Transport Decarbonization and Data-to-Deal

Lecture 6 Hands-on Exercise: Transport Modelling in OSeMOSYS: Transport Data

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Useful Links:

1. OSeMOSYS software
2. OSeMOSYS e-learning course
3. OSeMOSYS documentation
4. OSeMOSYS Discourse forum

Learning outcomes

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

1. Input data in OSeMOSYS: Global parameters
    a. Year Split
    b. Discount Rate
2. Input data in OSeMOSYS: Demands
    a. Accumulated Annual Demand
3. Input data in OSeMOSYS: Performance
    a. Capacity to Activity Unit
    b. Capacity Factor
    c. Availability Factor
    d. Operational Life
    e. Residual Capacity
    f. Input Activity Ratio
    g. Output Activity Ratio
4. Input data in OSeMOSYS: Technology Costs
    a. Capital Cost
    b. Variable Cost
    c. Fixed Cost

5. Input data in OSeMOSYS: Emissions
    a. Emission Activity Ratio
6. Run a model on OSeMOSYS
7. View OSeMOSYS results

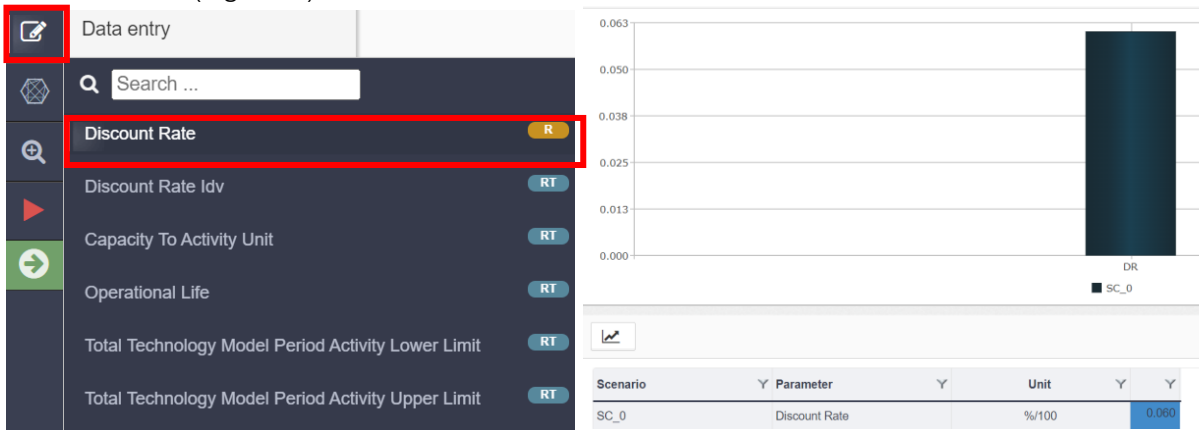
Note: This Hands-on Exercise continues on from Hands-on Exercise 5. It is suggested you complete Hands-on Exercise 5 before progressing to this exercise.

1.a. Global Parameters Data: Year Split

1. Year Split is the *duration of a modelled timeslice, expressed as a fraction of the year. The sum of each entry over one modelled year should equal 1.* Since we have 8 timeslices, the Year Split will be 1/8 = **0.125** for each timeslice. Insert this in the model. Save the data.

1.b. Global Parameters Data: Discount Rate

1. Discount Rate *represents the region-specific value for the discount rate, expressed in decimals* (e.g. 0.05). Save the data.



2.a. Demand Data: Accumulated Annual Demand

1. Accumulated Annual Demand is the *accumulated demand for a certain commodity in one specific year.* Since we are modelling the road passenger transport sector, the unit for this is billion passenger-km. The table below presents assumed accumulated annual demand data. Insert these in the model, for the DEMTRAMCY, DEMTRACAR, and DEMTRABUS demands. Save the data.

