Energy and Flexibility Modelling

Hands-on exercise 11: Installing FlexTool

Pease use the following citation for this exercise:

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Please download the IRENA FlexTool Package from this link

Learning outcomes

By the end of this exercise you will be able to:

1) Install and use FlexTool on your computer
2) Diagnose possible installation errors
3) Become familiar with the tool interface and different files
4) Run a model on your computer and get the result file

About FlexTool

IRENA FlexTool is a software package developed by IRENA and VTT Technical Research Centre of Finland published under GNU Lesser General Public License. Users are free to modify and redistribute the software under LGPL. New versions will be published on irena.org. The main aim of the tool is to make a quick but yet thorough assessment of potential flexibility gaps and identify the cost-effective mix of options to fill such gaps.

Note: To be able to use FlexTool, users must have Excel on their machines.

Installing FlexTool

There are a few easy steps for Installing FlexTool :

Downloading FlexTool and extracting to disk

a) Download FlexTool from the following link to IRENA's website https://www.irena.org/energytransition/Energy-System-Models-and-Data/IRENA-FlexTool

b) FlexTool can be run from anywhere on the computer. Therefore you can save the file in any place on your computer. Here we install FlexTool on "c:\FlexTool". Create a folder named "FlexTool" in your C drive and extract the downloaded zip file to it. We will call this the "root folder".

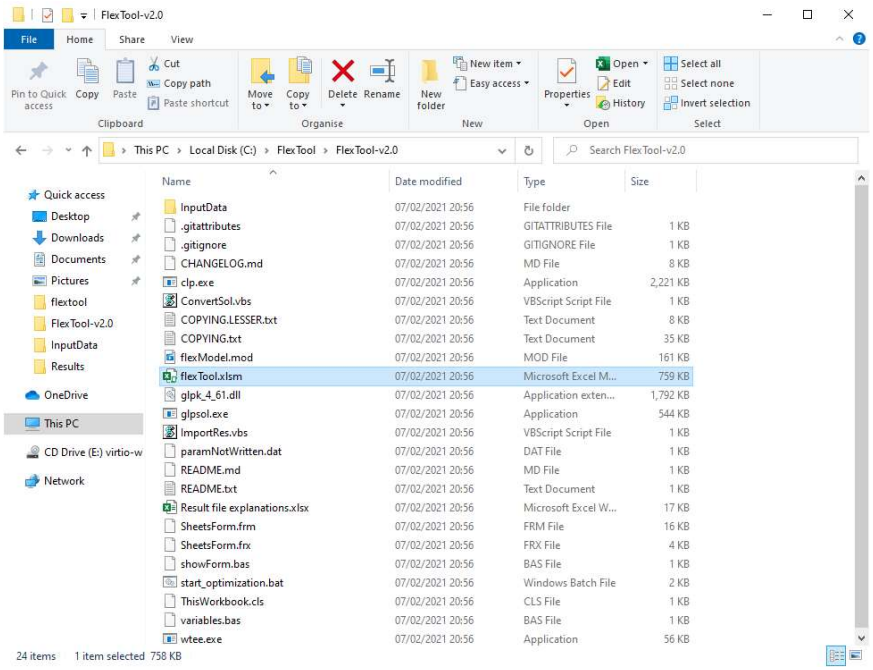
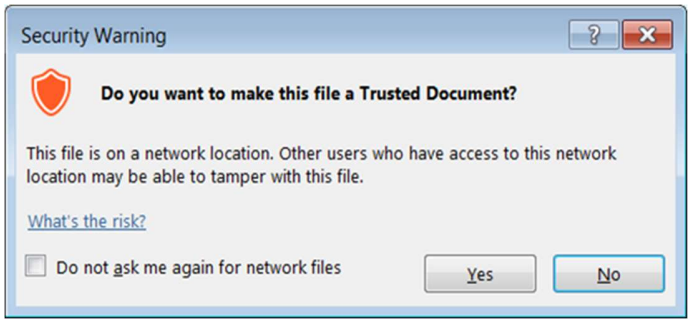


*Figure 1: FlexTool root folder. The main interface file **flexTool.xlsm** is highlighted. The input file can be found in the **InputData** folder*

