SMARTEN v1.0 Instruction Manual

Smarten

2021

Smart Management AlgoRiThm of Electricity Network

Smarten v1.0 Instruction Manual

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1. Getting started

Smarten (Smart Management AlgoRiThm of Electricity Network) is a multi-scale calculation tool for the management of mixed electrical energy flows developed by the scientists from the Physics and Mathematical Engineering Laboratory for Energy and Environment (PIMENT), University of La Reunion, 117 rue du Général Ailleret, 97430 Le Tampon, France and the Higher Institute of Technology of Antananarivo (I.S.T), Ministry of Higher Education and Scientific Research, Iadiambola Ampasampito, Po Box 8122, Antananarivo 101, Madagascar.

Smarten v1.0 is a new tool that simultaneously takes into account data from several buildings to manage their electrical energy distribution. This multi-spatial dimension makes it possible to extend energy management from a building level to a territory level.

Smarten v1.0 enables users to import their Renewable Energy Production file, their Energy Consumption file and the parameters that they define for the simulation. Then, Smarten v1.0 controls the flow of electrical energy between the buildings, the storage systems and the interconnected grid.

At each hour of the day, the tool compares the power available at the renewable source, the power required by the load, the power that can be withdrawn from the grid and the power that can be supplied by the storage system. Depending on the values of these powers and the operating parameters of the storage systems and the grid, the tool decides how much energy to draw from the grid and to supply or take from the storage system. The multi-scale spatial aspect of the tool consists of considering at the same time the data from several built spaces and determining at each time step the distribution of the electrical energy of each building. The tool, therefore, has as input a matrix whose number of columns corresponds to the number of buildings to be managed.

2. Acknowledgements

Smarten v1.0 has been developed with the collaboration of scientists from:

- the Physics and Mathematical Engineering Laboratory for Energy and Environment (PIMENT), University of La Reunion, 117 rue du Général Ailleret, 97430 Le Tampon, France ,
- and the Higher Institute of Technology of Antananarivo (I.S.T), Ministry of Higher Education and Scientific Research, Iadiambola Ampasampito, Po Box 8122, Antananarivo 101, Madagascar

Special thanks to:

- Manitra Pierrot RANJARANIMARO
- Mohamed Nasroudine MOHAMED RACHADI
- Ando Ny Aina RANDRIANTSOA
- Damien FAKRA
- Dolly Armël Sylvain ANDRIATOAVINA
- Jean Claude GATINA

3. Setup

3.1. System Recommended Requirements

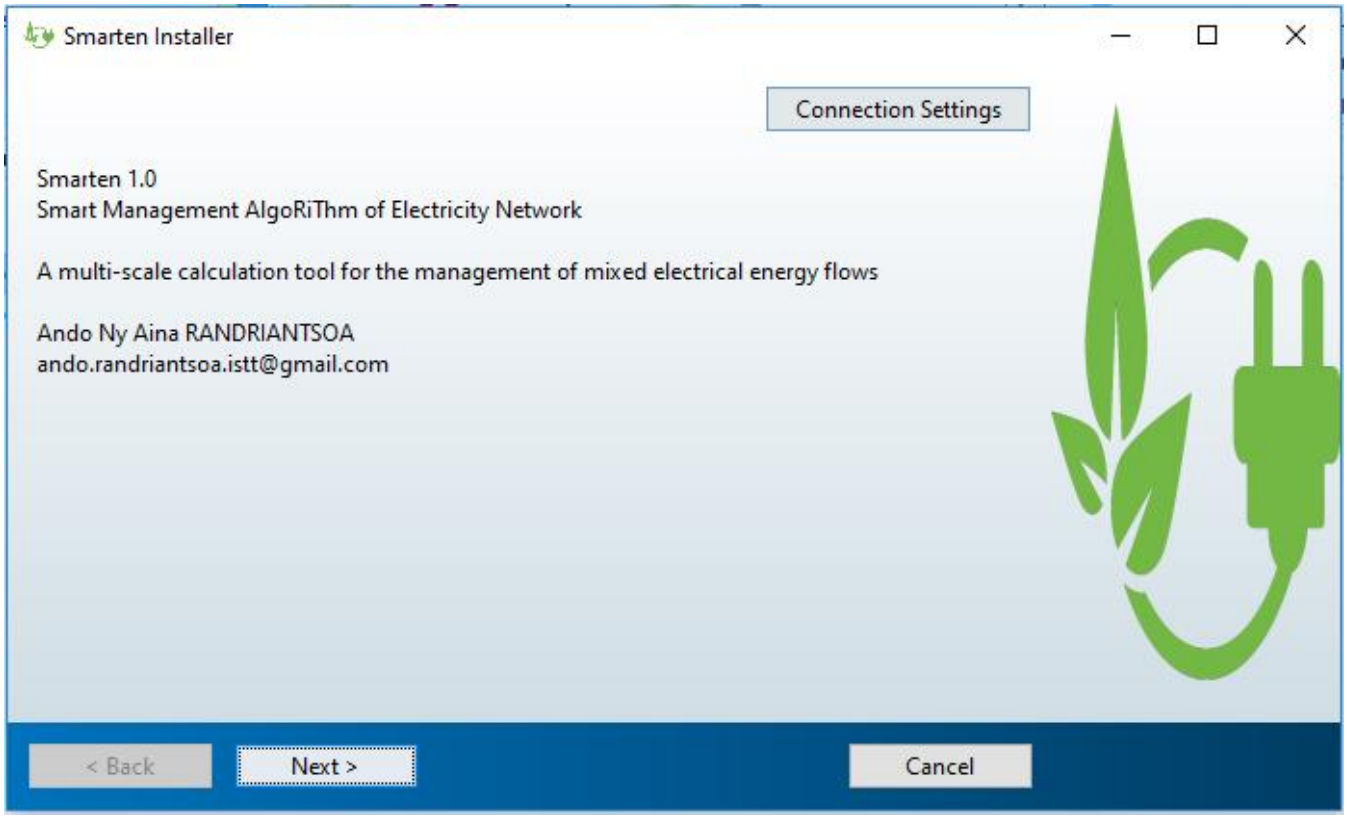
OS: Windows 7x64 / Windows 8.1x64 / Windows 10x64
Processor: Intel® Core™ i3-530 @ 2.93 GHz / AMD Phenom™ II X4 805 @ 2.50 GHz or better
Memory: 4 GB RAM
Graphics: NVIDIA® GeForce® GT 450 1GB / ATI® Radeon™ HD 7770 1GB or better
DirectX: Version 11
Storage: 4 GB available space if the MATLAB Runtime is not installed in the system

3.2. Running the application

Smarten v1.0 has been developed with Windows 64-bit version of the 2015b release of MATLAB. To install Smarten v1.0 in your system:

- Verify the MATLAB Runtime is installed and ensure you have installed version 9.0 (R2015b). If the MATLAB Runtime is installed, you can directly run the standalone application of Smarten without any installation setup

- If the MATLAB Runtime is not installed, run MyAppInstaller_mcr.exe (about 548 Mo) and follow these steps


