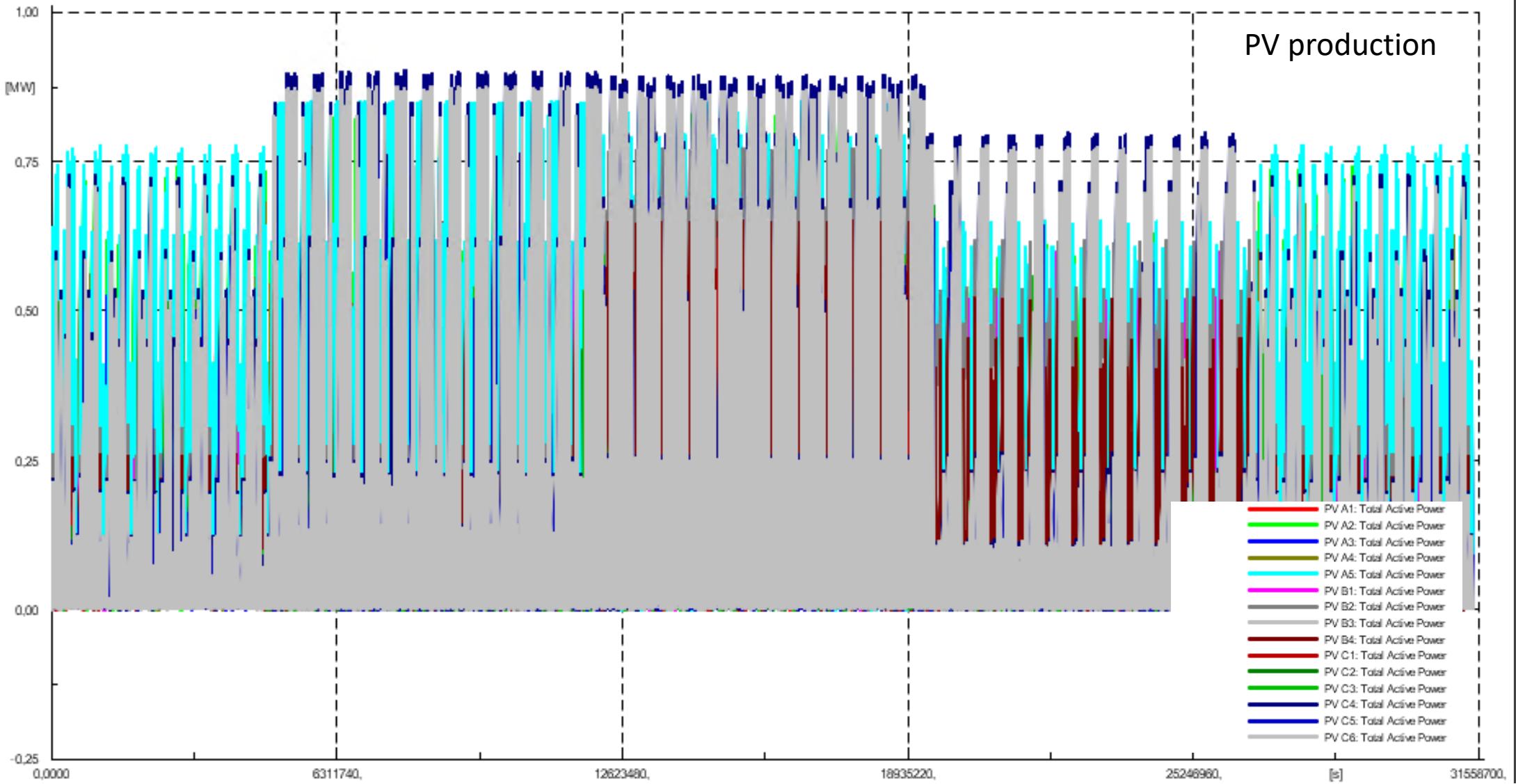


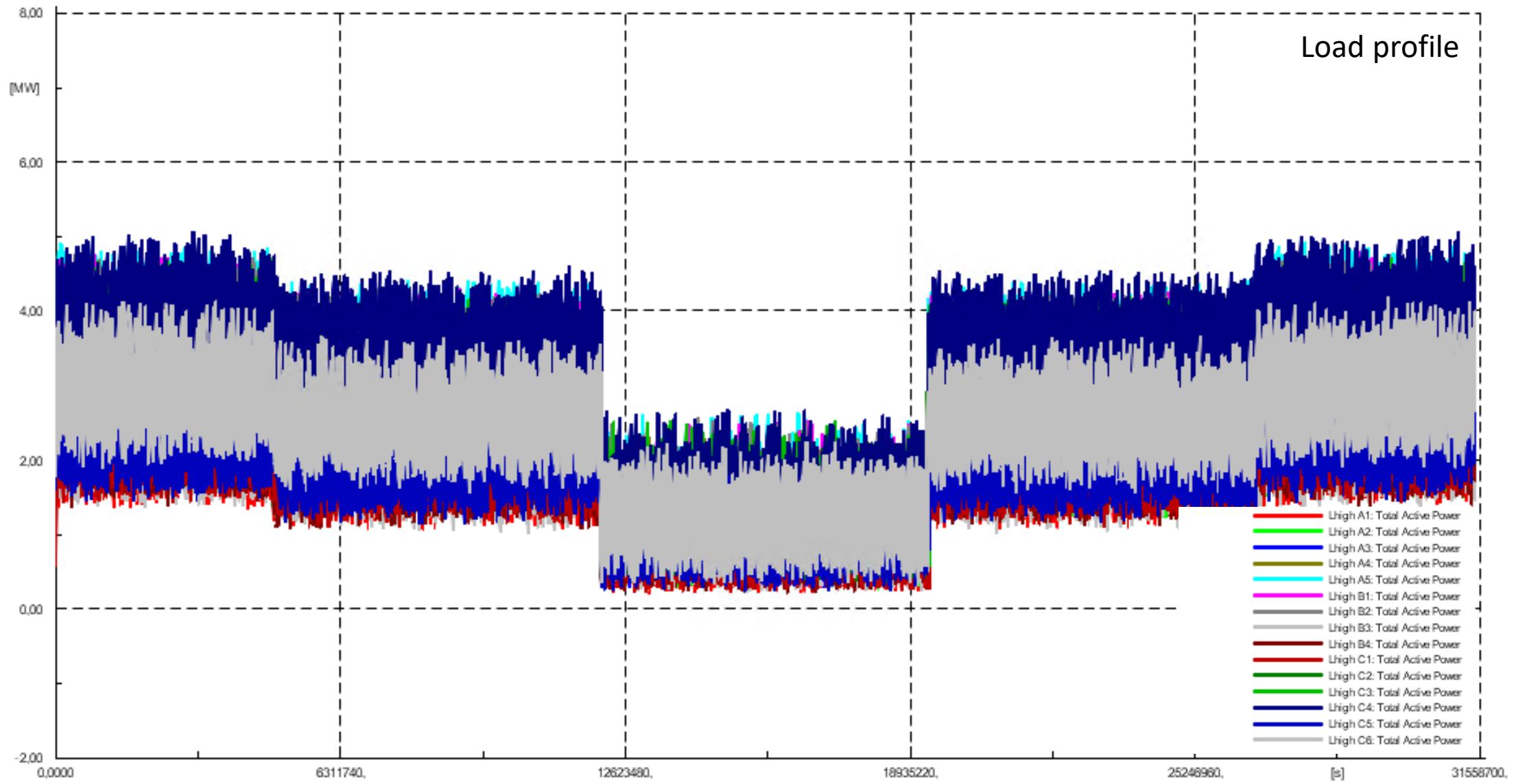
11 kV PF case - Dynamic loss evaluation

- The dynamic model
- Building the dynamic model
- Measurement files
- Building the dynamic model
- Running the simulation
- Results and discussion

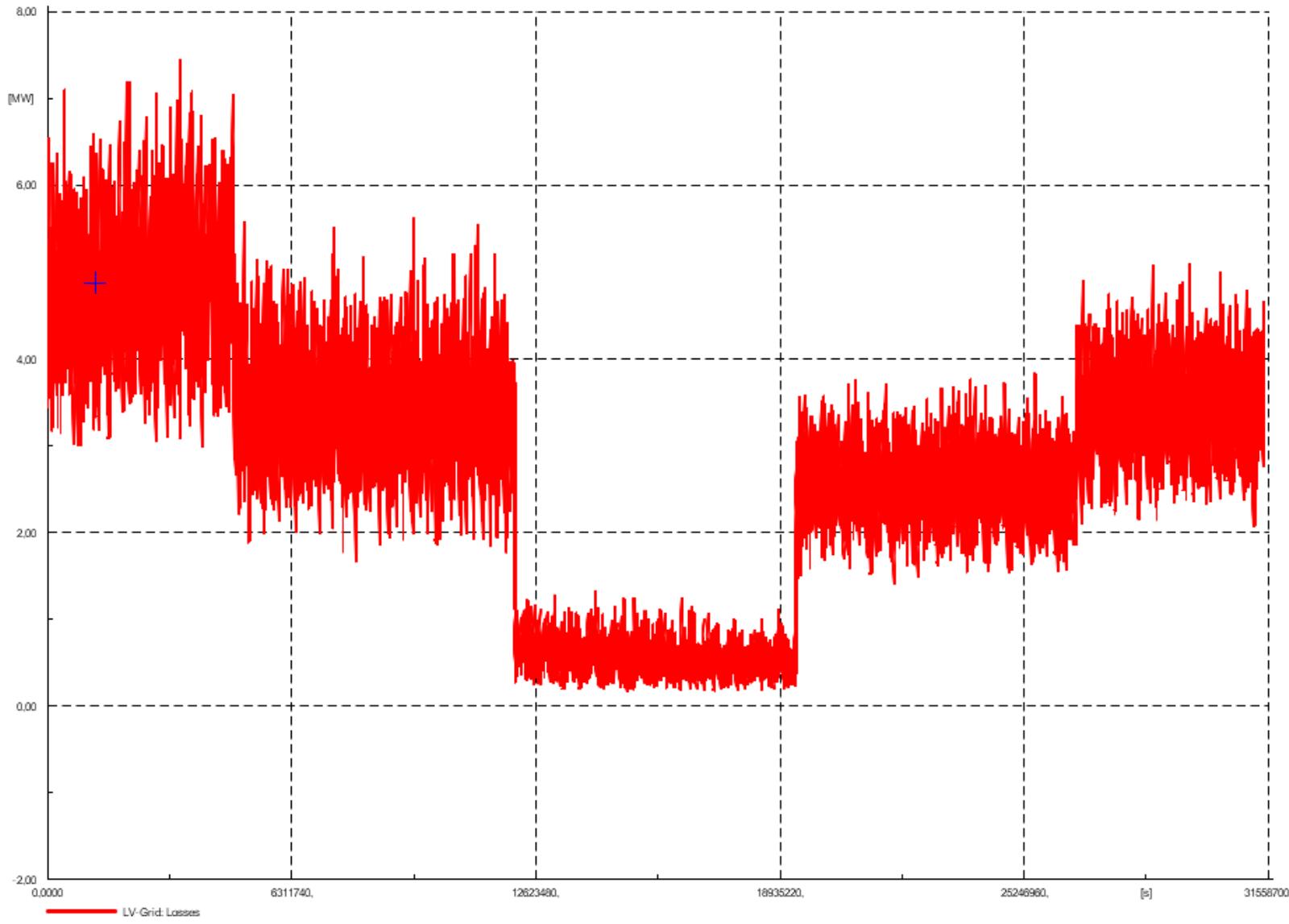
