

IRENA FlexTool

**TRAINING FOR EASTERN
EUROPE AND CENTRAL ASIA**

**SESSION 3: Introducing and installing the
IRENA FlexTool**



Introducing the FlexTool

1. FlexTool license

- IRENA FlexTool is a free software
- Redistribute or modify under GNU Lesser General Public License

2. Ongoing development

- The main branch is actively developed by IRENA and VTT Technical Research Centre of Finland
- New versions will be announced on irena.org

3. Future developments

- New features are developed according to user needs and wishes
- Any suggestions/comments can be submitted to Flextool@irena.org

1. First public version (November 2018)

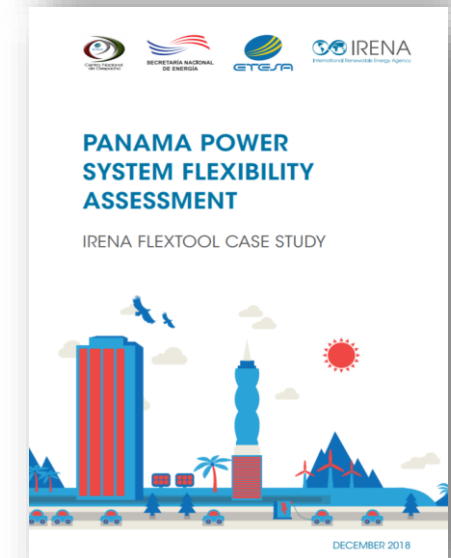
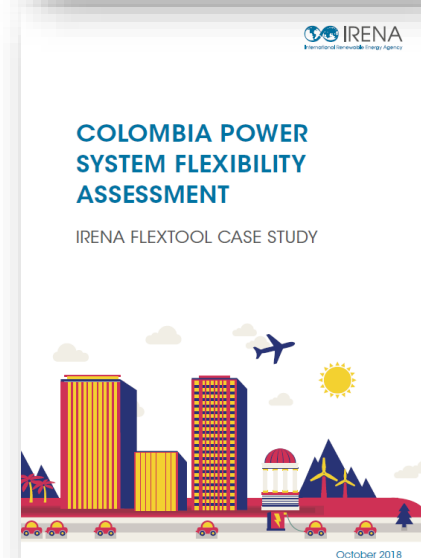
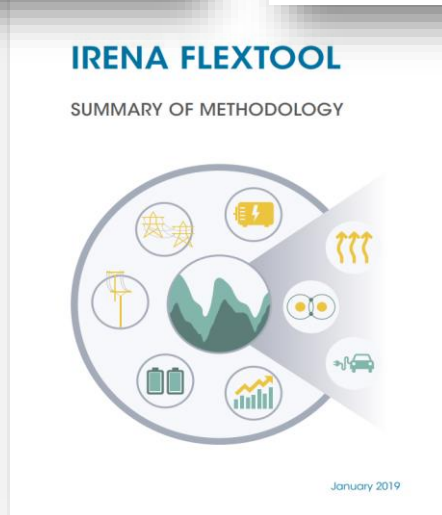
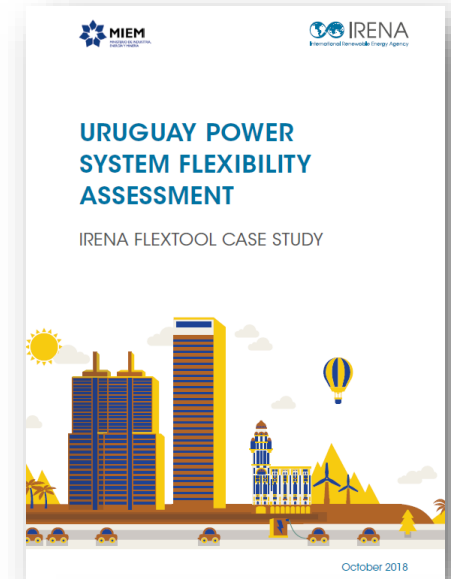
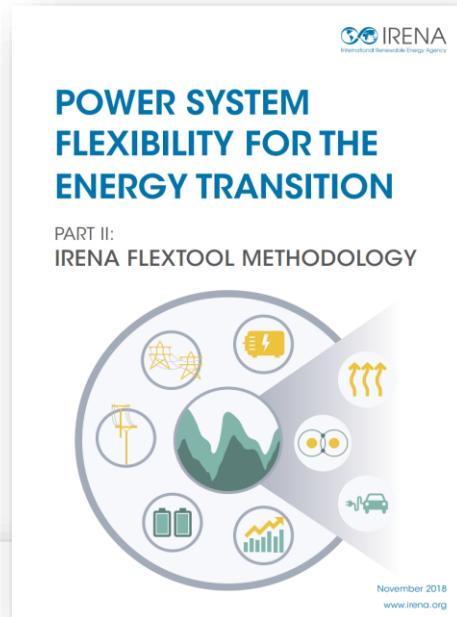
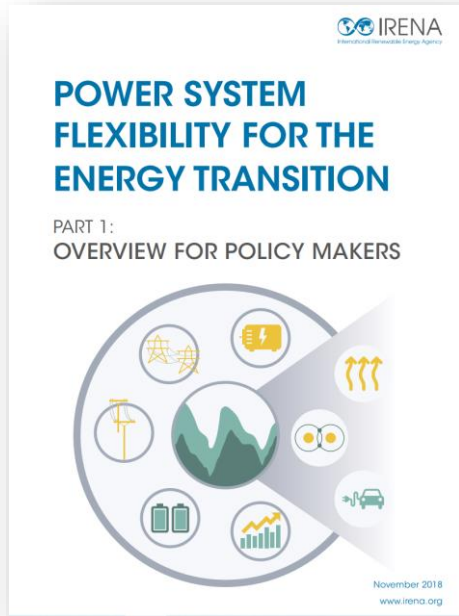
2. Version 1.2 (April 2019)

- New features were added for multinode models and improved result printing

3. Version 2.0 (April 2020)

- Added units with multiple outputs (*e.g.*, CHP units), better unit specific constraints (*e.g.*, minimum and maximum generation, fixed generation, etc.)
- Further improvements in results printing

Support documents



Main files (1-3)

FlexTool involves three main files:

1. flexTool.xlsm file (MS Excel)
2. Input-data files (MS Excel)
3. Result files (MS Excel)

