

Energy and Flexibility Modelling Hands-on 3 (macOS)

Please use the following citation for:

• This exercise

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• clicSANDMac Software

Cannone, C., Tan, N., Kell, A., de Wet, N., Howells, M., Yeganyan, R. (2021). clicSANDMac [computer software]. <u>http://doi.org/10.5281/zenodo.5879056</u>

• OSeMOSYS Google Forum

Please sign up to the help Google forum <u>here</u>. If you are stuck, please ask questions here. If you get ahead, please answer questions in the same forum. Please state that you are using the 'clicSAND' Interface.

Learning outcomes

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

- 1. Draw a RES with a Backstop and a demand
- 2. Define fuels
- 3. Define energy demands for a specific fuel
- 4. Define the temporal profile of energy demands
- 5. Define a simple technology that satisfies the demand (Backstop)
- 6. Run the model and check results



Draw RES with a Backstop and a demand

The first thing you will learn in this exercise is to draw a Reference Energy System (RES). As explained in Lecture 2, a RES is a conventional aggregated representation of a real energy system.

Different tools are available for this purpose, but they vary in price and functionality. For this course, we will choose <u>Diagram.net</u> which is a **free** software to draw diagrams.

1. Open <u>Diagram.net</u> in your browser and click **Start**.

🚹 diagrams.net

Blog	Start Now

Security-first diagramming for teams.

Bring your storage to our online tool, or go max privacy with the desktop app.





2. Click Create New Diagram



Change storage



 Change the Filename to "HandsOn3.drawio" and select 'Blank Diagram'. Click on 'Create' and save it in a folder of preference. Tip: create a folder for each Hands-On exercise of this course and keep building your RES, adding every piece proposed in the exercises.

Filename:	Handson3.drawio	XML File	e (.drawio) 🗸 🕐
Basic (9) Business (14) Charts (5) Cloud (41) Engineering (3) Flowcharts (9)	Blank Diagram	Class Diagram	Flowchart
Maps (5) Network (13) Other (11) Software (8) Tables (4) UML (8) Venn (8)	Org Chart	Swimlane Diagram	Entity Relationship Diagram
Witchantes (0)	Help	Cancel From	Template URL

- 4. On the left side of the tool, select a Rectangle from the General Group. Drag and drop it on the screen.
- 5. Double click in the middle of the **Rectangle** to add Text. Write **BACKSTOP**.





6. Let's draw the electricity demand. Select a **line** and drag and drop it on the right side of the Backstop technology. Bring your pointer on the right side of the rectangle and some **blue points** will appear. Click and drag until you reach the demand line, drawing an **arrow**. Double click on top of the demand line to add the code for the electricity demand: **ELC003** as per the **naming convention** guidelines explained in **Lecture 3**.



You have now drawn the first technology called **Backstop** and the final electricity demand (**ELC003**). The arrow that connects the two means that the output of the Backstop technology will address the final electricity demand (**ELC003**).



Define commodities

The next step is to add the names of our fuels in SAND Interface.

- 1. In the HO2 folder, make a copy of "SAND_Interface_HO2".
- Rename it as "SAND_Interface_HO3" and move it to a new HO3 folder (by copying this file in the new Hands-On folder we will avoid having to re-add the data already saved in Hands-On 2). Therefore, after Hands-On 2, you will not use the SAND Interface template created by clicSAND, but you will keep adding data to what you have previously done.

IMPORTANT: make copies when you move to the next HO and do not make edits on the same file. In this way if there is a problem, there is always a backup version to easily find the error.

- Go to the SETS Sheet. Click on Cell E3 and change the code from "COM001" to "ELC003"
- 4. Add a description in Cell F3 changing the text from "Additional Fuel" to "Electricity after distribution".

Commodities							
Code	Description						
ELC003	Electricity after distribution						
сом002	Additional Fuel						
сомооз	Additional Fuel						
сомоо4	Additional Fuel						
СОМ005	Additional Fuel						

Tip: Repeat this process in the future to add names for other Commodities (Fuels).



Define energy demands for a specific fuel

Your next task will be to choose the demand type. You have two options for demand type:

- **SpecifiedAnnualDemand** used for fuels whose demand varies within the year/day e.g. electricity
- AccumulatedAnnualDemand used for fuels that do not necessarily have to be provided at an exact point in time e.g. gasoline

We will add the demand for Electricity after distribution (ELC003).

- 1. Go to Parameters Sheet in SAND and filter out **SpecifiedAnnualDemand**.
- 2. Go on Cell K41971, correspondent to ELC003 (Fuel Column F).
- 3. Copy-paste the ELC003 demand data for the years 2015-2070. You can find the data in this <u>Data_prep file</u> (copy-paste only the data from the 'Specified Annual Demand' sheet, column J to column BN).