Plotting the result



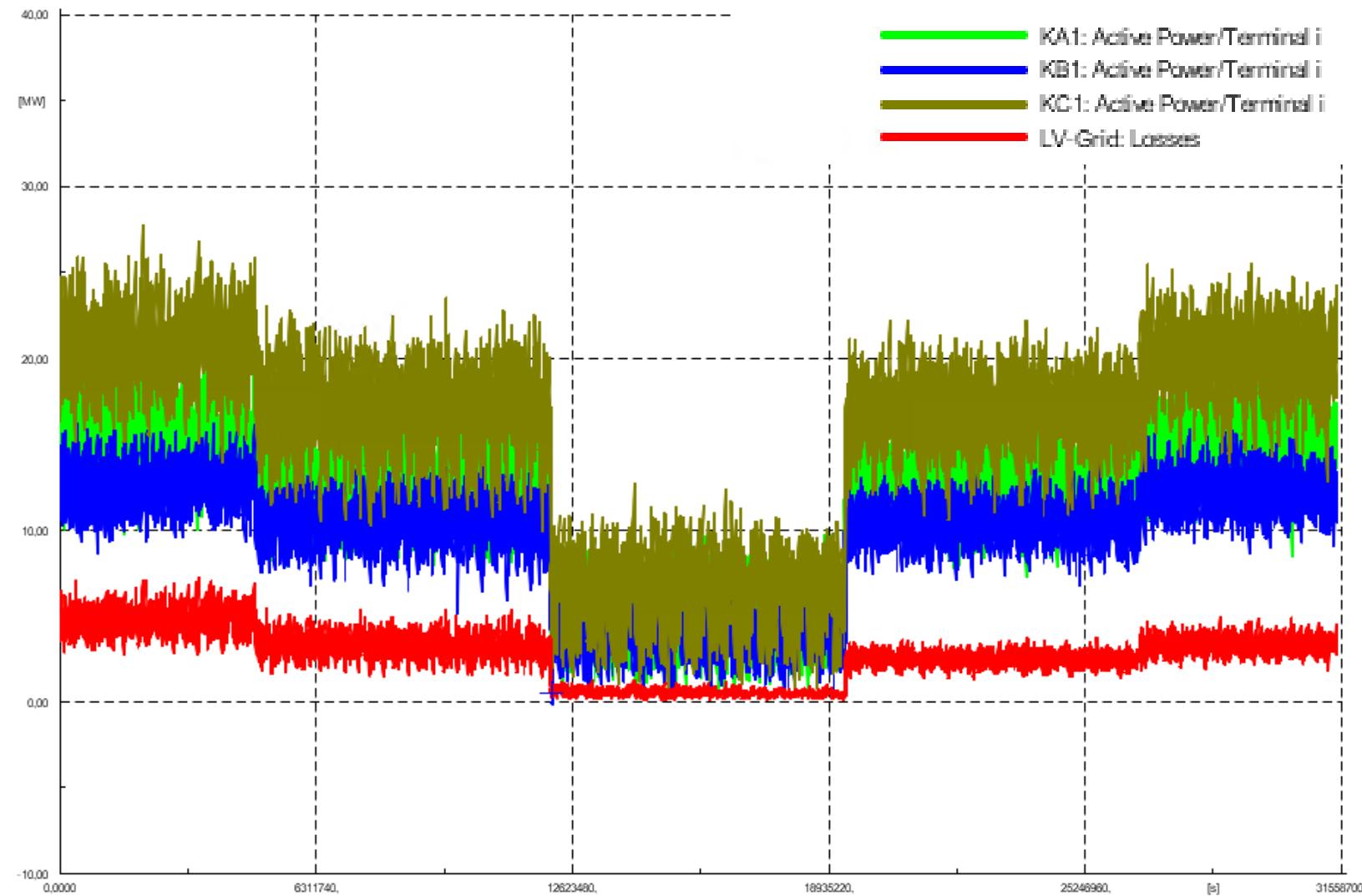




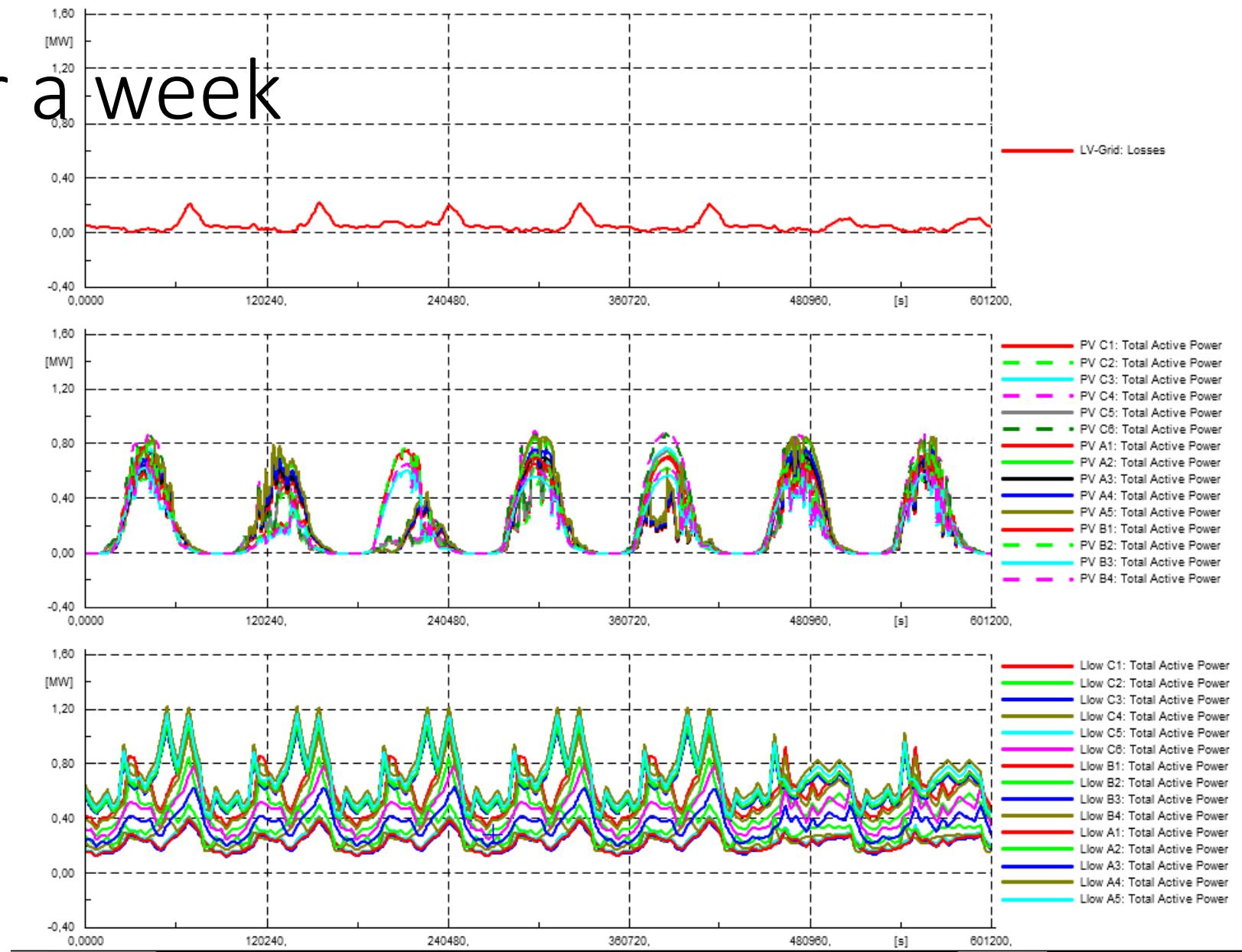