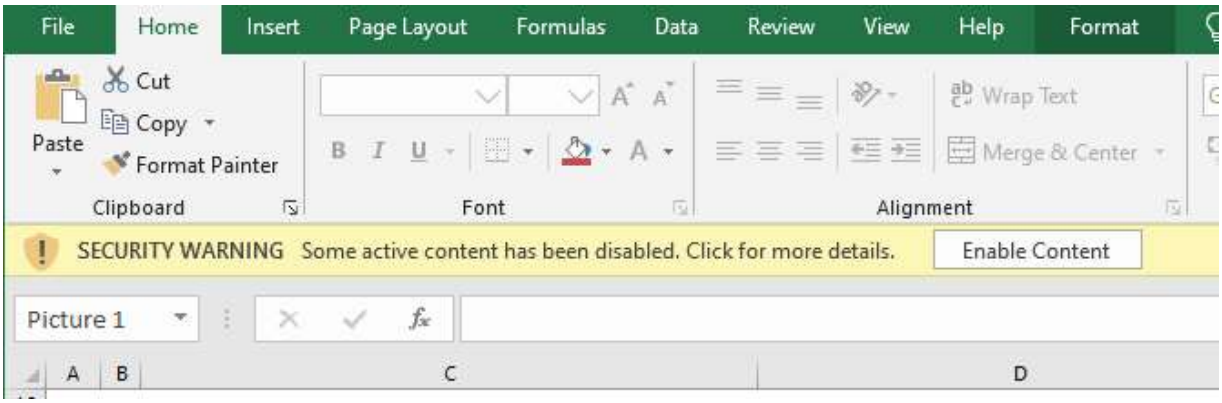
c) The extracted folder contains an **InputData** folder where you can find input excel workbooks, the executables files and the main interface of the tool, which is an excel file named flexTool.xlsm (highlighted in Figure 1).

Enabling macros in the main worksheet

a) From the root folder, open “flextTool.xlsm” excel file.
b) You may be asked if you trust the document. Click “yes”