	ј А		K		M	N	О	Р	Q	B		
1	Parameter	J FLIEL M	2015 💌	2016 🔽	2017 🔽	2018 🔽	2019 💌	2020 💌	2021 💌	2022 💌	2023 🔽	2024 🔽
41071	Specified	S EL C003	28 5228	29 7936	32 166	34 5395	36,9109	39 28334	414087	43 68493	46 12041	48 72429
41971	opecineuminuaidemanu	_/ LLC005	20.3220	20.1000	JZ. 100	34.3303	30.3103	33.20334	41.4001	40.00400	40.12041	40.12420
41972	SpecifiedAnnualDemand	COM002	0	0	0	0	0	0	0	0	0	0
41973	SpecifiedAnnualDemand	COM003	0	0	0	0	0	0	0	0	0	0
41974	SpecifiedAnnualDemand	COM004	0	0	0	0	0	0	0	0	0	0
41975	SpecifiedAnnualDemand	COM005	0	0	0	0	0	0	0	0	0	0
41976	SpecifiedAnnualDemand	COM006	0	0	0	0	0	0	0	0	0	0
41977	SpecifiedAnnualDemand	COM007	0	0	0	0	0	0	0	0	0	0
41978	SpecifiedAnnualDemand	COM008	0	0	0	0	0	0	0	0	0	0
41979	SpecifiedAppualDemand	COM009	Π	Π	Π	Π	Π	Π	Π	Π	Π	Π

Tip: For the same Commodity (Fuel) you should never add data for both **SpecifiedAnnualDemand** and **AccumulatedAnnualDemand**. Choose the type of demand associated with that fuel following the indications given in **Lecture 4**.

You now know how to add a SpecifiedAnnualDemand!



Define the temporal profile of energy demands

SpecifiedAnnualDemand is the parameter used to define a demand that changes within the year, as per the final electricity demand just seen (ELC003). Therefore, it now important to represent this time variability, and to do so we will use the **SpecifiedDemandProfile** parameter (as explained in Lecture 3).

If interested to know how the SpecifiedDemandProfile was calculated read this box

We divide the year into four representative seasons (Winter, Spring, Summer, and Autumn), further specifying the day-type (Day and Night for each of the four seasons). These eight representative day types are considered to have an equal length.

Therefore, the Year Split values for just 8 time slices are equal to ½ (0.125) for each timeslice and reported on the left side of the table below. The 8 numbers are then modified to obtain the Year Split values for all the 96 timeslices available in SAND.

Year Split		Specified demand profile for electricity	
TimeSlice	value	TimeSlice	ELC003
Winter Day	0.125	Winter Day	0.136
Winter Night	0.125	Winter Night	0.110
Spring Day	0.125	Spring Day	0.136
Spring Night	0.125	Spring Night	0.109
Summer Day	0.125	Summer Day	0.14
Summer Night	0.125	Summer Night	0.111
Autumn Day	0.125	Autumn Day	0.144
Autumn Night	0.125	Autumn Night	0.115



Following the same procedure, we now need to understand how the data for the **SpecifiedDemandProfile** was calculated for 8 timeslices and how to manipulate them to obtain a 96 time slices representation in SAND.

The data reported on the right side of the table were obtained from free hourly demand dataset called PLEXOS.

From these data we can see that the demand is higher during the Days and lower during Nights. Therefore, by using our data preparation spreadsheet we will calculate the percentage of average demand in each Time slice using the following formula:

[Specified demand profile (SD) / Year split (SD)] * Bennett Factor =

Data Manipulati	ion									
Making adjustments for CCG SAND										
We'll assume equal season legnths (3 months each) and an average hourly split per season (24h)										
S1 will be winter, S2 will be spring, S3 will be summer, S4 will be autumn										
50%	or	12.0	hrs are in a sum	mer night						
50%	or	12.0	hrs are in a winte	er night						
50%	or	12.0	hrs are in winter	day						
50%	or	12.0	hrs are in summer day							
		% of average de	mand in each tim	eslice						
	Winter Day	109%								
	Winter Night	88%								
	Spring Day	109%								
	Spring Night	87%								
	Summer Day	112%								
	Summer Night	89%								
	Autumn Day	115%								

= [0.14/0.125] *0.999=112%



Now we need to pass from 8 time slices to 96 in SAND. To do so, you need to multiply the average percentage of demand in each timeslice for the year split duration of that time slice.

To give you an example:

21			% of average de	mand in each tim	eslice
22		Winter Day	109%		
23		Winter Night	88%		
24		Spring Day	109%		
25		Spring Night	87%		
26		Summer Day	112%		
27		Summer Night	89%		
28		Autumn Day	115%		
29		Autumn Night	92%		
30					
31		Bennett Factor		0.999	
32		Sum	1.0000	1.0000	
33			Year Split	Specified Demar	nd Profile
34	Winter Night	S101	0.0104	=C34*\$C\$23	
35	Winter Night	S102	0.0104	0.0092	

You will find the SpecifiedDemandProfile in the <u>Data Preparation File</u> (for all the 96 timeslices that we are using in SAND).

Let's add the demand profile to SAND.