Smarten Installer
Connection Settings
Smarten 1.0
Smart Management AlgoRiThm of Electricity Network
A multi-scale calculation tool for the management of mixed electrical energy flows
Ando Ny Aina RANDRIANTSOA
ando.randriantsoa.istt@gmail.com
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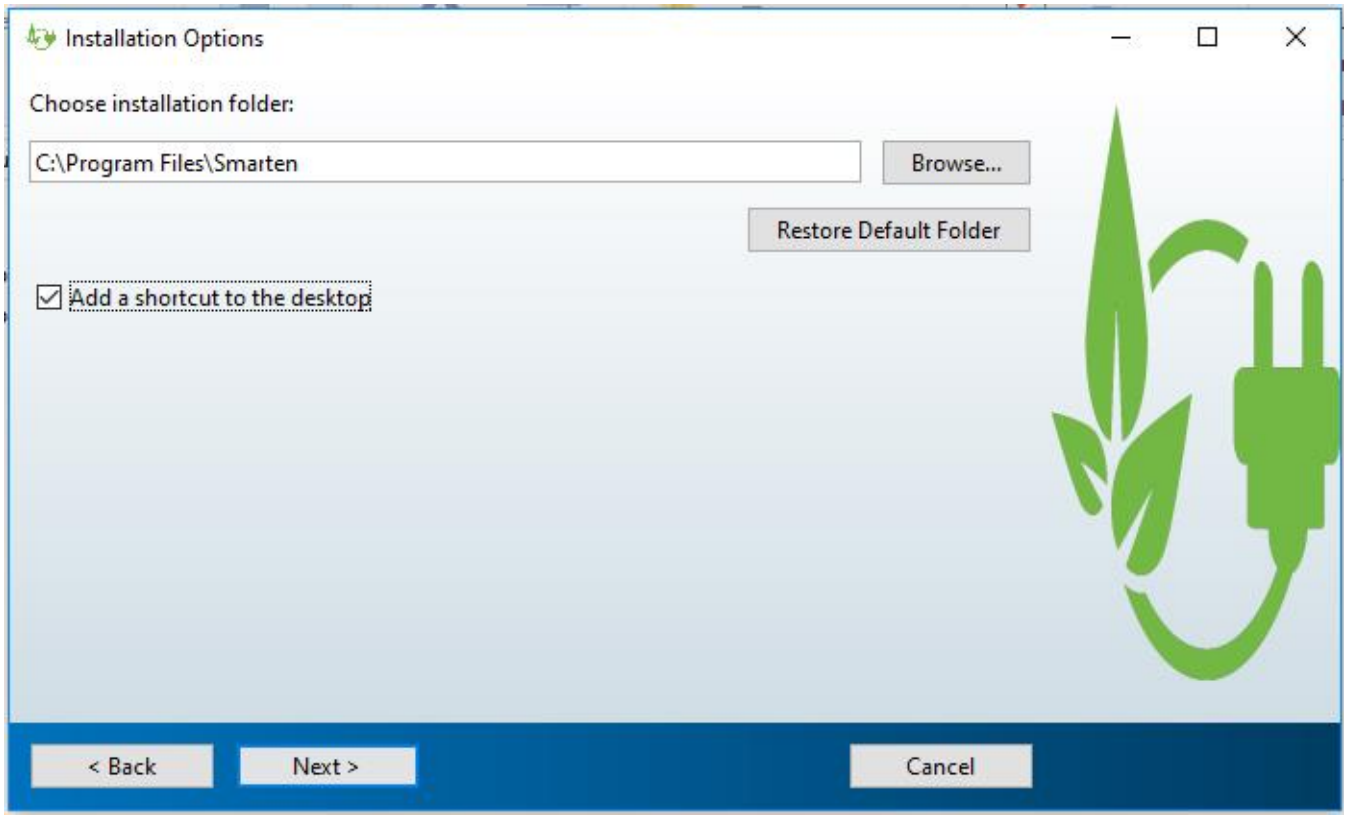
Installation Options
Choose installation folder:
C:\Program Files\Smarten
Browse...
Restore Default Folder
Add a shortcut to the desktop
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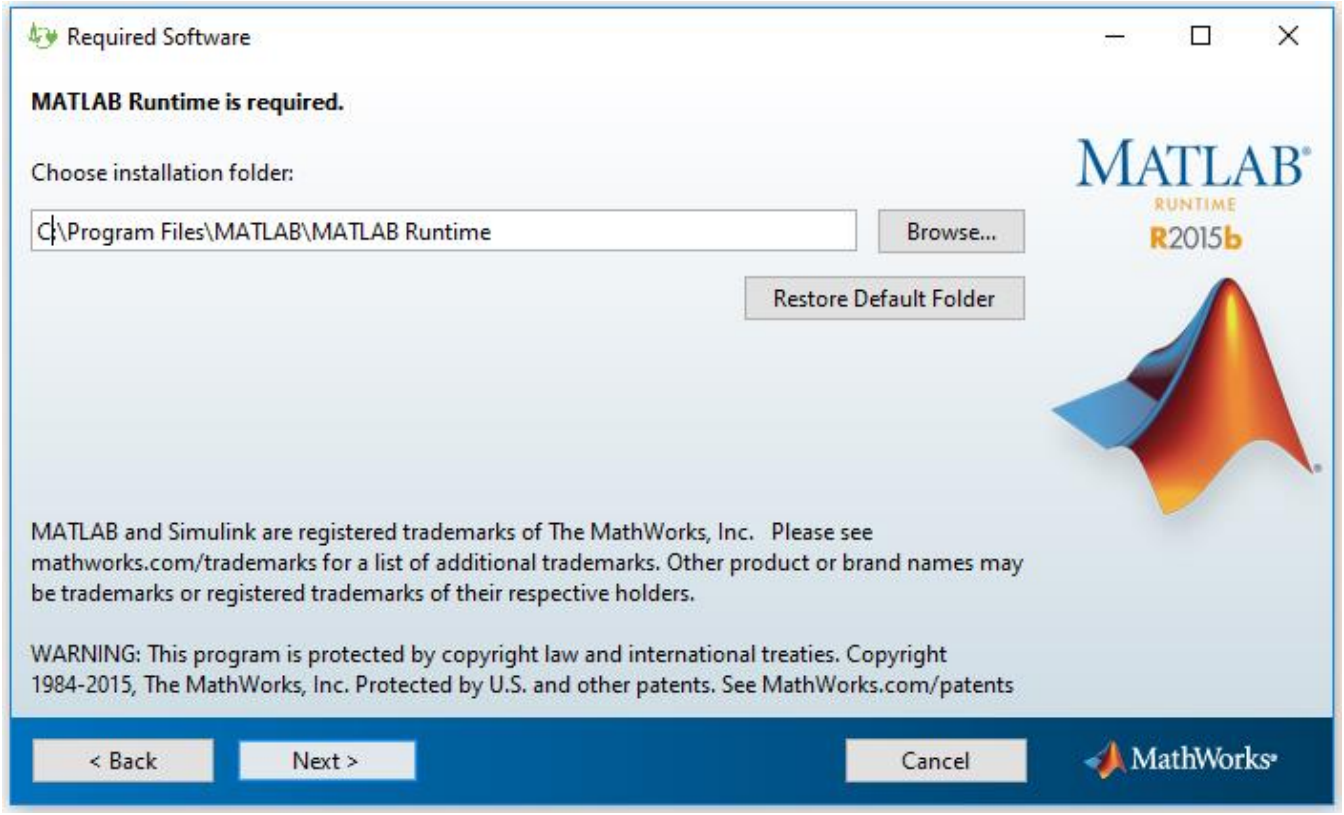
Required Software
MATLAB Runtime is required.
Choose installation folder:
C:\Program Files\MATLAB\MATLAB Runtime
Browse...
Restore Default Folder
MATLAB
RUNTIME
R2015b
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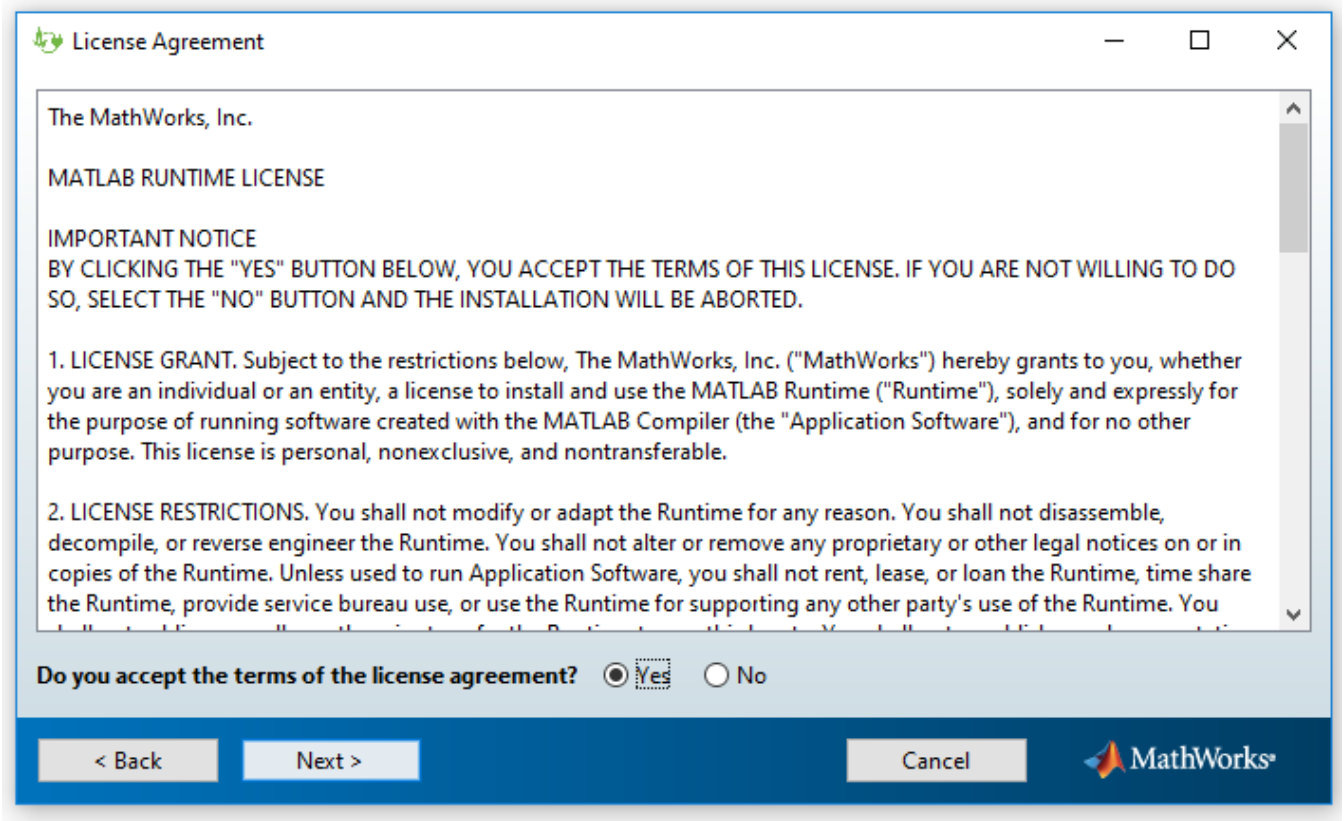
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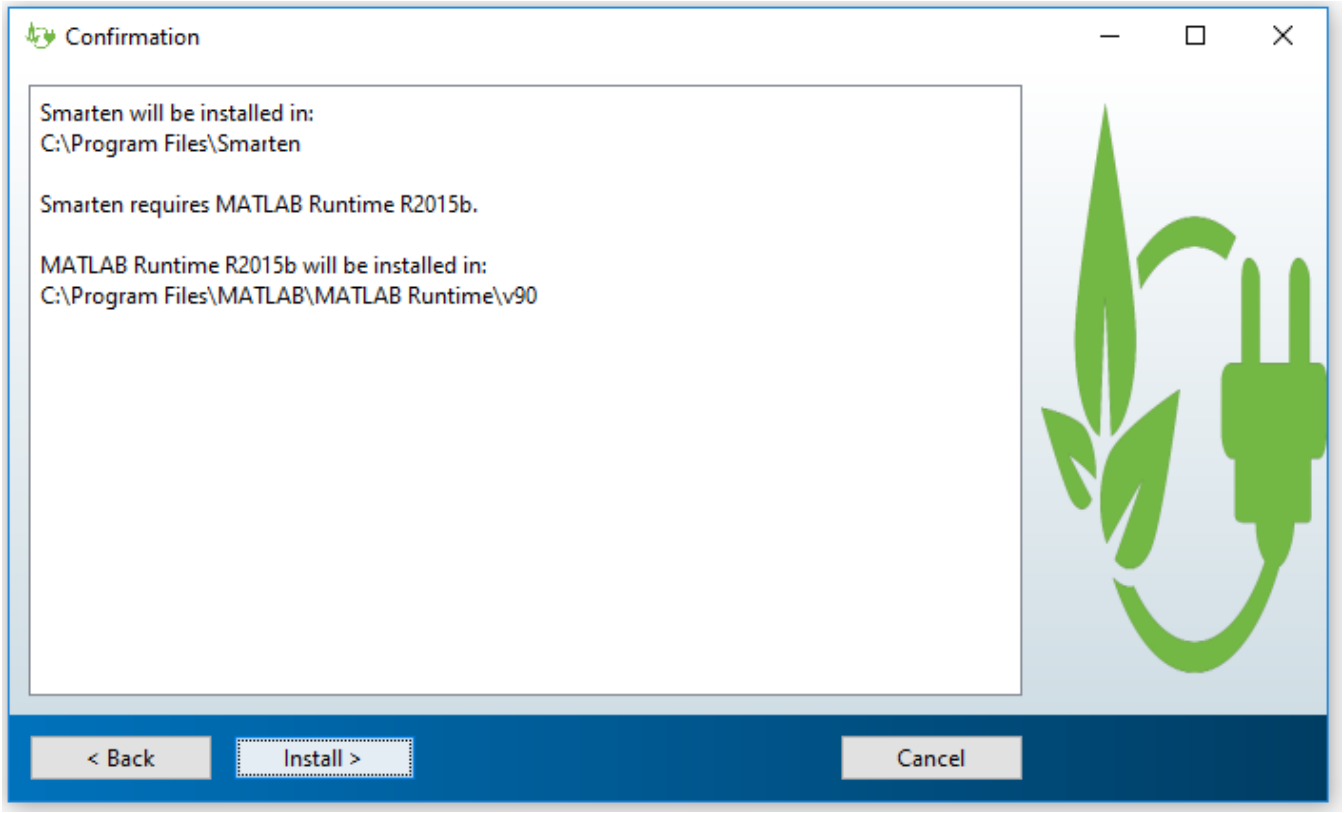


At this point, click on Install and Smarten v1.0 and the MATLAB Runtime 2015b will be installed in your system.

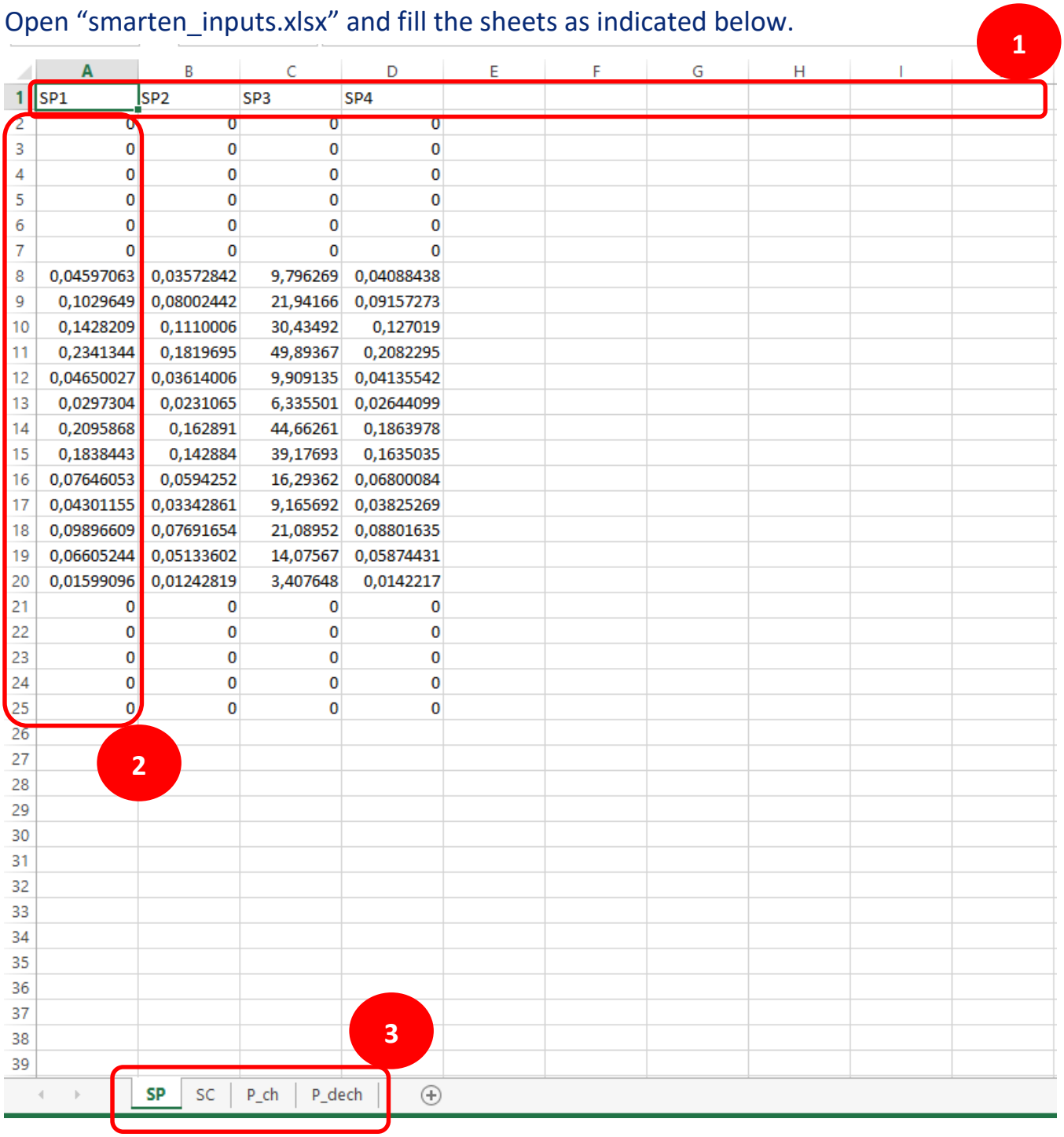
4. Pre-required files

4.1. Inputs file

Before launching Smarten v1.0, users must fill the inputs file in order to import it to the simulation.