Users must be Excel-enabled:



1. flexTool.xlsm (MS Excel)

- Main user interface:
 - Select used model and scenarios,
 - Run the model,
 - Print selected results

Screenshot: flexTool.xlsm

Run Scenarios

Import results

Import summary only

Write time series and Run Scenarios

Options for the modelling process:

- Leave results file open after importing results
- Import results after optimisation
- Create plots in the results file
- Use parallel calculation (no. of threads in the settings sheet)
- Run in the background

[Sensitivity definitions](#)
[Settings and filters](#)

IRENA FlexTool

Active input files:	Inactive input files:	Active scenarios:	Inactive scenarios:
template.xlsm	<->	Base	<->
	<-> template-transmission.xlsm		<-> Invest
	<-> template-storage.xlsm		<-> hydro-minus15p
	<-> template-EVs.xlsm		<-> hydro-plus15p
	<-> template-demandResponse.xlsm		<-> hydro-minus15p-invest
	<-> template-CSP.xlsm		<-> template_storageMW
	<-> template-17520.xlsm		<-> template_storageFree

Instructions

General

- This file contains macros. Macros must be enabled for this sheet and for Excel in general. See 'Getting Started' for more info.
- Edit only blue and light blue cells

Run scenarios:

- Tool will run all the active scenarios in the right selection for all the active input files in the left selection
- Swap scenarios or input files on or off using the green arrows

Main files: (2) Data input

2. Input-data files (MS Excel)

- Input data files define the model version
- flexTool.xlsm is the same for all countries, input data is unique
- Every model year needs its own input data file (e.g., Thailand 2019, Thailand 2030)

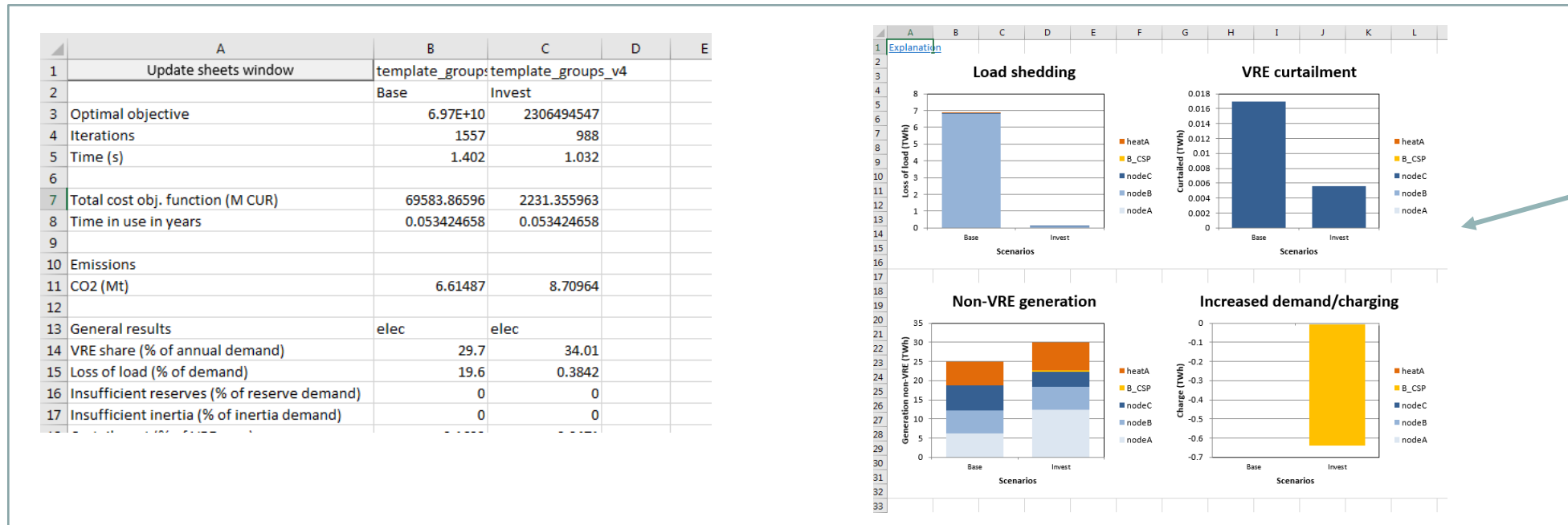
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
					demand (MWh)	import (MWh)	capacity margin (MW)	non synchronous share	inertia limit (Mw s)	use ts_reserve	use dynamic reserve	print results	color in results	Add empty row			
1	grid	node	nodeGroup	nodeGroup2													
2	elec	nodeA	sync1	reserve1	10000000	10000	67	0.8		1	1	1					
3	elec	nodeB	sync1	reserve1	16000000		260	0.8		0	0	1					
4	csp	B_CSP			0			1.0		0	0	0					
5	elec	nodeC		reserve1	9000000		130	0.8		0	0	1					
6	heat	heatA			10000000					0	0	1					
7																	
8																	
9																	
10																	
11																	

Screenshot of the input data file showing a table with columns for grid, node, nodeGroup, nodeGroup2, demand (MWh), import (MWh), capacity margin (MW), non synchronous share, inertia limit (Mw s), use ts_reserve, use dynamic reserve, print results, and color in results. The data is organized into rows for different nodes and their characteristics.

Screenshot of the input data file

3. Result files (MS Excel)

- Results show in large amounts, from summaries to more detailed ones
- User has the possibility to show only one scenario or to compare results from multiple scenarios



Screenshots of the results file

Install and test the FlexTool

Steps to install IRENA FlexTool

IRENA FlexTool can be installed and run in just **five steps**:

1. Create folders and copy files
2. Enable macros in flexTool.xlsm Excel file
3. Run existing demo model
4. Introduction to results file
5. Batch run – Running both dispatch and investment modes