- 1. Go to Parameters Sheet and filter out for SpecifiedDemandProfile parameter.
- 2. Go to Column F of the fuels and filter out for ELC003.
- 3. Go to Cell K42021 and copy-paste the data for the specified demand profile from the <u>Data Preparation File</u> (the data you need is in Cell D34 to D129)
- 4. Drag and drop until year 2070.
- 5. Save.



4	A	F	G	K	L	M
		_				
1	Parameter 🔹	FUEL Y	TIMESLICE	2015 🞽	2016 🗾	2017 🔼
42021	SpecifiedDemandProfile	ELC003	S101	0.00919	0.00919	0.00919
42022	SpecifiedDemandProfile	ELC003	S102	0.00919	0.00919	0.00919
42023	SpecifiedDemandProfile	ELC003	S103	0.00919	0.00919	0.00919
42024	SpecifiedDemandProfile	ELC003	S104	0.00919	0.00919	0.00919
42025	SpecifiedDemandProfile	ELC003	S105	0.00919	0.00919	0.00919
42026	SpecifiedDemandProfile	ELC003	S106	0.00919	0.00919	0.00919
42027	SpecifiedDemandProfile	ELC003	S107	0.01132	0.01132	0.01132
42028	SpecifiedDemandProfile	ELC003	S108	0.01132	0.01132	0.01132
42029	SpecifiedDemandProfile	ELC003	S109	0.01132	0.01132	0.01132
42030	SpecifiedDemandProfile	ELC003	S110	0.01132	0.01132	0.01132
42031	SpecifiedDemandProfile	ELC003	S111	0.01132	0.01132	0.01132
42032	SpecifiedDemandProfile	ELC003	S112	0.01132	0.01132	0.01132
42033	SpecifiedDemandProfile	ELC003	S113	0.01132	0.01132	0.01132
42034	SpecifiedDemandProfile	ELC003	S114	0.01132	0.01132	0.01132
42035	SpecifiedDemandProfile	ELC003	S115	0.01132	0.01132	0.01132
42036	SpecifiedDemandProfile	ELC003	S116	0.01132	0.01132	0.01132
42037	SpecifiedDemandProfile	ELC003	S117	0.01132	0.01132	0.01132
42038	SpecifiedDemandProfile	ELC003	S118	0.01132	0.01132	0.01132
42039	SpecifiedDemandProfile	ELC003	S119	0.00919	0.00919	0.00919
42040	SpecifiedDemandProfile	ELC003	S120	0.00919	0.00919	0.00919
42041	SpecifiedDemandProfile	ELC003	S121	0.00919	0.00919	0.00919
42042	SpecifiedDemandProfile	ELC003	S122	0.00919	0.00919	0.00919
42043	SpecifiedDemandProfile	ELC003	S123	0.00919	0.00919	0.00919
42044	SpecifiedDemandProfile	ELC003	S124	0.00919	0.00919	0.00919
42045	SpecifiedDemandProfile	ELC003	S201	0.00905	0.00905	0.00905
42046	SpecifiedDemandProfile	ELC003	S202	0.00905	0.00905	0.00905
42047	SpecifiedDemandProfile	ELC003	S203	0.00905	0.00905	0.00905
42048	SpecifiedDemandProfile	ELC003	S204	0.00905	0.00905	0.00905
42049	SpecifiedDemandProfile	ELC003	S205	0.00905	0.00905	0.00905
42050	SpecifiedDemandProfile	ELC003	S206	0.00905	0.00905	0.00905
42051	SpecifiedDemandProfile	ELC003	S207	0.0113	0.0113	0.0113
42052	SpecifiedDemandProfile	ELC003	S208	0.0113	0.0113	0.0113
42053	SpecifiedDemandProfile	ELC003	S209	0.0113	0.0113	0.0113
42054	SpecifiedDemandProfile	ELC003	S210	0.0113	0.0113	0.0113
42055	SpecifiedDemandProfile	ELC003	S211	0.0113	0.0113	0.0113
42056	SpecifiedDemandProfile	ELC003	S212	0.0113	0.0113	0.0113
42057	SpecifiedDemandProfile	ELC003	S213	0.0113	0.0113	0.0113
42058	SpecifiedDemandProfile	ELC003	S214	0.0113	0.0113	0.0113
42059	SpecifiedDemandProfile	ELC003	S215	0.0113	0.0113	0.0113
42060	SpecifiedDemandProfile	ELC003	S216	0.0113	0.0113	0.0113
42061	SpecifiedDemandProfile	ELC003	S217	0.0113	0.0113	0.0113
42062	SpecifiedDemandProfile	ELC003	S218	0.0113	0.0113	0.0113
42063	SpecifiedDemandProfile	ELC003	S219	0.00905	0.00905	0.00905
42064	SpecifiedDemandProfile	ELC003	S220	0.00905	0.00905	0.00905
42065	SpecifiedDemandProfile	ELC003	S221	0.00905	0.00905	0.00905
42066	SpecifiedDemandProfile	ELC003	S222	0.00905	0.00905	0.00905
42067	SpecifiedDemandProfile	ELC003	S223	0.00905	0.00905	0.00905
42068	SpecifiedDemandProfile	ELC003	S224	0.00905	0.00905	0.00905
42069	SpecifiedDemandProfile	ELC003	S301	0.00925	0.00925	0.00925
42070	SpecifiedDemandProfile	ELC003	5302	0.00925	0.00925	0.00925
42071	SpecifiedDemandProfile	ELC003	\$303	0.00925	0.00925	0.00925
42072	SpecifiedDemandProfile	IFI C003	5304	0.00925	0.00925	0.00925
•	Naming SETS Para	meters	ToDataFile	÷		



