MACTool Training
Module 3 – Small Hydropower Generation Model

ESMAP
Energy Sector Management Assistance Program

ERM

WELCOME

SMALL HYDROPOWER GENERATION MODEL

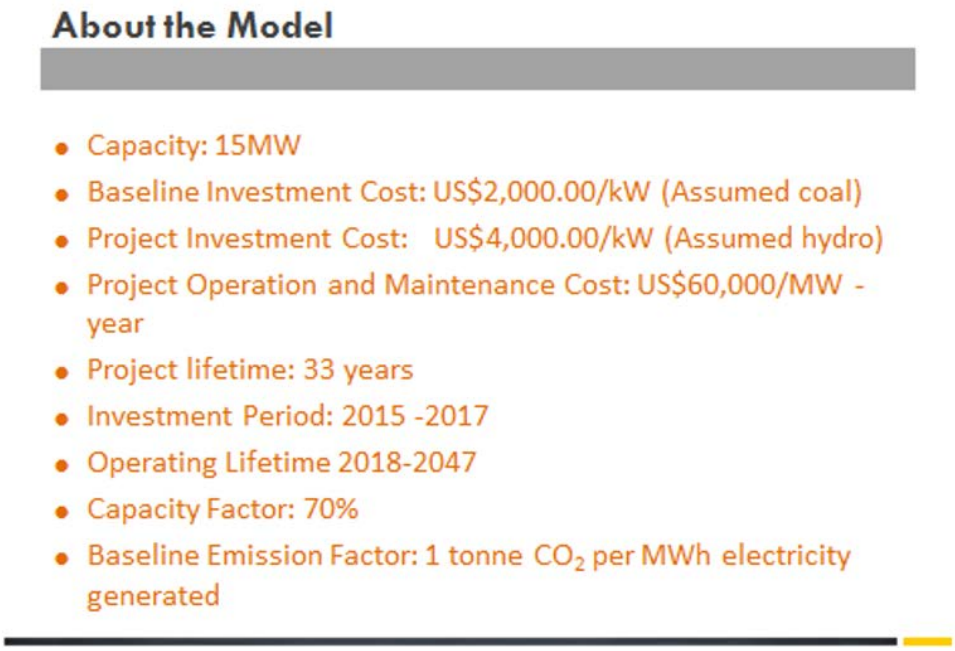
The last two tutorials have provided an introduction to marginal abatement cost curves also known as MAC Curves and introduced you to the features and functionality of the MACTool. In this tutorial, we will create a simplified power generation case study. At the end of this tutorial, you will be able to:

- Create a new power sector project model (template) based on the generic power generation template available in MACTool
- Customize MACTool's baseline data to a specific country power system
- Input data into the template based on specific low-carbon project features in the power sector
- Obtain and interpret MAC results for a low-carbon power sector project from a public/social and private perspectives.

ABOUT THE MODEL

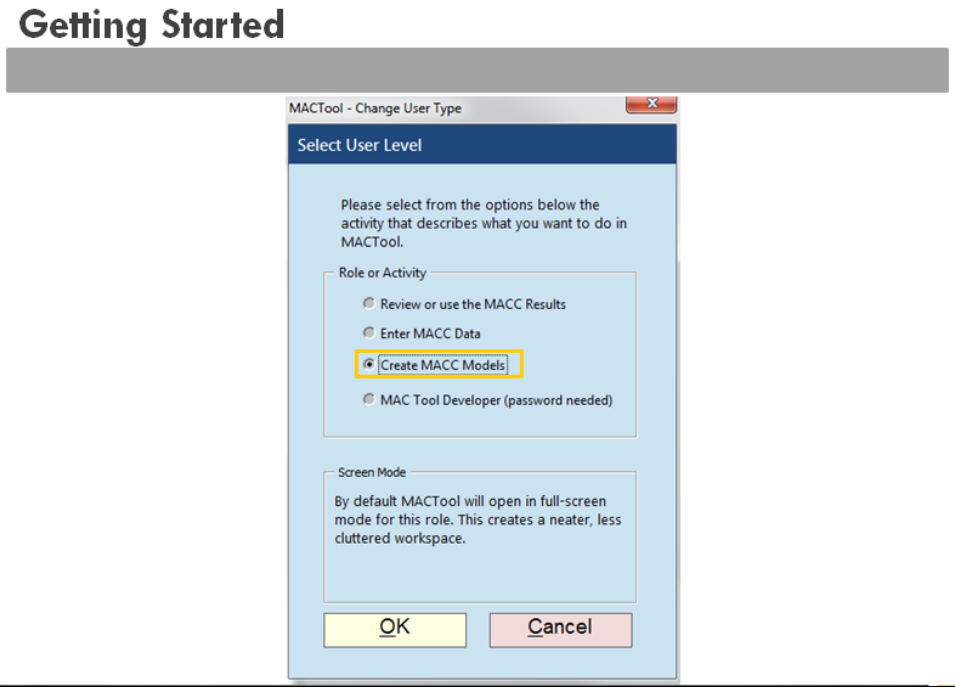
Data collection is the most intensive step in the creation of marginal abatement cost curves. All the data presented in this case study are illustrative, but intended to be realistic. The low-carbon project considered in the study is a 15-megawatt hydropower project to be built in Brazil. The small hydro project has an investment cost of $4,000 per kilowatt and an annual operation and maintenance cost of $60,000 per megawatt. All costs are in US dollars. The investment cost period is three years starting in 2015 and ending in 2017. The capacity factor is 70% resulting in a generation output of 92,043 megawatt-hours per year. Since hydroelectric power generation is a renewable energy, there are

no emissions associated with the project. The project however displaces baseline generation of coal-fired power plants which emit 1 tonne of carbon dioxide per megawatt-hour of electricity generated.