A model of the inputs file is released with the setup package. The model is named: “smarten_inputs.xlsx”.

Open “smarten_inputs.xlsx” and fill the sheets as indicated below.



	A	B	C	D
1	SP1	SP2	SP3	SP4
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0,04597063	0,03572842	9,796269	0,04088438
9	0,1029649	0,08002442	21,94166	0,09157273
10	0,1428209	0,1110006	30,43492	0,127019
11	0,2341344	0,1819695	49,89367	0,2082295
12	0,04650027	0,03614006	9,909135	0,04135542
13	0,0297304	0,0231065	6,335501	0,02644099
14	0,2095868	0,162891	44,66261	0,1863978
15	0,1838443	0,142884	39,17693	0,1635035
16	0,07646053	0,0594252	16,29362	0,06800084
17	0,04301155	0,03342861	9,165692	0,03825269
18	0,09896609	0,07691654	21,08952	0,08801635
19	0,06605244	0,05133602	14,07567	0,05874431
20	0,01599096	0,01242819	3,407648	0,0142217
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	0	0	0
25	0	0	0	0

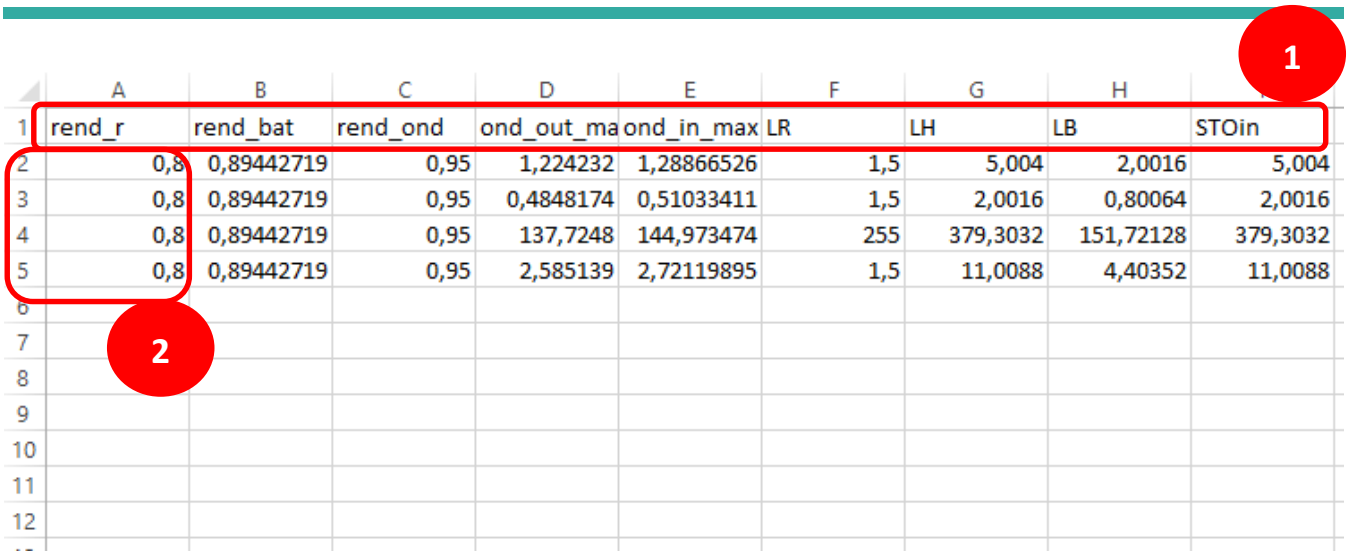
1- Each column corresponds to a building. In this model, there are 4 buildings data to simulate on Smarten.
2- Each row corresponds to an hour. In this model, there are 24 hours (from row n°2 to row n°25) of data to simulate on Smarten. The row n°1 indicates the buildings reference (SP1, SP2, SP3 and SP4), and doesn't count as an hour value.
3- There are four input sheets to run the simulation on Smarten:
    a. SP: Production System, the renewable energy production for each hour
    b. SC: Consumption System, the needed energy or load for each hour
    c. P_ch: Battery charging file, the battery charging situation for each hour (needed for the Strategy 2 only)
    d. P_dech: Battery discharging file, the battery discharging situation for each hour (needed for the Strategy 2 only)

Remarks:
- All the data filled in theses sheets must be in kilowatt [kW]
- The user must fill all these sheets according to their data for the simulation.

Example: in the model, in the SP sheet (Production System)
- at 1:00 (row n°2), the building n°1 has "0[kW]" of renewable energy production
- at 7:00 (row n°8), the building n°1 has "0,04597063[kW]" of renewable energy production

4.2. Parameters file

Before launching Smarten v1.0, users must fill the parameters file in order to use it for the simulation.
A model of the parameters file is released with the setup package. The model is named: "smarten_parameters.xlsx", and there is only one sheet inside.
Open "smarten_parameters.xlsx" and fill the sheet as indicated below.



	A	B	C	D	E	F	G	H	
1	rend_r	rend_bat	rend_ond	ond_out_ma	ond_in_max	LR	LH	LB	STOin
2	0,8	0,89442719	0,95	1,224232	1,28866526	1,5	5,004	2,0016	5,004
3	0,8	0,89442719	0,95	0,4848174	0,51033411	1,5	2,0016	0,80064	2,0016
4	0,8	0,89442719	0,95	137,7248	144,973474	255	379,3032	151,72128	379,3032
5	0,8	0,89442719	0,95	2,585139	2,72119895	1,5	11,0088	4,40352	11,0088
6									
7									
8									
9									
10									
11									
12									

1- Each column corresponds to a parameter needed for the simulation. To run a simulation in Smarten v1.0, the user has to fill 9 parameters. The first 5 parameters are needed for the Strategy 2 only. If the user choose the Strategy 1, Smarten v1.0 will not take in charge the first 5 parameters. The parameters are:
   a. rend_r: the network electricity yield (needed for the Strategy 2 only)
   b. rend_bat: the storage battery yield (needed for the Strategy 2 only)
   c. rend_ond: the converter yield (needed for the Strategy 2 only)
   d. ond_out_max: the maximum output power of the converter (needed for the Strategy 2 only) in [kW]
   e. ond_in_max: the maximum input power of the converter (needed for the Strategy 2 only) in [kW]
   f. LR: grid withdrawal limit in [kW]
   g. LH: upper limit of the storage system in [kW]
   h. LB: lower limit of the storage system in [kW]
   i. STOin: the initial storage before the simulation in [kW]

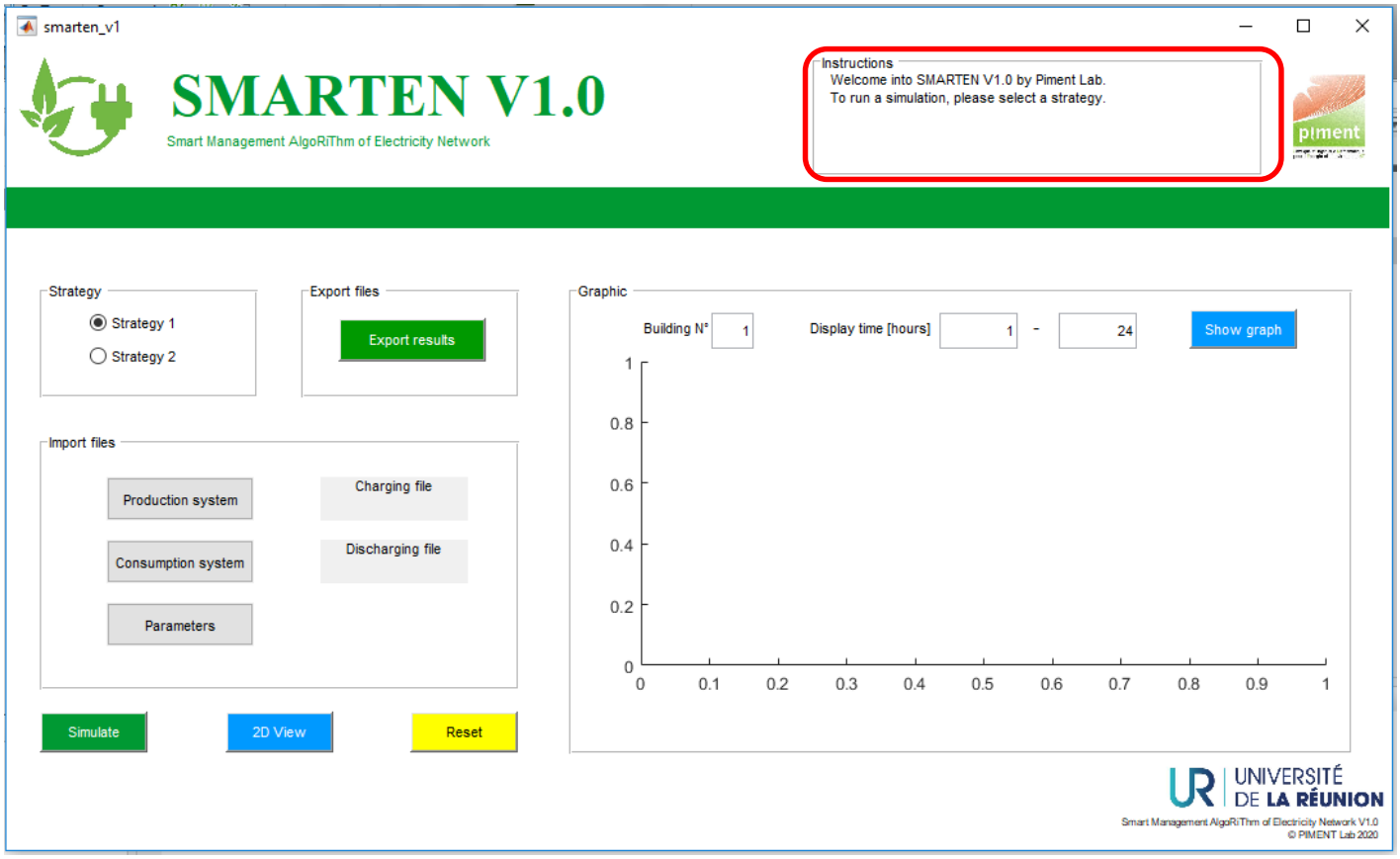
2- Each row corresponds to a building. In this model, there are 4 buildings, so there are four rows in the parameters file (from the row n°2 to the row n°5). The order of the buildings in the parameters file must correspond to the order of the buildings in the inputs file.

Example: in the parameters file model, the initial storage (STOin) of the building n°3 is “379.3032[kW]”.

5. Run a simulation with Smarten v1.0

To run a simulation with Smarten v1.0:

1. Perform the Setup of Smarten
2. Fill the Pre-required files
3. Run Smarten v1.0, and this window will appear. An instruction tab indicates to the user how to run a simulation step by step. Always refer to these instructions to avoid incorrect manipulation.