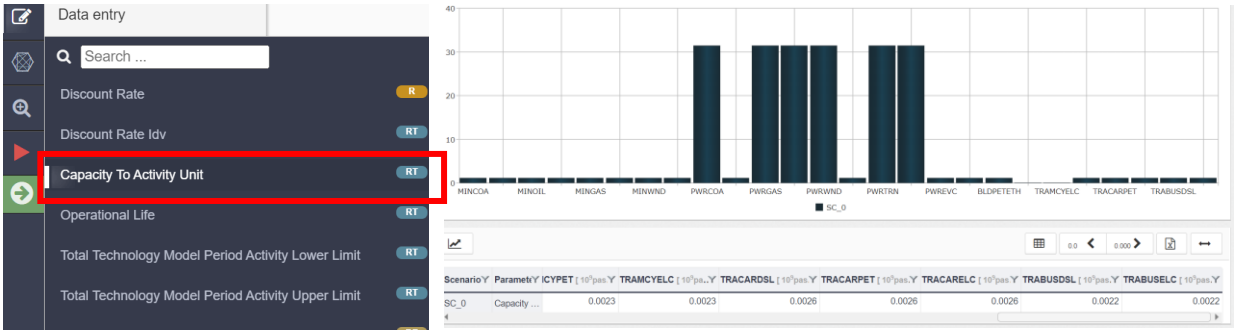
DEMTRAMCY									
2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
111.8	75.0	94.70	122.1	123.2	124.3	125.4	126.4	127.5	128.3
2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
129.2	130.1	130.9	131.8	132.6	133.4	134.2	135.0	135.8	136.5
2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
137.3	137.9	138.6	139.2	139.8	140.4	140.9	141.4	141.9	142.3
2050									
142.7									
DEMTRACAR									
2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
3.768	2.529	3.194	4.115	4.153	4.190	4.226	4.260	4.293	4.324
2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
4.355	4.385	4.415	4.443	4.471	4.499	4.526	4.552	4.578	4.603
2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
4.627	4.650	4.673	4.694	4.714	4.733	4.751	4.767	4.783	4.798
2050									
4.811									
DEMTRABUS									
2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
0.284	0.191	0.241	0.310	0.313	0.316	0.319	0.321	0.324	0.326
2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
0.32905	0.331	0.333	0.335	0.337	0.339	0.341	0.343	0.345	0.347
2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
0.34962	0.351	0.353	0.354	0.356	0.357	0.358	0.360	0.361	0.362
2050									
0.363									

Scenario	Co...	Unit	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
SC_0	DEMTR...	10...	111.800	75.000	94.700	122.100	123.200	124.300	125.400	126.400	127.500	128.300	129.200	130.100	130.900
SC_0	DEMTR...	10...	3.768	2.529	3.194	4.115	4.153	4.190	4.226	4.260	4.293	4.324	4.355	4.385	4.415
SC_0	DEMTR...	10...	0.284	0.191	0.241	0.310	0.313	0.316	0.319	0.321	0.324	0.326	0.329	0.331	0.333

3.a. Performance Data: Capacity to Activity Unit

1. Capacity to Activity Unit (CTAU) is the *conversion factor relating the energy that would be produced when one unit of capacity is fully used in one year.* For power plants, the Capacity to Activity Unit should be **31.356**.
2. For transport vehicles, the Capacity to Activity Unit are assumed and in the table below. Insert these data into the model. Save the data.

Tech	CTAU	Tech	CTAU
TRAMCYPET	0.0023	TRACARELC	0.0026
TRAMCYELC	0.0023	TRABUSDSL	0.0022
TRACARPET	0.0026	TRABUSELC	0.0022
TRACARDSL	0.0026		



3.b. Performance Data: Capacity Factor

1. Capacity Factor is the *capacity available per each timeslice expressed as a fraction of the total installed capacity, with values ranging from 0 to 1. It gives the possibility to account for forced outages.* In this example, we will add in capacity factors for the crude oil refinery, coal power plant, CCGT, solar and wind power plants – REFOIL, PWRCOA, PWRGAS, PWRSOL and PWRWND.
2. As we are working with 8 timeslices, you will likely have to proportionally adjust the capacity factor from an 8760 hour-profile to 8 timeslices. In this example, the capacity factors for the 8 timeslices are provided and are shown in the table below. Follow the table below and insert the capacity factors for each time slice accordingly, assuming they are the same for all years. Save the data.

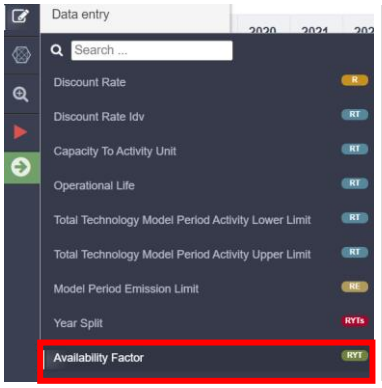
	REFOIL	PWRCOA	PWRGAS	PWRSOL	PWRWND
S11	0.9	0.75	0.55	0.21	0.16
S12	0.9	0.75	0.55	0.00	0.16
S21	0.9	0.75	0.55	0.24	0.13
S22	0.9	0.75	0.55	0.00	0.12

S31	0.9	0.75	0.55	0.26	0.13
S32	0.9	0.75	0.55	0.00	0.13
S41	0.9	0.75	0.55	0.23	0.18
S42	0.9	0.75	0.55	0.00	0.17

Scenario	Techn...	Timeslice	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
SC_0	PWRGAS	S11	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550
SC_0	PWRGAS	S12	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550
SC_0	PWRGAS	S21	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550
SC_0	PWRGAS	S22	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550
SC_0	PWRGAS	S31	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550
SC_0	PWRGAS	S32	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550
SC_0	PWRGAS	S41	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550
SC_0	PWRGAS	S42	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550
SC_0	PWRSOL	S11	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210
SC_0	PWRSOL	S12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SC_0	PWRSOL	S21	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.240
SC_0	PWRSOL	S22	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SC_0	PWRSOL	S31	0.260	0.260	0.260	0.260	0.260	0.260	0.260	0.260	0.260	0.260	0.260	0.260	0.260	0.260	0.260	0.260	0.260
SC_0	PWRSOL	S32	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SC_0	PWRSOL	S41	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230
SC_0	PWRSOL	S42	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

