



# Energy and Flexibility Modelling

## Hands-on 2 (macOS)

Please use the following citation for:

- **This exercise**

Tan, N., Cannone, C., Kell, A., Howells, M. (2022, January). Hands-on 2 (macOS): Energy and Flexibility Modelling. <http://doi.org/10.5281/zenodo.5920425>

- **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.

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## Learning outcomes

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

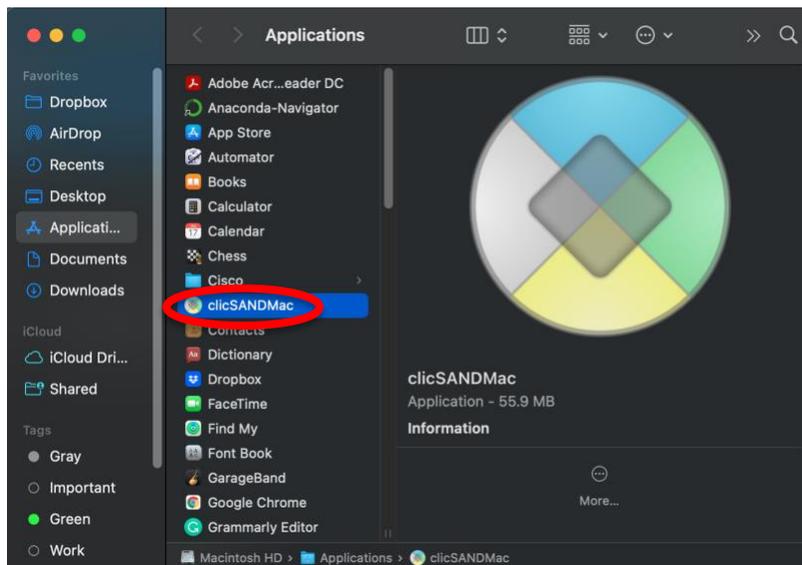
1. Create a new model in the SAND Interface
2. Learn the main functionalities of the SAND Interface
3. Define the duration of Timeslices
4. Add Year Split values
5. Check Depreciation Method and Discount Rate values



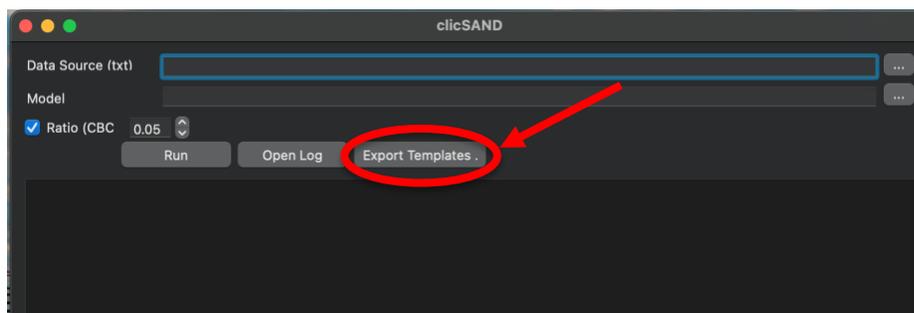
# Create a new model

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 'cllcSANDMac' to open the software.

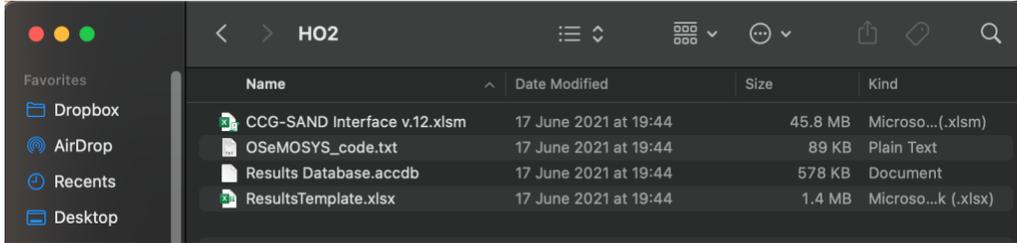


3. This screen will show up. Click on 'Export Templates' and direct it to the HO2 folder you created in Step 1.





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                          | <b>Rename the file to SAND_Interface_HO2</b> |
| 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**

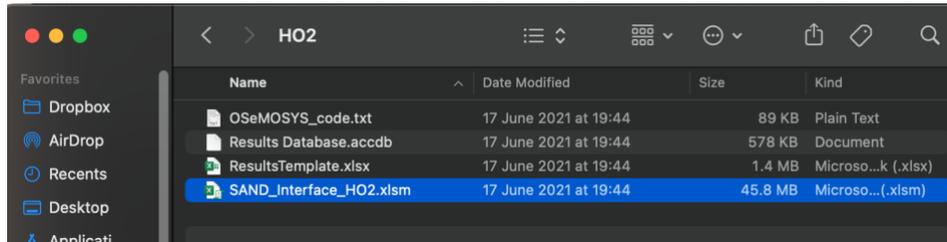
You now know how to manage your folders and files!



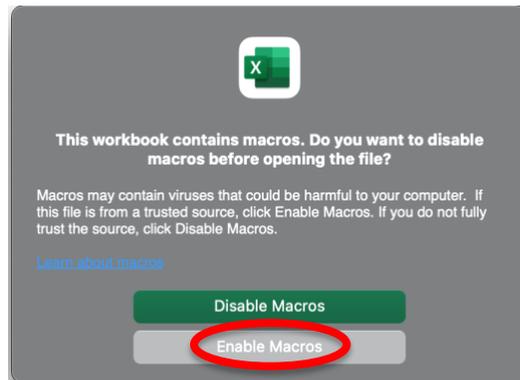
# Main functionalities of SAND Interface

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**

- 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).

