Energy and Flexibility Modelling

Hands-on 2 (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]. http://doi.org/10.5281/zenodo.5879056

- **OSeMOSYS Google Forum**

Please sign up to the help Google forum here. 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

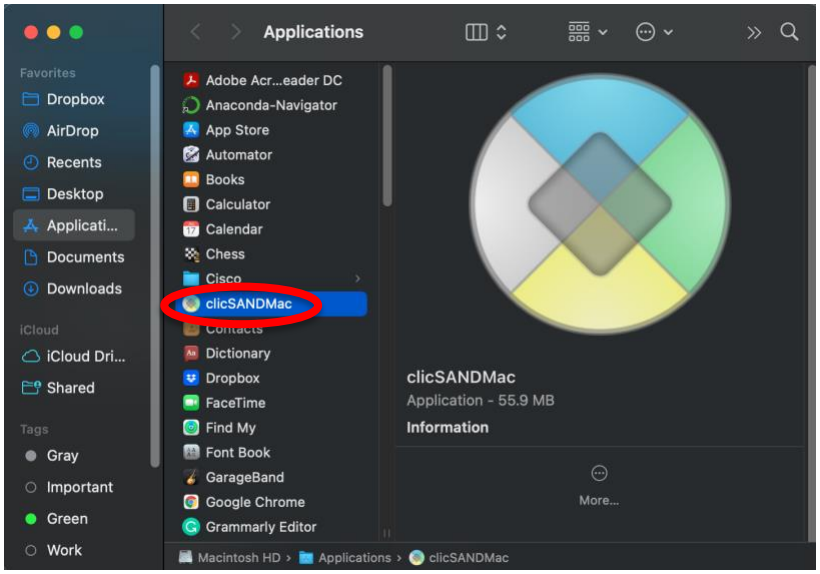
By the end of this exercise, you will be able to:

1. Create a new model in the SAND Interface
2. Learn the main functionalities of the SAND Interface
3. Define the duration of Timeslices
4. Add Year Split values
5. Check Depreciation Method and Discount Rate values

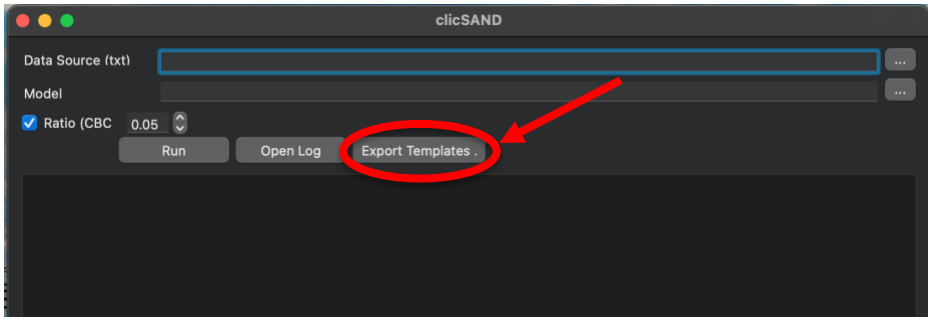
Create a new model

After installing the software and downloading the files needed (as in **Hands-on 1**), you can now create your first model in OSeMOSYS using the interface named SAND. This is an Excel-based (Macro-Enabled) file where you can input the data needed for OSeMOSYS to find the optimal solution to your problem. Let's learn how to save and manage your files.

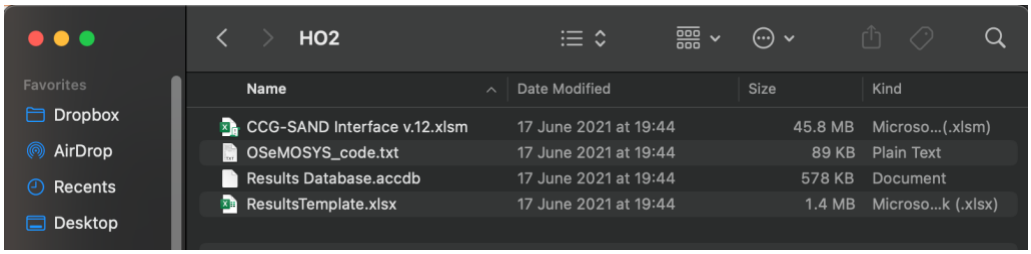
1. Create a folder called "**HO2**" for this Hands-On 2.
2. Go to your 'Applications' folder and double-click on 'clicSANDMac' to open the software.



3. This screen will show up. Click on 'Export Templates' and direct it to the HO2 folder you created in Step 1.



4. This will automatically save a blank copy of four files:



File name	Description	Action to take
CCG-SAND Interface v.12.xlsm	Excel Macro Enabled Workbook	**Rename the file to SAND_Interface_HO2**
OSeMOSYS_code.txt	Text file. This is the code needed to run your models	Nothing. We do not need to change it
Results Database.accdb	Access database to store the results obtained	Nothing. We will not use this file
ResultsTemplate.xlsm	Excel Macro Enabled Workbook	Nothing. We will not use this file

Tip: Every time you make substantial changes to your model, save it as a new version in the correspondent folder. For example, if I want to test different options on my Hands-On 2 file, I will create a new file in the folder "**HO2**" called "**SAND_Interface_HO2_v2**" and so on.