3.c. Performance Data: Availability Factor

1. Availability Factor is the *maximum time a technology can run in the whole year, as a fraction of the year ranging from 0 to 1. It gives the possibility to account for planned outages.* In this example, we will assume that all technologies are available at any given time, so we will insert a value of **1** for all technologies, for all years.

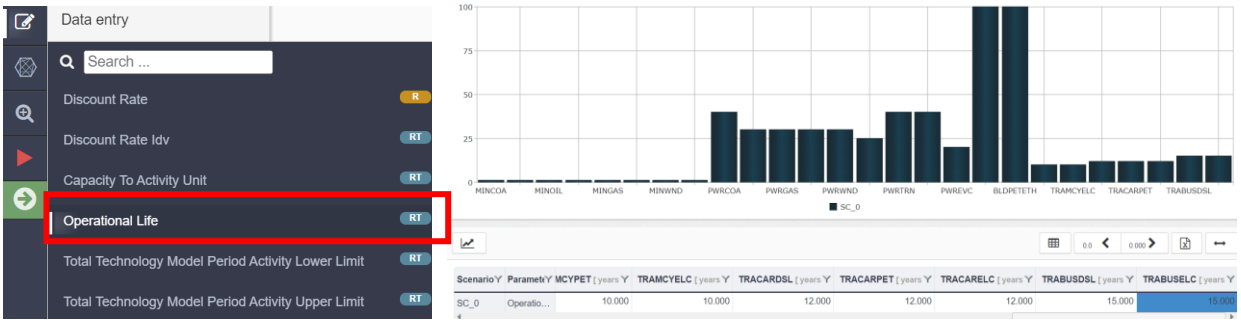


Scenario	Techno...	U...	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
SC_0	MINCOA	%/...	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SC_0	IMPCOA	%/...	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SC_0	MINOIL	%/...	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SC_0	IMPOIL	%/...	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SC_0	MINGAS	%/...	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SC_0	MINSOL	%/...	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SC_0	MINWND	%/...	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SC_0	MINBIO	%/...	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SC_0	PWRCOA	%/...	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SC_0	REFOIL	%/...	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

3.d. Performance Data: Operational Life

1. Operational Life is the *useful lifetime of a technology, expressed in years*. The table below lists the operational life of 26 technologies in the OSeMOSYS model. Note that the operational lifetime of the blending technologies (BLDDSLBDL and BLDPETETH) are 100. This is to ensure they do not get replaced, as they are 'dummy' technologies. Insert these years in the model. Save the data.

Tech	Years	Tech	Years	Tech	Years
REFOIL	30	PWRDIS	40	TRACARPET	12
PWRCOA	40	PWREVC	20	TRACARELC	12
PWRGAS	30	BLDDSLBDL	100	TRABUSDSL	15
PWRSOL	30	BLDPETETH	100	TRACARELC	15
PWRWND	30	TRAMCYPET	10		
REFBIO	25	TRAMCYELC	10		
PWRTRN	40	TRACARDSL	12		



3.e. Performance Data: Residual Capacity

1. Residual Capacity is the *remained capacity available from before the modelling period*. For the transport sector, it is in 1000 vehicles. In this example, we will assume that only the internal combustion engine (ICE) transport vehicles have residual capacity. These are noted in the table below.

	2020	2021	2022	2023	2024	2025	2026	2027	2028
TRAMCYPET	47221	47221	47221	47221	13777	11398	8960	3333	0
TRACARPET	1272	1272	1272	1272	1272	1272	576	465	318
TRACARDSL	92	92	92	92.	92	92	38	32	22
TRABUSDSL	112	112	112	112	112	112	112	112	112

Scenario	Techno…	Unit	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
SC_0	TRAMCY…	10^3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SC_0	TRACAR…	10^3	,272.000	,272.000	,272.000	,272.000	,272.000	,272.000	576.000	465.000	318.000	0.000
SC_0	TRACAR…	10^3	92.000	92.000	92.000	92.000	92.000	92.000	38.000	32.000	22.000	0.000
SC_0	TRACAR…	10^3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

3.f. Performance Data: Input Activity Ratio

1. Input Activity Ratio (IAR) is the *rate of use of a commodity by a technology, as a ratio of the rate of activity*. For power plants, the IAR is:

$$IAR = \frac{1}{efficiency\ [in\ decimals]}$$

For transport vehicles, the IAR is:

$$IAR = fuel\ content\ \left[\frac{PJ}{L}\right] * fuel\ consumption\ \left[\frac{L}{km}\right] * load\ factor\ [\frac{1}{passenger\ or\ tonne}]$$

2. In this example, the IAR is already given. Follow the table below for the assumed Input Activity Ratios. Note that BLDDSLBDL and BLDPETETH are both 1 as these are dummy technologies use for fuel blending purposes only. Insert the data into the model and save.