|    | A | B      | C                     | D | E      | F                  | G | H  | I                                     |
|----|---|--------|-----------------------|---|--------|--------------------|---|--|---------------------------------------|
| 1  |   |        | <b>Technologies</b>   |   |        | <b>Commodities</b> |   |  | <b>Emissions</b>                      |
| 2  |   | Code   | Description           |   | Code   | Description        |   | Code   | Description                           |
| 3  |   | TEC000 | Additional Technology |   | COM001 | Additional Fuel    |   | EMIC02   | Emission factor for CO2               |
| 4  |   | TEC001 | Additional Technology |   | COM002 | Additional Fuel    |   | EMICH4   | Emission factor for methane           |
| 5  |   | TEC002 | Additional Technology |   | COM003 | Additional Fuel    |   | EMIFGA   | Emission factor for Fluorinated gases |
| 6  |   | TEC003 | Additional Technology |   | COM004 | Additional Fuel    |   | EMIN2O   | Emission factor for Nitrous Oxide     |
| 7  |   | TEC004 | Additional Technology |   | COM005 | Additional Fuel    |   | EMIREN   | Emission factor for RET targets       |
| 8  |   | TEC005 | Additional Technology |   | COM006 | Additional Fuel    |   | <b>Region</b>  |                                       |
| 9  |   | TEC006 | Additional Technology |   | COM007 | Additional Fuel    |   | RE1  | Region 1                              |
| 10 |   | TEC007 | Additional Technology |   | COM008 | Additional Fuel    |   | <b>ResultsPath "C:\...\res\csv" (change it before running)</b> |                                       |
| 11 |   | TEC008 | Additional Technology |   | COM009 | Additional Fuel    |   | ="C:\Users\Carla\Desktop\runs\2020\UN\CLEW50\2\res\csv";       |                                       |
| 12 |   | TEC009 | Additional Technology |   | COM010 | Additional Fuel    |   |  |                                       |
| 13 |   | TEC010 | Additional Technology |   | COM011 | Additional Fuel    |   |  |                                       |
| 14 |   | TEC011 | Additional Technology |   | COM012 | Additional Fuel    |   |  |                                       |
| 15 |   | TEC012 | Additional Technology |   | COM013 | Additional Fuel    |   |  |                                       |

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**.

## 3.1 Naming Convention



### 3.1.5 OSeMOSYS Naming Convention Part 2

#### Sectors

Power: PWR  
 Industry: IND  
 Residential: RES  
 Transport: TRA  
 Agriculture: AGR  
 Commerce: COM  
 Cooking Stoves: STV  
 Mining/Extraction: MIN  
 Transformation: UPS  
 Imports: IMP

#### Commodities

Biomass: BIO      Geothermal: GEO  
 Coal: COA      Heat: HET  
 Natural gas: NGS      Hydro: HYD  
 Diesel: DSL      Bagasse: BAG  
 Fuel oil: HFO      Kerosene: KER  
 Uranium: URN      Solar energy: SOL  
 Waste: WAS      Wind energy: WND  
 Charcoal: CHC      Liquid petroleum gas: LNG  
 Crude Oil: CRU      Other hydrocarbons: OHC

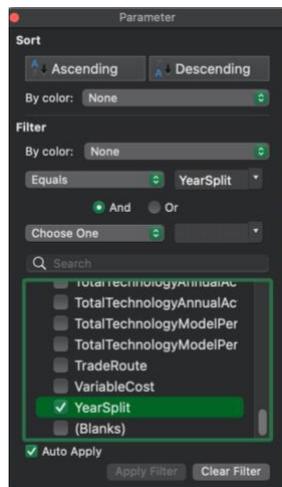
Electricity before transmission: ELC001  
 Electricity after transmission: ELC002



- 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.