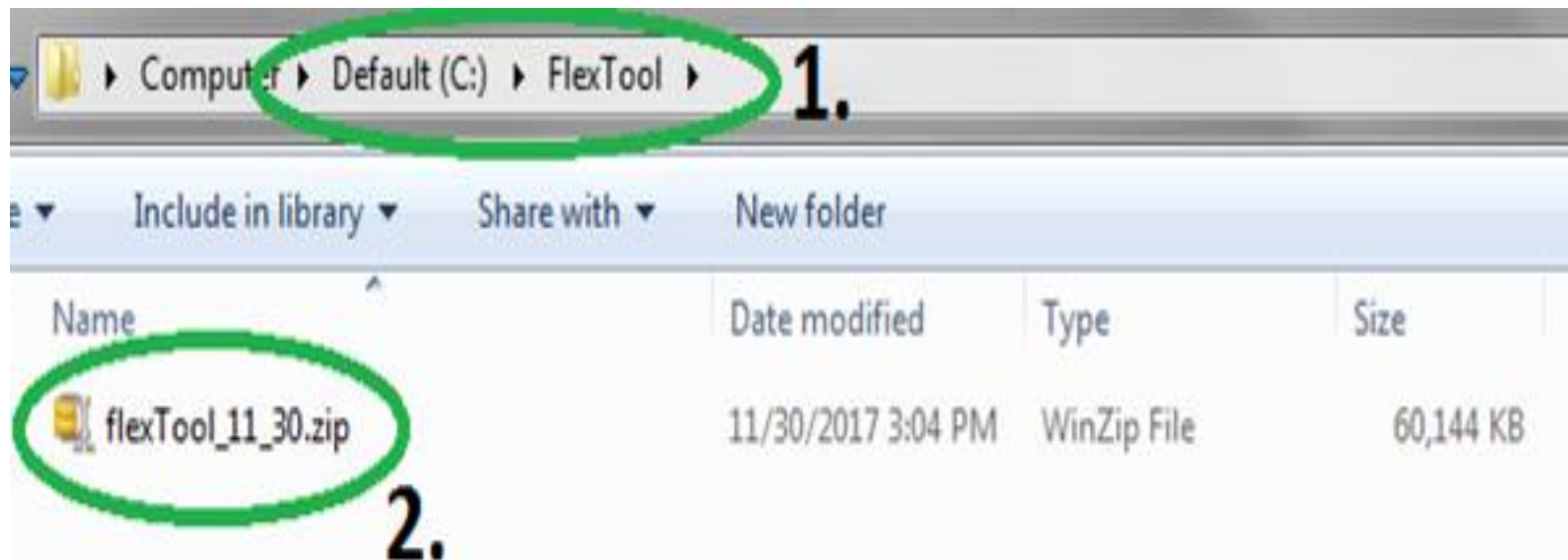
Create folders and copy files, 1/2

1. Create a folder for FlexTool (e.g., c:\FlexTool)

- Install folder is called root folder

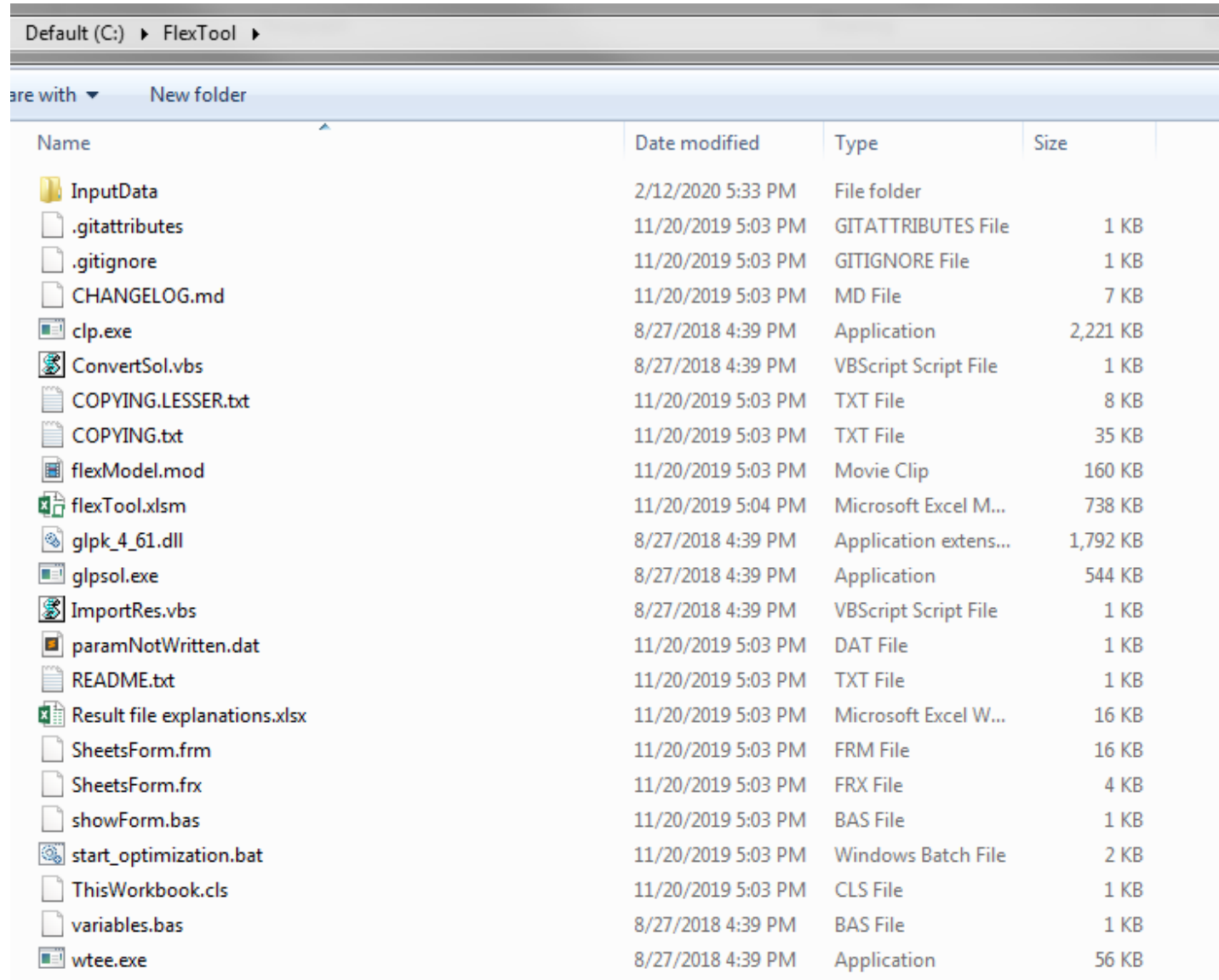
2. Copy zipped FlexTool install package to the new folder