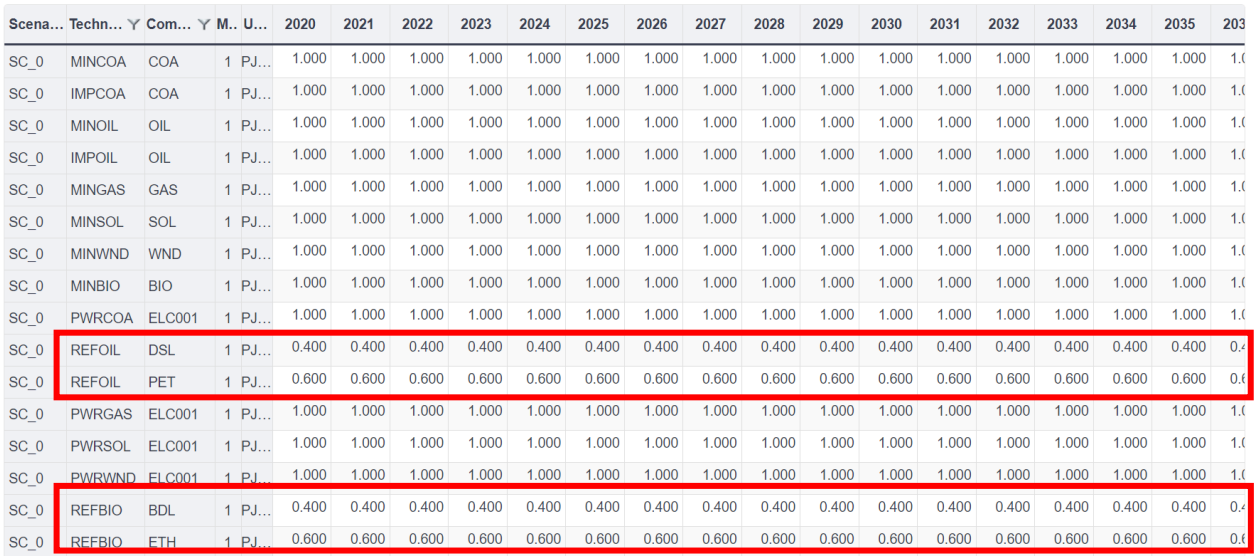
Tech	IAR	Tech	IAR	Tech	IAR
REFOIL	1.3	PWRTRN	0.9	TRAMCYELC	0.1
PWRCOA	0.3	PWRDIS	0.9	TRACARPET	3.8 (PET & PETETH)
PWRGAS	0.5	PWREVC	1	TRACARDSL	3.5 (DSL & DSLBDL)
PWRSOL	1	BLDDSLBDL	1 (DSL & BDL)	TRACARELC	0.5
PWRWND	1	BLDPETETH	1 (PET & ETH)	TRABUSDSL	0.2
REFBIO	0.9	TRAMCYPET	1.0	TRABUSELC	0.1

Scena…	Techn…	Com…	M..	U…	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2
SC_0	PWRCOA	COA	1	PJ…	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	
SC_0	REFOIL	OIL	1	PJ…	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300	
SC_0	PWRGAS	GAS	1	PJ…	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	
SC_0	PWRSOL	SOL	1	PJ…	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
SC_0	PWRWND	WND	1	PJ…	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
SC_0	REFBIO	BIO	1	PJ…	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	
SC_0	PWRTRN	ELC001	1	PJ…	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	
SC_0	PWRDIS	ELC002	1	PJ…	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	
SC_0	PWREVC	ELC003	1	PJ…	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
SC_0	BLDDSL…	DSL	1	PJ…	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
SC_0	BLDDSL…	BDL	1	PJ…	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	

3.g. Performance Data: Output Activity Ratio

1. Output Activity Ratio (OAR) is the *rate of commodity output from a technology as a ratio of the rate of activity*. For resources, conversions (power plants, transmission and distribution) and end-use technologies (transport vehicles), the OAR is **1**. Insert this into the model.
2. For refineries and distilleries, the OAR is based on the yield output of the different fuel types. The table below presents the assumed OAR for REFOIL and REFBIO. Use the table below to insert the OAR in the model.