Repeat these steps for each Hands-On (New Hox folder -> Open clicSANDMac -> Export Templates in the HOx folder)

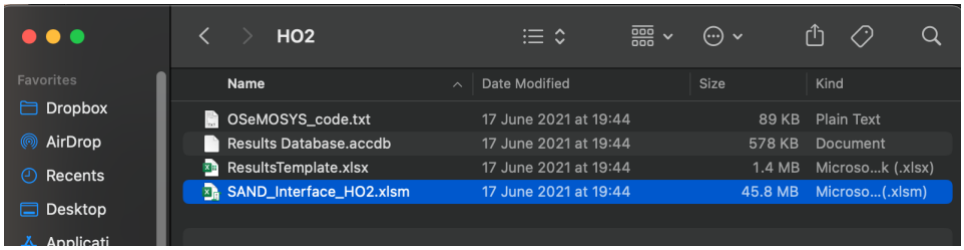
Important: The files should not be saved or synced in One Drive for clicSAND to work

You now know how to manage your folders and files!

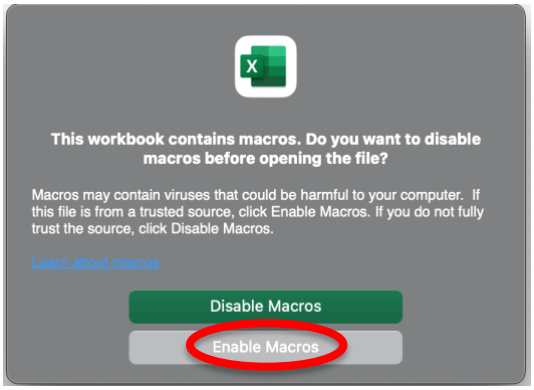
Main functionalities of SAND Interface

The next step is to learn how to use the SAND Interface. **Don't worry**, it looks more complicated than it really is.

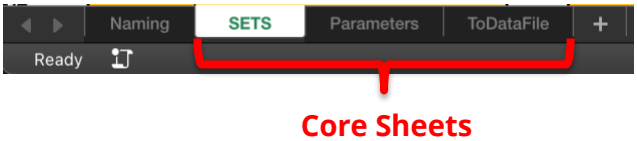
1. Open the renamed file **SAND_Interface_HO2**



2. A pop-up will appear. Click on 'Enable Macros'.

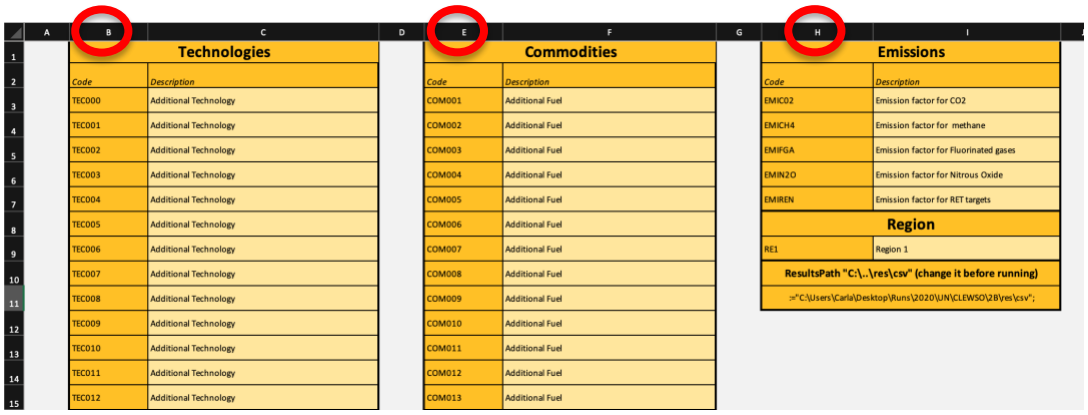


3. You will now see an Excel Workbook with four Sheets – **Naming**, **SETS**, **Parameters**, and **ToDataFile**. The Sheets **SETS**, **Parameters**, and **ToDataFile** represent the core of the Interface, and they are entirely interconnected to one another.



Core Sheets

4. Go to **SETS** - this is the place where you can define the name of your **Technologies** (in column B), **Commodities** (in column E) and **Emissions** (in column H).