4. Choose the strategy of the simulation.
   a. The strategy 1 refers to an algorithm that depends on these input files :
      - SP: Production System, the renewable energy production for each hour
      - SC: Consumption System, the needed energy or load for each hour

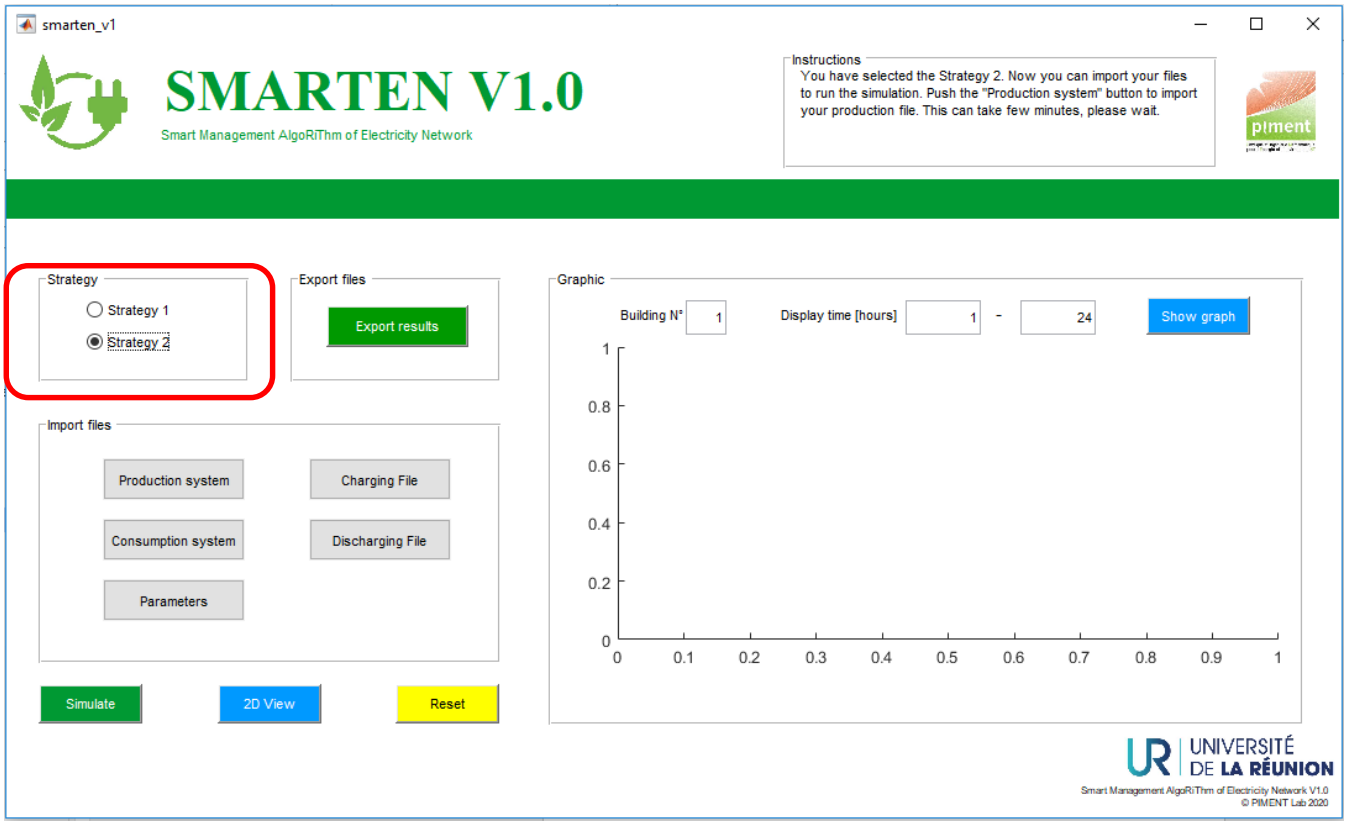
      And theses parameters:
      - LR: grid withdrawal limit in [kW]
      - LH: upper limit of the storage system in [kW]
      - LB: lower limit of the storage system in [kW]
      - STOin: the initial storage before the simulation in [kW]

b. The strategy 2 refers to an algorithm that depends on these input files :

- SP: Production System, the renewable energy production for each hour
- SC: Consumption System, the needed energy or load for each hour
- P_ch: Battery maximum charging power
- P_dech: Battery maximum discharging power

And theses parameters:

- rend_r: the network electricity yield
- rend_bat: the storage battery yield
- rend_ond: the converter yield
- ond_out_max: the maximum output power of the converter in [kW]
- ond_in_max: the maximum input power of the converter in [kW]
- LR: grid withdrawal limit in [kW]
- LH: upper limit of storage capacity in [kWh
- LB: lower limit of the storage capacity in [kW]
- STOin: the initial storage before the simulation in [kW]



5. Import the inputs file

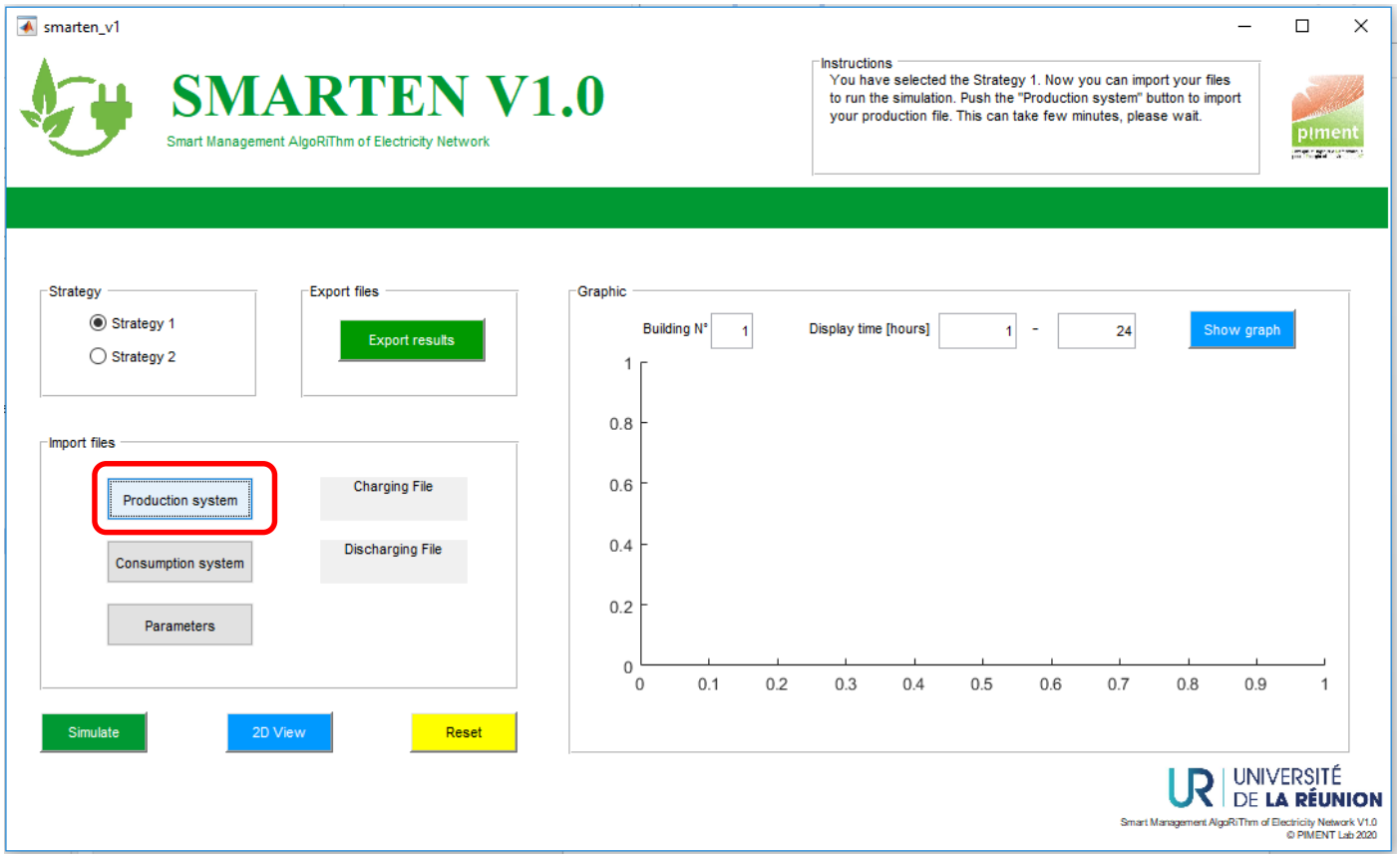
   a. For strategy 1, the user must import 3 datasheets:

- Production system (available in “smarten_inputs.xlsx”)
- Consumption system (available in “smarten_inputs.xlsx”)
- Parameters (available in “smarten_parameters.xlsx”)

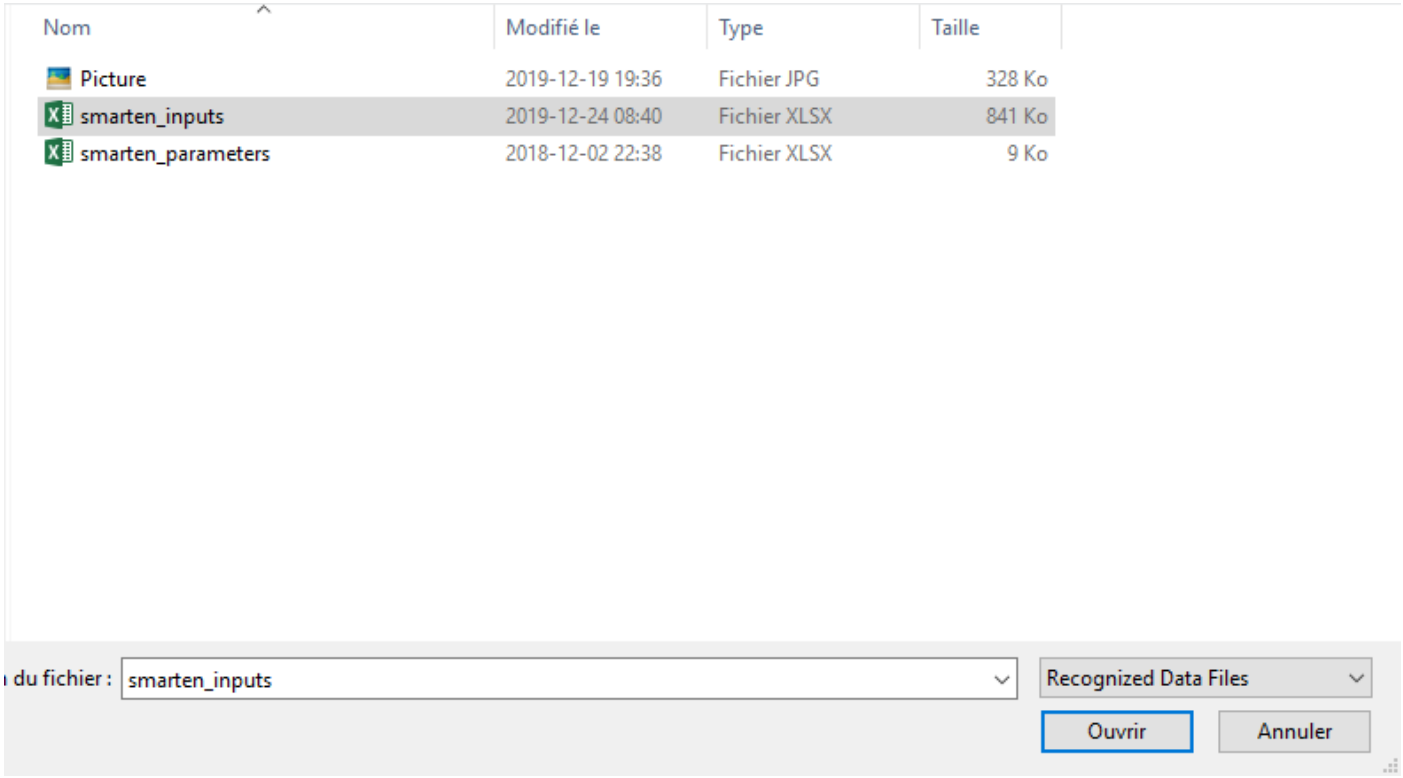
   b. For strategy 2, the user must import 5 datasheets:

- Production system (available in “smarten_inputs.xlsx”)
- Consumption system (available in “smarten_inputs.xlsx”)
- Parameters (available in “smarten_parameters.xlsx”)
- Charging file (available in “smarten_inputs.xlsx”)
- Discharging file (available in “smarten_inputs.xlsx”)