- File is named as flexTool_YYYY_MM_DD.zip (e.g., FlexTool_2019_11_03.zip)
- Check from file name which version (date) of the tool you are installing



Create folders and copy files, 2/2

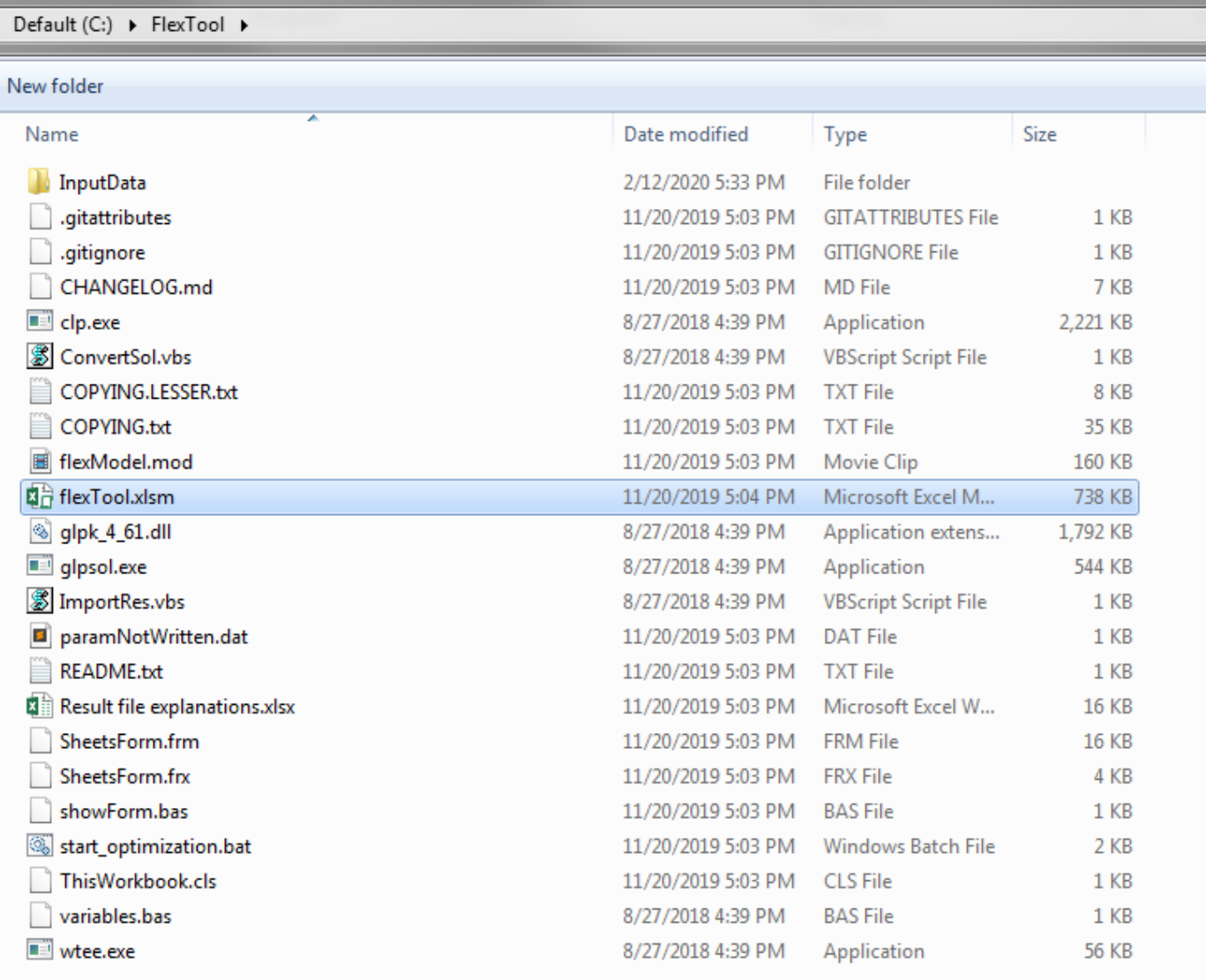
3. Unzip files to root folder



Name	Date modified	Type	Size
InputData	2/12/2020 5:33 PM	File folder	
.gitattributes	11/20/2019 5:03 PM	GITATTRIBUTES File	1 KB
.gitignore	11/20/2019 5:03 PM	GITIGNORE File	1 KB
CHANGELOG.md	11/20/2019 5:03 PM	MD File	7 KB
clp.exe	8/27/2018 4:39 PM	Application	2,221 KB
ConvertSol.vbs	8/27/2018 4:39 PM	VBScript Script File	1 KB
COPYING.LESSER.txt	11/20/2019 5:03 PM	TXT File	8 KB
COPYING.txt	11/20/2019 5:03 PM	TXT File	35 KB
flexModel.mod	11/20/2019 5:03 PM	Movie Clip	160 KB
flexTool.xlsm	11/20/2019 5:04 PM	Microsoft Excel M...	738 KB
glpk_4_61.dll	8/27/2018 4:39 PM	Application extens...	1,792 KB
glpsol.exe	8/27/2018 4:39 PM	Application	544 KB
ImportRes.vbs	8/27/2018 4:39 PM	VBScript Script File	1 KB
paramNotWritten.dat	11/20/2019 5:03 PM	DAT File	1 KB
README.txt	11/20/2019 5:03 PM	TXT File	1 KB
Result file explanations.xlsx	11/20/2019 5:03 PM	Microsoft Excel W...	16 KB
SheetsForm.frm	11/20/2019 5:03 PM	FRM File	16 KB
SheetsForm.frx	11/20/2019 5:03 PM	FRX File	4 KB
showForm.bas	11/20/2019 5:03 PM	BAS File	1 KB
start_optimization.bat	11/20/2019 5:03 PM	Windows Batch File	2 KB
ThisWorkbook.cls	11/20/2019 5:03 PM	CLS File	1 KB
variables.bas	8/27/2018 4:39 PM	BAS File	1 KB
wtee.exe	8/27/2018 4:39 PM	Application	56 KB