Technologies	
Code	Description
TEC000	Additional Technology
TEC001	Additional Technology
TEC002	Additional Technology
TEC003	Additional Technology
TEC004	Additional Technology
TEC005	Additional Technology
TEC006	Additional Technology
TEC007	Additional Technology
TEC008	Additional Technology
TEC009	Additional Technology
TEC010	Additional Technology
TEC011	Additional Technology
TEC012	Additional Technology

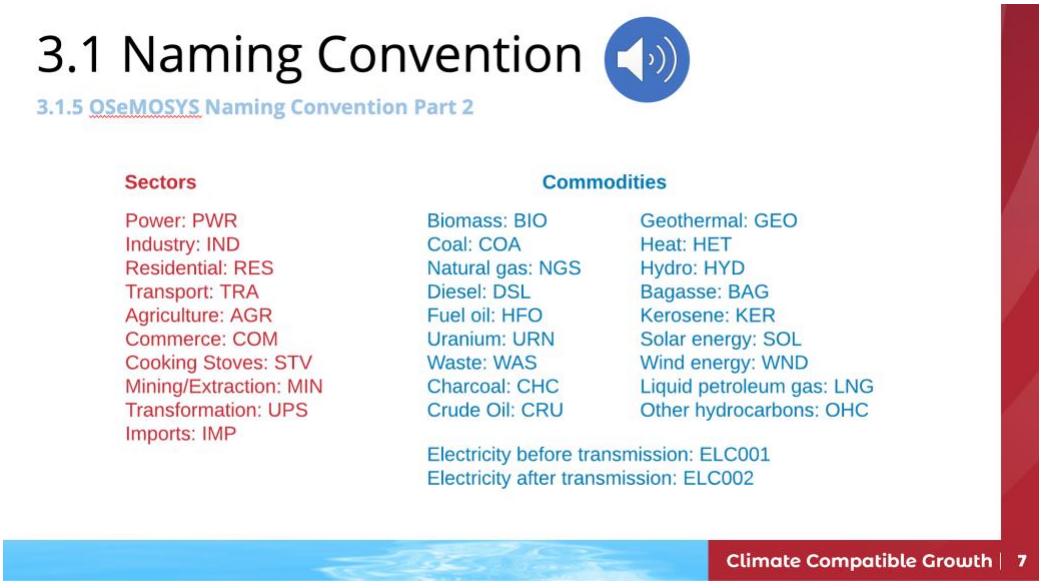
Commodities	
Code	Description
COM001	Additional Fuel
COM002	Additional Fuel
COM003	Additional Fuel
COM004	Additional Fuel
COM005	Additional Fuel
COM006	Additional Fuel
COM007	Additional Fuel
COM008	Additional Fuel
COM009	Additional Fuel
COM010	Additional Fuel
COM011	Additional Fuel
COM012	Additional Fuel
COM013	Additional Fuel

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:\..\res\csv" (change it before running)	
:="C:\Users\Carla\Desktop\Runs\2020\UN\CLEWSO\2B\res\csv";	

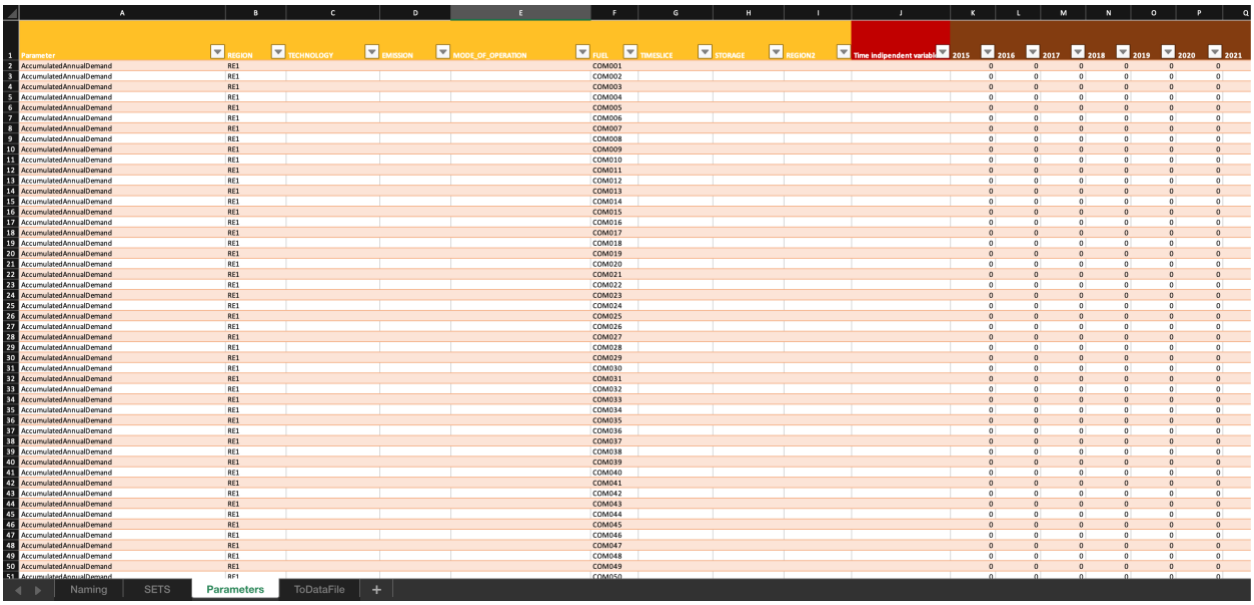
These three columns are linked to the '**ToDataFile**' Sheet that has the format needed by the solver to find the optimal solution. Therefore, whenever you specify the name of a Technology, Commodity, or Emission in these columns, it is automatically reported in their respective cells in the '**ToDataFile**' Sheet.