Grid losses



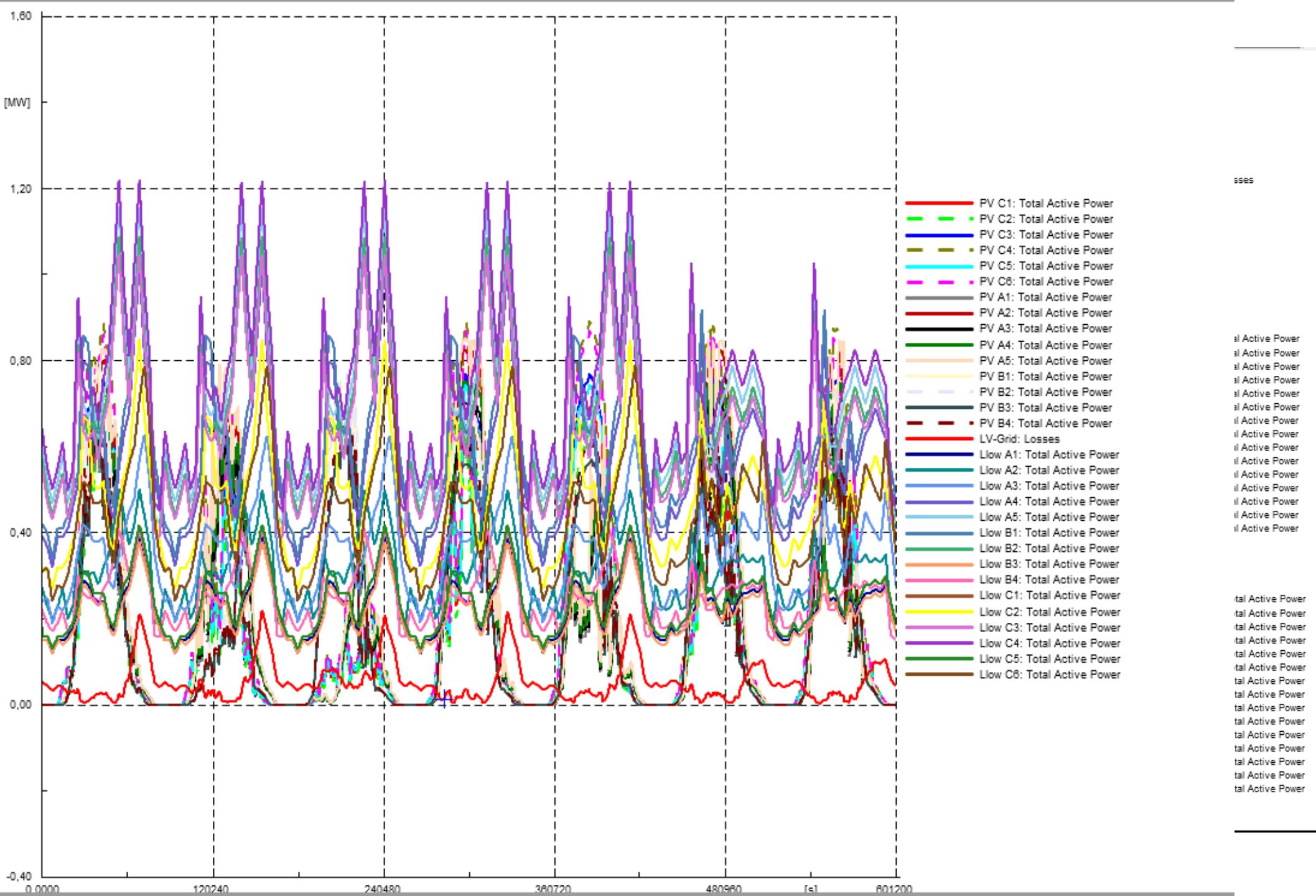
Summary