Tech	Fuel	OAR	Tech	Fuel	OAR
REFOIL	PET	0.6	REFBIO	ETH	0.6
	DSL	0.4		BDL	0.4



Scena...	Techn...	Com...	M..	U...	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	203
SC_0	MINCOA	COA	1	PJ...	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.(
SC_0	IMPCOA	COA	1	PJ...	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.(
SC_0	MINOIL	OIL	1	PJ...	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.(
SC_0	IMPOIL	OIL	1	PJ...	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.(
SC_0	MINGAS	GAS	1	PJ...	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.(
SC_0	MINSOL	SOL	1	PJ...	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.(
SC_0	MINWND	WND	1	PJ...	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.(
SC_0	MINBIO	BIO	1	PJ...	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.(
SC_0	PWRCOA	ELC001	1	PJ...	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.(
SC_0	REFOIL	DSL	1	PJ...	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.4
SC_0	REFOIL	PET	1	PJ...	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.6
SC_0	PWRGAS	ELC001	1	PJ...	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.(
SC_0	PWRSOL	ELC001	1	PJ...	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.(
SC_0	PWRWND	ELC001	1	PJ...	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.(
SC_0	REFBIO	BDL	1	PJ...	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.4
SC_0	REFBIO	ETH	1	PJ...	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.6

4.a. Costs Data: Capital Cost

1. Capital Cost (CC) is the *capital investment cost of a technology, per unit of capacity*. For power plants, this is M USD/GW. For transport vehicles, this is M USD/1,000 vehicles. Assumed capital costs are presented in the table below. Insert these values in the model. We will assume that they are constant throughout the modelling period.

Tech	CC	Tech	CC	Tech	CC	Tech	CC
REFOIL	25	PWRWND	1400	PWREVC	40	TRACARDSL	27
PWRCOA	1300	REFBIO	25	TRAMCYPET	1.3	TRACARELC	30
PWRGAS	1000	PWRTRN	300	TRAMCYELC	0.8	TRABUSDSL	72
PWRSOL	916	PWRDIS	300	TRACARPET	22	TRABUSELC	14

Scenario	Techno…	Unit	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	20
SC_0	TRAMCY…	10…	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0
SC_0	TRACAR…	10…	22.000	22.000	22.000	22.000	22.000	22.000	22.000	22.000	22.000	22.000	22.000	22.000	22
SC_0	TRACAR…	10…	27.000	27.000	27.000	27.000	27.000	27.000	27.000	27.000	27.000	27.000	27.000	27.000	27
SC_0	TRACAR…	10…	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30
SC_0	TRABUS…	10…	72.000	72.000	72.000	72.000	72.000	72.000	72.000	72.000	72.000	72.000	72.000	72.000	72
SC_0	TRABUS…	10…	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14

4.b. Costs Data: Variable Cost

1. Variable Cost (VC) is the cost of a technology for a given mode of operation per unit of activity. This is for the resources, in M USD/PJ. Assumed variable costs are presented in the table below. Note that the variable costs for MINSOL and MINWND are 0. This is because they are renewable sources, and do not cost. Insert these values in the model. We will assume that they are constant throughout the modelling period.

Fuel	VC	Fuel	VC	Fuel	VC	Fuel	VC
MINCOA	3.5	MINOIL	9.7	MINGAS	9.9	MINWND	0
IMPCOA	3.1	IMPOIL	9.7	MINSOL	0	MINBIO	6.4

Scenario	Techn…	MoO	Unit	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
SC_0	MINCOA	1	10^6USD/PJ	3.500	3.500	3.500	3.500	3.500	3.500	3.500	3.500	3.500	3.500	3.500
SC_0	IMPCOA	1	10^6USD/PJ	3.100	3.100	3.100	3.100	3.100	3.100	3.100	3.100	3.100	3.100	3.100
SC_0	MINOIL	1	10^6USD/PJ	9.700	9.700	9.700	9.700	9.700	9.700	9.700	9.700	9.700	9.700	9.700
SC_0	IMPOIL	1	10^6USD/PJ	9.700	9.700	9.700	9.700	9.700	9.700	9.700	9.700	9.700	9.700	9.700
SC_0	MINGAS	1	10^6USD/PJ	9.900	9.900	9.900	9.900	9.900	9.900	9.900	9.900	9.900	9.900	9.900
SC_0	MINSOL	1	10^6USD/PJ	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SC_0	MINWND	1	10^6USD/PJ	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SC_0	MINBIO	1	10^6USD/PJ	6.400	6.400	6.400	6.400	6.400	6.400	6.400	6.400	6.400	6.400	6.400

4.c. Costs Data: Fixed Cost

1. Fixed Cost (FC) is the *fixed O&M cost of a technology, per unit of capacity*. For power plants, this is M USD/GW/year. For transport vehicles, this is M USD/1,000 vehicles/year. Assumed fixed costs are presented in the table below. Insert these values in the model. We will assume that they are constant throughout the modelling period.