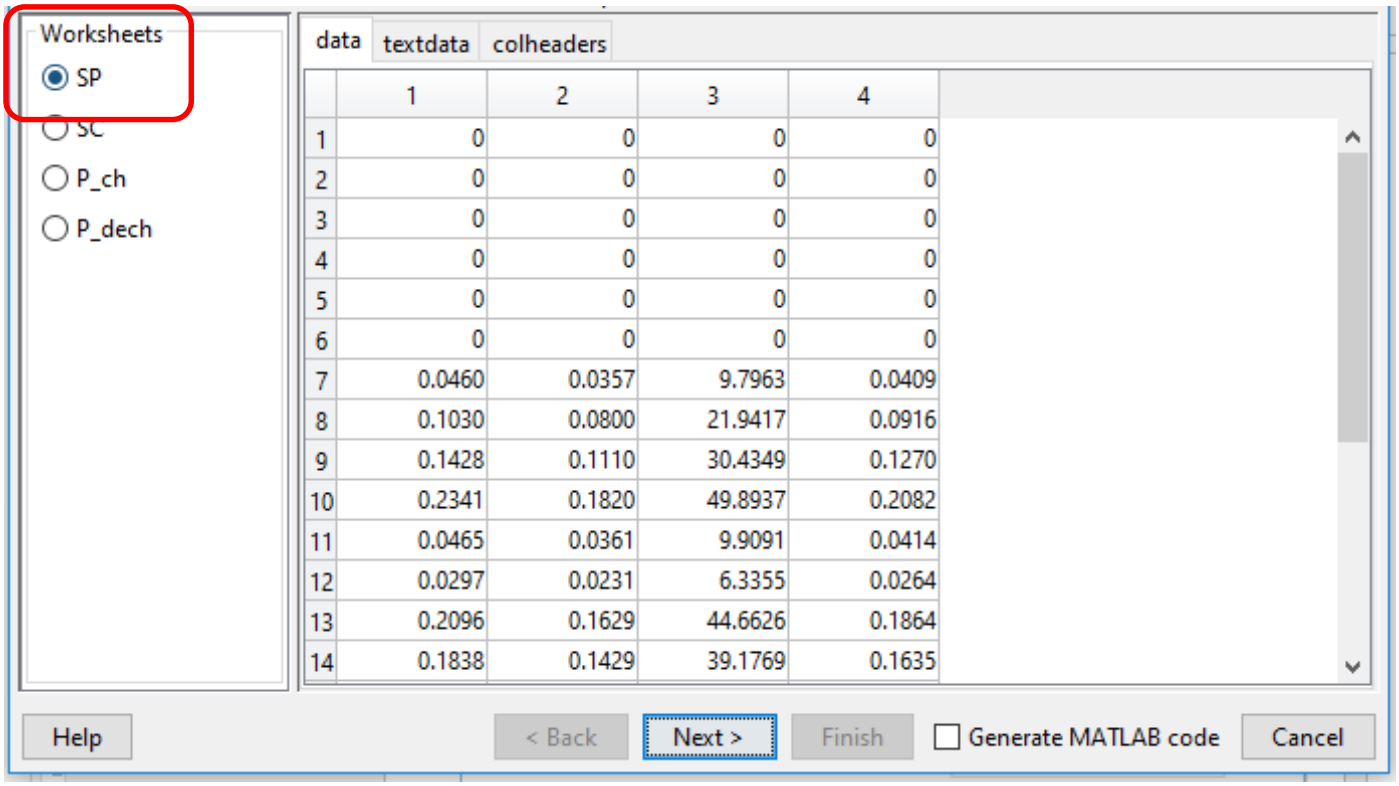
To import a file, click on the corresponding button.



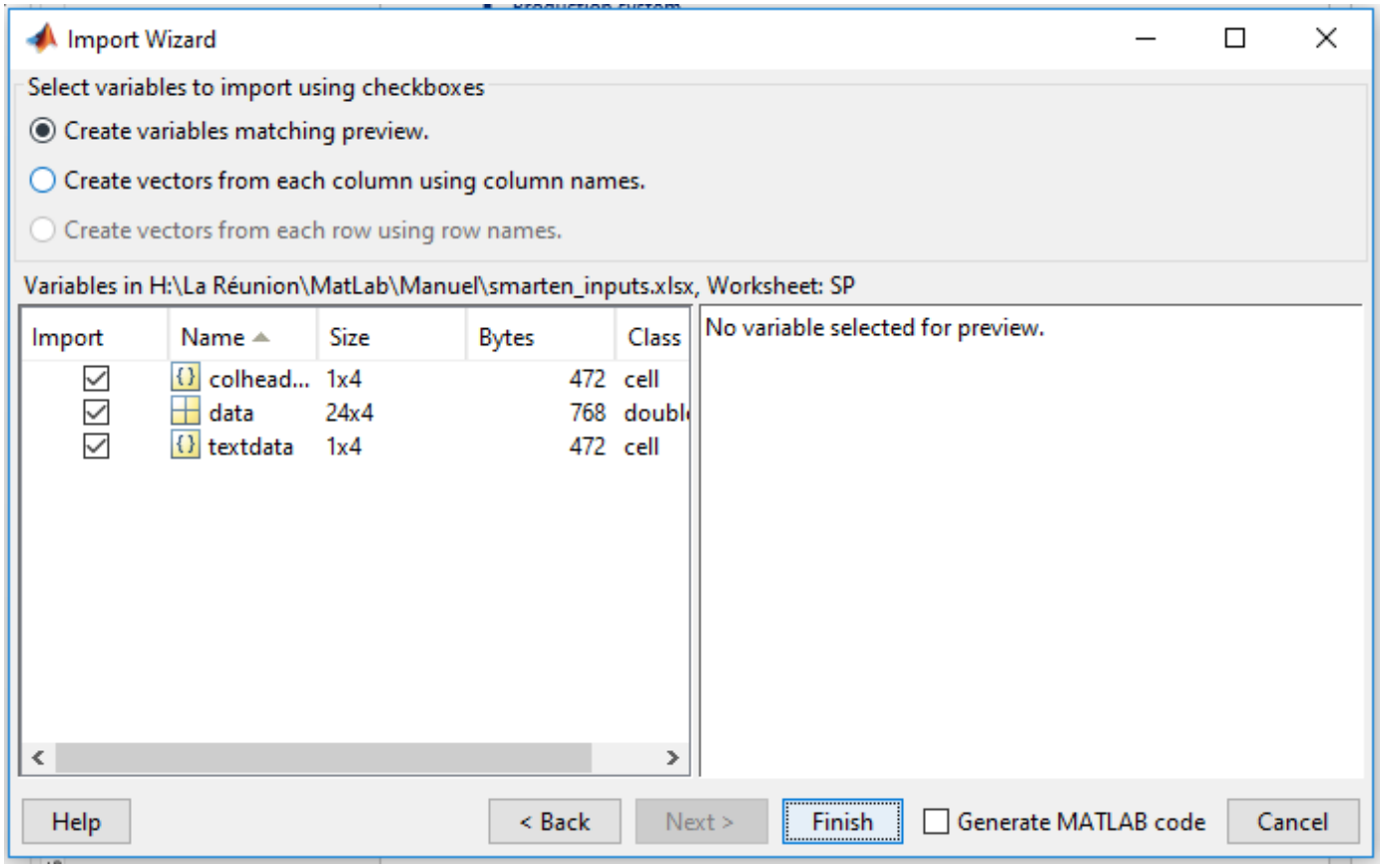
Choose the corresponding file. In this example, we will import the Production System sheet, and it is available in “smarten_inputs.xlsx”.



Choose the corresponding sheet (SP: Production System in this example)

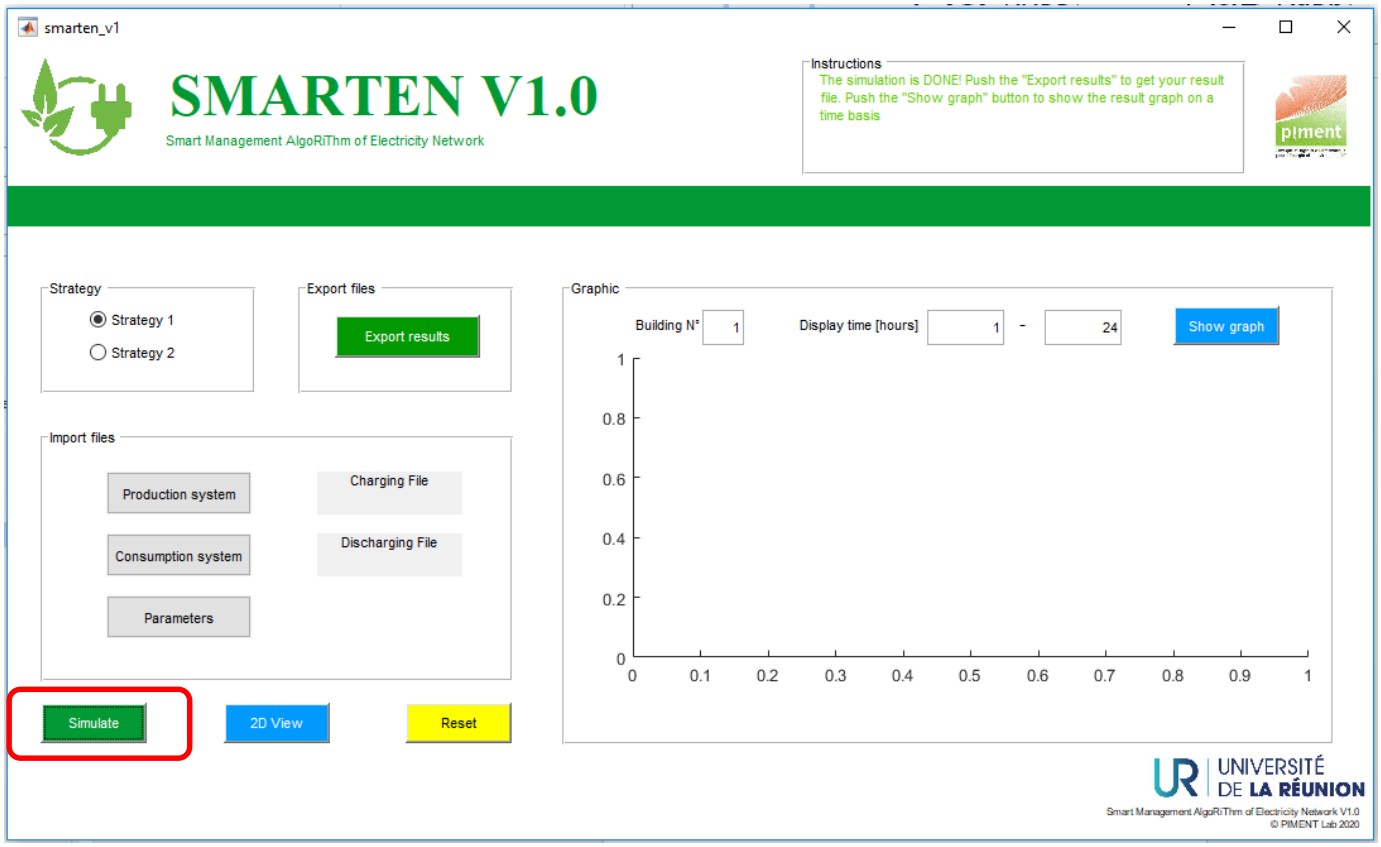


	1	2	3	4
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0.0460	0.0357	9.7963	0.0409
8	0.1030	0.0800	21.9417	0.0916
9	0.1428	0.1110	30.4349	0.1270
10	0.2341	0.1820	49.8937	0.2082
11	0.0465	0.0361	9.9091	0.0414
12	0.0297	0.0231	6.3355	0.0264
13	0.2096	0.1629	44.6626	0.1864
14	0.1838	0.1429	39.1769	0.1635



Repeat these steps to import all the needed files according to the chosen strategy.