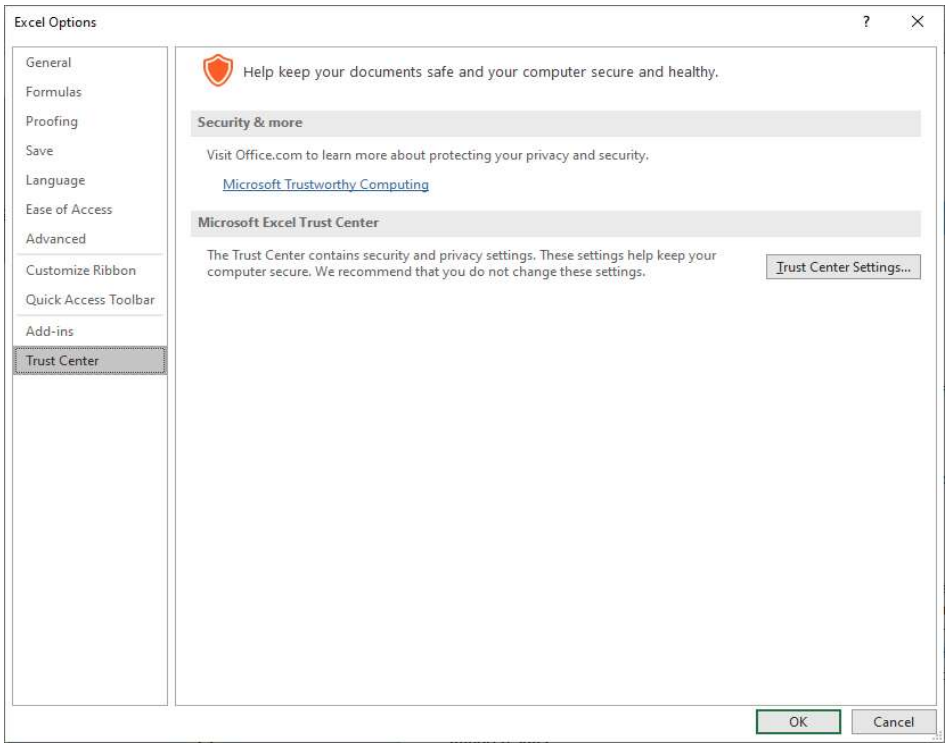


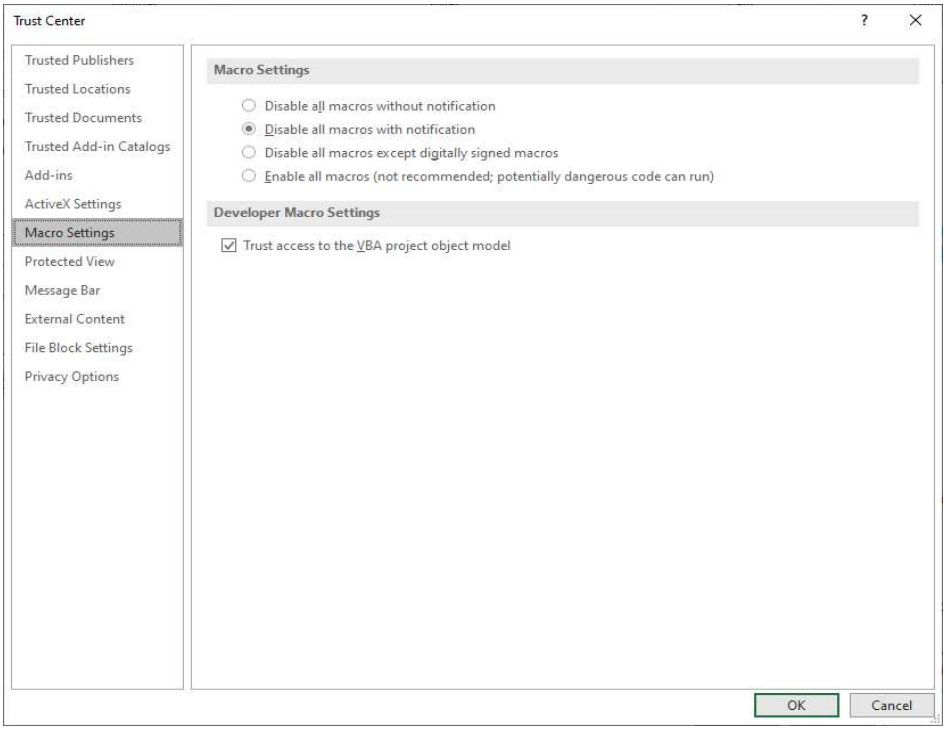
c) After opening the file you should enable content of the workbook



d) Enable macros:
   1. From the excel menu go to “File” -> “Options”.
   2. Then from the left pane select “Trust Center”
   3. Click on “Trust Center Settings”
   4. A new window will open. From the left pane select “Macro Settings”
   5. Enable “Trust access to the VBA project object model”
   6. Click “OK” to save settings and close.

Note: These steps are needed only for the first time you run the tool.


Excel Options
General
Formulas
Proofing
Save
Language
Ease of Access
Advanced
Customize Ribbon
Quick Access Toolbar
Add-ins
Trust Center
Help keep your documents safe and your computer secure and healthy.
Security & more
Visit Office.com to learn more about protecting your privacy and security.
Microsoft Trustworthy Computing
Microsoft Excel Trust Center
The Trust Center contains security and privacy settings. These settings help keep your computer secure. We recommend that you do not change these settings.
Trust Center Settings...
OK
Cancel


Trust Center
Trusted Publishers
Trusted Locations
Trusted Documents
Trusted Add-in Catalogs
Add-ins
ActiveX Settings
Macro Settings
Protected View
Message Bar
External Content
File Block Settings
Privacy Options
Macro Settings
Disable all macros without notification
Disable all macros with notification
Disable all macros except digitally signed macros
Enable all macros (not recommended; potentially dangerous code can run)
Developer Macro Settings
Trust access to the VBA project object model
OK
Cancel

Error:	Cause/Possible solution
Result file created but empty	Solver memory issue, CLP can handle larger models than GLPSOL
Programmatic access to visual basic project is not trusted	Check macro settings. "Trust access to the VBA project object model" have to be selected
flexmodel.mod:240: ts_inflow[NODE,0] out of domain (or similar)	You may have wrong time series, try to update the time series
Anti-virus program blocks some of the used executables: clp.exe, glpsol.exe, wtee.exe	Make an exception in the anti-virus program for the executable

Troubleshooting:

If optimization fails check errors from Results/Input data file name/Scenario name/output_[D/I]_y.txt.