Tech	FC	Tech	FC	Tech	FC	Tech	FC
REFOIL	5	PWRWND	88	PWREVC	5	TRACARDSL	0.54
PWRCOA	52	REFBIO	5	TRAMCYPET	0.03	TRACARELC	0.6
PWRGAS	40	PWRTRN	6	TRAMCYELC	0.02	TRABUSDSL	1.44
PWRSOL	15	PWRDIS	6	TRACARPET	0.44	TRABUSELC	0.28

Scenario	Techno…	Unit	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
SC_0	TRAMCY…	10…	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
SC_0	TRACAR…	10…	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440
SC_0	TRACAR…	10…	0.540	0.540	0.540	0.540	0.540	0.540	0.540	0.540	0.540	0.540	0.540
SC_0	TRACAR…	10…	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600
SC_0	TRABUS…	10…	1.440	1.440	1.440	1.440	1.440	1.440	1.440	1.440	1.440	1.440	1.440
SC_0	TRABUS…	10…	0.280	0.280	0.280	0.280	0.280	0.280	0.280	0.280	0.280	0.280	0.280

5.a. Emissions Data: Emission Activity Ratio

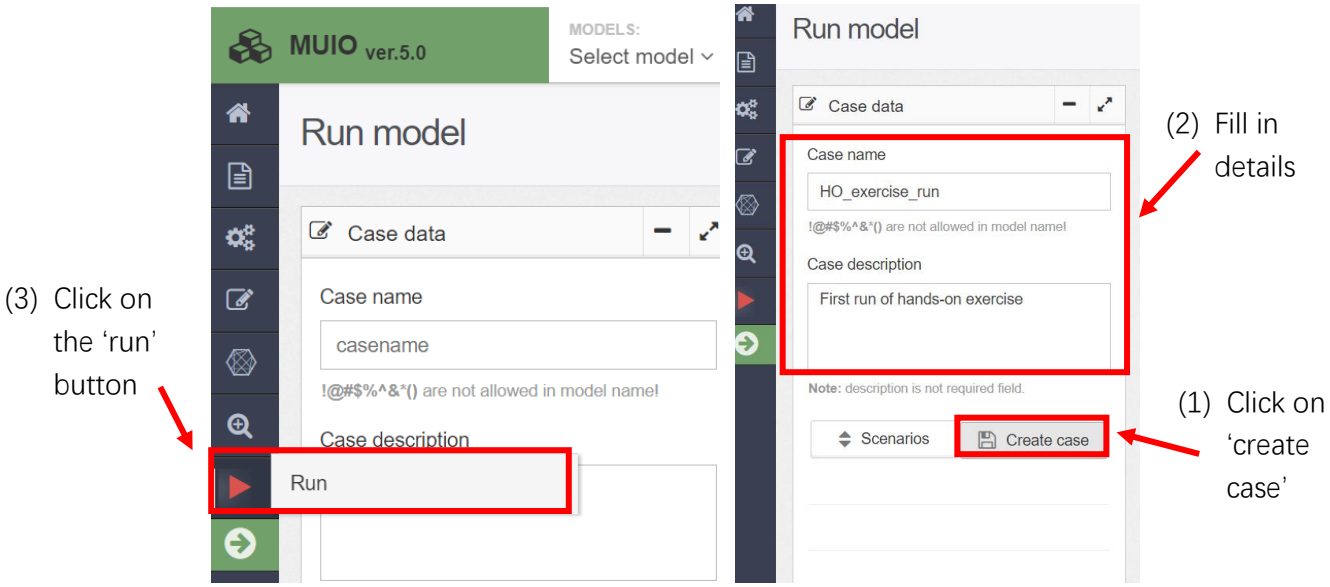
1. Emission Activity Ratio is the *emission factor of a technology per unit of activity, per mode of operation*. For power plants, this is Mt/PJ. For transport vehicles, this is Mt/billion passenger-km. Assumed emission activity ratios are presented in the table below. Insert these values in the model. We will assume that they are constant throughout the modelling period.

Tech	EAC	Tech	EAC	Tech	EAC
PWRCOA	0.2	TRAMCYPET	0.04	TRACARDSL	0.13
PWRGAS	0.1	TRACARPET	0.13	TRABUSDSL	0.05

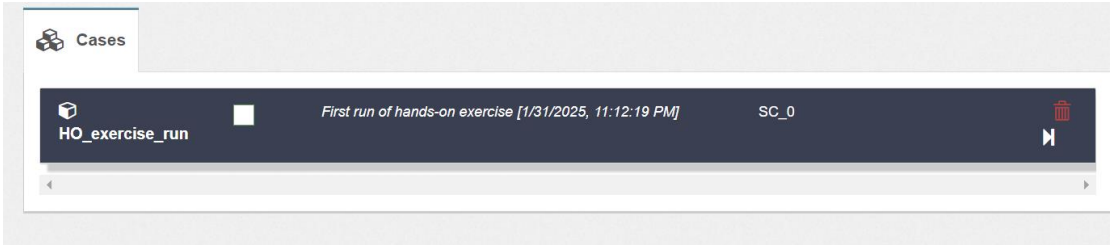
Scena…	Techn…	Emiss…	M..	U…	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
SC_0	PWRCOA	EMI_C…	1	M…	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
SC_0	PWRGAS	EMI_C…	1	M…	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
SC_0	TRAMCY…	EMI_C…	1	M…	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
SC_0	TRACAR…	EMI_C…	1	M…	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
SC_0	TRACAR…	EMI_C…	1	M…	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
SC_0	TRABUS…	EMI_C…	1	M…	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