You have the freedom to change the names **as many times as necessary** without losing the data previously added for that specific entry.

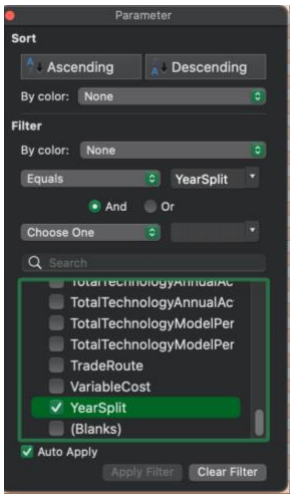
Important: Technologies, Commodities and Emissions codes in your model should be named following the guidelines explained in **Lecture 3**.



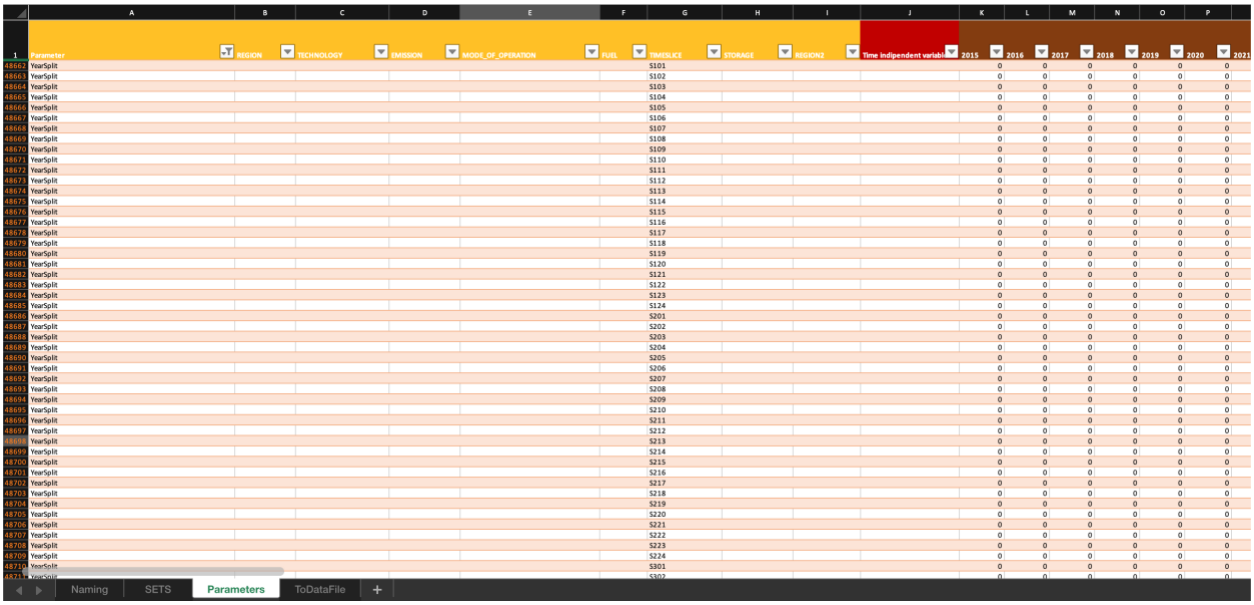
5. Go to **Parameters** - this is a giant Sheet where you will be adding data for each OSeMOSYS parameter. To make things easier and faster for you, there are filters at the top of each column where you can filter for either **Parameter (column A), Technology (Column C), Commodities/Fuel (Column F).** Columns K to BN is where you can insert data from 2015 to 2070.



6. In **Parameters (Column A)**, filter for **YearSplit**. You will see that only data associated with the parameter called YearSplit are shown. You can add as many filters as you want. Play around with the filters and get confident with this functionality!