(x = scenario number, y = phase number in optimisation, D/I = dispatch or investment mode)

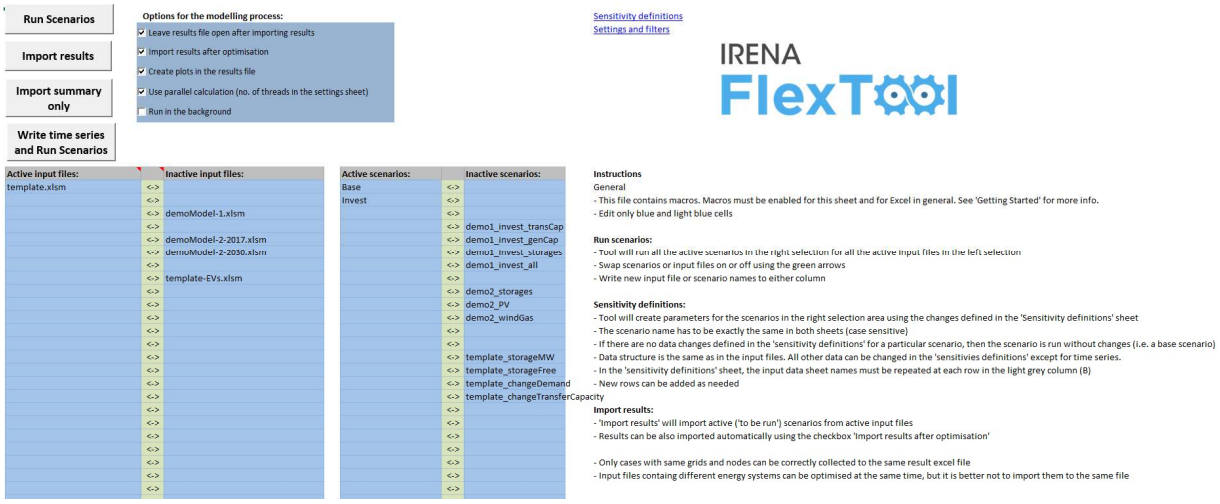
The table above summarizes the possible errors you may encounter in the installation process and possible causes and solutions.

The main files

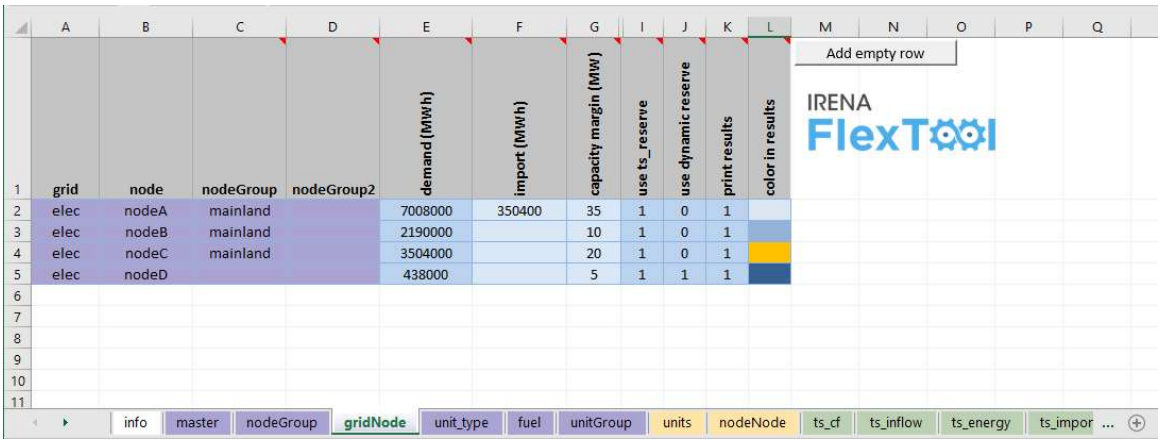
The tool includes three main MS Excel files:

- The main flexTool.xlsm file
- Input data files
- Result files

1) The **flexTool.xlsm** file acts as the interface to the tool. It is used to select the model and scenario used in the simulation, start running the model and define the sensitivity cases in “Sensitivity definitions” sheet.



