

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 <u>irena.org</u>. The main aim of the tool is to make 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 <u>https://www.irena.org/energytransition/Energy-System-Models-and-Data/IRENA-</u> <u>FlexTool</u>
- 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".

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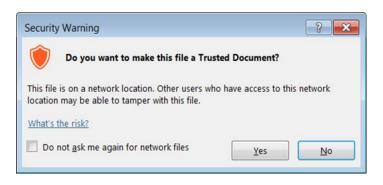
Figure 1: FlexTool root folder. The main interface file **flexTool.xlsm** is highlighted. The input file can be found in the **InputData** folder

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).

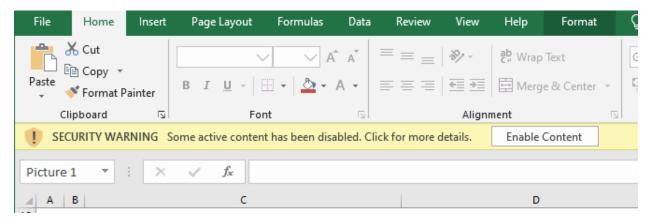


Enabling macros in the main worksheet

- 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

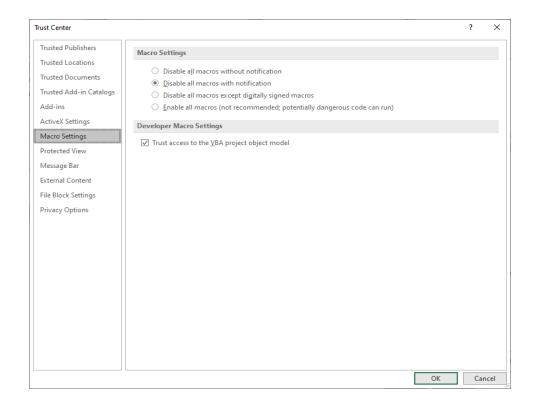


- d) Enable macros:
 - 1. From excel menu go to "File" -> "Options".
 - 2. Then from the left pane select "Trust Center"
 - 3. Click on "Trust Center Settings"
 - 4. A new window will open. From the left pane select "Macro Settings"
 - 5. Enable "Trust access to the VBA project object model"
 - 6. Click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

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

	Excel Options		?	×	
	General Formulas	Velp keep your documents safe and your computer secure and healthy.			
	Proofing	Security & more			
CCG 2021	Save	Visit Office.com to learn more about protecting your privacy and security.			Page 3
	Language	Microsoft Trustworthy Computing			
	Ease of Access				







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	Check macro settings. "Trust access to the
not trusted	VBA project object model" have to be
	selected
flexmodel.mod:240: ts_inflow[NODE,0] out of	You may have wrong time series, try to
domain (or similar)	update the time series
Anti-virus program blocks some of the used	Make an exception in the anti-virus program
executables: clp.exe, glpsol.exe, wtee.exe	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.xism** 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 defining the sensitivity cases in "Sensitivity definitions" sheet.

Run Scenarios Import results Import summary only	Options for the modelling process: Leave results file open after importing result import results after optimisation Create plots in the results file Use parallel calculation (no. of threads in th			IRENA
Write time series and Run Scenarios	Run in the background			
Active input files:	Inactive input files:	Active scenarios:	Inactive scenarios:	Instructions
template.xlsm	↔	Base	<->	General
	(c)	Invest	<>>	- This file contains macros. Macros must be enabled for this sheet and for Excel in general. See 'Getting Started' for more info.
	<-> demoModel-1.xlsm		↔	- Edit only blue and light blue cells
	↔		<-> demo1_invest_transCap	
	<-> demoModel-2-2017.xlsm		<-> demo1_invest_genCap	Run scenarios:
	<-> demoModel-2-2030.xlsm		<-> demo1_invest_storages	
			<-> demo1_invest_all	- Swap scenarios or input files on or off using the green arrows
	<-> template-EVs.xlsm		<>	- Write new input file or scenario names to either column
			<-> demo2_storages	
	↔		<-> demo2_PV	Sensitivity definitions:
			<-> demo2_windGas	 Tool will create parameters for the scenarios in the right selection area using the changes defined in the 'Sensitivity definitions' sheet
			(c) (c)	 The scenario name has to be exactly the same in both sheets (case sensitive) If there are no data changes defined in the 'sensitivity definitions' for a particular scenario, then the scenario is run without changes (i.e. a base scenario)
	6		<-> template storageMW	 In there are no data changes defined in the sensitivity definitions for a particular scenario, inent the scenario is fun without changes (i.e. a base scenario) Data structure is the same as in the input files. All other data can be changed in the "sensitivies definitions" except for time series.
	6		template_storageFree	 Data structure is the same as in the input mes, an other bata can be changed in the sensitivity except to the sense. In the 'sensitivity' definitions' sheet, the input data sheet names must be repeated at each row in the light grey column (B)
	6		template_storagerree	
			<-> template_changeDeman	
	60 60		<->	Import results:
	(c)		(-)	- 'import results' will import active ('to be run') scenarios from active input files
	60		<->	- Results can be also imported automatically using the checkbox 'import results after optimisation'
			<>	
	0		<->	- Only cases with same grids and nodes can be correctly collected to the same result excel file
	⇔		<>	- Input files containg different energy systems can be optimised at the same time, but it is better not to import them to the same file
	65		<->	

 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).