Tip: the sum of all the Year Split values for the 96 time slices should always be 1. The same is true for the SpecifiedDemandProfile values.

Define a simple technology that satisfies the demand (Backstop)

As explained in Lecture 4, Backstop technologies are a last resort option for the optimization solver, being fictitious technologies with extremely high cost. We will add a backstop technology with an output of electricity (ELC003) demand. Therefore, the backstop will be the only technology in the model able to supply the ELC003 demand we have added. To add the backstop, we need to add the data available here in the right place.

Try it: Add backstop technology

- 1. Go to Parameters Sheet and clear all the filters in case you didn't yet.
- Go to SETS and in Cell B3 change "TEC000" to "BACKSTOP", and "Additional Technology" to "Backstop Technology".

	А	В	C	D	E	F
1			Technologies			Commodities
2		Code	Description		Code	Description
3		BACKSTOP	Backstop Technology		ELC003	Electricity after distribution
4		TEC001	Additional Technology		СОМ002	Additional Fuel
		TEC002	Additional Technology		COM003	Additional Fuel

- 3. Go to the Parameters Sheet and filter out in Column C (Technology) for 'BACKSTOP'. You will now see all the parameters associated only to this technology.
- 4. You will need to add data in SAND as presented in the BACKSTOP Sheet of <u>the data</u> <u>preparation file</u>. Remember to copy-paste the values until 2070.



	A	В	С	D	E	F	G	Н	I.	J	К	L
143	CapacityFactor	RE1	BACKSTOP				S424			1	1	
144	CapacityOfOneT	RE1	BACKSTOP							0	0	
145	CapacityToActiv	i RE1	BACKSTOP						1			
146	CapitalCost	RE1	BACKSTOP							9999999	9999999	999
147	EmissionActivity	RE1	BACKSTOP	EMICO2	1					0	0	
148	EmissionActivity	RE1	BACKSTOP	EM1002	1					0	0	
149	EmissionActivity	RE1	BACKSTOP	EMI003	1					0	0	
150	EmissionActivity	RE1	BACKSTOP	EM1004	1					0	0	
151	EmissionActivity	RE1	BACKSTOP	EMI005	1					0	0	
152	FixedCost	RE1	BACKSTOP							9999999	9999999	999
153	InputActivityRat	RE1	BACKSTOP		1	ELC003				0	0	
154	InputActivityRat	RE1	BACKSTOP		1	COM002				0	0	
155	InputActivityRat	RE1	BACKSTOP		1	COM003				0	0	
156	InputActivityRat	RE1	BACKSTOP		1	COM004				0	0	
157	InputActivityRat	RE1	BACKSTOP		1	COM005				0	0	
158	InputActivityRat	RE1	BACKSTOP		1	COM006				0	0	
159	InputActivityRat	RE1	BACKSTOP		1	COM007				0	0	
160	InputActivityRat	RE1	BACKSTOP		1	COM008				0	0	
••••												
	+ ≣ R	aw Data 👻	(0) SETS -	(2) Specified A	Annual Demand	- (3) Yea	rSplit & Profiles	BACKS	TOP -			

5. Save your Excel file.

Tip: check cells highlighted in blue and be sure that the correspondent cell in SAND has that number! Make use of as many filters as needed for the input data process.

Run the model and check results on production by technology

It's time to run our first model.

1. Go to the 'SETS' sheet. Paste the path of the folder you'd like your results to be saved in. This could be the HO3 folder.

	Emissions						
Code	Description						
EMIC02	Emission factor for CO2						
EMICH4	Emission factor for methane						
EMIFGA Emission factor for Fluorinated gases							
EMIN2O Emission factor for Nitrous Oxide							
EMIREN	Emission factor for RET targets						
	Region						
RE1	Region 1						
ResultsPath "C:\\	ResultsPath "C:\\res\csv" (change it before running)						
:="/Users/naomitan/Deskto	pp/CCG/Training/2a OSeMOSYS/Hands-On/HO3";						



- 2. Go to the 'ToDataFile' sheet on the SAND interface.
- 3. Click on the top left corner of the spreadsheet. This will select all the data within the sheet. Alternatively, you can press on the **command key** (策) + **A**.
- 4. Once highlighted, right click copy. Alternatively, you can press on the **command key** (策) + **C.**
- 5. Now go to your 'Applications' folder and open an app called TextEdit. You will already have this app by default.