|    | A                       | B      | C          | D        | E                 | F      | G          | H       | I       | J                         | K    | L    | M    | N    | O    | P    | Q    |
|----|-------------------------|--------|------------|----------|-------------------|--------|------------|---------|---------|---------------------------|------|------|------|------|------|------|------|
|    | Parameter               | REGION | TECHNOLOGY | EMISSION | MODE_OF_OPERATION | FUEL   | TIME_SLICE | STORAGE | REGION2 | Time Independent variable | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| 2  | AccumulatedAnnualDemand | RES    |            |          |                   | COM001 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 3  | AccumulatedAnnualDemand | RES    |            |          |                   | COM002 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 4  | AccumulatedAnnualDemand | RES    |            |          |                   | COM003 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 5  | AccumulatedAnnualDemand | RES    |            |          |                   | COM004 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 6  | AccumulatedAnnualDemand | RES    |            |          |                   | COM005 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 7  | AccumulatedAnnualDemand | RES    |            |          |                   | COM006 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 8  | AccumulatedAnnualDemand | RES    |            |          |                   | COM007 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 9  | AccumulatedAnnualDemand | RES    |            |          |                   | COM008 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 10 | AccumulatedAnnualDemand | RES    |            |          |                   | COM009 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 11 | AccumulatedAnnualDemand | RES    |            |          |                   | COM010 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 12 | AccumulatedAnnualDemand | RES    |            |          |                   | COM011 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 13 | AccumulatedAnnualDemand | RES    |            |          |                   | COM012 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 14 | AccumulatedAnnualDemand | RES    |            |          |                   | COM013 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 15 | AccumulatedAnnualDemand | RES    |            |          |                   | COM014 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 16 | AccumulatedAnnualDemand | RES    |            |          |                   | COM015 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 17 | AccumulatedAnnualDemand | RES    |            |          |                   | COM016 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 18 | AccumulatedAnnualDemand | RES    |            |          |                   | COM017 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 19 | AccumulatedAnnualDemand | RES    |            |          |                   | COM018 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 20 | AccumulatedAnnualDemand | RES    |            |          |                   | COM019 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 21 | AccumulatedAnnualDemand | RES    |            |          |                   | COM020 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 22 | AccumulatedAnnualDemand | RES    |            |          |                   | COM021 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 23 | AccumulatedAnnualDemand | RES    |            |          |                   | COM022 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 24 | AccumulatedAnnualDemand | RES    |            |          |                   | COM023 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 25 | AccumulatedAnnualDemand | RES    |            |          |                   | COM024 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 26 | AccumulatedAnnualDemand | RES    |            |          |                   | COM025 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 27 | AccumulatedAnnualDemand | RES    |            |          |                   | COM026 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 28 | AccumulatedAnnualDemand | RES    |            |          |                   | COM027 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 29 | AccumulatedAnnualDemand | RES    |            |          |                   | COM028 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 30 | AccumulatedAnnualDemand | RES    |            |          |                   | COM029 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 31 | AccumulatedAnnualDemand | RES    |            |          |                   | COM030 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 32 | AccumulatedAnnualDemand | RES    |            |          |                   | COM031 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 33 | AccumulatedAnnualDemand | RES    |            |          |                   | COM032 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 34 | AccumulatedAnnualDemand | RES    |            |          |                   | COM033 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 35 | AccumulatedAnnualDemand | RES    |            |          |                   | COM034 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 36 | AccumulatedAnnualDemand | RES    |            |          |                   | COM035 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 37 | AccumulatedAnnualDemand | RES    |            |          |                   | COM036 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 38 | AccumulatedAnnualDemand | RES    |            |          |                   | COM037 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 39 | AccumulatedAnnualDemand | RES    |            |          |                   | COM038 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 40 | AccumulatedAnnualDemand | RES    |            |          |                   | COM039 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 41 | AccumulatedAnnualDemand | RES    |            |          |                   | COM040 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 42 | AccumulatedAnnualDemand | RES    |            |          |                   | COM041 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 43 | AccumulatedAnnualDemand | RES    |            |          |                   | COM042 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 44 | AccumulatedAnnualDemand | RES    |            |          |                   | COM043 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 45 | AccumulatedAnnualDemand | RES    |            |          |                   | COM044 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 46 | AccumulatedAnnualDemand | RES    |            |          |                   | COM045 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 47 | AccumulatedAnnualDemand | RES    |            |          |                   | COM046 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48 | AccumulatedAnnualDemand | RES    |            |          |                   | COM047 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 49 | AccumulatedAnnualDemand | RES    |            |          |                   | COM048 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 50 | AccumulatedAnnualDemand | RES    |            |          |                   | COM049 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 51 | AccumulatedAnnualDemand | RES    |            |          |                   | COM050 |            |         |         |                           | 0    | 0    | 0    | 0    | 0    | 0    | 0    |

- 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**:

| Parameter       | REGION | TECHNOLOGY | EMISSION | MODE_OF_OPERATION | FUEL | THRESHOLD | STORAGE | REGION2 | Time Independent variable | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|-----------------|--------|------------|----------|-------------------|------|-----------|---------|---------|---------------------------|------|------|------|------|------|------|------|
| 48802 YearSplit |        |            |          |                   |      |           |         |         | S101                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48803 YearSplit |        |            |          |                   |      |           |         |         | S102                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48804 YearSplit |        |            |          |                   |      |           |         |         | S103                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48805 YearSplit |        |            |          |                   |      |           |         |         | S104                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48806 YearSplit |        |            |          |                   |      |           |         |         | S105                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48807 YearSplit |        |            |          |                   |      |           |         |         | S106                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48808 YearSplit |        |            |          |                   |      |           |         |         | S107                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48809 YearSplit |        |            |          |                   |      |           |         |         | S108                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48810 YearSplit |        |            |          |                   |      |           |         |         | S109                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48811 YearSplit |        |            |          |                   |      |           |         |         | S110                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48812 YearSplit |        |            |          |                   |      |           |         |         | S111                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48813 YearSplit |        |            |          |                   |      |           |         |         | S112                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48814 YearSplit |        |            |          |                   |      |           |         |         | S113                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48815 YearSplit |        |            |          |                   |      |           |         |         | S114                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48816 YearSplit |        |            |          |                   |      |           |         |         | S115                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48817 YearSplit |        |            |          |                   |      |           |         |         | S116                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48818 YearSplit |        |            |          |                   |      |           |         |         | S117                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48819 YearSplit |        |            |          |                   |      |           |         |         | S118                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48820 YearSplit |        |            |          |                   |      |           |         |         | S119                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48821 YearSplit |        |            |          |                   |      |           |         |         | S120                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48822 YearSplit |        |            |          |                   |      |           |         |         | S121                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48823 YearSplit |        |            |          |                   |      |           |         |         | S122                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48824 YearSplit |        |            |          |                   |      |           |         |         | S123                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48825 YearSplit |        |            |          |                   |      |           |         |         | S124                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48826 YearSplit |        |            |          |                   |      |           |         |         | S201                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48827 YearSplit |        |            |          |                   |      |           |         |         | S202                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48828 YearSplit |        |            |          |                   |      |           |         |         | S203                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48829 YearSplit |        |            |          |                   |      |           |         |         | S204                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48830 YearSplit |        |            |          |                   |      |           |         |         | S205                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48831 YearSplit |        |            |          |                   |      |           |         |         | S206                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48832 YearSplit |        |            |          |                   |      |           |         |         | S207                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48833 YearSplit |        |            |          |                   |      |           |         |         | S208                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48834 YearSplit |        |            |          |                   |      |           |         |         | S209                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48835 YearSplit |        |            |          |                   |      |           |         |         | S210                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48836 YearSplit |        |            |          |                   |      |           |         |         | S211                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48837 YearSplit |        |            |          |                   |      |           |         |         | S212                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48838 YearSplit |        |            |          |                   |      |           |         |         | S213                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48839 YearSplit |        |            |          |                   |      |           |         |         | S214                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48840 YearSplit |        |            |          |                   |      |           |         |         | S215                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48841 YearSplit |        |            |          |                   |      |           |         |         | S216                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48842 YearSplit |        |            |          |                   |      |           |         |         | S217                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48843 YearSplit |        |            |          |                   |      |           |         |         | S218                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48844 YearSplit |        |            |          |                   |      |           |         |         | S219                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48845 YearSplit |        |            |          |                   |      |           |         |         | S220                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48846 YearSplit |        |            |          |                   |      |           |         |         | S221                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48847 YearSplit |        |            |          |                   |      |           |         |         | S222                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48848 YearSplit |        |            |          |                   |      |           |         |         | S223                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48849 YearSplit |        |            |          |                   |      |           |         |         | S224                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48850 YearSplit |        |            |          |                   |      |           |         |         | S301                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48851 YearSplit |        |            |          |                   |      |           |         |         | S302                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    |

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.