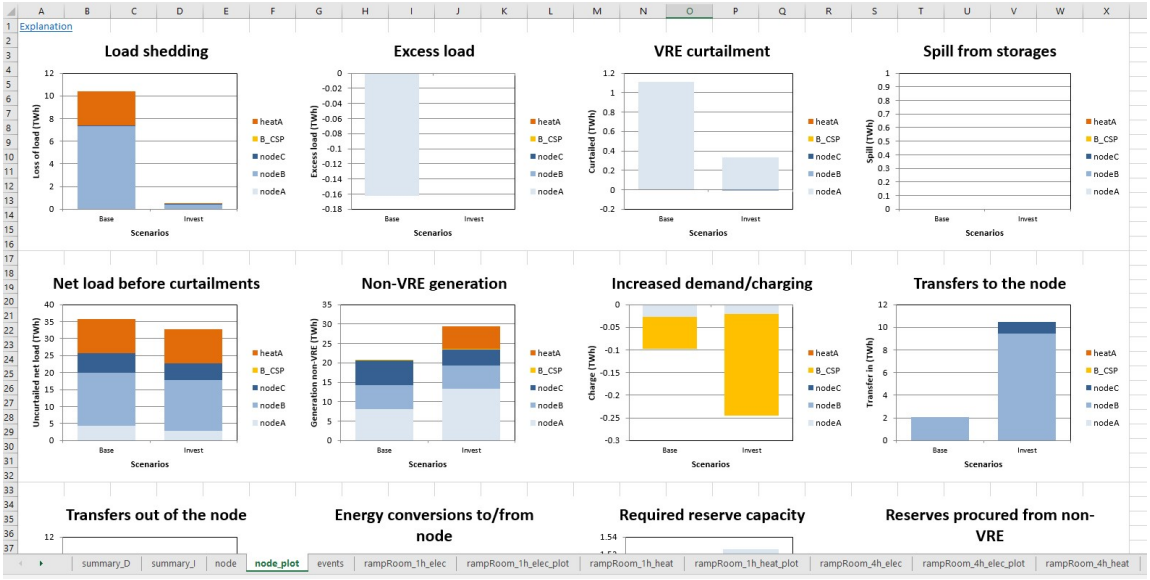
2) **Input file:** In FlexTool the Input data file define the model version. The flexTool.xlsm file is the same for all countries or regions, but input data is unique and case-specific. Therefore every case, region or model year needs its own input data file (e.g., Thailand 2019, Thailand 2030).

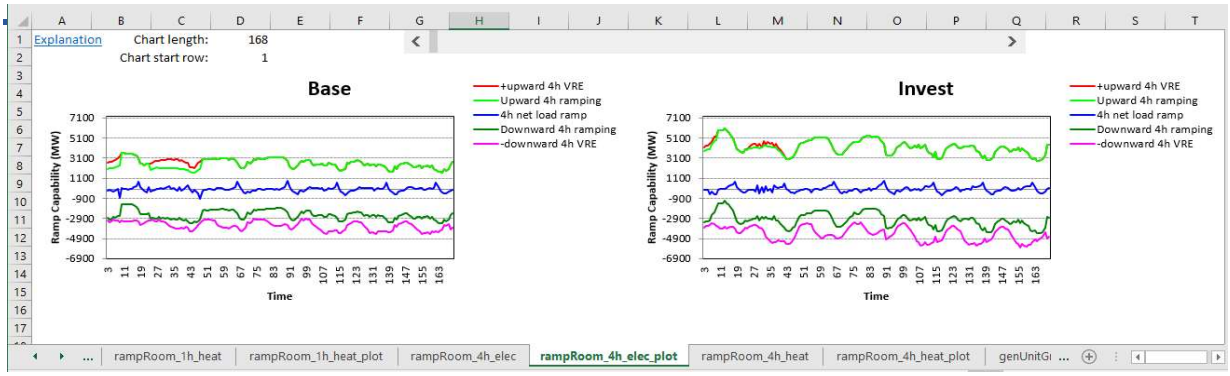


3) **Result output files:** The results file includes a diverse range of results for all the scenarios. The user can show only one scenario or to compare results from multiple scenarios.
   Once you run the model, a result folder is generated in the root folder which contains the result output excel files.

	A	B	C
1	Update sheets window	template	template
2		Base	Invest
3	Status	Optimal	Optimal
4	Optimal objective	1.06E+11	5203698667
5	Iterations	211	286
6	Solving time (s)	0.272	0.362
7			
8	Total cost obj. function (M CUR)	106431	5203.7
9	Total cost calculated (M CUR)	107108.2721	6247.177294
10	...Operational cost of units (M CUR)	1357.965577	1348.286882
11	...Investment cost of units (M CUR)	0	183.1187884
12	...Investment cost for transfers (M CUR)	0	8.86285496
13	...Penalty costs (M CUR)	105750.3066	4706.908769
14	...Curtailment payments (M CUR)	55.37235204	16.66851774
15			
16	Time in use in years	0.022146119	0.022146119
17	Full time series in years	1	1