Enable macros, 1/3

1. Run flexTool.xlsm from root folder



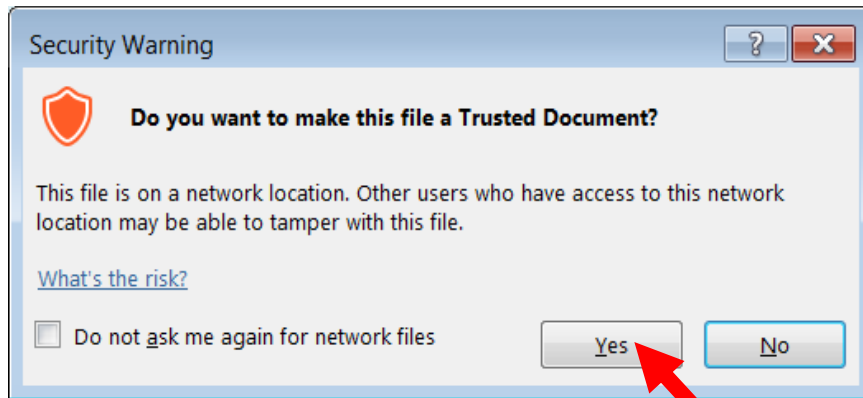
Default (C:) > FlexTool >

New folder

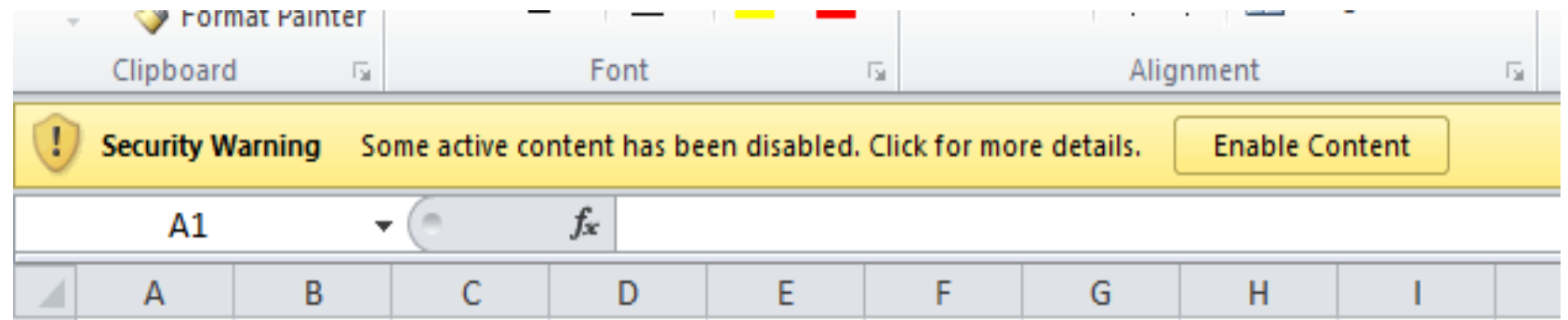
Name	Date modified	Type	Size
InputData	2/12/2020 5:33 PM	File folder	
.gitattributes	11/20/2019 5:03 PM	GITATTRIBUTES File	1 KB
.gitignore	11/20/2019 5:03 PM	GITIGNORE File	1 KB
CHANGELOG.md	11/20/2019 5:03 PM	MD File	7 KB
clp.exe	8/27/2018 4:39 PM	Application	2,221 KB
ConvertSol.vbs	8/27/2018 4:39 PM	VBScript Script File	1 KB
COPYING.LESSER.txt	11/20/2019 5:03 PM	TXT File	8 KB
COPYING.txt	11/20/2019 5:03 PM	TXT File	35 KB
flexModel.mod	11/20/2019 5:03 PM	Movie Clip	160 KB
flexTool.xlsm	11/20/2019 5:04 PM	Microsoft Excel M...	738 KB
glpk_4_61.dll	8/27/2018 4:39 PM	Application extens...	1,792 KB
glpsol.exe	8/27/2018 4:39 PM	Application	544 KB
ImportRes.vbs	8/27/2018 4:39 PM	VBScript Script File	1 KB
paramNotWritten.dat	11/20/2019 5:03 PM	DAT File	1 KB
README.txt	11/20/2019 5:03 PM	TXT File	1 KB
Result file explanations.xlsx	11/20/2019 5:03 PM	Microsoft Excel W...	16 KB
SheetsForm.frm	11/20/2019 5:03 PM	FRM File	16 KB
SheetsForm.frx	11/20/2019 5:03 PM	FRX File	4 KB
showForm.bas	11/20/2019 5:03 PM	BAS File	1 KB
start_optimization.bat	11/20/2019 5:03 PM	Windows Batch File	2 KB
ThisWorkbook.cls	11/20/2019 5:03 PM	CLS File	1 KB
variables.bas	8/27/2018 4:39 PM	BAS File	1 KB
wtee.exe	8/27/2018 4:39 PM	Application	56 KB