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

| Parameter       | REGION | TECHNOLOGY | EMISSION | MODE_OF_OPERATION | FUEL | THRESHOLD | STORAGE | REGION2 | Time Independent variable | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 |
|-----------------|--------|------------|----------|-------------------|------|-----------|---------|---------|---------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 48802 YearSplit |        |            |          |                   |      |           |         |         | S101                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48803 YearSplit |        |            |          |                   |      |           |         |         | S102                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48804 YearSplit |        |            |          |                   |      |           |         |         | S103                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48805 YearSplit |        |            |          |                   |      |           |         |         | S104                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48806 YearSplit |        |            |          |                   |      |           |         |         | S105                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48807 YearSplit |        |            |          |                   |      |           |         |         | S106                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48808 YearSplit |        |            |          |                   |      |           |         |         | S107                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48809 YearSplit |        |            |          |                   |      |           |         |         | S108                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48810 YearSplit |        |            |          |                   |      |           |         |         | S109                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48811 YearSplit |        |            |          |                   |      |           |         |         | S110                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48812 YearSplit |        |            |          |                   |      |           |         |         | S111                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48813 YearSplit |        |            |          |                   |      |           |         |         | S112                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48814 YearSplit |        |            |          |                   |      |           |         |         | S113                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48815 YearSplit |        |            |          |                   |      |           |         |         | S114                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48816 YearSplit |        |            |          |                   |      |           |         |         | S115                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48817 YearSplit |        |            |          |                   |      |           |         |         | S116                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48818 YearSplit |        |            |          |                   |      |           |         |         | S117                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48819 YearSplit |        |            |          |                   |      |           |         |         | S118                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48820 YearSplit |        |            |          |                   |      |           |         |         | S119                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48821 YearSplit |        |            |          |                   |      |           |         |         | S120                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48822 YearSplit |        |            |          |                   |      |           |         |         | S121                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48823 YearSplit |        |            |          |                   |      |           |         |         | S122                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48824 YearSplit |        |            |          |                   |      |           |         |         | S123                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48825 YearSplit |        |            |          |                   |      |           |         |         | S124                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48826 YearSplit |        |            |          |                   |      |           |         |         | S201                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48827 YearSplit |        |            |          |                   |      |           |         |         | S202                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48828 YearSplit |        |            |          |                   |      |           |         |         | S203                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48829 YearSplit |        |            |          |                   |      |           |         |         | S204                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48830 YearSplit |        |            |          |                   |      |           |         |         | S205                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48831 YearSplit |        |            |          |                   |      |           |         |         | S206                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48832 YearSplit |        |            |          |                   |      |           |         |         | S207                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48833 YearSplit |        |            |          |                   |      |           |         |         | S208                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48834 YearSplit |        |            |          |                   |      |           |         |         | S209                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48835 YearSplit |        |            |          |                   |      |           |         |         | S210                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48836 YearSplit |        |            |          |                   |      |           |         |         | S211                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48837 YearSplit |        |            |          |                   |      |           |         |         | S212                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48838 YearSplit |        |            |          |                   |      |           |         |         | S213                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48839 YearSplit |        |            |          |                   |      |           |         |         | S214                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48840 YearSplit |        |            |          |                   |      |           |         |         | S215                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48841 YearSplit |        |            |          |                   |      |           |         |         | S216                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 48842 YearSplit |        |            |          |                   |      |           |         |         | S217                      | 0    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |



**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.

Welcome to the OSeMOSYS' documentation!  
OSeMOSYS  
Open Source Energy Modelling System  
RTH - dEESA, www.osemosys.org

Descriptions of SETS/Parameters/Variables used in SAND Interface from OSeMOSYS  
(<https://osemosys.readthedocs.io/en/latest/manual/Structure%20of%20OSeMOSYS.html>)

Important Note: NOT all the Sets, Parameters and Variables presented here are used in SAND Interface.