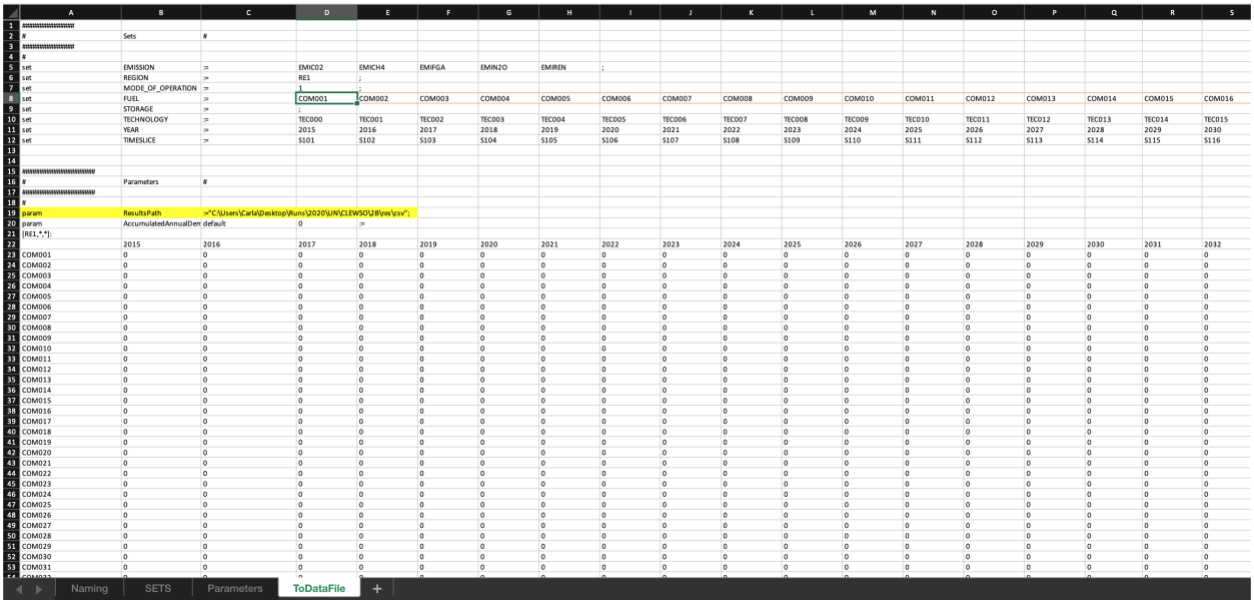


This is what you will see if you filter out for the Parameter **Year Split**:



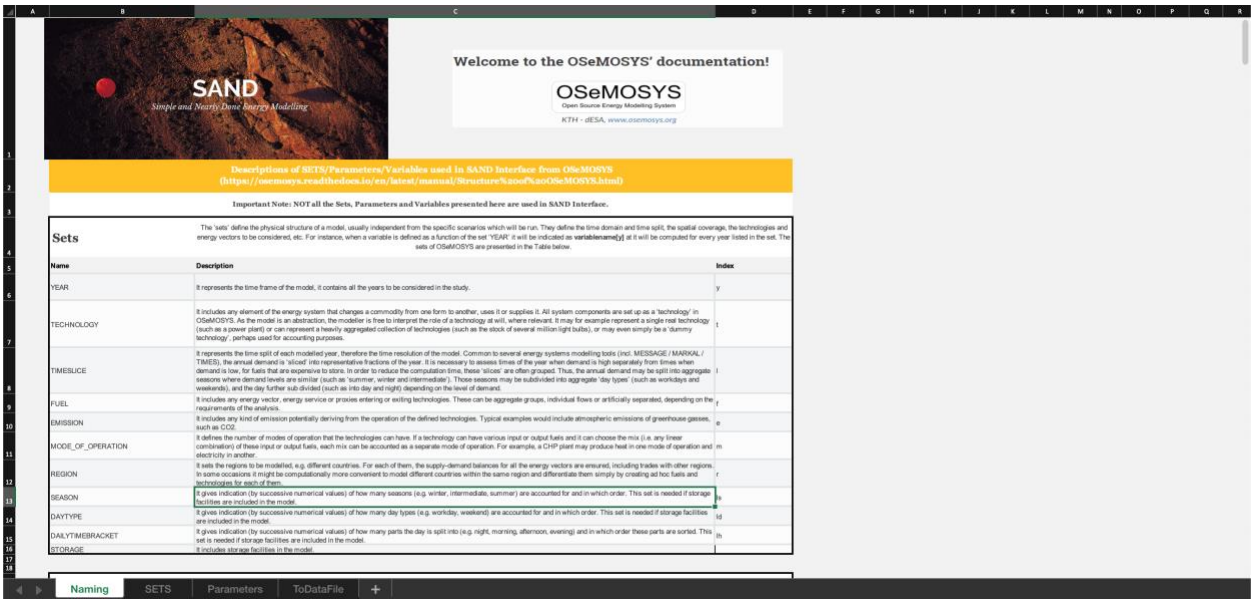
You see that from column K to column BN there are default values added. In this case, it is 0. We will add data for YearSplit at the end of this Hands-On.

7. Go to **ToDataFile** - this Sheet has the format needed by the solver to find the optimal solution to your problem.



Important: never add data to this **ToDataFile** Sheet - data should only be added to the **Parameters** and **SETS** sheets. The interface is made up in a way that all the entries will be automatically read by the **ToDataFile** sheet.

8. **Go to Naming** – here you will find the description of the parameters used in SAND Interface. Note that we are not going to use all the parameters listed here.



Define the duration of time slices

To carry out a modelling exercise with OSeMOSYS, it is necessary to assign values to the set called **Timeslices**, which represents periods of the year with a similar demand. In this model, the year was initially divided into 4 timeslices representing two periods of 6 months (two representative seasons), each of which has similar demand. This was then further sub-divided into day and night periods, called: **Summer Day (SD)**, **Summer Night (SN)**, **Winter Day (WD)**, **Winter Night (WN)**.