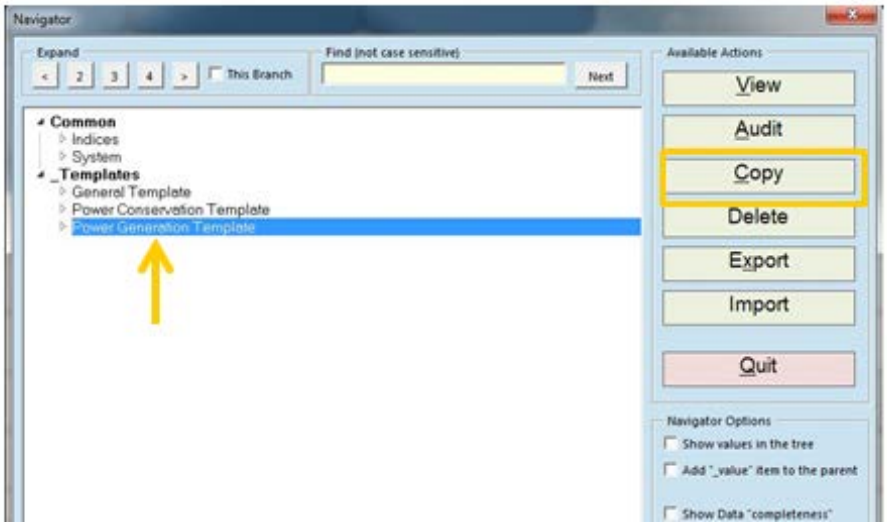
GETTING STARTED

To get started, open the MACTool. The "Select User Level" screen launches when the tool is fully loaded. Select "Create MACC Models" as the User level.



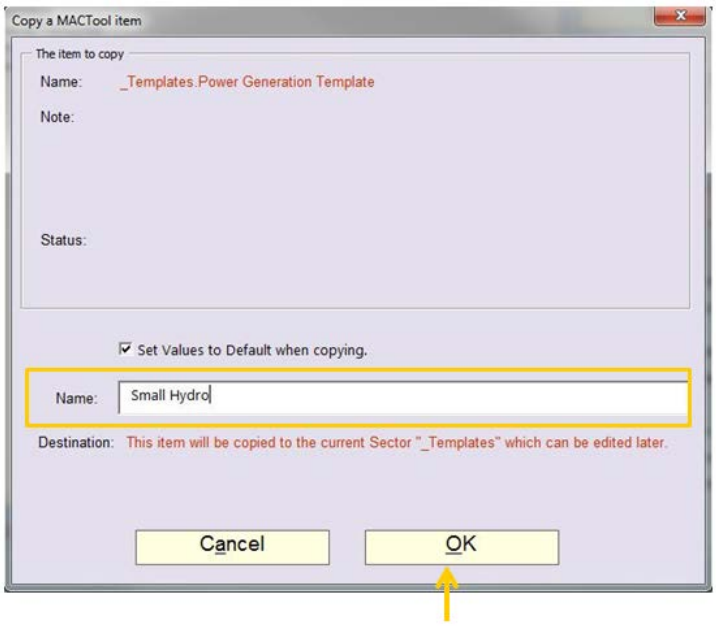
COPYING A TEMPLATE

Once you have selected the User level, select the "Data" tab at the top to launch the navigator. To create a new model, select the Power Generation Template under "Templates" and then click the "Copy" button on the right-hand side.



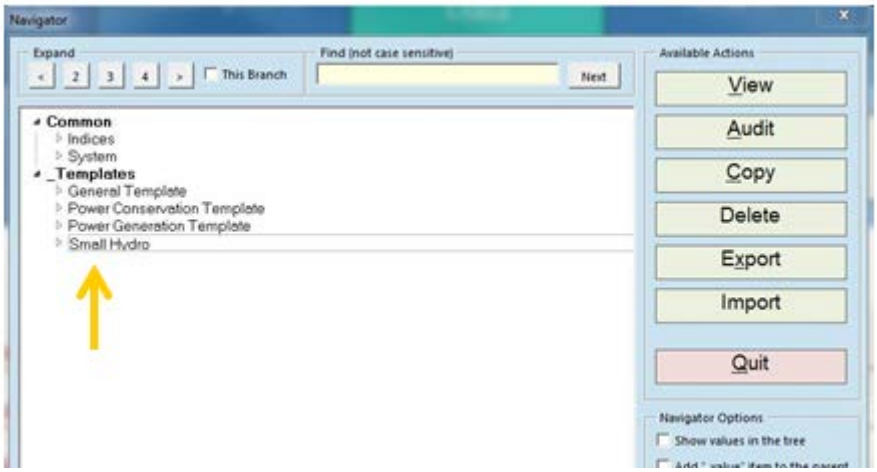
NAMING A MODEL

You will be prompted to enter a name for your new model. We shall call this model "Small Hydro" then click "OK". A warning sign notifying the user of the length of the copying process will appear. Click "Yes".



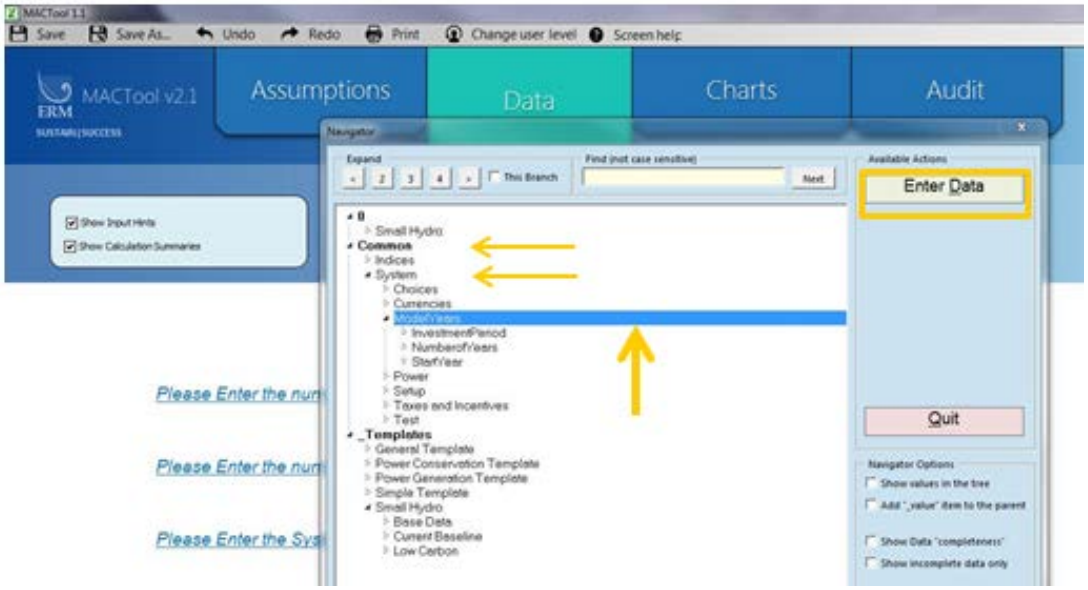
SMALL HYDRO MODEL

Once this is complete, you will be able to see your new model in the Navigator screen under the templates.