| Name              | Description  | Index |
|-------------------|--|-------|
| YEAR              | It represents the time frame of the model, it contains all the years to be considered in the study.  | 1     |
| TECHNOLOGY        | It includes any element of the energy system that changes a commodity from one form to another, uses it or supplies it. All system components are set up as a "technology" in OSeMOSYS. As the model is an abstraction, the modeller is free to interpret the role of a technology as well, where relevant. It may for example represent a single root technology (such as a power plant) or can represent a nested/ aggregated collection of technologies (such as the stock of several nuclear light bulbs), or may even simply be a dummy technology, perhaps used for accounting purposes.   | 2     |
| TIMEslice         | It represents the time split of each modelled year, therefore the time resolution of the model. Common to several energy systems modelling tools (i.e. MESSAGE / MARKAL / TIMES), the annual demand is "sliced" into representative fractions of the year. It is necessary to assess times of the year when demand is high separately from times when demand is low, for fuels that are expensive to store. In order to reduce the computation time, these "slices" are often grouped. Thus, the annual demand may be split into aggregate seasons where demand levels are similar (such as "summer, winter and intermediate"). These seasons may be subdivided into aggregate "day types" (such as workdays and weekends), and the day further sub-divided (such as into day and night) depending on the level of demand. | 3     |
| FUEL              | It includes any energy vector, energy service or process entering or exiting technologies. These can be aggregate groups, individual flows or artificially separated, depending on the requirements of the analysis.   | 4     |
| EMISSION          | It includes any kind of emission potentially deriving from the operation of the defined technologies. Typical examples would include atmospheric emissions of greenhouse gases, such as CO2.   | 5     |
| MODE_OF_OPERATION | It defines the number of modes of operation that the technologies can have. If a technology can have various input or output fuels and it can choose the mix (i.e. any linear combination of these input or output fuels, each mix can be accounted as a separate mode of operation. For example, a CHP plant may produce heat in one mode of operation and electricity in another.  | 6     |
| REGION            | It sets the regions to be modelled, e.g. different countries. For each of them, the supply-demand balances for all the energy vectors are ensured, including trades with other regions. In some occasions it might be convenient to model different countries within the same region and differentiate them simply by creating set of fuels and technologies for each of them.   | 7     |
| SEASON            | It gives indication (by successive numerical values) of how many seasons (e.g. winter, intermediate, summer) are accounted for and in which order. This set is needed if storage facilities are included in the model.   | 8     |
| DAYTYPE           | It gives indication (by successive numerical values) of how many day types (e.g. workday, weekend) are accounted for and in which order. This set is needed if storage facilities are included in the model.   | 9     |
| DAILYTIMEBRACKET  | It gives indication (by successive numerical values) of how many parts the day is split into (e.g. night, morning, afternoon, evening) and in which order these parts are sorted. This set is needed if storage facilities are included in the model.  | 10    |
| STORAGE           | It includes storage facilities in the model.   | 11    |

## 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 would have 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:

$$4 \text{ Seasons/year} * 24\text{hr of a representative day/season} = 96 \text{ Timeslices/Year}$$

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

$$1 \text{ Year} / 96 \text{ Timeslices} = 0.0104$$

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**

The screenshot shows the OpenAIRE interface for the resource 'Energy and Flexibility Modelling Hands-on 2 (macOS)'. The 'Files' tab is active, displaying a table of files. The file 'Data\_prep\_HO2.xlsx' (15.5 kB) is highlighted, and its 'Download' button is circled in red. Other files include 'HO2\_macOS.pdf' (2.0 MB). The interface also shows the OpenAIRE logo, publication date (January 30, 2022), DOI (10.5281/zenodo.5920445), and license (Creative Commons Attribution 4.0 International). A 'Versions' section lists three versions of the resource, all dated January 30, 2022.

| Name               | Size    | Download         |
|--------------------|---------|------------------|
| Data_prep_HO2.xlsx | 15.5 kB | Download         |
| HO2_macOS.pdf      | 2.0 MB  | Preview Download |



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**).