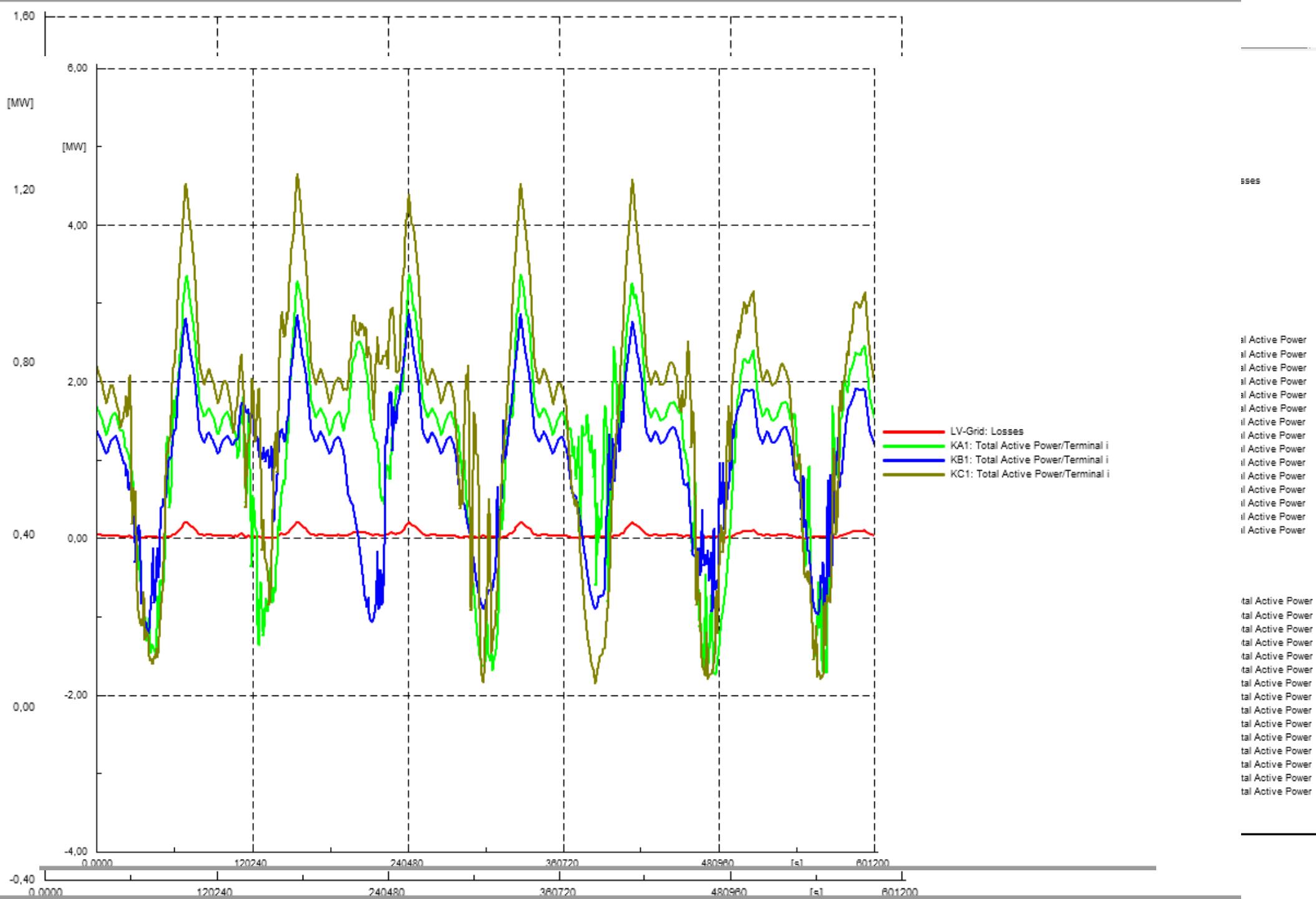
Summary for a week



SI

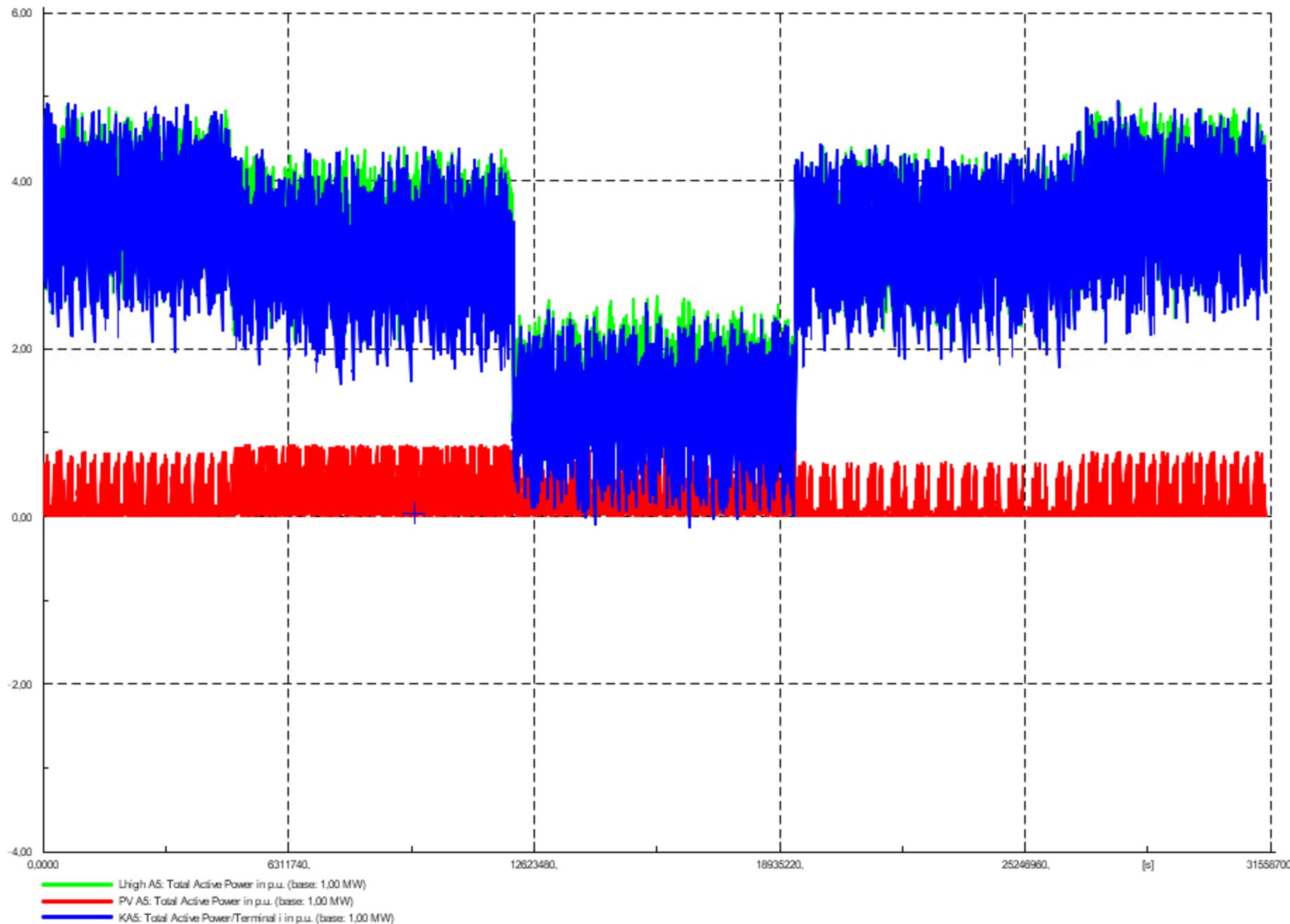


S1