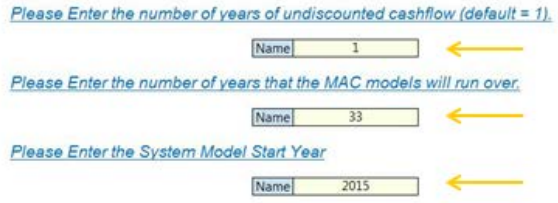
NAVIGATOR – SYSTEM SETUP

To start building your model, we recommend that you set up the years and timeline of your model first. In the Navigator menu, under "Common", click on the little triangle by "System" to expand it, then select "Model Years", then click "Enter Data" on the right-hand side.



SETTING UP THE TIMELINE AND YEARS: VIEW

In the next screen you will be able to enter information on the starting year and the analytical period (time horizon) of the model. The total number of years is the sum of years of the investment period and operating period. The small hydro project will have a three-year investment period (2015-2017) and a thirty-year operating period ending in 2047. So the number of years that the MAC model will run is 33. The initial year of the analytical period is not discounted as it is assumed to be the current year when the modeling exercise is taking place. The model will thus have one year (2015) of undiscounted cashflow. This is the default setting of the tool. Once you are done making changes, click the "Save" button to save the changes.



Then click the "Data" tab to return to the navigator menu.

ENTERING POWER GENERATION DATA

Since the Small Hydro model is created from the generic Power Generation template, there are several other inputs under "Power" that need to be entered.

From the navigator menu, select "Power" under "Common/System" and click the "Enter Data" button on the right-hand side to open the respective data entry sheet. If the inputs are already present (which may be the case if the generic template contained pre-existing data), they may need to be revised or left as is. These input data characterize the overall power system in the country concerned, including several categories of costs (fossil fuel costs, investment costs, and O&M costs) per MWh of electricity generated, and the GHG emission factor in tCO2 per MWh.

The fossil fuel cost per MWh, the Investment cost per MWh and the Operating and Maintenance costs per MWh are country specific or project specific values that should be provided aiming at determining the baseline investment, O&M and fuel costs. They will be multiplied by the yearly MWh output of the low carbon power plant to establish the respective values for the baseline alternative. In our case, the baseline plant would incur annual fuel costs of $50/MWh and annual O&M costs of $10/MWh as shown below, from Year 2018 through Year 2047, so the respective values need to be entered in the lines highlighted in red, as follows:

Actual Fossil Fuel Cost per MWh of electricity generated

	Fossil Fuels Cost per MWh	Sensitivity
Base Case (Case*Sens)	Base Case	100.00%
(Case*Sens)	System.Power.FossilFuelCostperMWh_value	

USD	Entry Currency					
2015	2016	2017	2018	2019	2020	2021
-	-	-	50.00	50.00	50.00	50.00
-	-	-	50.00	50.00	50.00	50.00

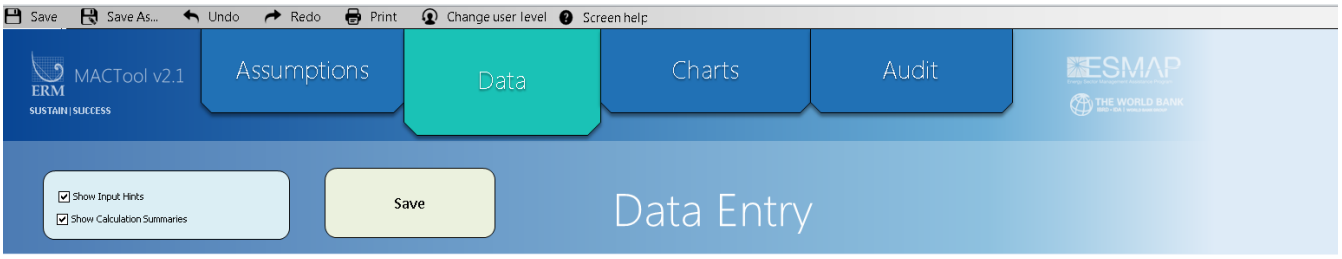
Actual O and M Costs per MWh of electricity generated

	Operations and Maintenance Cost per MWh	Sensitivity
Base Case (Case*Sens)	Base Case	100.00%
(Case*Sens)	System.Power.OandMCostsperMWh_value	

USD	try Currency					
2015	2016	2017	2018	2019	2020	2021
-	-	-	10.00	10.00	10.00	10.00
-	-	-	10.00	10.00	10.00	10.00

If any of the system-wide cost categories are unavailable but Baseline cost estimates can be assigned to a specific or notional generation plant meeting the same electricity demand, then the cost data for that plant can be entered directly in the respective model sheet, i.e., our "Small Hydro" sheet.