|     | A  | B    | C          | D |
|-----|----|------|------------|---|
| 1   |    |      | Year Split |   |
| 2   | WN | S101 | 0.0104     |   |
| 3   | WN | S102 | 0.0104     |   |
| 4   | WN | S103 | 0.0104     |   |
| 5   | WN | S104 | 0.0104     |   |
| 6   | WN | S105 | 0.0104     |   |
| 7   | WN | S106 | 0.0104     |   |
| 8   | WD | S107 | 0.0104     |   |
| 9   | HD | S108 | 0.0104     |   |
| 10  | WD | S109 | 0.0104     |   |
| 11  | WD | S110 | 0.0104     |   |
| 12  | HD | S111 | 0.0104     |   |
| 13  | WD | S112 | 0.0104     |   |
| 14  | WD | S113 | 0.0104     |   |
| 15  | HD | S114 | 0.0104     |   |
| 16  | WD | S115 | 0.0104     |   |
| 17  | WD | S116 | 0.0104     |   |
| 18  | HD | S117 | 0.0104     |   |
| 19  | WD | S118 | 0.0104     |   |
| 20  | WN | S119 | 0.0104     |   |
| 21  | WN | S120 | 0.0104     |   |
| 22  | WN | S121 | 0.0104     |   |
| 23  | WN | S122 | 0.0104     |   |
| 24  | WN | S123 | 0.0104     |   |
| 25  | WN | S124 | 0.0104     |   |
| 26  | BN | S201 | 0.0104     |   |
| 27  | BN | S202 | 0.0104     |   |
| 28  | BN | S203 | 0.0104     |   |
| 29  | BN | S204 | 0.0104     |   |
| 30  | BD | S205 | 0.0104     |   |
| 31  | BD | S206 | 0.0104     |   |
| 32  | BD | S207 | 0.0104     |   |
| 33  | BD | S208 | 0.0104     |   |
| 34  | BD | S209 | 0.0104     |   |
| 35  | BD | S210 | 0.0104     |   |
| 36  | BD | S211 | 0.0104     |   |
| 37  | BD | S212 | 0.0104     |   |
| 38  | BD | S213 | 0.0104     |   |
| 39  | BD | S214 | 0.0104     |   |
| 40  | BD | S215 | 0.0104     |   |
| 41  | BD | S216 | 0.0104     |   |
| 42  | BD | S217 | 0.0104     |   |
| 43  | BD | S218 | 0.0104     |   |
| 44  | BD | S219 | 0.0104     |   |
| 45  | BD | S220 | 0.0104     |   |
| 46  | BD | S221 | 0.0104     |   |
| 47  | BD | S222 | 0.0104     |   |
| 48  | BD | S223 | 0.0104     |   |
| 49  | BD | S224 | 0.0104     |   |
| 50  | BD | S225 | 0.0104     |   |
| 51  | BD | S226 | 0.0104     |   |
| 52  | BD | S227 | 0.0104     |   |
| 53  | BD | S228 | 0.0104     |   |
| 54  | BD | S229 | 0.0104     |   |
| 55  | BD | S230 | 0.0104     |   |
| 56  | BD | S231 | 0.0104     |   |
| 57  | BD | S232 | 0.0104     |   |
| 58  | BD | S233 | 0.0104     |   |
| 59  | BD | S234 | 0.0104     |   |
| 60  | BD | S235 | 0.0104     |   |
| 61  | BD | S236 | 0.0104     |   |
| 62  | BD | S237 | 0.0104     |   |
| 63  | BD | S238 | 0.0104     |   |
| 64  | BD | S239 | 0.0104     |   |
| 65  | BD | S240 | 0.0104     |   |
| 66  | BD | S241 | 0.0104     |   |
| 67  | BD | S242 | 0.0104     |   |
| 68  | BD | S243 | 0.0104     |   |
| 69  | BD | S244 | 0.0104     |   |
| 70  | BD | S245 | 0.0104     |   |
| 71  | BD | S246 | 0.0104     |   |
| 72  | BD | S247 | 0.0104     |   |
| 73  | BD | S248 | 0.0104     |   |
| 74  | BD | S249 | 0.0104     |   |
| 75  | BD | S250 | 0.0104     |   |
| 76  | BD | S251 | 0.0104     |   |
| 77  | BD | S252 | 0.0104     |   |
| 78  | BD | S253 | 0.0104     |   |
| 79  | BD | S254 | 0.0104     |   |
| 80  | BD | S255 | 0.0104     |   |
| 81  | BD | S256 | 0.0104     |   |
| 82  | BD | S257 | 0.0104     |   |
| 83  | BD | S258 | 0.0104     |   |
| 84  | BD | S259 | 0.0104     |   |
| 85  | BD | S260 | 0.0104     |   |
| 86  | BD | S261 | 0.0104     |   |
| 87  | BD | S262 | 0.0104     |   |
| 88  | BD | S263 | 0.0104     |   |
| 89  | BD | S264 | 0.0104     |   |
| 90  | BD | S265 | 0.0104     |   |
| 91  | BD | S266 | 0.0104     |   |
| 92  | BD | S267 | 0.0104     |   |
| 93  | BD | S268 | 0.0104     |   |
| 94  | BD | S269 | 0.0104     |   |
| 95  | BD | S270 | 0.0104     |   |
| 96  | BD | S271 | 0.0104     |   |
| 97  | BD | S272 | 0.0104     |   |
| 98  | BD | S273 | 0.0104     |   |
| 99  | BD | S274 | 0.0104     |   |
| 100 | BD | S275 | 0.0104     |   |
| 101 | BD | S276 | 0.0104     |   |
| 102 | BD | S277 | 0.0104     |   |
| 103 | BD | S278 | 0.0104     |   |
| 104 | BD | S279 | 0.0104     |   |
| 105 | BD | S280 | 0.0104     |   |
| 106 | BD | S281 | 0.0104     |   |
| 107 | BD | S282 | 0.0104     |   |
| 108 | BD | S283 | 0.0104     |   |
| 109 | BD | S284 | 0.0104     |   |
| 110 | BD | S285 | 0.0104     |   |
| 111 | BD | S286 | 0.0104     |   |
| 112 | BD | S287 | 0.0104     |   |
| 113 | BD | S288 | 0.0104     |   |
| 114 | BD | S289 | 0.0104     |   |
| 115 | BD | S290 | 0.0104     |   |
| 116 | BD | S291 | 0.0104     |   |
| 117 | BD | S292 | 0.0104     |   |
| 118 | BD | S293 | 0.0104     |   |
| 119 | BD | S294 | 0.0104     |   |
| 120 | BD | S295 | 0.0104     |   |
| 121 | BD | S296 | 0.0104     |   |
| 122 | BD | S297 | 0.0104     |   |
| 123 | BD | S298 | 0.0104     |   |
| 124 | BD | S299 | 0.0104     |   |
| 125 | BD | S300 | 0.0104     |   |
| 126 | BD | S301 | 0.0104     |   |
| 127 | BD | S302 | 0.0104     |   |
| 128 | BD | S303 | 0.0104     |   |
| 129 | BD | S304 | 0.0104     |   |
| 130 | BD | S305 | 0.0104     |   |
| 131 | BD | S306 | 0.0104     |   |
| 132 | BD | S307 | 0.0104     |   |
| 133 | BD | S308 | 0.0104     |   |
| 134 | BD | S309 | 0.0104     |   |
| 135 | BD | S310 | 0.0104     |   |
| 136 | BD | S311 | 0.0104     |   |
| 137 | BD | S312 | 0.0104     |   |
| 138 | BD | S313 | 0.0104     |   |
| 139 | BD | S314 | 0.0104     |   |
| 140 | BD | S315 | 0.0104     |   |
| 141 | BD | S316 | 0.0104     |   |
| 142 | BD | S317 | 0.0104     |   |
| 143 | BD | S318 | 0.0104     |   |
| 144 | BD | S319 | 0.0104     |   |
| 145 | BD | S320 | 0.0104     |   |
| 146 | BD | S321 | 0.0104     |   |
| 147 | BD | S322 | 0.0104     |   |
| 148 | BD | S323 | 0.0104     |   |
| 149 | BD | S324 | 0.0104     |   |