6.a. Run a Model on OSeMOSYS

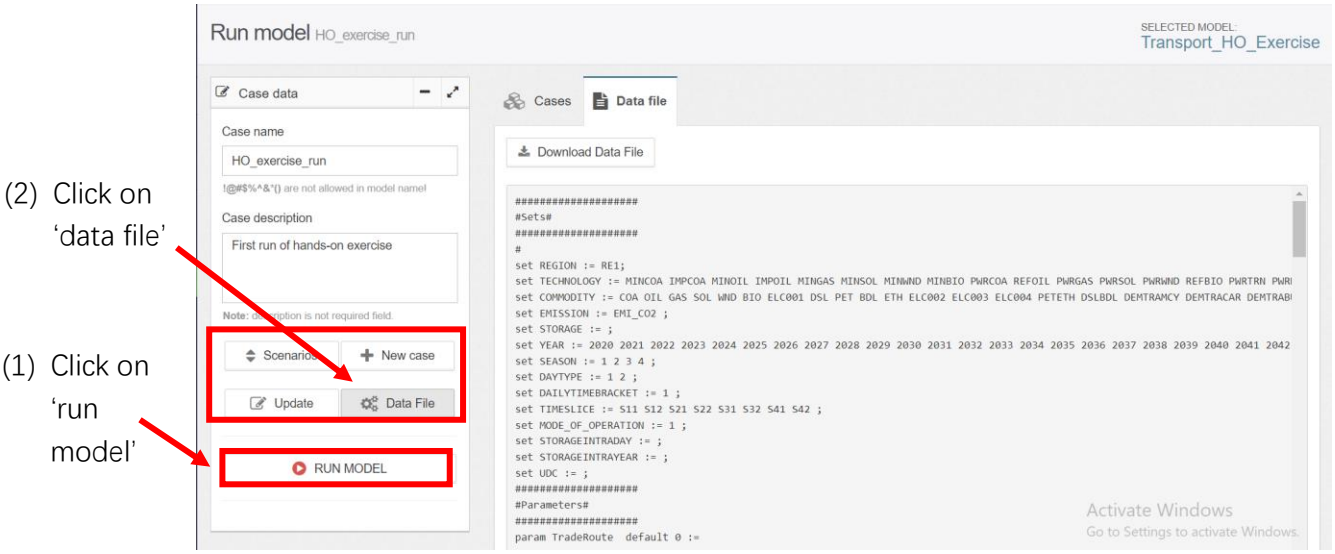
1. Once all data are inputted, we can run the model. To run, go to the left navigation bar and click on the 'run' button.
2. You will be taken to the 'run model' page. Write a new case name (*HO_exercise_run*) and a case description. Then click on the 'create case' button.



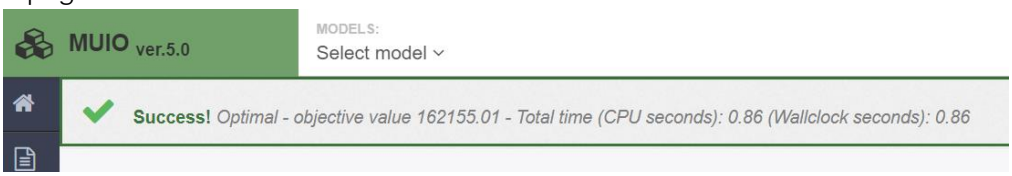
3. A new case with the name *HO_exercise_run* will pop up on the right side of the page. Click on this case.



4. This will reveal four buttons in the lower left page. Click on the 'data file' button. The data file will appear on the right and a new button called 'run model' will appear in the lower left. Click on 'run model'.