Enable macros, 2/3

2. Click "Yes" or "Enable Content"



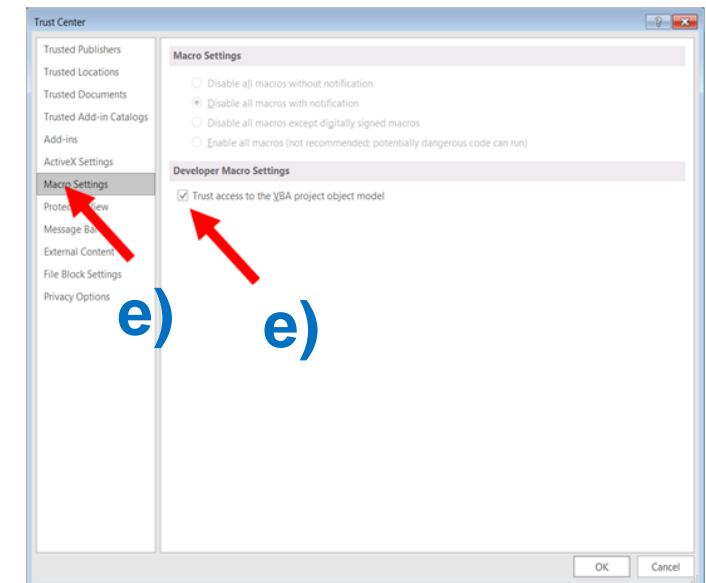
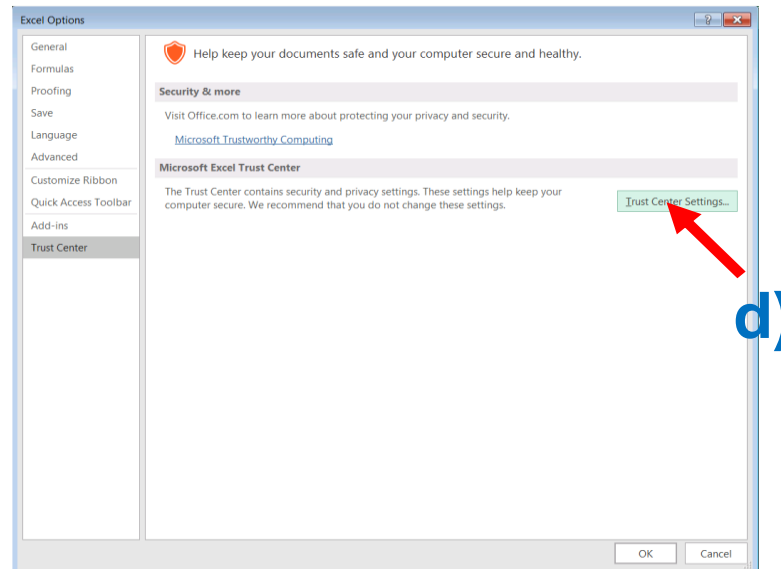
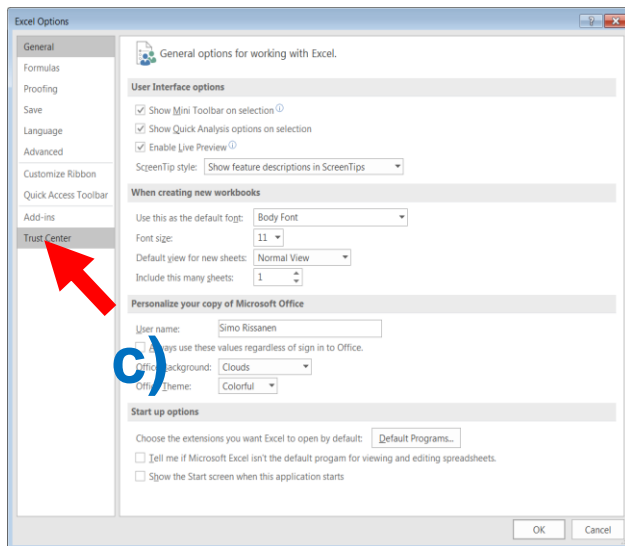
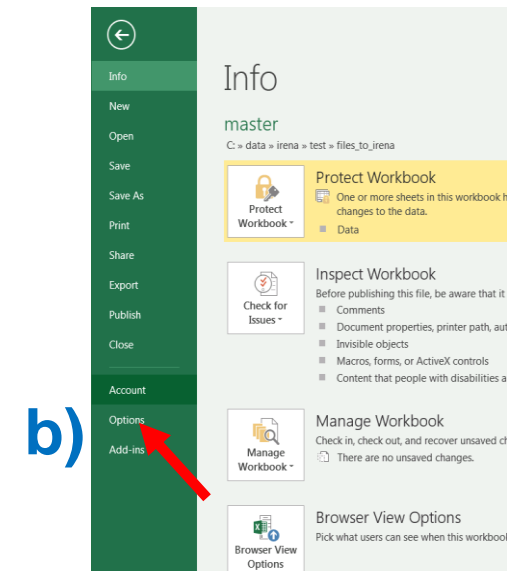
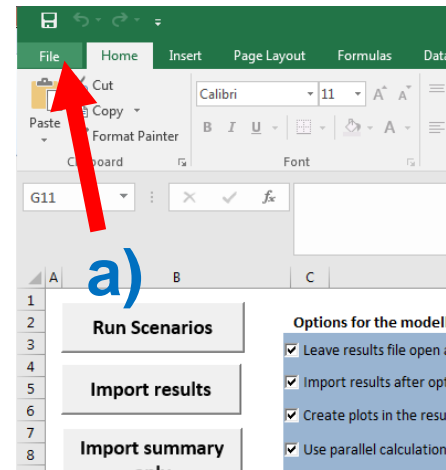
OR



Enable macros, 3/3

3. In flexTool.xlsm

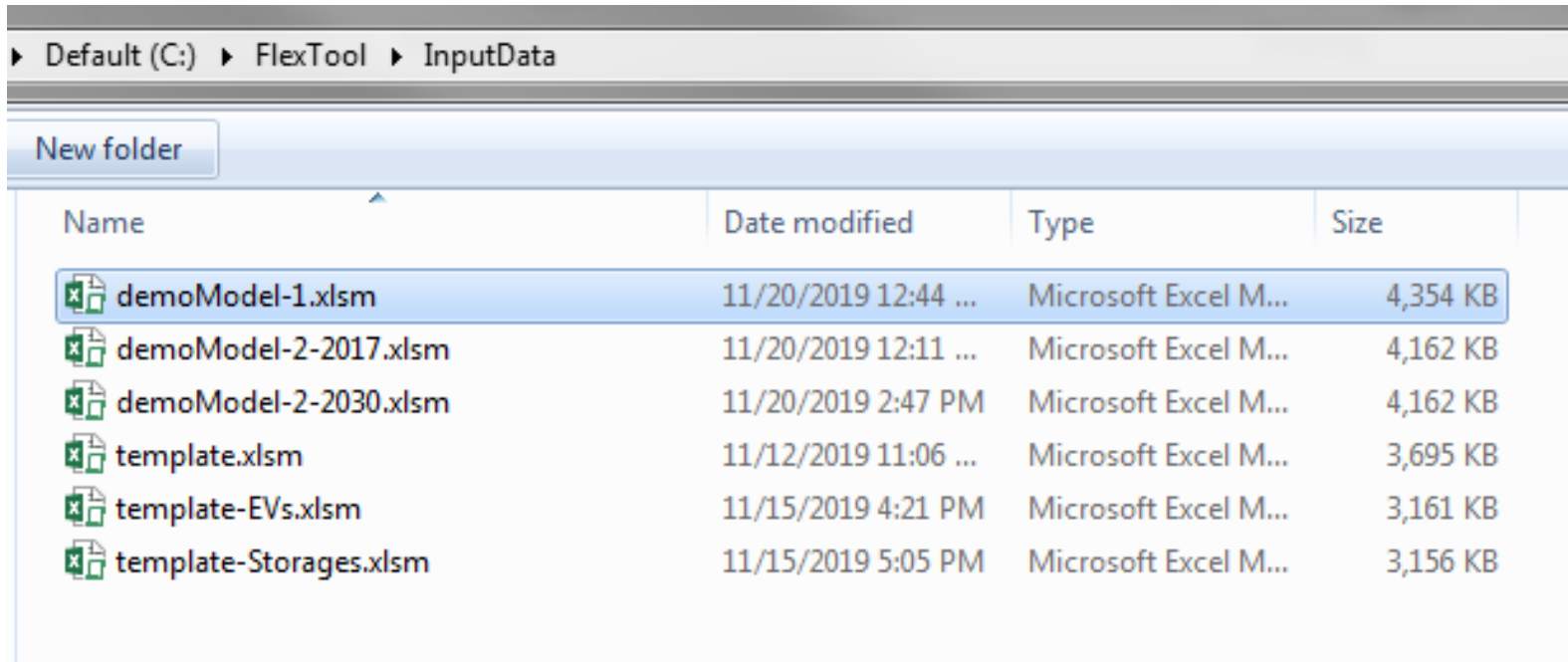
- a) Click "File", then
- b) "Options",
- c) "Trust Center",
- d) "Trust Center settings",
- e) "Macro settings" and make sure that "Trust access to the VBA project object model" is checked