In our case, for example, it will be assumed that the Baseline investment cost is US$2,000.00/kW as the Small Hydro project would generate an amount of electricity that would otherwise be met by a new coal-fired power plant requiring this level of investment per kW. The respective investment cost values will be entered directly in the "Small Hydro" sheet as will be described later. For now, to avoid double counting, the system costs under "Actual Investment Costs per MWh of Electricity Generated" will be left empty (or set to zero):



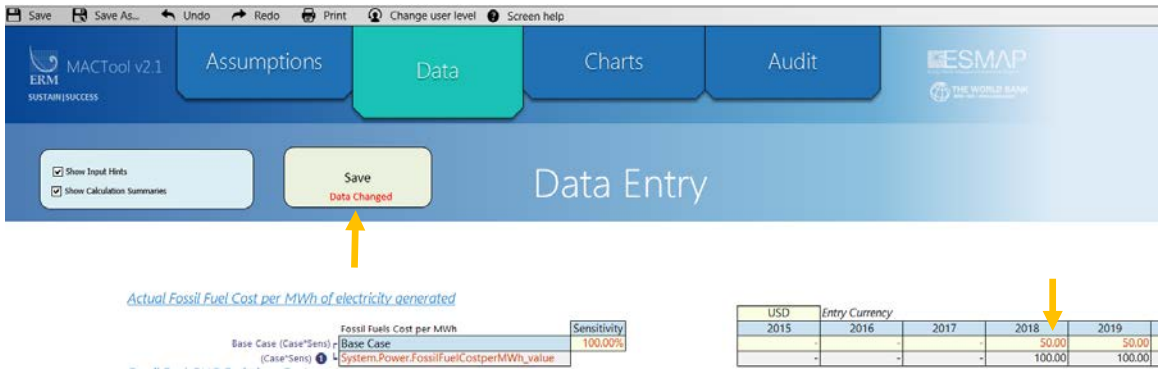
Actual Investment Cost per MWh of electricity generated

	Actual Investment Cost per MWh	Sensitivity
Base Case (Case*Sens)	Base Case	100.00%
(Case*Sens)	System.Power.InvestmentCostperMWh_value	

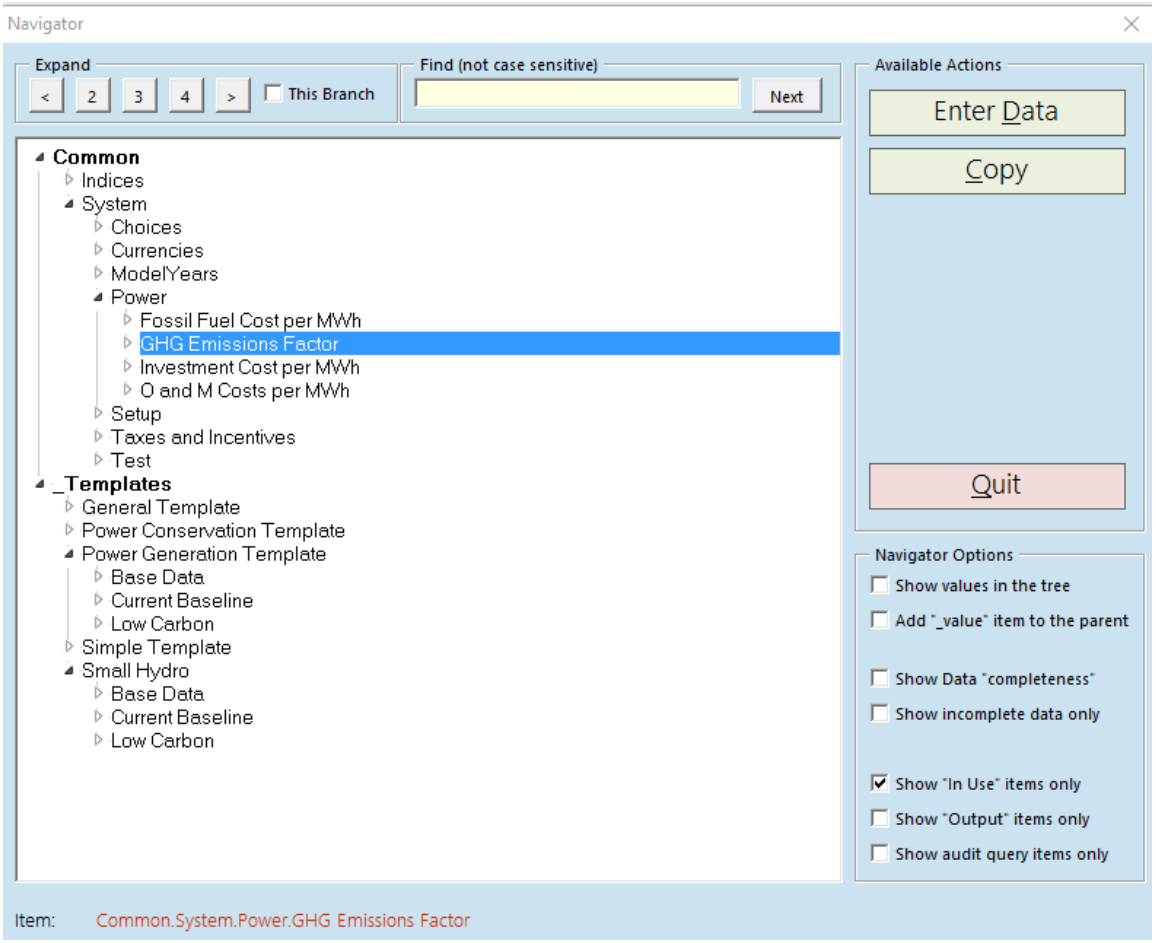
GHS	*Entry Currency*			
2015	2016	2017	2018	2019
-	-	-	-	-
-	-	-	-	-

The emission factor appears on the same sheet. As noted previously, it should be set to 1 tCO2 per MWh in our example.

Once you are done making changes to the "Data Entry" sheet, click the "Save" button to save the changes. MACTool reminds you to save the changes by displaying the "Data Changed" alert on the "Save" button:

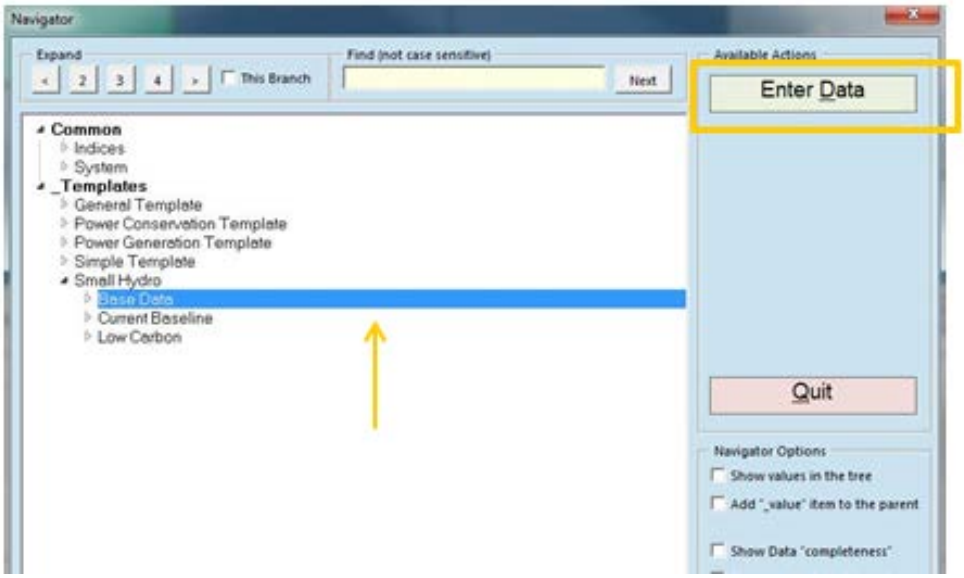


The alternative way to enter the "Power" data is by clicking "Enter" while a given data category is selected from the Navigator menu. For example, you can enter the emission factor by clicking "Enter Data" while "GHG Emission Factor" is selected:



ENTERING DATA THROUGH THE NAVIGATOR

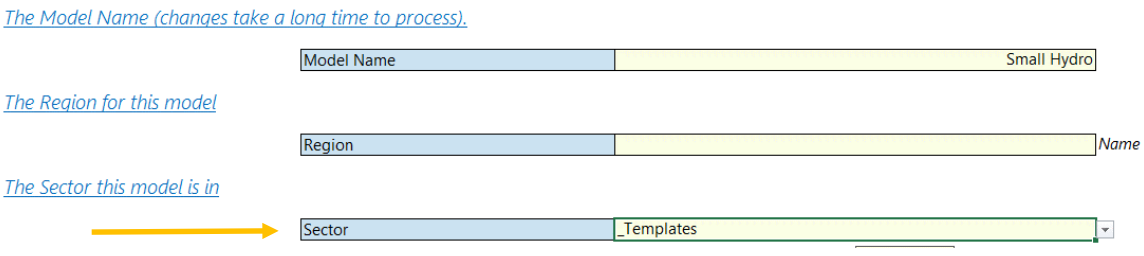
In many cases, there are several different ways to input data into the MACTool. One of them is through the Navigator menu. To do this in our case, click the "Data" tab to launch the Navigator, then click on the "Small Hydro" Model, then expand the drop down menu and select the model section that you want to add data to: "Base Data", "Current Baseline", or "Low Carbon".



In this example, we will apply this entry method to the "Base Data" section.

ENTERING BASE DATA – NAVIGATOR

Clicking "Enter Data" while "Base Data" is selected in the Navigator menu will take you to a page where all the base data can be entered, including Sector, Region, ISIC Code, and the Discount Rates used in the model. Scroll down to "Sector" first.



Place the cursor in the yellow cell in the same line and use the down arrow to set the sector to "Power Generation".

Similarly, scroll to "ISIC Categories for the model" and select appropriate categories. For this Small Hydro model, the Section and Division should be "Electricity, gas, steam, and air conditioning supply", and the group and class are "Electric power generation, transmission and distribution".

The ISIC Categories for the model

	ISIC Section (level 1)	Electricity, gas, steam and air conditioning supply	*Description*
35	ISIC Division (level 2)	Electricity, gas, steam and air conditioning supply	*Description*
351	ISIC Group (level 3)	Electric power generation, transmission and distribution	*Description*
3510	ISIC Class (level 4)	Electric power generation, transmission and distribution	*escription*
	SmallHydro.BaseData.ISIC_value	3510	*4-digit ISIC Code*

Then scroll to "The Region…" to select South America and "The Sub-region…" to select Brazil from the drop down menu.

This screen is also the right place to set the **discount rates** for the model. Scroll to the "Real Model Discount Rate" line under "The Discount Rate Specific to this Model", place the cursor in the yellow cell and enter the appropriate economic discount rate in real terms. In our example, this should be 8%:

The Discount Rate specific to this Model (may be overiden based on the System "Discount Rate Source")

Real Model Discount Rate	8%

The Discount Rate used in this model (depending on the System "Discount Rate Source"). Shown for information.

Real Discount Rate Used	10%	%

The 10% value in the gray line can be ignored for now, as it will be automatically updated later on.

Similarly, unless it is already there as a default value, set the "Break-even Market Discount Rate" to 15%, which is our choice of the financial, private sector discount rate which, in our example, is meant to reflect the risk of the type of projects such as Small Hydro:

The Break-Even Market Discount Rate

Break-Even or Market Discount Rate.	15%

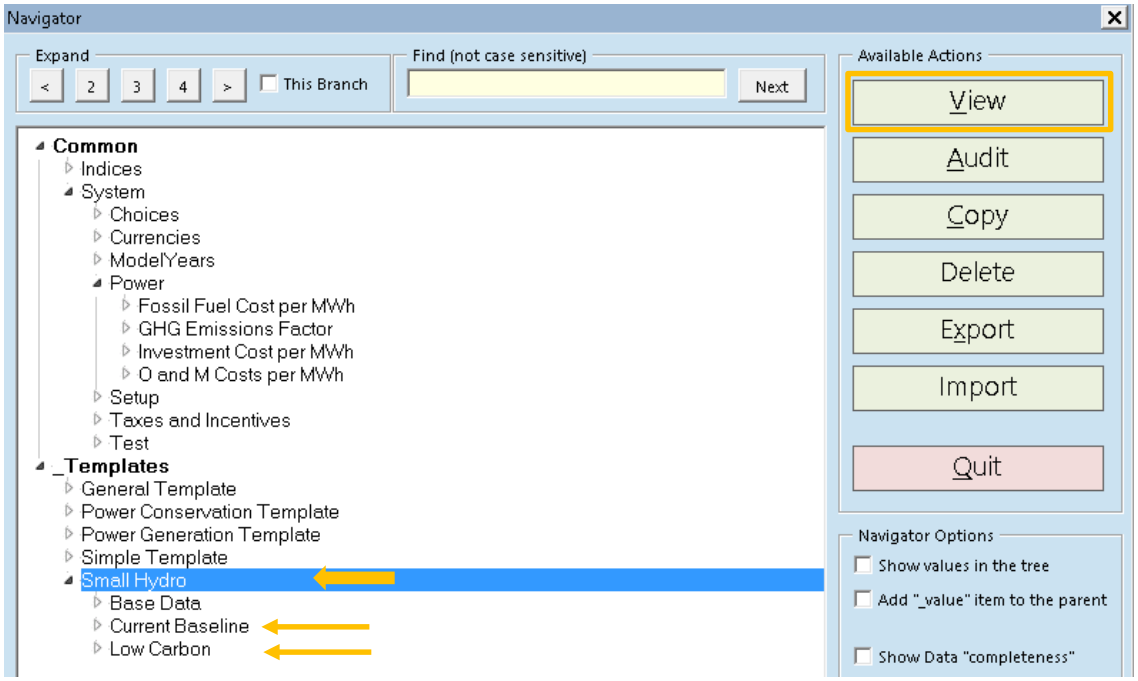
When this is complete, scroll to the top of the page and click the "Save" button to save this information into your model. Then click the "Data" tab to return to the navigator menu.