However, in the SAND Interface it is possible to define up to 96 timeslices, so these initial data were manipulated to obtain a 24-hour representation of a reference day for each of SD, SN, WD, and WN (24 hours each * 4 = 96 timeslices). Therefore, each year is divided into 96 periods instead of the previous 4.

It was assumed each season has an equal length, with an average hourly split per season (24hr representative), therefore obtaining:

4 Seasons/year * 24hr of a representative day/season = 96 Timeslices/Year

Each Timeslice represents an equal fraction of the Year in the following way, defined as the Year Split:

1 Year / 96 Timeslices = 0.0104

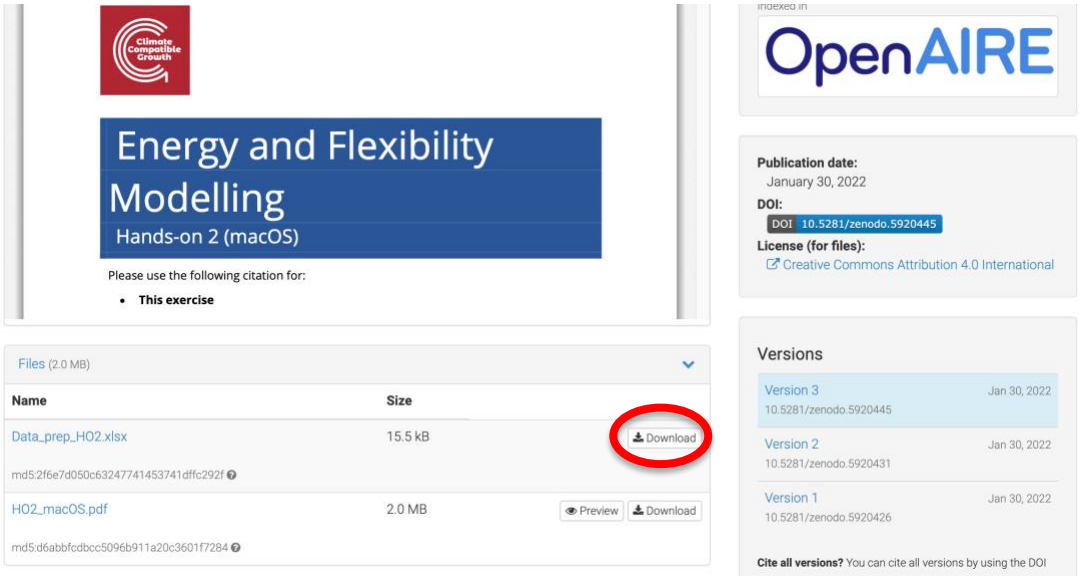
Therefore, you should add this number to the Year Split column for each year.

Tip: To help you deal with all the data, there is a **Data Preparation Spreadsheet** that will allow you to copy-paste the data in a faster way.

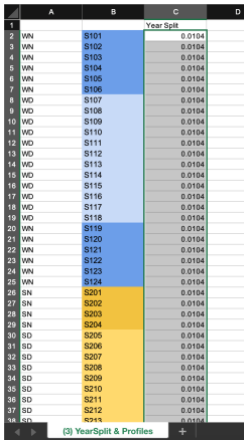
Add Year Split values

After defining the duration of each time slice and calculating the Year Split profile we need to add these values in the SAND Interface.

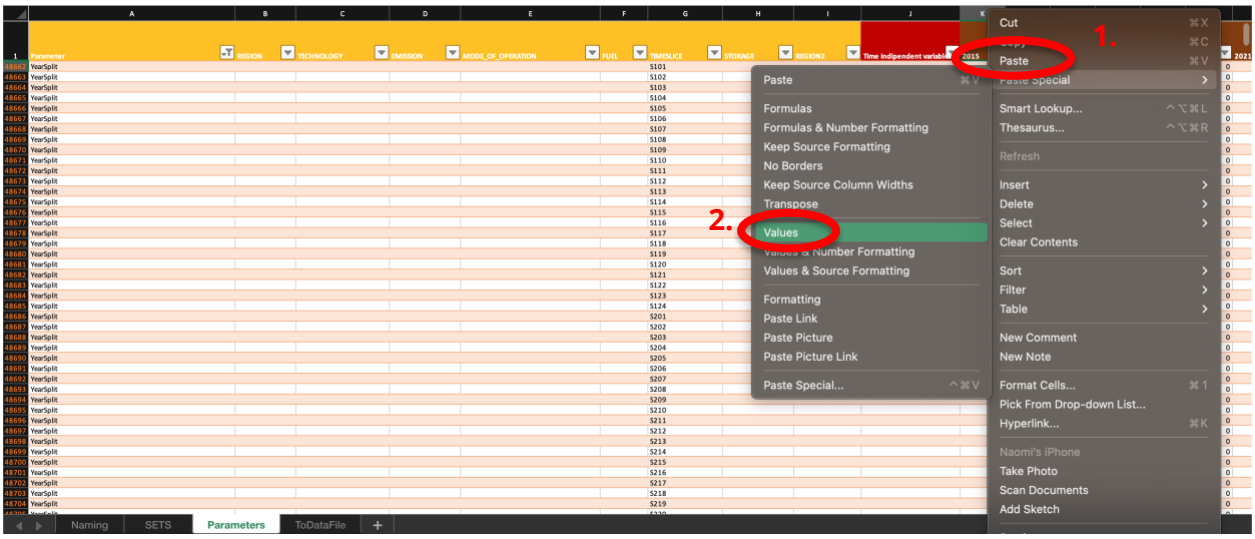
1. Go to the Parameters Sheet and filter for **YearSplit** (in Column A).
2. Click on this link to open the **Data Preparation Spreadsheet**.
3. At the bottom of the webpage, you will see a tab called 'Files'. Click on Download beside **Data_Prep_HO2.xlsx**