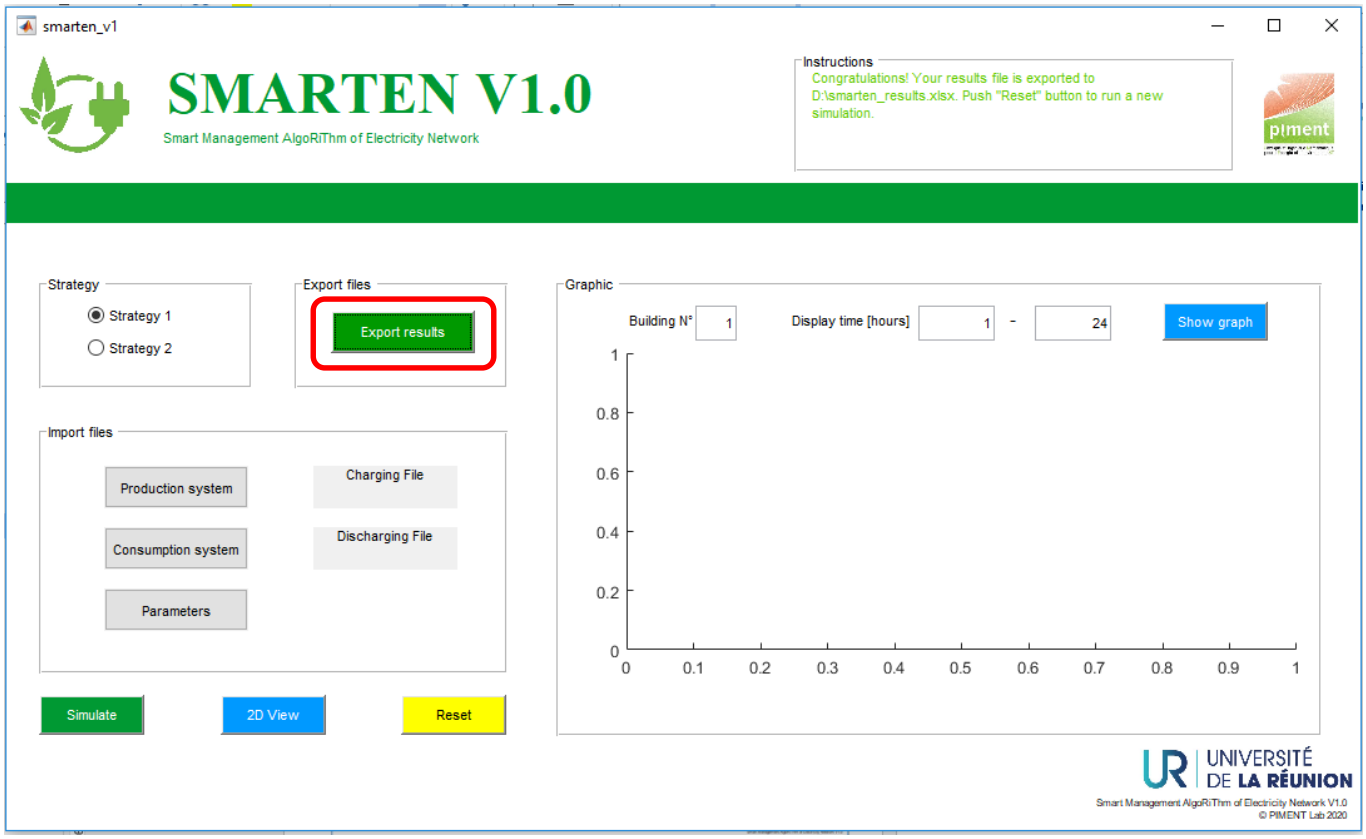
6. Run the simulation after all the input files have been imported. Click on the "Simulate" button and Smarten will calculate the scenarios.



6. Export the results

After the simulation is done, the user can export the results of the simulation in a file named "smarten_results.xlsx", which will be located to the directory "D:\smarten_results.xlsx".

Remark: If the computer of the user doesn't have a "\D:" partition, insert a USB flash disk in the" \D:" USB port to export the results file inside.

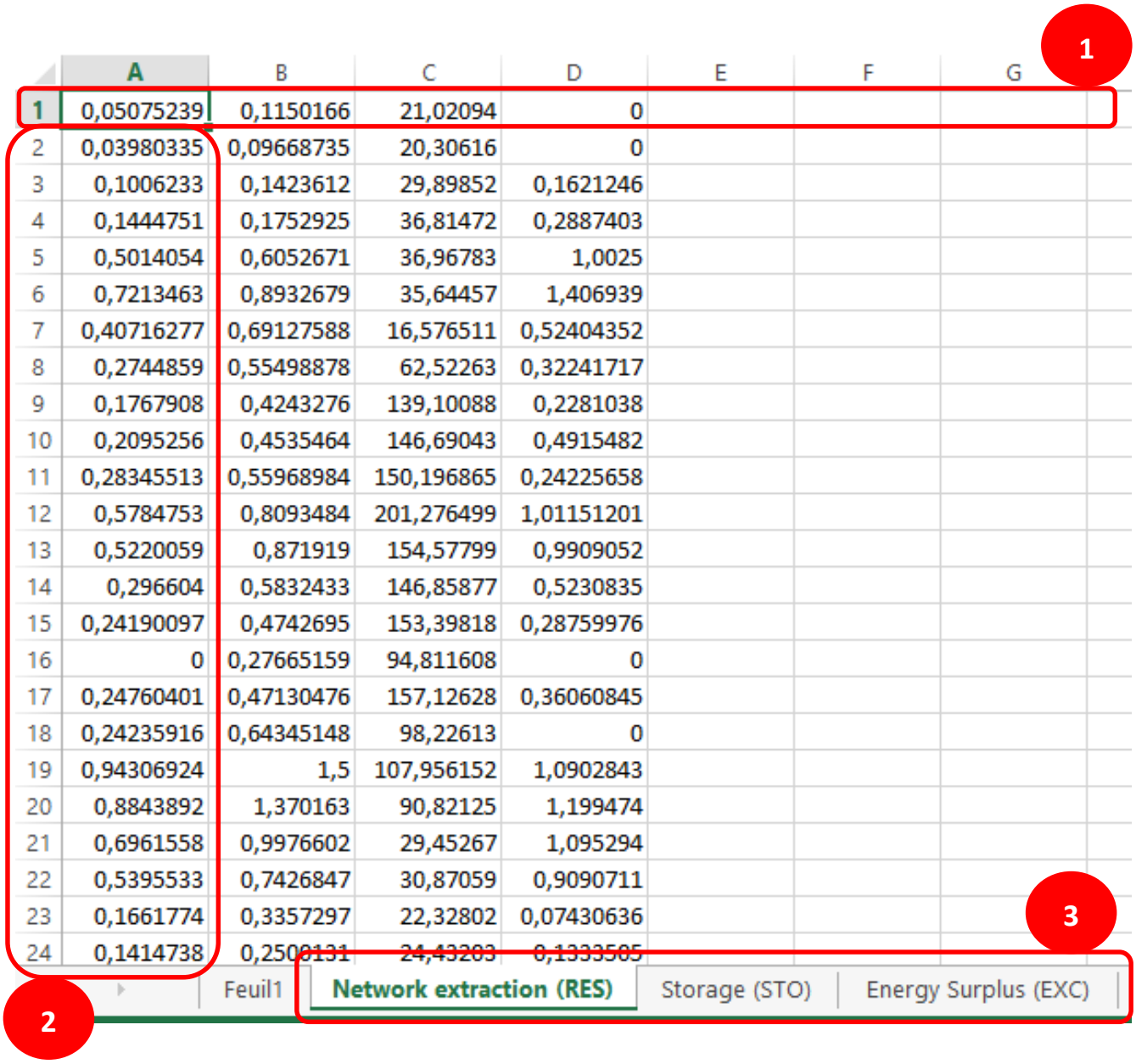


For the strategy 1, the results file contains 3 sheets, corresponding to:

- The Network extraction (RES)
- The Storage (STO)
- The Energy Surplus (EXC)

For the strategy 2, the results file contains 4 sheets, corresponding to:

- The Network extraction (RES)
- The Storage (STO)
- The Energy Surplus 1 (EXC1) : the DC renewable-energy-production surplus before the converter
- The Energy Surplus 2 (EXC) : the AC renewable-energy-production surplus after the converter



	A	B	C	D	E	F	G
1	0,05075239	0,1150166	21,02094	0			
2	0,03980335	0,09668735	20,30616	0			
3	0,1006233	0,1423612	29,89852	0,1621246			
4	0,1444751	0,1752925	36,81472	0,2887403			
5	0,5014054	0,6052671	36,96783	1,0025			
6	0,7213463	0,8932679	35,64457	1,406939			
7	0,40716277	0,69127588	16,576511	0,52404352			
8	0,2744859	0,55498878	62,52263	0,32241717			
9	0,1767908	0,4243276	139,10088	0,2281038			
10	0,2095256	0,4535464	146,69043	0,4915482			
11	0,28345513	0,55968984	150,196865	0,24225658			
12	0,5784753	0,8093484	201,276499	1,01151201			
13	0,5220059	0,871919	154,57799	0,9909052			
14	0,296604	0,5832433	146,85877	0,5230835			
15	0,24190097	0,4742695	153,39818	0,28759976			
16	0	0,27665159	94,811608	0			
17	0,24760401	0,47130476	157,12628	0,36060845			
18	0,24235916	0,64345148	98,22613	0			
19	0,94306924	1,5	107,956152	1,0902843			
20	0,8843892	1,370163	90,82125	1,199474			
21	0,6961558	0,9976602	29,45267	1,095294			
22	0,5395533	0,7426847	30,87059	0,9090711			
23	0,1661774	0,3357297	22,32802	0,07430636			
24	0,1414738	0,2508131	24,43283	0,1333585			

1. Each column corresponds to a building, so there are 4 buildings in this example
2. Each row corresponds to an hour, so there are 24 hours of simulation in this example
3. This example have been simulated with the Strategy 1, so there are 3 sheets in the results file:
    - The Network extraction (RES)
    - The Storage (STO)
    - The Energy Surplus (EXC)

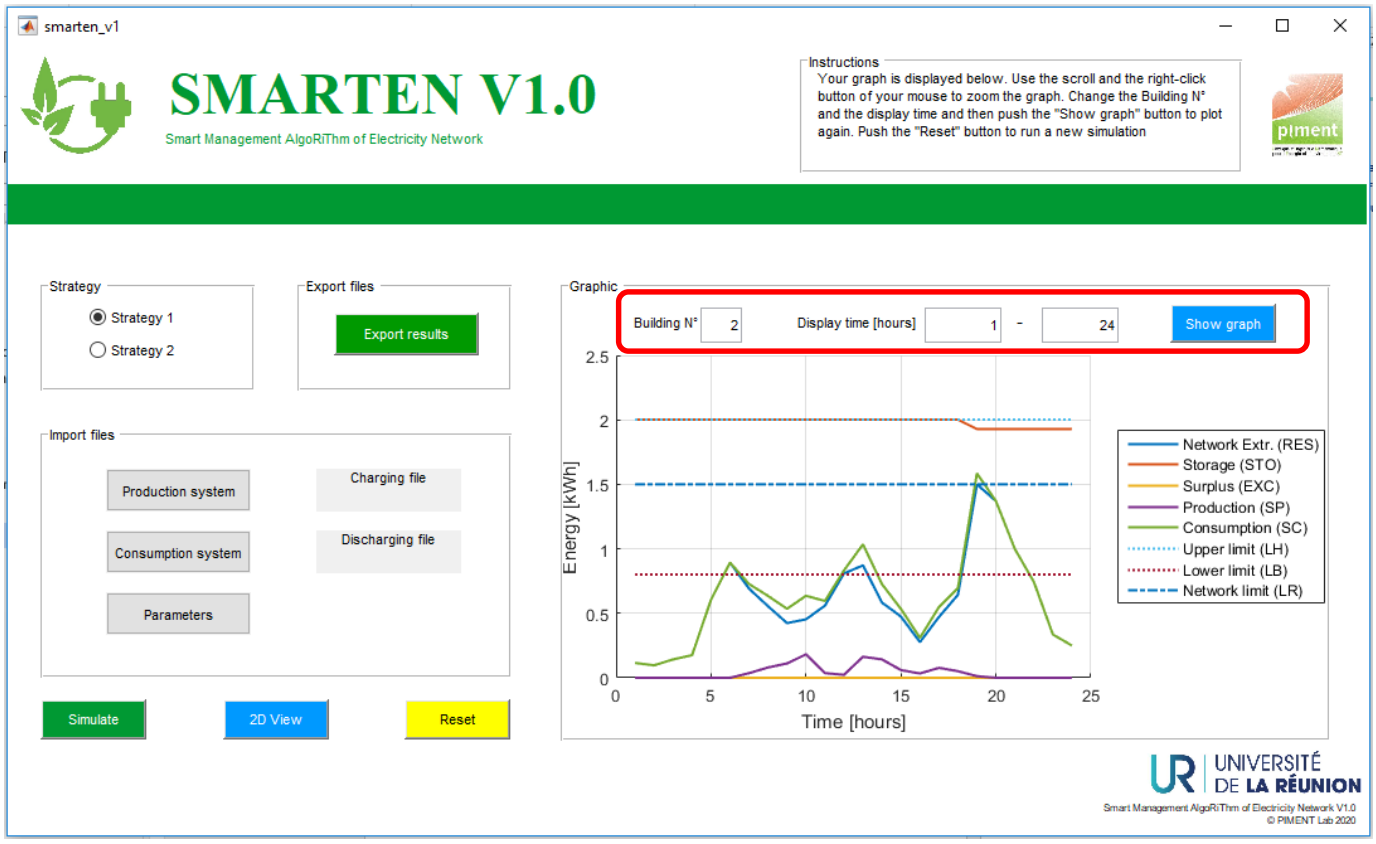
Remark: This results file is made available and modifiable for the users' convenience (showing graphics, sorting out, presentation …)

7. Graph

After the simulation is done, to view the graph of the simulation in Smarten v1.0:

1. Fill the “Building N°” field, according to the number of building set in the inputs file
2. Fill the “Display time [hours]” field, according to the number of hours of simulation set in the inputs file
3. Push the “Show graph” button
4. Repeat the step 1-2-3 to view another graph

This example show the graph of the simulation for the Building N°2 from the hour 1 to the hour 24.