6. Click on 'New Document'.





	🛑 😑 🛑 Untitled — Edited										

######### #	Sotc	#									
# ########		#									
#											
" set	EMISSION	N :=	EMTC02	FMTCH4	FMTEGA	FMTN20	FMTREN				
set	REGTON	:=	RF1	:	Linzi on	2.1.2.12.0		'			
set	MODE OF	OPERATIO	N N	:=	1	:					
set	FUEL	:=	ELC003	C0M002	C0M003	COM004	COM005	COM006	COM007	C0M008	COM009
COM010	COM011	COM012	C0M013	COM014	COM015	COM016	COM017	C0M018	COM019	C0M020	COM021
C0M022	C0M023	C0M024	C0M025	C0M026	C0M027	C0M028	C0M029	C0M030	COM031	C0M032	COM033
C0M034	C0M035	C0M036	C0M037	C0M038	C0M039	COM040	COM041	C0M042	C0M043	C0M044	C0M045
C0M046	C0M047	C0M048	C0M049	COM050	;						
set	STORAGE	:=	;								
set	TECHNOL	DGY	:=	BACKSTO	P TEC001	TEC002	TEC003	TEC004	TEC005	TEC006	TEC007
TEC008	TEC009	TEC010	TEC011	TEC012	TEC013	TEC014	TEC015	TEC016	TEC017	TEC018	TEC019
TEC020	TEC021	TEC022	TEC023	TEC024	TEC025	TEC026	TEC027	TEC028	TEC029	TEC030	TEC031
TEC032	TEC033	TEC034	TEC035	TEC036	TEC037	TEC038	TEC039	TEC040	TEC041	TEC042	TEC043
TEC044	TEC045	TEC046	TEC047	TEC048	TEC049	TEC050	TEC051	TEC052	TEC053	TEC054	TEC055
TEC056	TEC057	TEC058	TEC059	TEC060	TEC061	TEC062	TEC063	TEC064	TEC065	TEC066	TEC067
TEC068	TEC069	TEC070	TEC071	TEC072	TEC073	TEC074	TEC075	TEC076	TEC077	TEC078	TEC079
TEC080	TEC081	TEC082	TEC083	TEC084	TEC085	TEC086	TEC087	TEC088	TEC089	TEC090	TEC091
TEC092	TEC093	TEC094	TEC095	TEC096	TEC097	TEC098	TEC099	TEC100	TEC101	TEC102	TEC103
TEC104	TEC105	TEC106	TEC107	TEC108	TEC109	TEC110	TEC111	TEC112	TEC113	TEC114	TEC115
TEC116	TEC117	TEC118	TEC119	TEC120	TEC121	TEC122	TEC123	TEC124	TEC125	TEC126	TEC127
TEC128	TEC129	TEC130	TEC131	TEC132	TEC133	TEC134	TEC135	TEC136	TEC137	TEC138	TEC139
TEC140	TEC141	TEC142	TEC143	TEC144	TEC145	TEC146	TEC147	TEC148	TEC149	TEC150	TEC151
TEC152	TEC153	TEC154	TEC155	TEC156	TEC157	TEC158	TEC159	TEC160	TEC161	TEC162	TEC163
TEC164	TEC165	TEC166	TEC167	TEC168	TEC169	TEC170	TEC171	TEC172	TEC173	TEC174	TEC175
TEC176	TEC177	TEC178	TEC179	TEC180	TEC181	TEC182	TEC183	TEC184	TEC185	TEC186	TEC187
TEC188	TEC189	TEC190	TEC191	TEC192	TEC193	TEC194	TEC195	TEC196	TEC197	TEC198	;

- 8. Save your new TextEdit file with a sensible name (i.e. **HO3_data**) in your new HO3 folder and close it. We now have a .txt file.
- 9. Now go to your 'Applications' folder and open clicSANDMac





10. The screen below will show up. The button highlighted in red allows you to select the data txt file you want to run. In this case, we want to choose HO3_data.txt. The button highlighted in green allows you to select the model txt file. In all cases, we must choose OSeMOSYS_code.txt. You can obtain this coded txt file by clicking on 'Export Templates ...' – as explained in Hands-On 2.

•••	clicSAND	·
Data Source (txt)		
Model		
🗸 Ratio (CBC 0.05		
	Run Open Log Export Templates .	

- 11. When you have selected these two files, click on RUN. This is the button highlighted in yellow. **TIP:** Close any high memory (or disk) consuming programs for a faster run.
- 12. Now wait.... The solvers (glpsol and cbc) will run the txt file with the OSeMOSYS code to find the optimal solution.