4. Open **Data_Prep_HO2.xlsx** once downloaded. You will see this Excel Workbook. Copy the data in Column C of the **Data Preparation File** (click on cell C2 and press on the **command key (⌘) + shift + down arrow**).

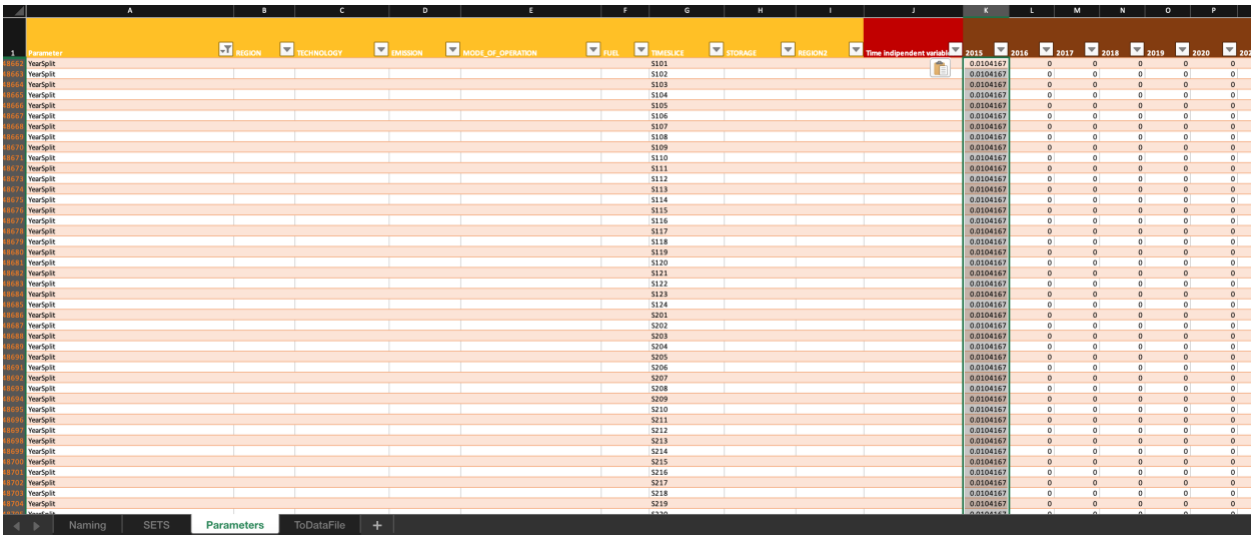


5. Paste these values to Column K of SAND interface, corresponding to the year 2015. **IMPORTANT**: right click on Cell K48662 and go to '**Paste Special', then 'Values'.**