summary_D | summary_I | node | node_plot | events | rampRoc





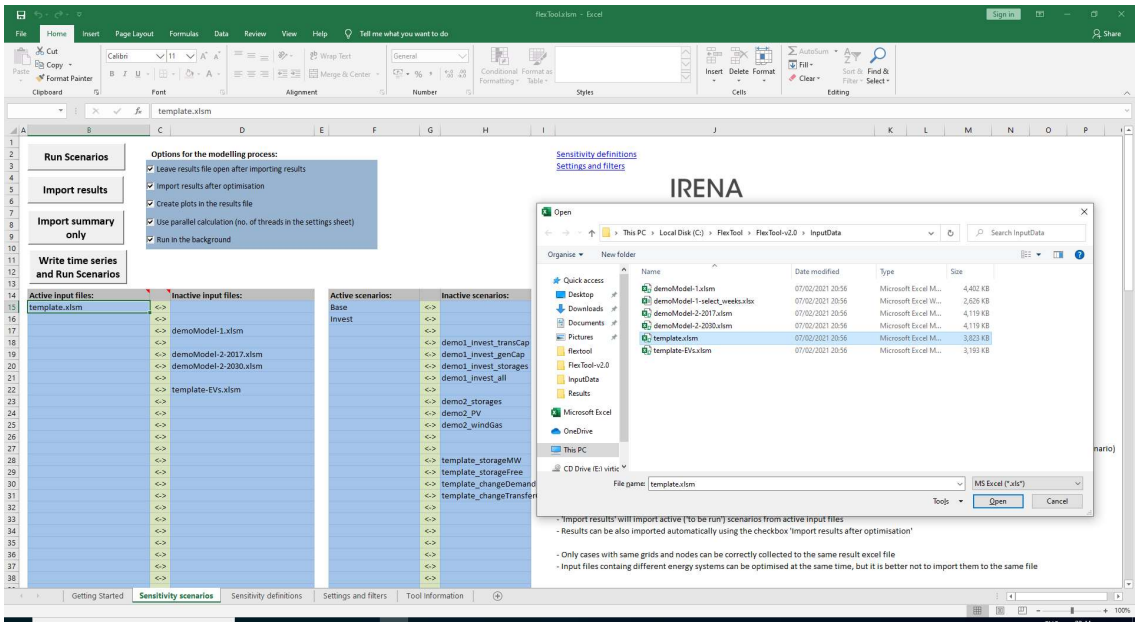
Running a model

As we said in FlexTool, the input data file will define the model version. A few models and templates are included in the package and you can read them from “InputData” folder in the root folder.

- “template.xlsm” is the template to create new models
- “template-XX.xlsm” are additional example templates with specific technologies
- Other input data files such as country-specific or versions for different years demo models.

To run a model:

- Open the interface worksheet ("flexTool.xlsm"). Make sure macros are enabled, as explained above.
- Navigate to "Sensitivity scenarios" sheet.
- Click on the first cell in "Active input files" column.
- A file picker opens. Select "template.xlsm" from **InputData** folder and click "Open".



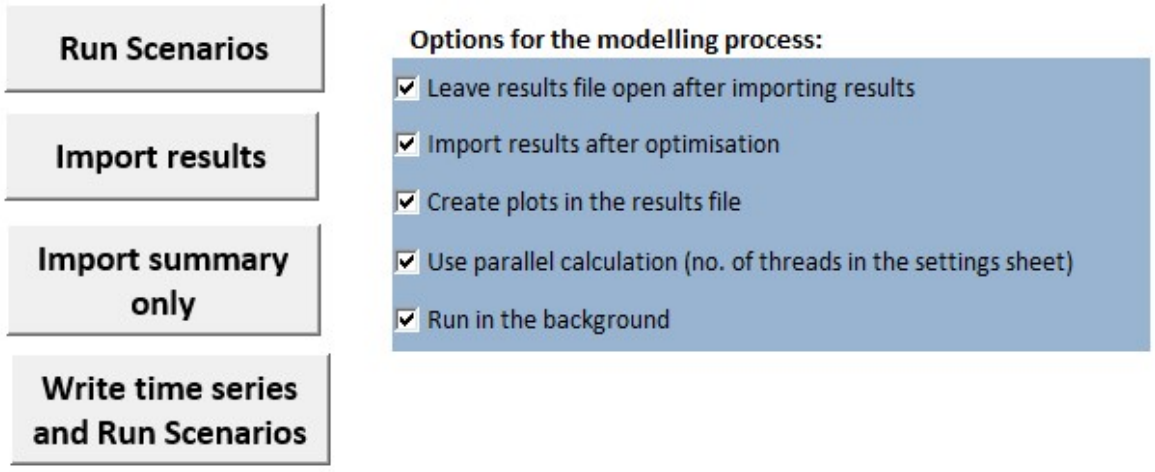
- In "Active Scenarios" column, activate the "Base" scenario.
- You can toggle scenarios active or inactive by clicking on the green arrow ("<->").
- Only scenarios in the "Active Scenarios" column will be run by the model.