13. You will see this on clicSANDMac if the run is successful.





14. You will now see three new files in your HO3 folder.

•••	< > ноз	:≡ ≎	⊙ • ₾ ⊘	Q
Favorites	Name	A Date Modified	Size Kind	
🗎 Dropbox	" HO3_data.txt	Today at 13:52	27 MB Plain Text	
lirDrop	HO3_data.txt.lp	Today at 14:01	730.5 MB Document	
P Recents	📗 HO3_data.txt.results.txt	Today at 14:03	1.3 MB Plain Text	
	📄 HO3_data.txt20220126135526.log.txt	Today at 14:03	4 KB Plain Text	
Desktop	OSeMOSYS_code.txt	17 June 2021 at 19:44	89 KB Plain Text	
🙏 Applicati	Results_Database_HO3.accdb	22 November 2021 at 11:05	598 KB Document	
	Results_Template_HO3.xlsx	22 November 2021 at 11:05	1.4 MB Microsok (.xls	sx)
Documents	SAND_Interface_HO3.xlsm	Today at 13:55	43.3 MB Microso(.xlsm	n)
🕑 Downloads				
iCloud				

Results Visualization

We will now visualize the results from the model run.



 Go to this <u>link</u> to download conversion.app.zip and Results_Visualization_Template.xlsx

Files (83.3 MB)		~	Versions	
Name	Size		Version v.1.1.0	Jan 3
Additional Info.zip	11.5 MB	Preview Download	10.5281/zenodo.5925647	
md5:48bdfeee01eb139a9feec5b4b027d614 @			Version v.1.0.3 10.5281/zenodo.5884075	Jan 2
clicSANDMac.zip	13.7 MB	Preview Download	Version v.1.0.2	Jan 1
md5:7a018fa12ebe5deba185caf9263cdf2e 🖗			10.5281/zenodo.5879057	
conversion.app.zip	49.2 MB	Previe / Lownload	Cite all versions? You can cite all versions by	using th
md5:3371191b75b564c7c7242af8d21f1315 🔞		\sim	10.5281/zenodo.5879056. This DOI represent: and will always resolve to the latest one. Read	s all ver more.
Results_Visualization_Template.xlsx	8.9 MB	▲ Download		
md5:2b234a08090140bbc2143c6ea12bea86 🕜			Share	

2. Once downloaded, unzip and right-click to open the conversion.app.zip file. This file will convert our results txt file to a csv file.

• • •	< > Downloads			∕ ⊙ ~	Ů ⊘ Q
Favorites	Name	Date Modified			
🛅 Dropbox	Data prep.xlsx	17 January 2022 a	at 13:33	19 KB	Microsok (.xlsx)
AirDrop	results_template.xlsx	14 January 2022 a	at 06:22	4.9 MB	Microsok (.xlsx)
Recents	conversion	Onen	0:13	49.8 MB	Application
	> 💳 output_10831	Open			Folder
Desktop	output_10831.zip	Show Package Contents	7:22	1.5 MB	ZIP archive

3. Click on 'Open'.



4. A window will pop-up. Click on 'Input file' and choose 'HO3_data.txt.results.txt'. For 'Output directory', choose your HO3 folder. Now choose an output name. In this case, we can write "HO3_results". Now click on 'Save output filename'.





5. Click on 'Run' to finish. You will have a csv file in your HO3 folder called "HO3_results.csv". Open this file. This will open a spreadsheet.

•••	< > ноз	≣ ≎		Ů ⊘ Q
Favorites	Name	Date Modified		Kind
🛅 Dropbox	HO3_data.txt	Today at 13:52	27 MB	Plain Text
🕟 AirDrop	HO3_data.txt.lp	Today at 14:01	730.5 MB	Document
Recents	HO3_data.txt.results.txt	Today at 14:03	1.3 MB	Plain Text
	📄 HO3_data.txt20220126135526.log.txt	Today at 14:03		Plain Text
Desktop	HO3_results.csv	Today at 14:20	597 KB	commad values
🙏 Applicati	📄 OSeMOSYS_code.txt	17 June 2021 at 19:44	89 KB	Plain Text
Decumente	Results_Database_HO3.accdb	22 November 2021 at 11:05	598 KB	Document
Documents	Results_Template_HO3.xlsx	22 November 2021 at 11:05	1.4 MB	Microsok (.xlsx)
Downloads	SAND_Interface_HO3.xlsm	Today at 13:55	43.3 MB	Microso(.xlsm)

6. Click on Cell A2. Now press on the **command key (光) + shift + right arrow + right arrow + down arrow.** This will select all the data in Columns A to L, without the header row.