Remark: The user can zoom in and zoom out the graph by using the scroll and the right-click button of the mouse.

8. 2D visualization

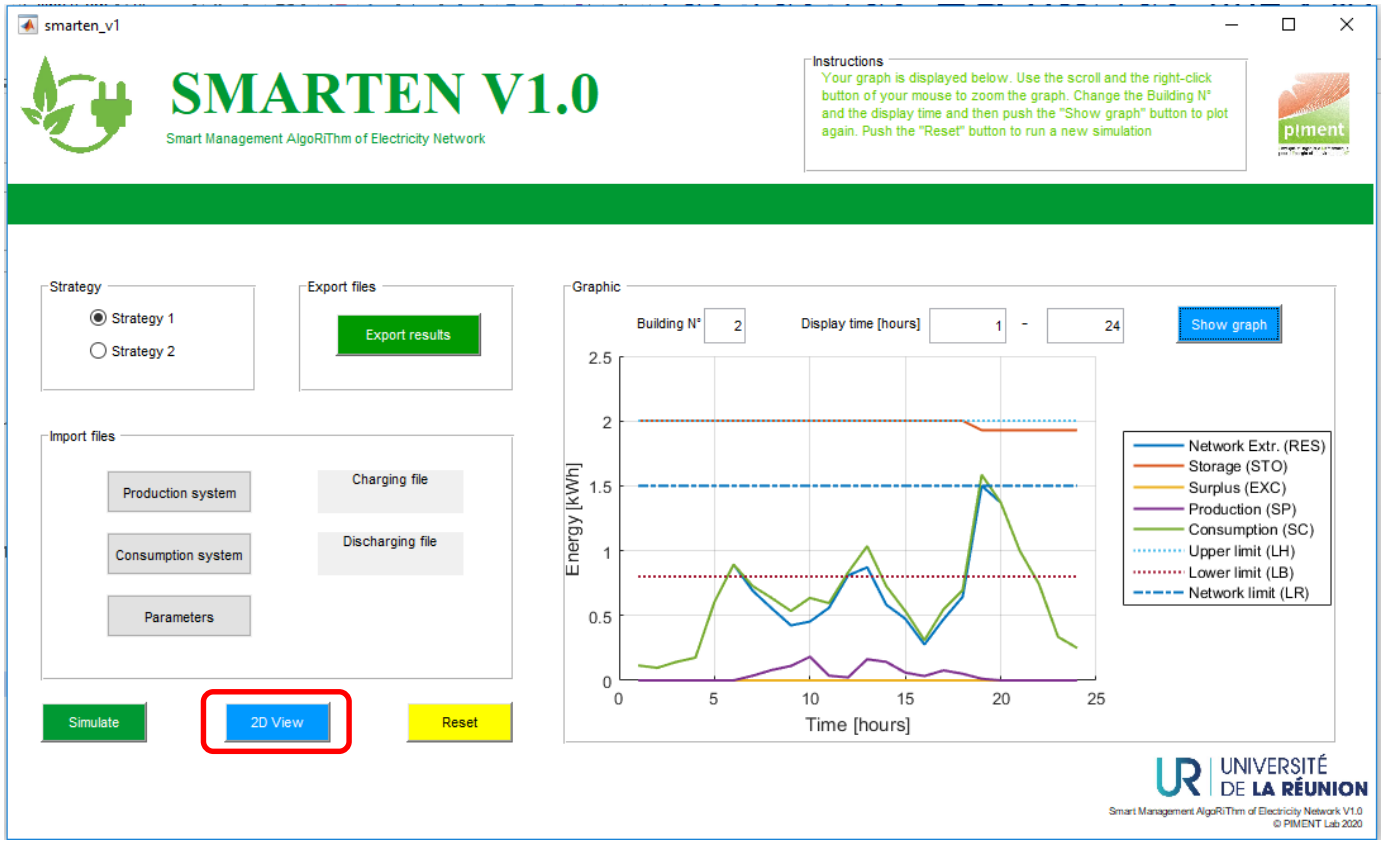
One of the best advantage using Smarten v1.0 is his multi-scale aspect. With the “2D view” button of Smarten, the user have the possibility to view a 2D visualization of the simulation in a map.

8.1. Prepare a map

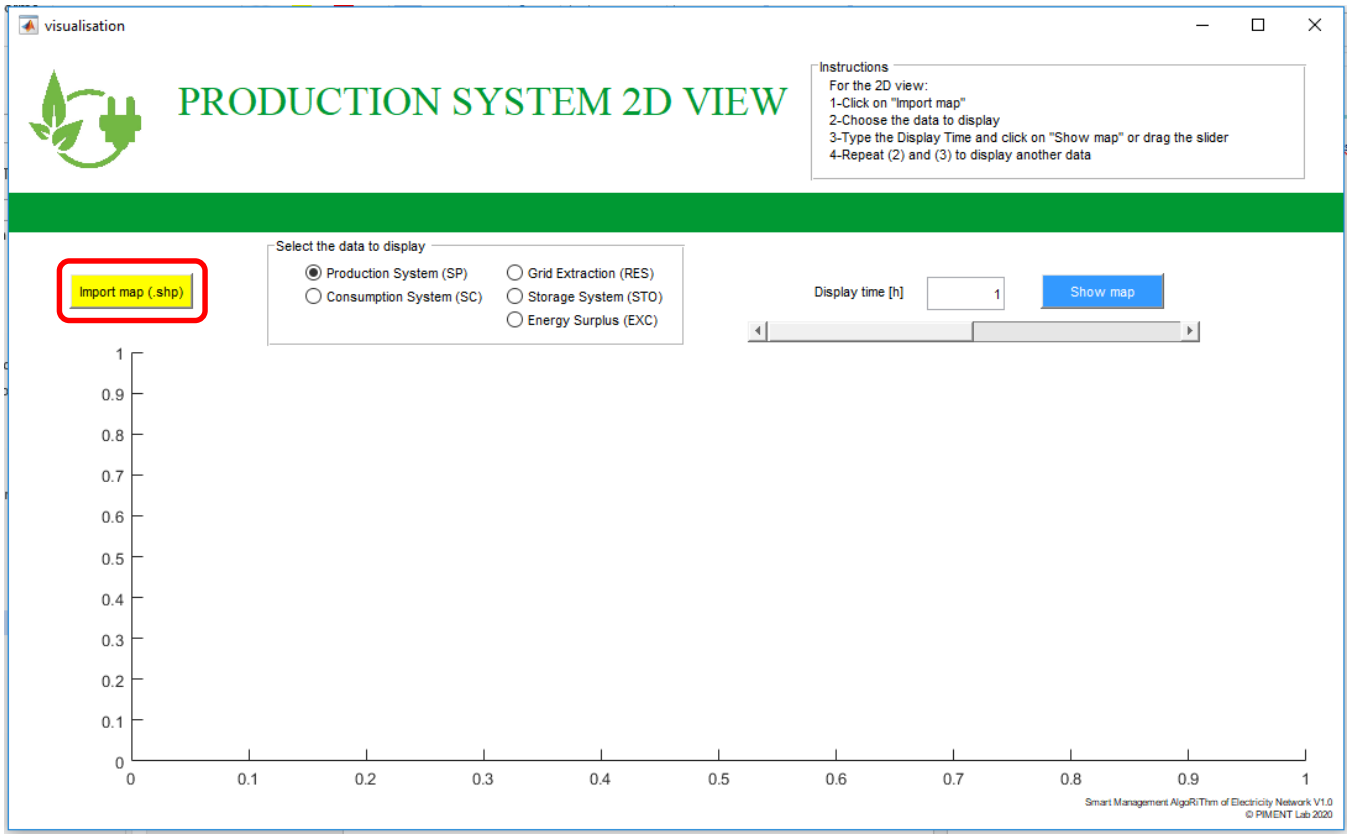
The user have to prepare a map of a village, or a district, or a city, or a town …where he wants to install the mixed electrical energy management. In this case, the map must be in a Shapefile (.shp) extension.
There are many tools and software which edit and create a Shapefile from an existing map (QGIS …).
The key point of the preparation of the map is that each “Polygon” of the Shapefile corresponds to a number that refers to a building. Smarten will take these numbers and will link them to the columns of the inputs file.

8.2. Display the 2D view

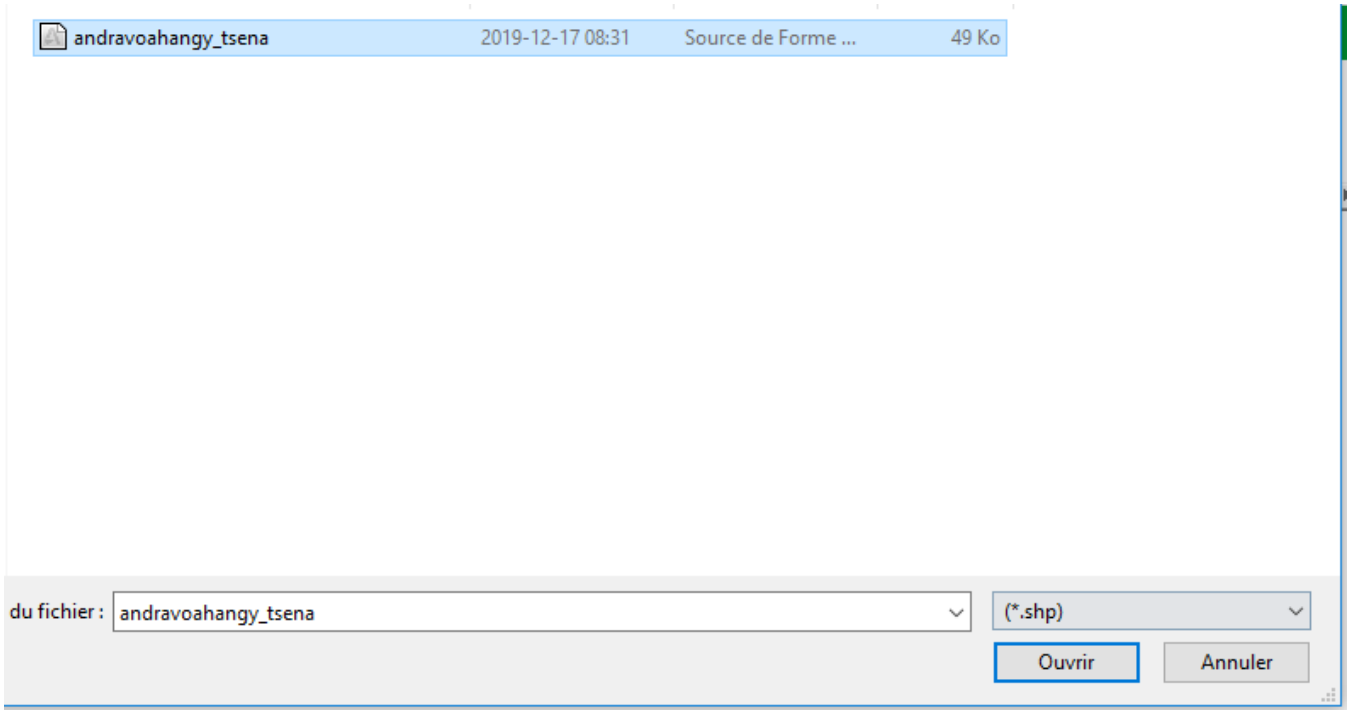
1. Click on the “2D view” button and a window will appear