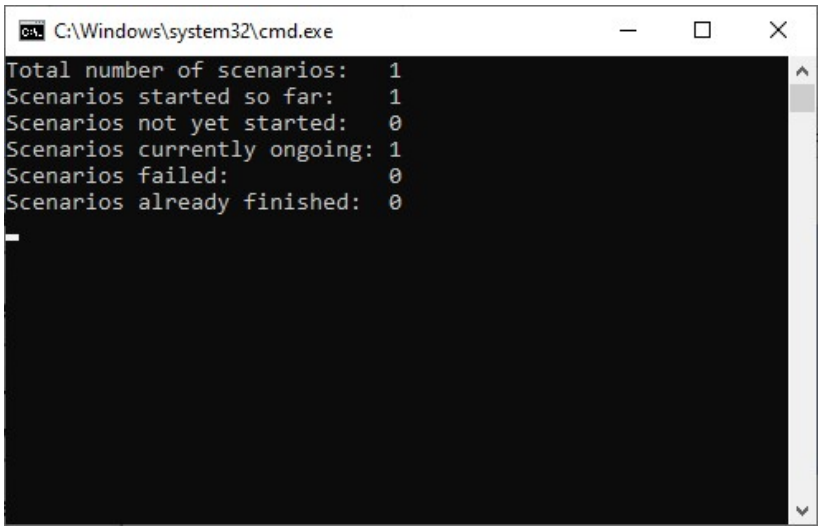
Active scenarios:		Inactive scenarios:
Base	<->	
	<->	Invest
	<->	
	<->	demo1_invest_transCap
	<->	demo1_invest_genCap
	<->	demo1_invest_storages
	<->	demo1_invest_all
	<->	
	<->	demo2_storages
	<->	demo2_PV
	<->	demo2_windGas
	<->	
	<->	

- Click on "Write time series and Run Scenarios" to start running the model.

  Note: Input file must be closed before running the model. If the input file is still open FlexTool will warn you to close the file.

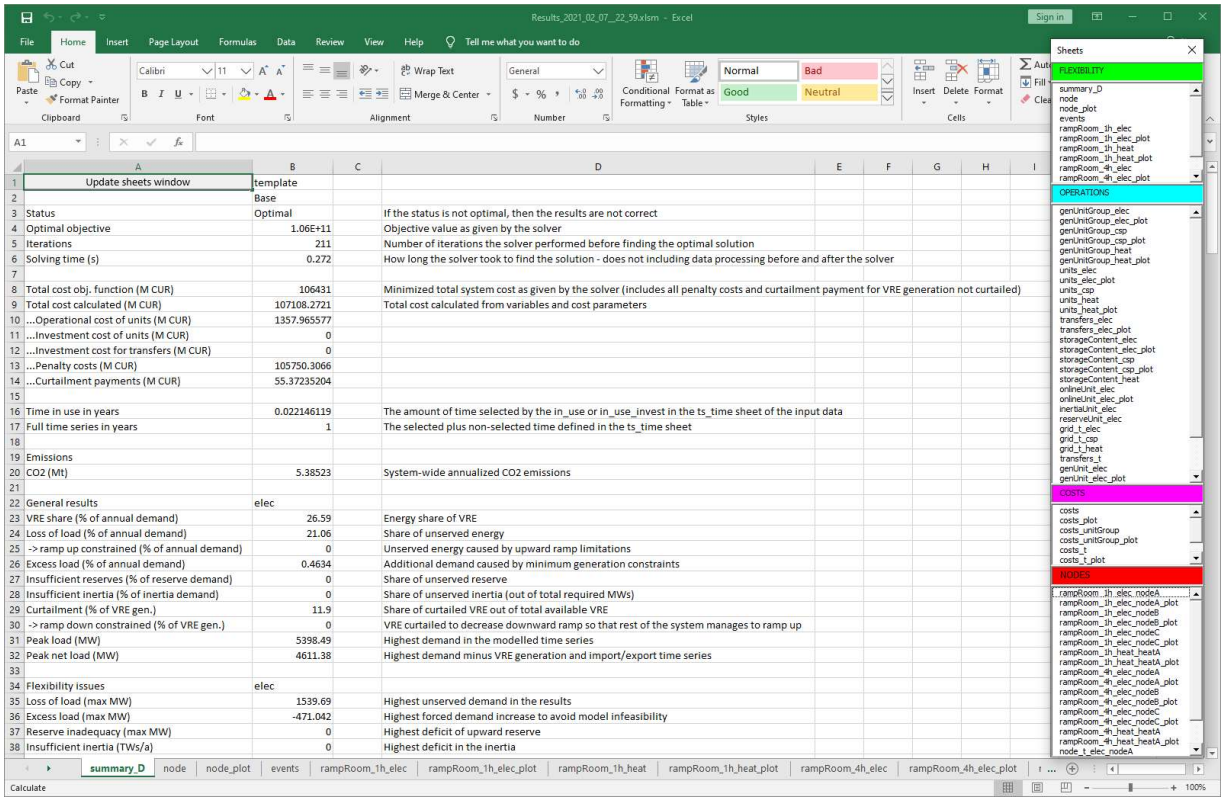
- A prompt window will open while the model is running to display the status of the execution.
- In "Options for the modelling process" you can set various processing options.