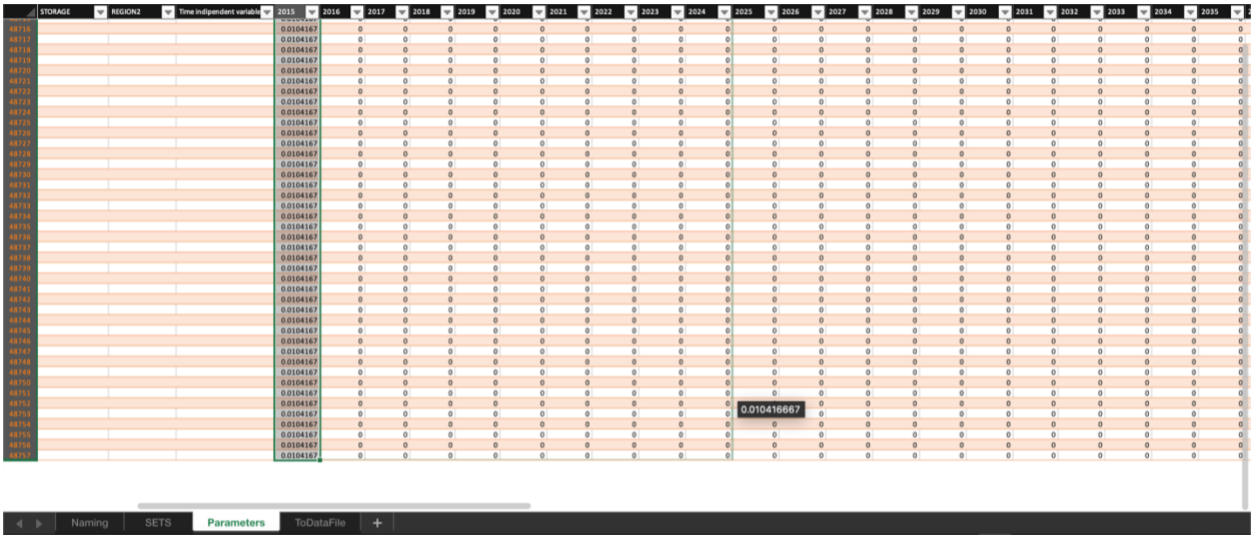


IMPORTANT: Unfortunately, you cannot copy-paste all the data in one go. This is because when filters are applied, Excel will not copy-paste the data into the correct rows of the spreadsheet if multiple lines are copy-pasted at the same time. Therefore, if you select all the data at once, instead of line-by-line or data in consecutive rows, you will add data for completely wrong parameters and the model will not work.

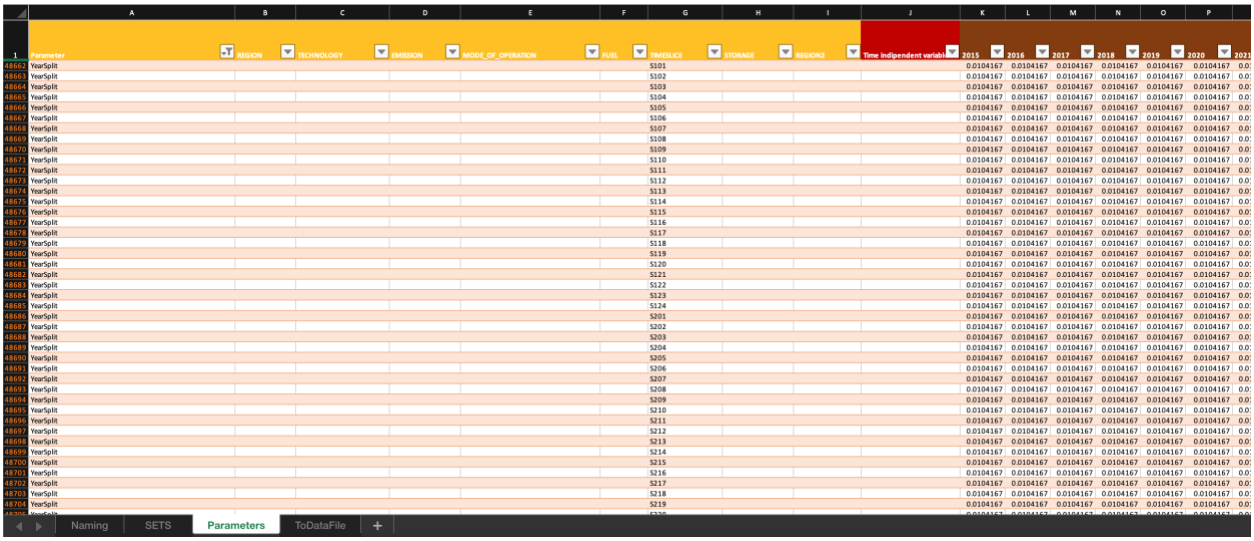
To help you with this task, check the blue cells in the Data Preparation file that highlight the data you need to change every time.



6. Go to Cell K48662; press on the **command key (⌘) + shift + down arrow** to select only the data in column K. Navigate to the bottom right corner of the selected data until you see a '**+**' symbol. Now press and drag to the right to copy the data until column BK (year 2070).



You have now added the Year Split values for all 96 time slices available in the SAND Interface for every model year from 2015-2070.



Check Depreciation Method and Discount Rate values

We will leave default values for Depreciation Method and Discount Rate. In the future, you are free to change them following these steps.

1. Go to the **Parameters** Sheet. In Column A, filter for '**Depreciation Method**' and '**Discount Rate**'. You will see the following. Do not change these numbers, we will use these defaults values.

The **Depreciation Method** will have a value of 1 and the **Discount Rate** of 0.1 (10% discount rate). These are time independent variables; you will therefore see their value in Column J. When a variable is time dependent instead, no values will be in Column J and there will be a value for each of the modelling years (Column K to Column BN).

Name	Description
YearSplit	Duration of a modelled time slice, expressed as a fraction of the year. The sum of each entry over one modelled year should equal 1.
DiscountRate	Region specific value for the discount rate, expressed in decimals (e.g. 0.1)
DepreciationMethod	Binary parameter defining the type of depreciation to be applied. It has value 1 for sinking fund depreciation, value 2 for straight-line depreciation.

2. Save your **SAND_Interface_HO2** file. We will continue with file in Hands-On 3.