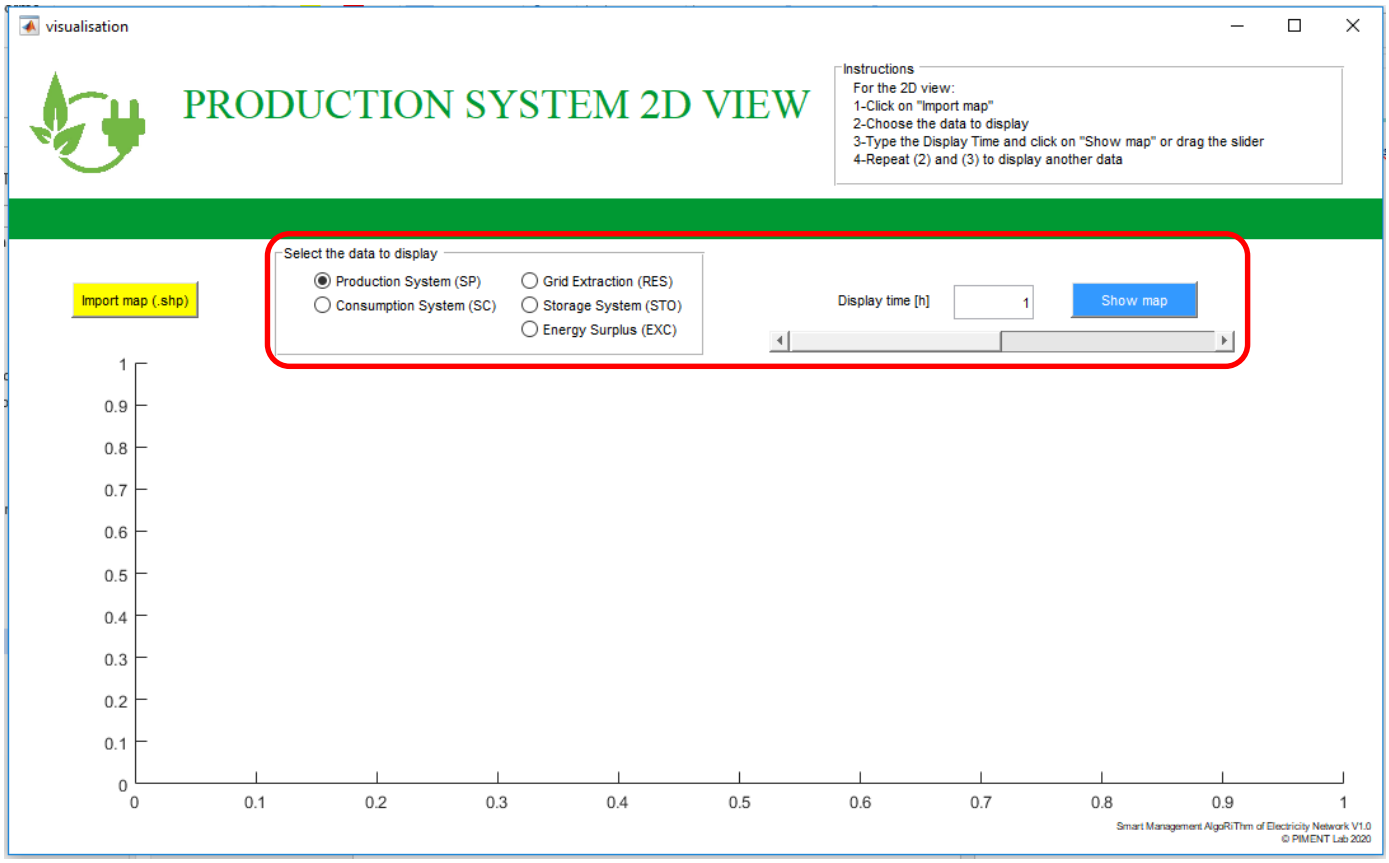
2. Import the prepared map by clicking the “Import map (.shp)” button



3. Choose the Shapefile

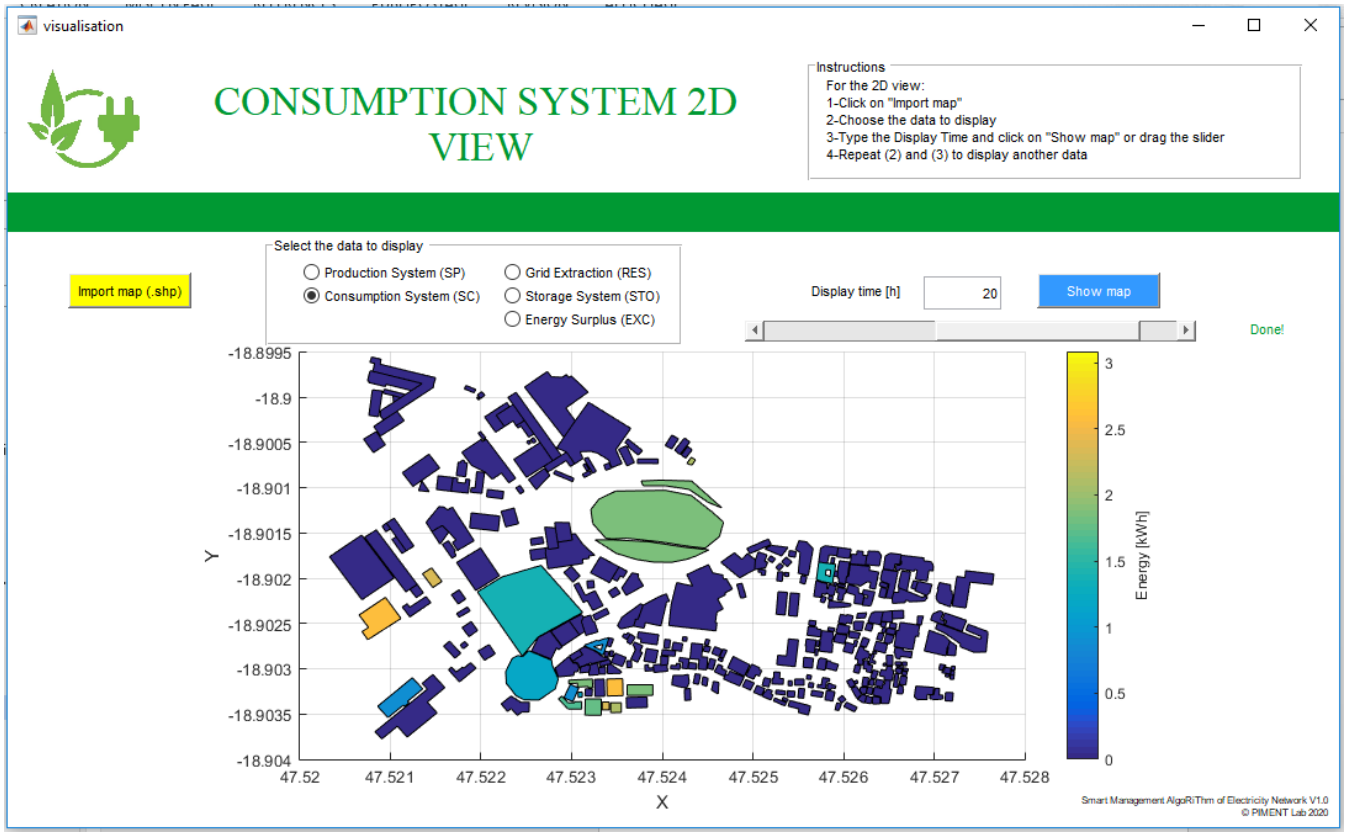


4. Select the data to display
5. Choose the display time by filling the field
6. Push “Show map” button and the map will be showed according with the chosen data and the chosen display time
7. The user can change the display time with the slider
8. Repeat the steps 4-5-6-7 to have another view



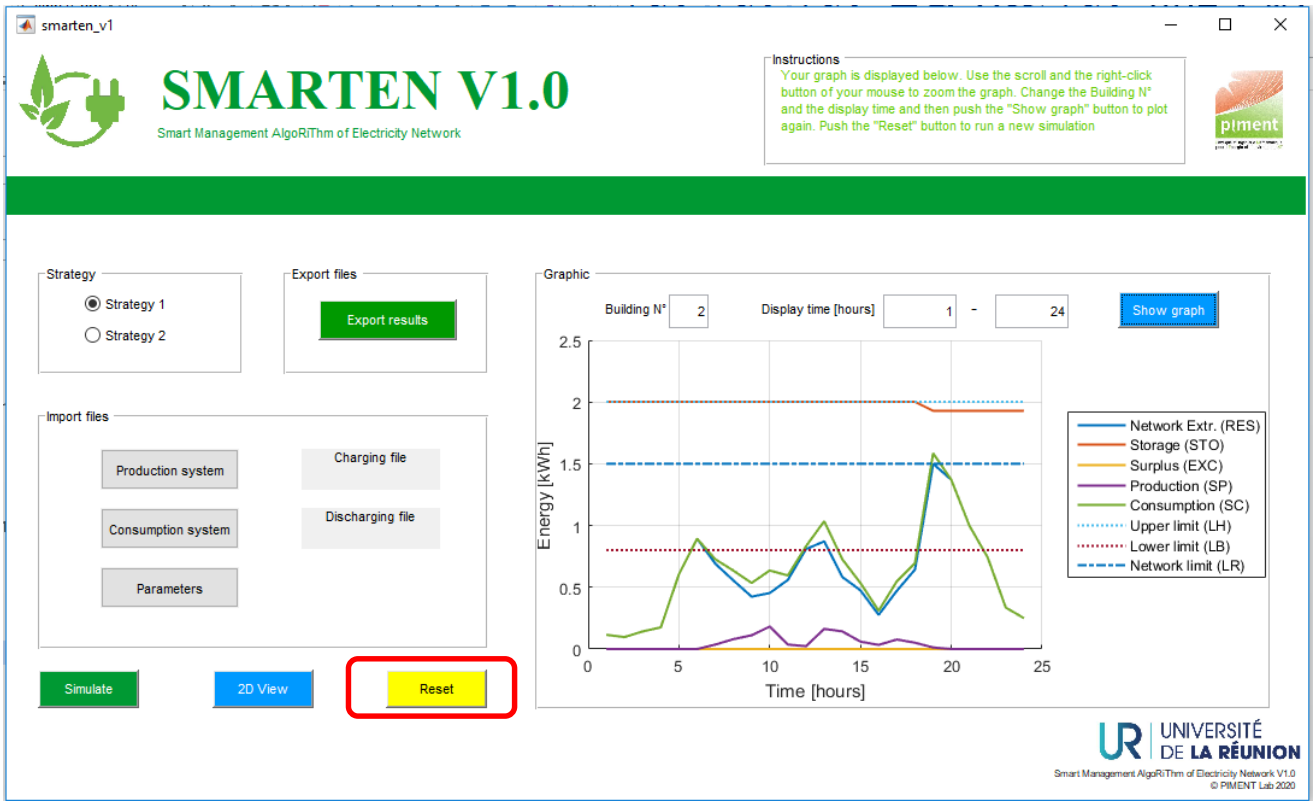
Example: In this example, the 2D tool shows the “Consumption System (SC)” of an area where 20 buildings are connected to the mixed electrical energy management tool at 20:00.

The color-bar indicates the range of energy, each connected building has a color according to that color-bar.



9. Run a new simulation

To run a new simulation with Smarten, press the “Reset” button and repeat the steps from Run a simulation with Smarten v1.0.



Smarten

Author:
Ando Ny Aina RANDRIANTSOA
ando.randriantsoa.istt@gmail.com

Please feel free to contact us for any question, issue or comment about Smarten v1.0

Thank you for using Smarten v1.0