ENTERING DATA – VIEW

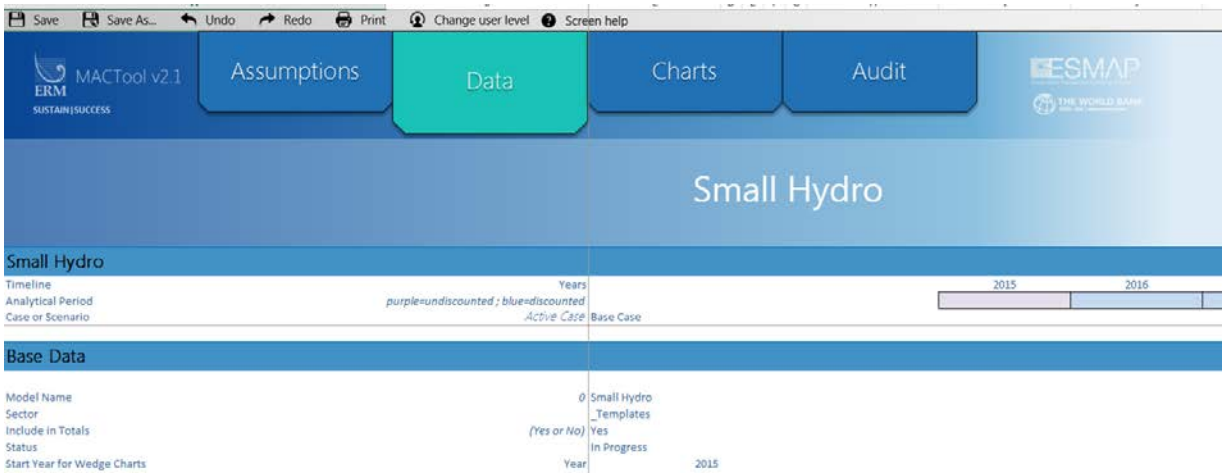
While a separate data entry sheet was available for the Base Data section, MACTool also allows entering data by selecting the model as a whole (in our

case, the Small Hydro model) in the navigator menu, and clicking the "View" button on the right hand side.

This entry method allows viewing the complete model on one screen (if you do not see an option to View, you should check your user level). We will use this input method to enter the Current Baseline data and the Low Carbon project data.



In the navigator menu, highlight the "Small Hydro" template and click the "View" button. This will open the detailed sheet containing the "Small Hydro" model:

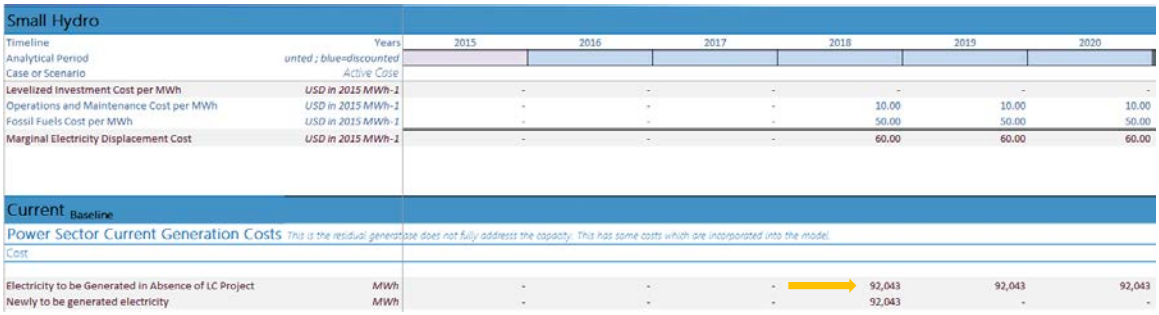


Note that while the entire "Small Hydro" sheet contains more than 400 rows and more than 40 columns, data entry is required only for a few specific rows, as described below.

CURRENT BASELINE

We will now fill out the information for the Current Baseline section in the "Small Hydro" sheet. The electricity that will be displaced by our small hydro project is 92,043 megawatt-hours per year. For this, we assumed a capacity utilization factor of 70 percent, which corresponds to 8766 hours per year at full capacity, accounting for leap years in the average number of days per year.

To reflect this information in the model, just type in 92,043 as a number directly in the "Electricity to be generated in absence of LC Project" line, starting in 2018 and copying the same number across through year 2047. The "Newly to be generated electricity" line will be updated automatically and needs no data entry.