	A	В	с	D	E	F	G	н		J	К	L
1	Variable	Dim1	Dim2	Dim3	Dim4	Dim5	Dim6	Dim7	Dim8	Dim9	Dim10	ResultValue
2	NewCapacity	RE1	BACKSTOP	2015								32.825383
3	NewCapacity	RE1	BACKSTOP	2016								1.4625206
4	NewCapacity	RE1	BACKSTOP	2017								2.7303177
5	NewCapacity	RE1	BACKSTOP	2018								2.7303062
6	NewCapacity	RE1	BACKSTOP	2019								2.7303177
7	NewCapacity	RE1	BACKSTOP	2020								2.7303062
8	NewCapacity	RE1	BACKSTOP	2021								2.4459777
9	NewCapacity	RE1	BACKSTOP	2022								2.6195831
10	NewCapacity	RE1	BACKSTOP	2023								2.8028672
11	NewCapacity	RE1	BACKSTOP	2024								2.99667
12	NewCapacity	RE1	BACKSTOP	2025								3.2018202
13	NewCapacity	RE1	BACKSTOP	2026								4.1304394
14	NewCapacity	RE1	BACKSTOP	2027								4.414998
15	NewCapacity	RE1	BACKSTOP	2028								4.7184076
16	NewCapacity	RE1	BACKSTOP	2029								5.0417729
17	NewCapacity	RE1	BACKSTOP	2030								5.3864978

- 7. Copy the data by pressing **command key** (**H**) + C.
- 8. Now open the newly downloaded Results_Visualization_Template.xlsx file.



9. In the top ribbon, click on 'Enable Content'.



10. Click on Cell A2 and press on the **command key (光) + shift + right arrow + right arrow + down arrow** to highlight all the data in Columns A to L, without the header row. Now click on the delete key to delete the values.

	А	В	С		D	E	F	G	н		I J	к	L	
1	Variable	🗖 Din 🔻	Dim2	▼ Dim3		Dim4 💌	Din 🔻	Dir 🔻	Dim7	🔻 Dir	▼ Din ▼	Dim 🔻	ResultValu 🔻	
2	NewCapacity	RE1	MINOIL		2018								750.43416	
3	NewCapacity	RE1	MINOIL		2019								750.43416	
4	NewCapacity	RE1	MINOIL		2020								750.43416	
5	NewCapacity	RE1	MINOIL		2021								725.41968	
6	NewCapacity	RE1	MINOIL		2022								700.40521	
7	NewCapacity	RE1	MINOIL		2023								675.39074	
8	NewCapacity	RE1	MINOIL		2024								650.37627	
9	NewCapacity	RE1	MINOIL		2025								625.3618	
10	NewCapacity	RE1	MINOIL		2026								625.3618	
11	NewCapacity	RE1	MINOIL		2027								625.3618	
12	NewCapacity	RE1	MINOIL		2028								625.3618	
13	NewCapacity	RE1	MINOIL		2029								625.3618	
14	NewCapacity	RE1	MINOIL		2030								625.3618	
15	NewCapacity	RE1	MINOIL		2031								625.3618	
16	NewCapacity	RE1	MINOIL		2032								625.3618	
17	NewCapacity	RE1	MINOIL		2033								625.3618	
18	NewCapacity	RE1	MINOIL		2034								587.364	
19	NewCapacity	RE1	MINOIL		2035								625.3618	
20	NewCapacity	RE1	MINOIL		2036								625.3618	
21	NewCapacity	RE1	MINOIL		2037								625.3618	
22	NewCapacity	RE1	MINOIL		2038								625.3618	
23	NewCapacity	RE1	MINOIL		2039								625.3618	
24	NewCapacity	RE1	MINOIL		2040								600.34732	
25	NewCapacity	RE1	MINOIL		2041								540.31259	
26	NewCapacity	RE1	MINOIL		2042								531.74199	
27	NewCapacity	RE1	MINOIL		2043								560.32417	
28	NewCapacity	RE1	MINOIL		2044								480.27786	
29	NewCapacity	RF1	MINOII		2045								300,17366	

11. In a now empty Cell A2, paste the data with the **command key** (**#**) + V.



		A	В	с			D	E		F	G		н		I	J	к	L	
1	Variable		Dir 🔻	Dim2	-	Dim3		Dim4	•	Dir 🔻	Din 🔻	Dim7		•	Dir 🔻	Din 🔻	Dim 🔻	ResultValu 🔻	
2	NewCapacity		RE1	BACKSTOP			201	5										32.825383	P
3	NewCapacity		RE1	BACKSTOP			201	6										1.4625206	
4	NewCapacity		RE1	BACKSTOP			201	7										2.7303177	
5	NewCapacity		RE1	BACKSTOP			201	8										2.7303062	
6	NewCapacity		RE1	BACKSTOP			201	9										2.7303177	
7	NewCapacity		RE1	BACKSTOP			202	0										2.7303062	
8	NewCapacity		RE1	BACKSTOP			202	1										2.4459777	
9	NewCapacity		RE1	BACKSTOP			202	2										2.6195831	
10	NewCapacity		RE1	BACKSTOP			202	3										2.8028672	
11	NewCapacity		RE1	BACKSTOP			202	4										2.99667	
12	NewCapacity		RE1	BACKSTOP			202	5										3.2018202	
13	NewCapacity		RE1	BACKSTOP			202	6										4.1304394	
14	NewCapacity		RE1	BACKSTOP			202	7										4.414998	
15	NewCapacity		RE1	BACKSTOP			202	8										4.7184076	
16	NewCapacity		RE1	BACKSTOP			202	9										5.0417729	
17	NewCapacity		RE1	BACKSTOP			203	0										5.3864978	
18	NewCapacity		RE1	BACKSTOP			203	1										5.9418971	

12. We will first visualize Annual Electricity Production. Go to the 'AnnualElecProduction' Sheet. Click on Cell A3. 'PivotTable Analyze' should show up in the ribbon. Click on this, then click on 'Refresh'.