| 150 | BD | S325 | 0.0104     |   |
| 151 | BD | S326 | 0.0104     |   |
| 152 | BD | S327 | 0.0104     |   |
| 153 | BD | S328 | 0.0104     |   |
| 154 | BD | S329 | 0.0104     |   |
| 155 | BD | S330 | 0.0104     |   |
| 156 | BD | S331 | 0.0104     |   |
| 157 | BD | S332 | 0.0104     |   |
| 158 | BD | S333 | 0.0104     |   |
| 159 | BD | S334 | 0.0104     |   |
| 160 | BD | S335 | 0.0104     |   |
| 161 | BD | S336 | 0.0104     |   |
| 162 | BD | S337 | 0.0104     |   |
| 163 | BD | S338 | 0.0104     |   |
| 164 | BD | S339 | 0.0104     |   |
| 165 | BD | S340 | 0.0104     |   |
| 166 | BD | S341 | 0.0104     |   |
| 167 | BD | S342 | 0.0104     |   |
| 168 | BD | S343 | 0.0104     |   |
| 169 | BD | S344 | 0.0104     |   |
| 170 | BD | S345 | 0.0104     |   |
| 171 | BD | S346 | 0.0104     |   |
| 172 | BD | S347 | 0.0104     |   |
| 173 | BD | S348 | 0.0104     |   |
| 174 | BD | S349 | 0.0104     |   |
| 175 | BD | S350 | 0.0104     |   |
| 176 | BD | S351 | 0.0104     |   |
| 177 | BD | S352 | 0.0104     |   |
| 178 | BD | S353 | 0.0104     |   |
| 179 | BD | S354 | 0.0104     |   |
| 180 | BD | S355 | 0.0104     |   |
| 181 | BD | S356 | 0.0104     |   |
| 182 | BD | S357 | 0.0104     |   |
| 183 | BD | S358 | 0.0104     |   |
| 184 | BD | S359 | 0.0104     |   |
| 185 | BD | S360 | 0.0104     |   |
| 186 | BD | S361 | 0.0104     |   |
| 187 | BD | S362 | 0.0104     |   |
| 188 | BD | S363 | 0.0104     |   |
| 189 | BD | S364 | 0.0104     |   |
| 190 | BD | S365 | 0.0104     |   |
| 191 | BD | S366 | 0.0104     |   |
| 192 | BD | S367 | 0.0104     |   |
| 193 | BD | S368 | 0.0104     |   |
| 194 | BD | S369 | 0.0104     |   |
| 195 | BD | S370 | 0.0104     |   |
| 196 | BD | S371 | 0.0104     |   |
| 197 | BD | S372 | 0.0104     |   |
| 198 | BD | S373 | 0.0104     |   |
| 199 | BD | S374 | 0.0104     |   |
| 200 | BD | S375 | 0.0104     |   |
| 201 | BD | S376 | 0.0104     |   |
| 202 | BD | S377 | 0.0104     |   |
| 203 | BD | S378 | 0.0104     |   |
| 204 | BD | S379 | 0.0104     |   |
| 205 | BD | S380 | 0.0104     |   |
| 206 | BD | S381 | 0.0104     |   |
| 207 | BD | S382 | 0.0104     |   |
| 208 | BD | S383 | 0.0104     |   |
| 209 | BD | S384 | 0.0104     |   |
| 210 | BD | S385 | 0.0104     |   |
| 211 | BD | S386 | 0.0104     |   |
| 212 | BD | S387 | 0.0104     |   |
| 213 | BD | S388 | 0.0104     |   |
| 214 | BD | S389 | 0.0104     |   |
| 215 | BD | S390 | 0.0104     |   |
| 216 | BD | S391 | 0.0104     |   |
| 217 | BD | S392 | 0.0104     |   |
| 218 | BD | S393 | 0.0104     |   |
| 219 | BD | S394 | 0.0104     |   |
| 220 | BD | S395 | 0.0104     |   |
| 221 | BD | S396 | 0.0104     |   |
| 222 | BD | S397 | 0.0104     |   |
| 223 | BD | S398 | 0.0104     |   |
| 224 | BD | S399 | 0.0104     |   |
| 225 | BD | S400 | 0.0104     |   |
| 226 | BD | S401 | 0.0104     |   |
| 227 | BD | S402 | 0.0104     |   |
| 228 | BD | S403 | 0.0104     |   |
| 229 | BD | S404 | 0.0104     |   |
| 230 | BD | S405 | 0.0104     |   |
| 231 | BD | S406 | 0.0104     |   |
| 232 | BD | S407 | 0.0104     |   |
| 233 | BD | S408 | 0.0104     |   |
| 234 | BD | S409 | 0.0104     |   |
| 235 | BD | S410 | 0.0104     |   |
| 236 | BD | S411 | 0.0104     |   |
| 237 | BD | S412 | 0.0104     |   |
| 238 | BD | S413 | 0.0104     |   |
| 239 | BD | S414 | 0.0104     |   |
| 240 | BD | S415 | 0.0104     |   |
| 241 | BD | S416 | 0.0104     |   |
| 242 | BD | S417 | 0.0104     |   |
| 243 | BD | S418 | 0.0104     |   |
| 244 | BD | S419 | 0.0104     |   |
| 245 | BD | S420 | 0.0104     |   |
| 246 | BD | S421 | 0.0104     |   |
| 247 | BD | S422 | 0.0104     |   |
| 248 | BD | S423 | 0.0104     |   |
| 249 | BD | S424 | 0.0104     |   |
| 250 | BD | S425 | 0.0104     |   |
| 251 | BD | S426 | 0.0104     |   |
| 252 | BD | S427 | 0.0104     |   |
| 253 | BD | S428 | 0.0104     |   |
| 254 | BD | S429 | 0.0104     |   |
| 255 | BD | S430 | 0.0104     |   |
| 256 | BD | S431 | 0.0104     |   |
| 257 | BD | S432 | 0.0104     |   |
| 258 | BD | S433 | 0.0104     |   |
| 259 | BD | S434 | 0.0104     |   |
| 260 | BD | S435 | 0.0104     |   |
| 261 | BD | S436 | 0.0104     |   |
| 262 | BD | S437 | 0.0104     |   |
| 263 | BD | S438 | 0.0104     |   |
| 264 | BD | S439 | 0.0104     |   |
| 265 | BD | S440 | 0.0104     |   |
| 266 | BD | S441 | 0.0104     |   |
| 267 | BD | S442 | 0.0104     |   |
| 268 | BD | S443 | 0.0104     |   |
| 269 | BD | S444 | 0.0104     |   |
| 270 | BD | S445 | 0.0104     |   |
| 271 | BD | S446 | 0.0104     |   |
| 272 | BD | S447 | 0.0104     |   |
| 273 | BD | S448 | 0.0104     |   |
| 274 | BD | S449 | 0.0104     |   |
| 275 | BD | S450 | 0.0104     |   |
| 276 | BD | S451 | 0.0104     |   |
| 277 | BD | S452 | 0.0104     |   |
| 278 | BD | S453 | 0.0104     |   |
| 279 | BD | S454 | 0.0104     |   |
| 280 | BD | S455 | 0.0104     |   |
| 281 | BD | S456 | 0.0104     |   |
| 282 | BD | S457 | 0.0104     |   |
| 283 | BD | S458 | 0.0104     |   |
| 284 | BD | S459 | 0.0104     |   |
| 285 | BD | S460 | 0.0104     |   |
| 286 | BD | S461 | 0.0104     |   |
| 287 | BD | S462 | 0.0104     |   |
| 288 | BD | S463 | 0.0104     |   |
| 289 | BD | S464 | 0.0104     |   |
| 290 | BD | S465 | 0.0104     |   |
| 291 | BD | S466 | 0.0104     |   |
| 292 | BD | S467 | 0.0104     |   |
| 293 | BD | S468 | 0.0104     |   |
| 294 | BD | S469 | 0.0104     |   |
| 295 | BD | S470 | 0.0104     |   |
| 296 | BD | S471 | 0.0104     |   |
| 297 | BD | S472 | 0.0104     |   |
| 298 | BD | S473 | 0.0104     |   |
| 299 | BD | S474 | 0.010      |   |