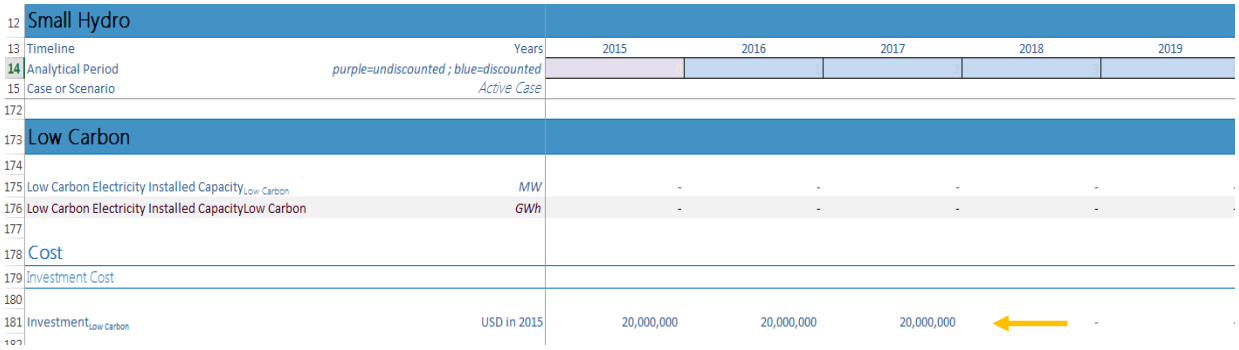
Small Hydro							
Timeline	Years	2015	2016	2017	2018	2019	2020
Analytical Period	unted ; blue=discounted						
Case or Scenario	Active Case						
Levelized Investment Cost per MWh	USD in 2015 MWh-1	-	-	-	-	-	-
Operations and Maintenance Cost per MWh	USD in 2015 MWh-1	-	-	-	10.00	10.00	10.00
Fossil Fuels Cost per MWh	USD in 2015 MWh-1	-	-	-	50.00	50.00	50.00
Marginal Electricity Displacement Cost	USD in 2015 MWh-1	-	-	-	60.00	60.00	60.00
Current Baseline							
Power Sector Current Generation Costs	This is the residual generation that does not fully address the capacity. This has some costs which are incorporated into the model.						
Cost							
Electricity to be Generated in Absence of LC Project	MWh	-	-	-	92,043	92,043	92,043
Newly to be generated electricity	MWh	-	-	-	92,043	-	-

As noted earlier, in our case it is assumed that the MACTool user has no reliable baseline investment cost estimate per MWh for the country's power system as a whole. However, the user has an idea about the investment cost of a baseline plant that would have to be built to generate the amount of electricity equivalent to that of the proposed Small Hydro plant. Specifically, it is assumed that the investment cost of the Baseline coal plant is $30 million, spread in equal portions of $10 million over three years starting from 2015. We will enter this data by clicking the cells for 2015-2017 in the "Actual Investment Cost" line under the "Current $_{\text{Baseline}}$" heading and typing in 10,000,000 in each of the three cells:

12	Small Hydro							
13	Timeline	Years	2015	2016	2017	2018	2019	2020
14	Analytical Period	unted ; blue=discounted						
15	Case or Scenario	Active Case						
49	Levelized Investment Cost per MWh	USD in 2015 MWh-1	-	-	-	-	-	-
50	Operations and Maintenance Cost per MWh	USD in 2015 MWh-1	-	-	-	10.00	10.00	10.00
51	Fossil Fuels Cost per MWh	USD in 2015 MWh-1	-	-	-	50.00	50.00	50.00
52	Marginal Electricity Displacement Cost	USD in 2015 MWh-1	-	-	-	60.00	60.00	60.00
53								
54								
55								
56	Current Baseline							
57	Power Sector Current Generation Costs	This is the residual generatase does not fully address the capacity. This has some costs which are incorporated into the model.						
58	Cost							
59								
60	Electricity to be Generated in Absence of LC Project	MWh	-	-	-	92,043	92,043	92,043
61	Newly to be generated electricity	MWh	-	-	-	92,043	-	-
62								
63	Investment cost							
64	Actual Investment Cost per MWh	USD in 2009 MWh-1	-	-	-	-	-	-
65	Actual Investment Cost	USD in 2015	10,000,000	10,000,000	10,000,000	-	-	-

LOW CARBON – INVESTMENT COST

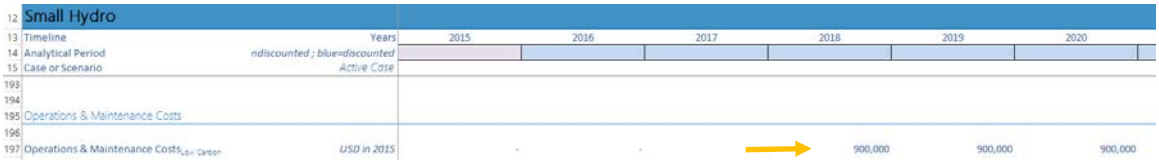
The next step is to fill out the information in the Low Carbon section of the "Small Hydro" sheet. As already mentioned, the investment cost is $4,000 per kilowatt, and the installed capacity is 15 megawatts. Therefore the total investment cost is $60 million. Similar to the baseline coal plant, we choose to split the investment cost of the Small Hydro Project evenly across the three year investment period for a total of $20 million per year. You can enter this data by clicking the cells for 2015-2017 in the "Investment $_{\text{Low Carbon}}$" line and typing in 20,000,000 in each of the three cells:



12	Small Hydro						
13	Timeline	Years	2015	2016	2017	2018	2019
14	Analytical Period	purple=undiscounted ; blue=discounted					
15	Case or Scenario	Active Case					
172							
173	Low Carbon						
174							
175	Low Carbon Electricity Installed Capacity$_{\text{Low Carbon}}$	MW	-	-	-	-	
176	Low Carbon Electricity Installed CapacityLow Carbon	GWh	-	-	-	-	
177							
178	Cost						
179	Investment Cost						
180							
181	Investment$_{\text{Low Carbon}}$	USD in 2015	20,000,000	20,000,000	20,000,000	-	