					А	В			
				1 Variabl	e	(Multiple Items	5) -T		
				2					
				3 Sum of	ResultValue	Column Labels	▼		
				4 Row La	bels 💌	Grand Total			
				5 Grand	Fotal				
Home	Insert	Draw	Page Layout	Formulas	Data R	eview View	Developer	PivotTable Analyz	e Design
PivotTable	Name:		Active Field:		Expand Field		R R		
PivotTab	ole1	Options	Sum of Result\	Field -	Collapse Field	Group Selection	Insert Insert Slicer Timeline	Filter Connections	Change efresh ^{Bource}
A3	* ×	$\checkmark f_x$	Sum of ResultValu	ue					

13. Now go to the filter setting of 'Column Labels' in Cell B3 and tick 'Select All'.

Α			с	D	E	F
/ariable	ProductionBy	FechnologyAnnual 🖅				
Sum of ResultValue	Column Label	s 🛛 🔽				
Row Labels	BACKSTOP		•			
2015		28.522751	Sort			
2016		29.79357				
2017		22 166000	?↓ Asce	ending 🖌	Descendir	ng
2018			Sort but	Dim2		
2019	600		Sort by.	Dimz	_	<u> </u>
2020			Filter			
2021						_
2022	500		By label:	Choose One	•	0
2024			By value:	Choose On	,	0
2025	400					_
2026			Q Sean			
2027						
2028	300			Select All)		U
2029				DEMCOMEL	С	
2030	200		🖉 г			
2031						
2032			<u> </u>			
2033	100		E	MIC02		
2034			🔰 🗸 M	AINBIO		
2035			🗹 N	/INCOA		
2030	c	15 17 19 21 23 23 25				
2037		20 20 20 20 20 20 20 20 20 20 20 20 20 2				bor
2039		140 53216				
		140.33210				



14. You will be able to see a table and a graph. Your results for Annual Electricity Production from this exercise are now visualized! Save the file as results_visualization_HO3.xlsx

	А	В		D	E	F	G	н			к	
1	Variable	ProductionByTechnologyAnnual										
2												
3	Sum of ResultValue	Column Labels 🔍										
4	Row Labels 🛛 🔻	BACKSTOP	Grand Total									
5	2015	28.522751	28.522751									
6	2016	29.79357	29.79357	0				b				
7	2017	32.166008	32.166008				BAC	KSTOP				
8	2018	34.538435	34.538435	600								
9	2019	36.910873	36.910873	600								
10	2020	39.283301	39.283301	_								
11	2021	41.408669	41.408669	500								
12	2022	43.684886	43.684886							- 11 -		
13	2023	46.120364	46.120364							. attitte -		
14	2024	48.724241	48.724241	400								
15	2025	51.506378	51.506378									
16	2026	55.095415	55.095415						. al III III II		Ц	
17	2027	58.931711	58.931711	300				11.			BACKSTOP	
18	2028	63.031647	63.031647									
19	2029	67.412563	67.412563	200								
20	2030	72.093018	72.093018									
21	2031	77.256073	77.256073				ullii					
22	2032	82.820457	82.820457	100			,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,					
23	2033	88.813551	88.813551			tttttt						
24	2034	95.265115	95.265115	_								
25	2035	104.3988	104.3988	0	9 N 9 H 9 9	0 1 0 4	0 0 0 0 0	0 N O I O	5000	0 0 0 0		
20	2030	112.47219	12.47219		201 201 201 202 202 202 202 202	202 202 203 203 203	203 203 203 204 204 204	204 204 205 205 205 205	205 205 205 205 205	206 206 206 206 206 206 206 206 206 206		
27	2037	121.15400	121.15408	0				P			0	
20	2038	140 53216	140 53216									
30	2035	151 33105	151 33105									
31	2040	160.22964	160,22964									
32	2042	169.64923	169.64923									
33	2043	179.62122	179.62122									
34	2044	190.17811	190.17811									
35	2045	201.354	201.354									
26	2046	212 41410	212 41410									
	ResultsD	ata SETS Annual	ElecProductio	n E	lecProductionB	уTS To	otalCapacityA		Cooking&Hea		port Ann	iual C

In this graph, you will see that the only technology producing electricity is the BACKSTOP. This is because it is the only technology that we added in our energy system to provide ELC003.

15. You will also notice that this file is made of different Sheets for each of the variable we want to obtain results for:

Annual Electricity Production	Electricity Production by Timeslice	Annual Total Capacity	Cooking & Heat
Transport	Annual CO2	Annual CO2 by Technology	Demand
Annual Fixed Operating Costs	Annual Variable Operating Costs	Capital Investment	

The steps are the same for the above graphs.