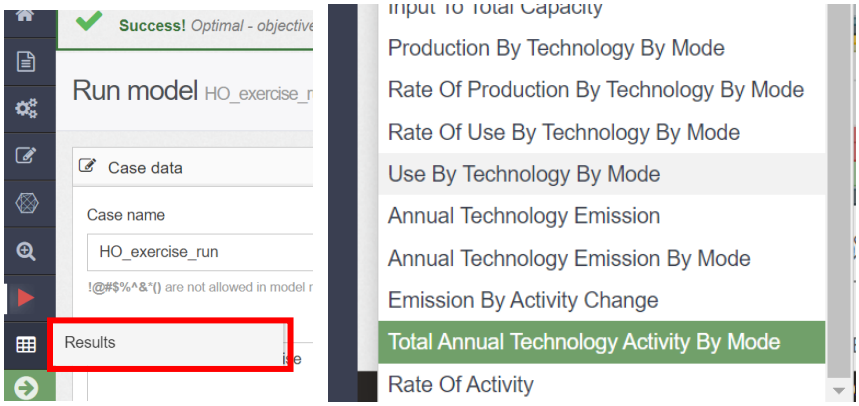


5. Your model will run instantly. When done, a bar with a green tick will appear at the top of the page with the title 'success'.



6.a. View OSeMOSYS results

1. Click on the 'results' button in the left navigation bar. A new page for results will come up. Let's look at the transport activity first, so click on 'Total Annual Technology Activity By Mode' in the drop-down bar.



2. As we only want to see transport activity, go to the left side of the page and right click on 'tech', which is right under 'column'. Next, click on 'field settings'.
3. A small pop-up box will appear. Type in 'tra' in the search box so that we only filter for the technologies with the 'tra' prefix. These are the transport end-use technologies.
4. Click on 'ok' when done.

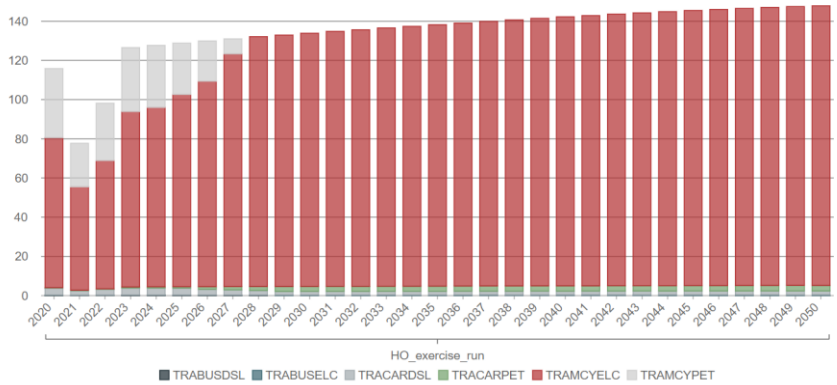
(1) Filter for the transport end-use technologies by typing in 'tra' in the search bar

(2) Click on 'ok'

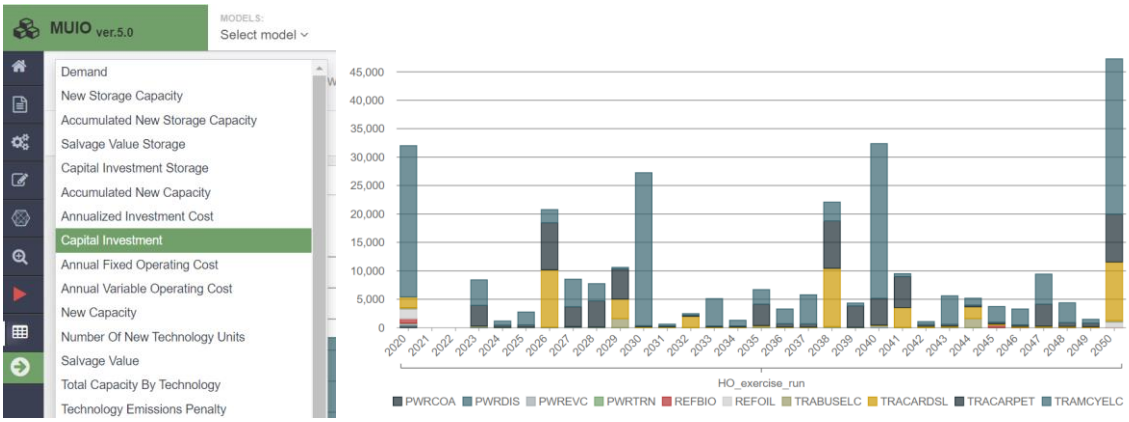
(3) Click on 'field settings'

(4) Right click on 'tech'

5. The graph should now show the activity for the different transport vehicles only. From this, we can see that the activity is dominated by motorcycles, with electric motorcycles replacing petrol motorcycles. This could be explained by the relatively cheap costs and high efficiency of electric motorbikes. As OSeMOSYS is a cost optimizer, it choose the cheapest technology to meet the demand – in this simple example, it is electric motorcycles.



6. Let's look at capital costs now. Go back to the drop-down bar and click on 'capital investment'. A graph like the one below will show up, showing the costs from both the power and transport sectors.



7. Let's do the same with emissions. Go back to the drop-down bar and click on 'annual technology emissions'. A graph like the one below will show up, showing the emissions from both the power and transport sectors.

Well done! You have run your first transport-power model on OSeMOSYS.