| 1    | Parameter | REGION | TECHNOLOGY | EMISSION | MODE_OF_OPERATION | FUEL | TIMESLICE | STORAGE | REGION2 | Time independent variable | 2015      | 2016      | 2017      | 2018      | 2019      | 2020      | 2021      |           |
|------|-----------|--------|------------|----------|-------------------|------|-----------|---------|---------|---------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 4880 | YearSplit |        |            |          |                   |      |           |         |         | 5001                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4881 | YearSplit |        |            |          |                   |      |           |         |         | 5002                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4882 | YearSplit |        |            |          |                   |      |           |         |         | 5003                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4883 | YearSplit |        |            |          |                   |      |           |         |         | 5004                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4884 | YearSplit |        |            |          |                   |      |           |         |         | 5005                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4885 | YearSplit |        |            |          |                   |      |           |         |         | 5006                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4886 | YearSplit |        |            |          |                   |      |           |         |         | 5007                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4887 | YearSplit |        |            |          |                   |      |           |         |         | 5008                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4888 | YearSplit |        |            |          |                   |      |           |         |         | 5009                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4889 | YearSplit |        |            |          |                   |      |           |         |         | 5110                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4890 | YearSplit |        |            |          |                   |      |           |         |         | 5111                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4891 | YearSplit |        |            |          |                   |      |           |         |         | 5112                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4892 | YearSplit |        |            |          |                   |      |           |         |         | 5113                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4893 | YearSplit |        |            |          |                   |      |           |         |         | 5114                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4894 | YearSplit |        |            |          |                   |      |           |         |         | 5115                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4895 | YearSplit |        |            |          |                   |      |           |         |         | 5116                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4896 | YearSplit |        |            |          |                   |      |           |         |         | 5117                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4897 | YearSplit |        |            |          |                   |      |           |         |         | 5118                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4898 | YearSplit |        |            |          |                   |      |           |         |         | 5119                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4899 | YearSplit |        |            |          |                   |      |           |         |         | 5120                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4900 | YearSplit |        |            |          |                   |      |           |         |         | 5121                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4901 | YearSplit |        |            |          |                   |      |           |         |         | 5122                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4902 | YearSplit |        |            |          |                   |      |           |         |         | 5123                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4903 | YearSplit |        |            |          |                   |      |           |         |         | 5124                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4904 | YearSplit |        |            |          |                   |      |           |         |         | 5201                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4905 | YearSplit |        |            |          |                   |      |           |         |         | 5202                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4906 | YearSplit |        |            |          |                   |      |           |         |         | 5203                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4907 | YearSplit |        |            |          |                   |      |           |         |         | 5204                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4908 | YearSplit |        |            |          |                   |      |           |         |         | 5205                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4909 | YearSplit |        |            |          |                   |      |           |         |         | 5206                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4910 | YearSplit |        |            |          |                   |      |           |         |         | 5207                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4911 | YearSplit |        |            |          |                   |      |           |         |         | 5208                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4912 | YearSplit |        |            |          |                   |      |           |         |         | 5209                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4913 | YearSplit |        |            |          |                   |      |           |         |         | 5210                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4914 | YearSplit |        |            |          |                   |      |           |         |         | 5211                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4915 | YearSplit |        |            |          |                   |      |           |         |         | 5212                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4916 | YearSplit |        |            |          |                   |      |           |         |         | 5213                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4917 | YearSplit |        |            |          |                   |      |           |         |         | 5214                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4918 | YearSplit |        |            |          |                   |      |           |         |         | 5215                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4919 | YearSplit |        |            |          |                   |      |           |         |         | 5216                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4920 | YearSplit |        |            |          |                   |      |           |         |         | 5217                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4921 | YearSplit |        |            |          |                   |      |           |         |         | 5218                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4922 | YearSplit |        |            |          |                   |      |           |         |         | 5219                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |
| 4923 | YearSplit |        |            |          |                   |      |           |         |         | 5220                      | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 | 0.0104167 |

# 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.

| 1     | Parameter          | REGION | TECHNOLOGY | EMISSION | MODE_OF_OPERATION | FUEL | TIMESLICE | STORAGE | REGION2 | Time independent variable | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|-------|--------------------|--------|------------|----------|-------------------|------|-----------|---------|---------|---------------------------|------|------|------|------|------|------|------|
| 15962 | DepreciationMethod | RE1    |            |          |                   |      |           |         |         | 1                         |      |      |      |      |      |      |      |
| 15963 | DiscountRate       | RE1    |            |          |                   |      |           |         |         | 0.1                       |      |      |      |      |      |      |      |

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.
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