Run existing demo model, 1/4

1. Check from 'InputData' subfolder which files are included in the installation package.

- a) Template file is the default model and basis to create new models
- b) Template_XXX are additional examples on how to model specific technologies
- c) In addition, your installation package might contain other input data files (e.g., demo models or input data for your own country)



Name	Date modified	Type	Size
 demoModel-1.xlsm	11/20/2019 12:44 ...	Microsoft Excel M...	4,354 KB
 demoModel-2-2017.xlsm	11/20/2019 12:11 ...	Microsoft Excel M...	4,162 KB
 demoModel-2-2030.xlsm	11/20/2019 2:47 PM	Microsoft Excel M...	4,162 KB
 template.xlsm	11/12/2019 11:06 ...	Microsoft Excel M...	3,695 KB
 template-EVs.xlsm	11/15/2019 4:21 PM	Microsoft Excel M...	3,161 KB
 template-Storages.xlsm	11/15/2019 5:05 PM	Microsoft Excel M...	3,156 KB

Run existing demo model, 2/4

2. Open flexTool.xlsm

- a) Check from previous chapter that macros are enabled from two places

3. Open 'sensitivity scenarios' sheet.

- a) Click the first 'active input files' blue cell
- b) Choose 'template' input file from the pop-up window
- c) open the input file

The screenshot displays the FlexTool interface. On the left, a table lists 'Active input files' and 'Inactive input files'. The first cell in the 'Active input files' column, 'template.xlsm', is circled in green and labeled '3a.'. To the right, the 'Options for the modelling process' panel is visible, with several checkboxes checked. An 'Open' file dialog window is overlaid on the right side, showing a file explorer view of the 'FlexTool \ InputData' directory. The file 'template.xlsm' is selected and circled in green, labeled '3b.'. The 'Open' button in the dialog is also circled in green and labeled '3c.'. The background shows a portion of an Excel spreadsheet with columns A through I and rows 1 through 37.

- Only cases with same grids and nodes can
- Input files containing different energy syste

Run existing demo model, 3/4

4. Select active scenarios

- a) Check that only 'Base' is selected
- b) You can activate (list on left) or deactivate (list on right) scenarios with green arrows
- c) The list of inactive scenarios can be long, model does not run them unless activated
- d) You will later learn how to create your own scenarios

Active input files:	Inactive input files:
template.xlsm	<->
	<-> template-transmission.xlsm
	<-> template-storage.xlsm
	<-> template-EVs.xlsm
	<-> template-demandResponse.xlsm
	<-> template-CSP.xlsm
	<-> template-17520.xlsm
	<->
	<->
	<->
	<->
	<->

4a.

Active scenarios:	Inactive scenarios:
Base	<->
	<-> Invest
	<-> hydro-minus15p
	<-> hydro-plus15p
	<-> hydro-minus15p-invest
	<-> template_storageMW
	<-> template_storageFree
	<-> template_changeDemand
	<-> template_changeTransferC
	<-> Transmission
	<-> Gas engine

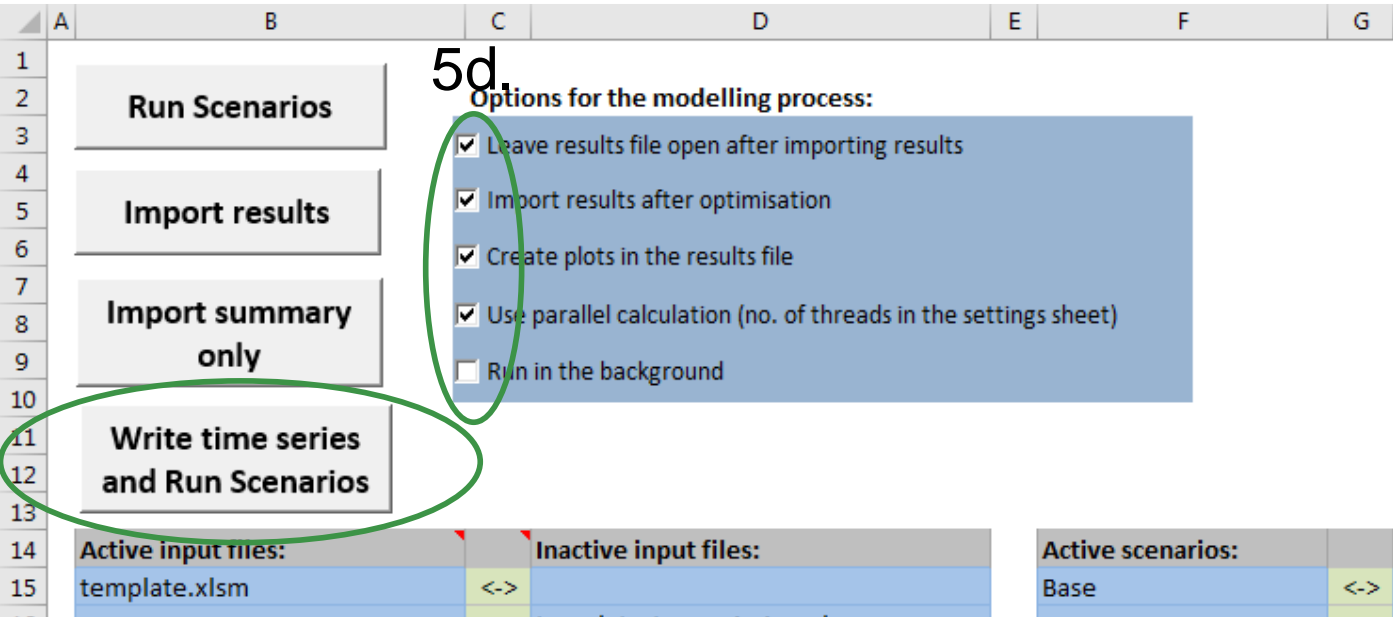
4b.