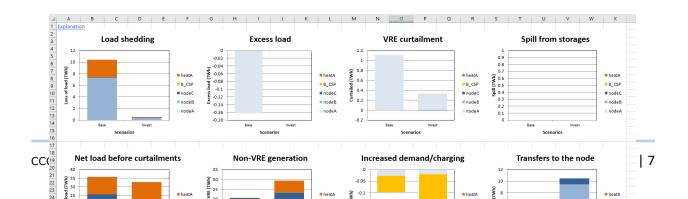
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3	elec	nodeB	mainland		2190000		10	1	0	1							
4	elec	nodeC	mainland		3504000		20	1	0	1							
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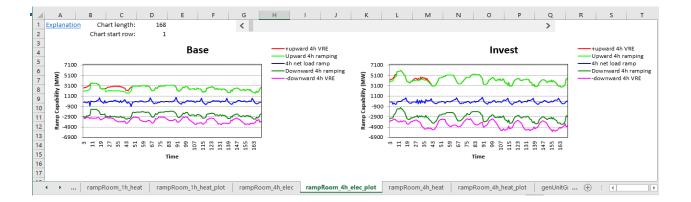
3) **Result output files:** The results file includes a diverse range of results for all the scenarios. User has the possibility to show only one scenario or to compare results from multiple scenarios.

Once you run the model a result folder is generated in the root folder which contains the result output excel files.

	А	В	с
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
10	summary_D summary_I nod	e node_plot	events rampRo







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".

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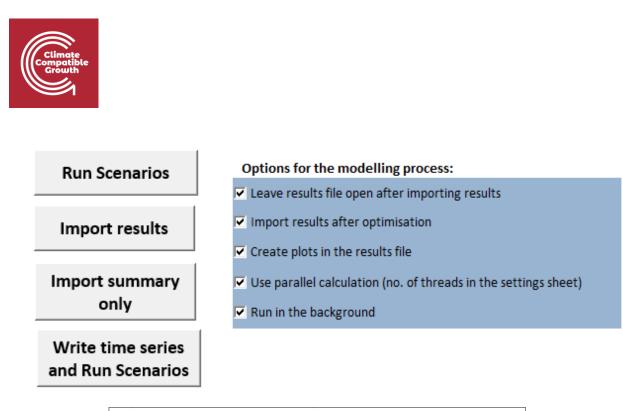
- In "Active Scenarios" column, activate the "Base" scenario.
- You can toggle scenarios active or inactive by clicking on the green arrow ("<->").
- Only scenarios in the "Active Scenarios" column will be run by the model.

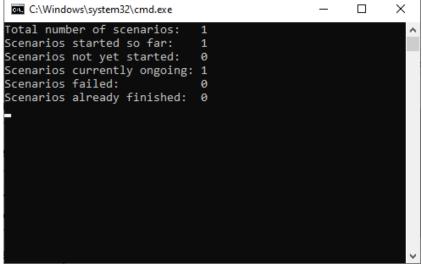
Active scenarios:		Inactive scenarios:
Base	<->	
	<->	Invest
	<->	
	<->	demo1_invest_transCap
	<->	demo1_invest_genCap
	<->	demo1_invest_storages
	<->	demo1_invest_all
	<->	
	<->	demo2_storages
	<->	demo2_PV
	<->	demo2_windGas
	<->	
	<->	

• 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 model is running to display status of the execution.
- In "Options for the modelling process" you can set various processing options





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

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

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3	Status	Base Optimal	If the sta	us is not optin	nal, then the results are	not correct							genUnitGroup_elec	-
4	Optimal objective	1.06E+11		pjective value as given by the solver						genUnitGroup_elec_plot genUnitGroup_csp				
5	Iterations	211	Number	ber of iterations the solver performed before finding the optimal solution							genUnitGroup_csp_plot genUnitGroup_heat			
6	Solving time (s)	0.272	How long	the solver too	ok to find the solution - d	oes not including dat	a processing befor	e and after the	e solver				genUnitGroup_heat_plot	
7													units_elec units_elec_plot	
8	Total cost obj. function (M CUR)	106431	Minimize	d total system	cost as given by the solv	er (includes all penal	Ity costs and curtai	lment paymen	t for VRE	generatio	n not curtail	ed)	units_csp	



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.