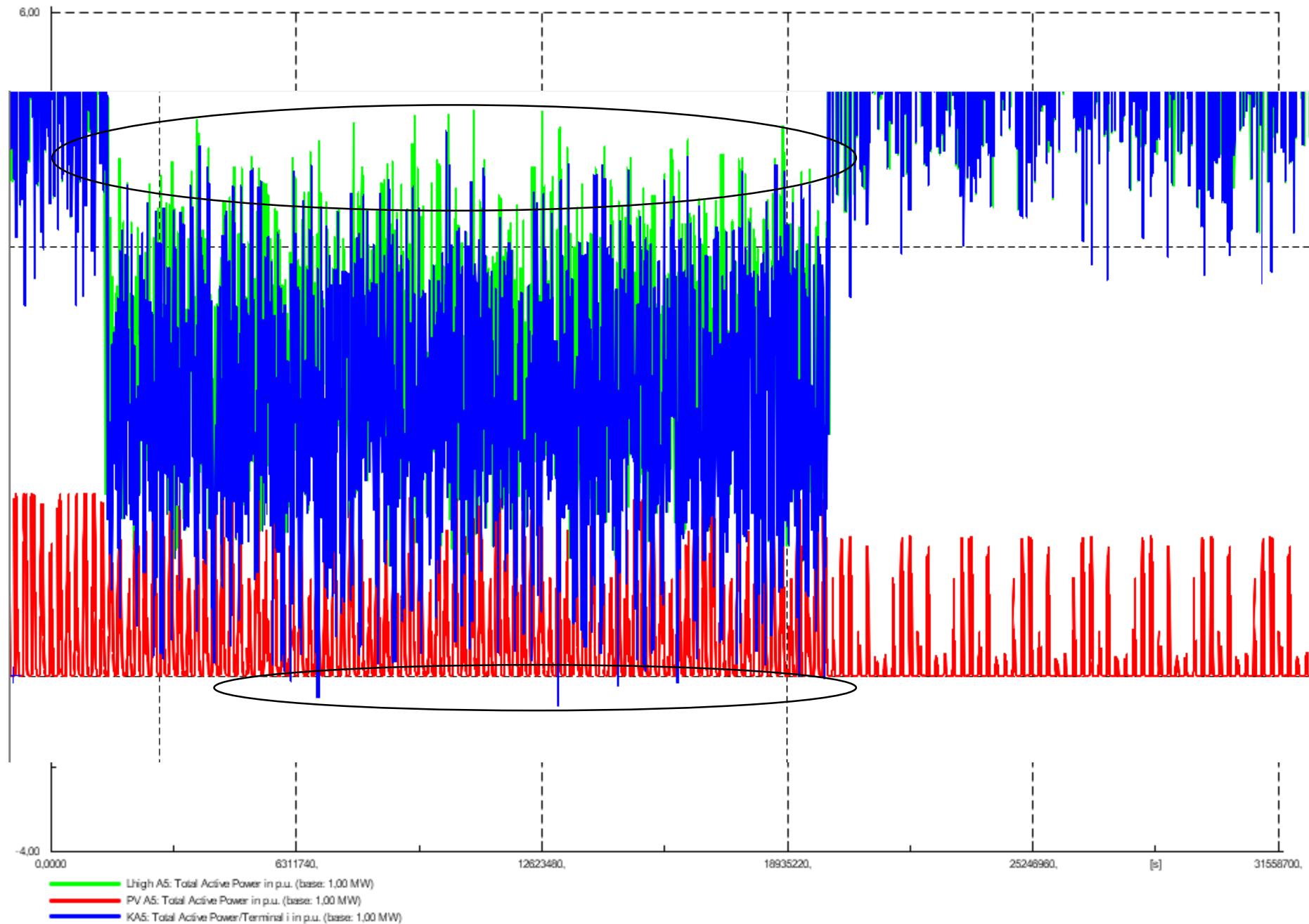
Deeper study over a year

- Green: Load profile for group A5
- Red: PV production for group 5
- Blue: Load-PV



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