4c.

5. Run demo model

- Click 'Write time series and Run Scenarios'
- Close the input file before running the model. The Flextool warns you if the input file is open.
- Wait and watch
- FlexTool automatically imports results file if the option is selected

5a.



5d.

Options for the modelling process:

- Leave results file open after importing results
- Import results after optimisation
- Create plots in the results file
- Use parallel calculation (no. of threads in the settings sheet)
- Run in the background

Active input files:	Inactive input files:	Active scenarios:
template.xlsxm		Base

5c.

```
C:\WINDOWS\system32\cmd.exe
Total number of scenarios: 1
Scenarios started so far: 1
Scenarios not yet started: 0
Scenarios currently ongoing: 1
Scenarios failed: 0
Scenarios already finished: 0
```

Introduction to results file

6. Summary of results

- a) Shows most important results
- b) Open 'summary_D' sheet from results file
- c) Use the quick selection to find 'summary_D' sheet
- d) Run input data files and scenarios are shown at the top
- e) Summary result types are list at left side

The screenshot displays a spreadsheet with columns A through H and rows 1 through 45. The data is organized into sections: 'General results', 'Flexibility issues', 'Energy balance', and 'Costs'. Annotations are present: '6c.' points to the 'template' and 'Invest' cells in row 2; '6a.' points to the 'summary_D' sheet in the 'Sheets' window; '6b.' points to the 'OPERATIONS' section in the 'Sheets' window; and '6d.' points to the 'Loss of load (max MW)' cell in row 23. The 'summary_D' sheet is highlighted in the window, and the 'summary_D' tab is selected in the spreadsheet's tab bar at the bottom.

	A	B	C	D	E	F	G	H
1	Update sheets window	template	template					
2		Base	Invest					
3	Optimal objective	6.44E+10	881881379.7					
4	Iterations	624	0					
5	Time (s)	0.412	0.312					
7	Total cost obj. function (M CUR)	64418.14324	860.0364647					
8	Time in use in years	0.018837643	0.019178082					
11	CO2 (Mt)	3.77309	5.93801					
13	General results	elec	elec					
14	VRE share (% of annual demand)	50.4	52.53					
15	Loss of load (% of demand)	18.05	0.06378					
16	Insufficient reserves (% of reserve demand)	0	0					
17	Insufficient inertia (% of inertia demand)	0	0					
18	Curtailement (% of VRE gen.)	4.263	0.0232					
21	Flexibility issues	elec	elec					
22	Loss of load (max MW)	1518.62	266.676					
23	Reserve inadequacy (max MW)	0	0					
24	Insufficient inertia (TWh/a)	0	0					
25	Curtailement (max MW)	661.513	36.2827					
26	Curtailement (TWh/a)	0.751842	0.00426613					
27	Model leakage (TWh/a)	-0.00492173	-0.000723485					
28	Capacity inadequacy (max MW)	0	0					
29	Spill (TWh/a)	52.7544	0					
31	Energy balance	elec	elec					
32	Demand (TWh)	-35.2083	-35.2083					
33	Consume (TWh)	-0.0910943	-0.01095					
34	Loss of load (TWh)	6.35591	0.0224563					
35	Generation, fuel based (TWh)	12.1592	15.0178					
36	Generation, VRE inc. river hydro (TWh)	17.6383	18.3859					
37	Discharge, inc. reserv. hydro (TWh)	0.752994	0.729219					
38	Charge (TWh)	-0.135782	-0.0324858					
39	Convert (TWh)	-1.4594	1.17352					
40	Import (TWh)	0.01	0.01					
41	Transfer losses (TWh)	-0.0218506	-0.0871419					
43	Costs	elec	elec					
44	Cost operations (M CUR)	771.272	789.287					
45	Cost investments (M CUR)	0	11.2479					

Batch run - Dispatch and Investment

7. It is easy to run many scenarios with FlexTool

- Select input files
- Select base and invest scenarios *
- Click 'Run Scenarios' or 'Write time series and Run Scenarios' **

The screenshot shows the FlexTool interface with the following elements:

- Buttons:** 'Run Scenarios' (circled in green, labeled 7c.), 'Import results', 'Import summary only', and 'Write time series and Run Scenarios' (circled in green, labeled 7c.).
- Options for the modelling process:**
 - Leave results file open after importing results
 - Import results after optimisation
 - Create plots in the results file
 - Use parallel calculation (no. of threads in the settings sheet)
 - Run in the background
- Input Files:**

Active input files:	Inactive input files:
template.xlsxm (circled in green, labeled 7a.)	<->
	<-> template-transmission.xlsxm
	<-> template-storage.xlsxm
	<-> template-FV.xlsxm
- Scenarios:**

Active scenarios:	Inactive scenarios:
Base (circled in green, labeled 7b.)	<->
Invest (circled in green, labeled 7b.)	<->
	<-> hydro-minus15p
	<-> hydro-plus15p

FlexTool will run all combinations of selected input files and scenarios (e.g., 3 input files and 5 scenarios means $3 \times 5 = 15$ model runs)



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www.youtube.com/user/irenaorg