If the option is enabled, after successful execution of the model results file is automatically opened. In any case, results are automatically saved in the "Results" folder in the root directory.

In the results file go to the “summary_D” sheet which contains the most important results. You can use the quick selection window to find “summary_D” sheet to explore the results. The attributed input data files and scenarios are shown on the top two rows.



	A	B	C	D
1	Update sheets window	template		
2		Base		
3	Status	Optimal		If the status is not optimal, then the results are not correct
4	Optimal objective	1.06E+11		Objective value as given by the solver
5	Iterations	211		Number of iterations the solver performed before finding the optimal solution
6	Solving time (s)	0.272		How long the solver took to find the solution - does not including data processing before and after the solver
7				
8	Total cost obj. function (M CUR)	106431		Minimized total system cost as given by the solver (includes all penalty costs and curtailment payment for VRE generation not curtailed)
9	Total cost calculated (M CUR)	107108.2721		Total cost calculated from variables and cost parameters
10	...Operational cost of units (M CUR)	1357.965577		
11	...Investment cost of units (M CUR)	0		
12	...Investment cost for transfers (M CUR)	0		
13	...Penalty costs (M CUR)	105750.3066		
14	...Curtailment payments (M CUR)	55.37235204		
15				
16	Time in use in years	0.022146119		The amount of time selected by the in_use or in_use_invest in the ts_time sheet of the input data
17	Full time series in years	1		The selected plus non-selected time defined in the ts_time sheet
18				
19	Emissions			
20	CO2 (Mt)	5.38523		System-wide annualized CO2 emissions
21				
22	General results	elec		
23	VRE share (% of annual demand)	26.59		Energy share of VRE
24	Loss of load (% of annual demand)	21.06		Share of unserved energy
25	-> ramp up constrained (% of annual demand)	0		Unserved energy caused by upward ramp limitations
26	Excess load (% of annual demand)	0.4634		Additional demand caused by minimum generation constraints
27	Insufficient reserves (% of reserve demand)	0		Share of unserved reserve
28	Insufficient inertia (% of inertia demand)	0		Share of unserved inertia (out of total required MWs)
29	Curtailment (% of VRE gen.)	11.9		Share of curtailed VRE out of total available VRE
30	-> ramp down constrained (% of VRE gen.)	0		VRE curtailed to decrease downward ramp so that rest of the system manages to ramp up
31	Peak load (MW)	5398.49		Highest demand in the modelled time series
32	Peak net load (MW)	4611.38		Highest demand minus VRE generation and import/export time series
33				
34	Flexibility issues	elec		
35	Loss of load (max MW)	1539.69		Highest unserved demand in the results
36	Excess load (max MW)	-471.042		Highest forced demand increase to avoid model infeasibility
37	Reserve inadequacy (max MW)	0		Highest deficit of upward reserve
38	Insufficient inertia (TWs/a)	0		Highest deficit in the inertia

Activity: Try to run different combination of input files and scenarios that are included in the package and go through input files and results files to familiarize yourself with the Tool and content of each file.

In the following sessions you will learn to make your own input files and scenarios.