LOW CARBON – OPERATION AND MAINTENANCE COST

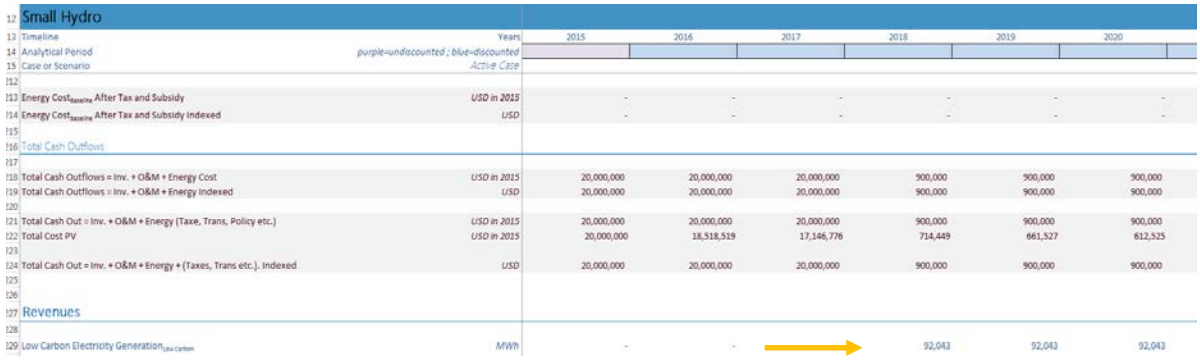
Next we input the operation and maintenance cost. The hydro project has an annual maintenance cost of $60,000 per megawatt. Therefore the operation and maintenance cost per year is 900,000 US Dollars. We input 900,000 in year 2018, line "Operations and Maintenance Costs $_{\text{Low Carbon}}$", and copy this across through year 2047.



12	Small Hydro							
13	Timeline	Years	2015	2016	2017	2018	2019	2020
14	Analytical Period	ndiscounted ; blue=discounted						
15	Case or Scenario	Active Case						
193								
194								
195	Operations & Maintenance Costs							
196								
197	Operations & Maintenance Costs$_{\text{Low Carbon}}$	USD in 2015	-	-	→	900,000	900,000	900,000

LOW CARBON – REVENUES

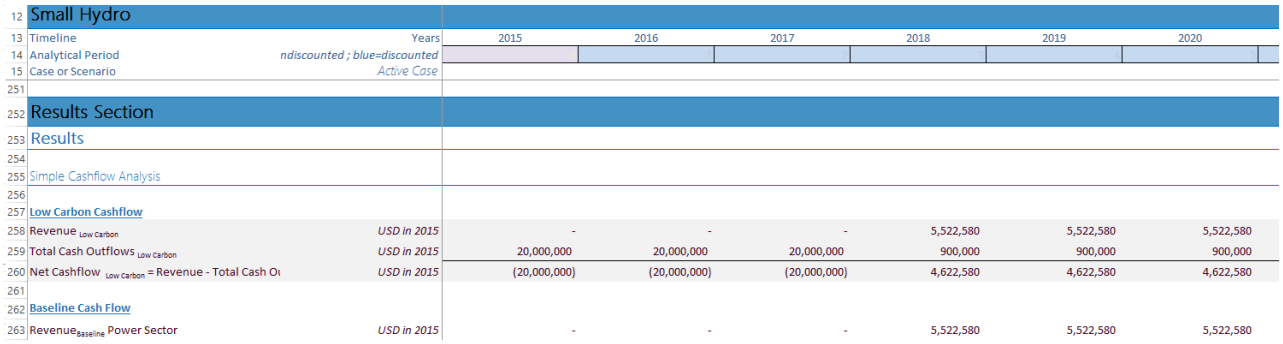
Lastly, under "Revenues", we enter the electricity generation of 92,043 megawatt-hours per year in line "Low Carbon Electricity Generation $_{\text{Low Carbon}}$" starting from 2018 and copy this across through year 2047.



12	Small Hydro							
13	Timeline	Years	2015	2016	2017	2018	2019	2020
14	Analytical Period	purple=undiscounted ; blue=discounted						
15	Case or Scenario	Active Case						
112								
113	Energy Cost$_{\text{Baseline}}$ After Tax and Subsidy	USD in 2015	-	-	-	-	-	-
114	Energy Cost$_{\text{Baseline}}$ After Tax and Subsidy Indexed	USD	-	-	-	-	-	-
115								
116	Total Cash Outflows							
117								
118	Total Cash Outflows = Inv. + O&M + Energy Cost	USD in 2015	20,000,000	20,000,000	20,000,000	900,000	900,000	900,000
119	Total Cash Outflows = Inv. + O&M + Energy Indexed	USD	20,000,000	20,000,000	20,000,000	900,000	900,000	900,000
120								
121	Total Cash Out = Inv. + O&M + Energy (Taxe, Trans, Policy etc.)	USD in 2015	20,000,000	20,000,000	20,000,000	900,000	900,000	900,000
122	Total Cost PV	USD in 2015	20,000,000	18,518,519	17,146,776	714,449	661,527	612,525
123								
124	Total Cash Out = Inv. + O&M + Energy + (Taxes, Trans etc.). Indexed	USD	20,000,000	20,000,000	20,000,000	900,000	900,000	900,000
125								
126								
127	Revenues							
128								
129	Low Carbon Electricity Generation$_{\text{Low Carbon}}$	MWh	-	-	→	92,043	92,043	92,043

COMPLETED LOW CARBON

Once you have input this data, your model is complete. At this point, the "Results Section" of the "Small Hydro" sheet should be automatically populated, as indicated in the screen shot below:



12	Small Hydro							
13	Timeline	Years	2015	2016	2017	2018	2019	2020
14	Analytical Period	ndiscounted ; blue=discounted						
15	Case or Scenario	Active Case						
251								
252	Results Section							
253	Results							
254								
255	Simple Cashflow Analysis							
256								
257	Low Carbon Cashflow							
258	Revenue $_{\text{Low Carbon}}$	USD in 2015	-	-	-	5,522,580	5,522,580	5,522,580
259	Total Cash Outflows $_{\text{Low Carbon}}$	USD in 2015	20,000,000	20,000,000	20,000,000	900,000	900,000	900,000
260	Net Cashflow $_{\text{Low Carbon}}$ = Revenue - Total Cash Ou	USD in 2015	(20,000,000)	(20,000,000)	(20,000,000)	4,622,580	4,622,580	4,622,580
261								
262	Baseline Cash Flow							
263	Revenue$_{\text{Baseline}}$ Power Sector	USD in 2015	-	-	-	5,522,580	5,522,580	5,522,580

Note that the color of the 2015 cell in the "Analytical Period" line is different from the rest of the project years to show its special role as "year zero" in the project. This means that no discounting applies to year 2015. The discounting starts in year 2016.

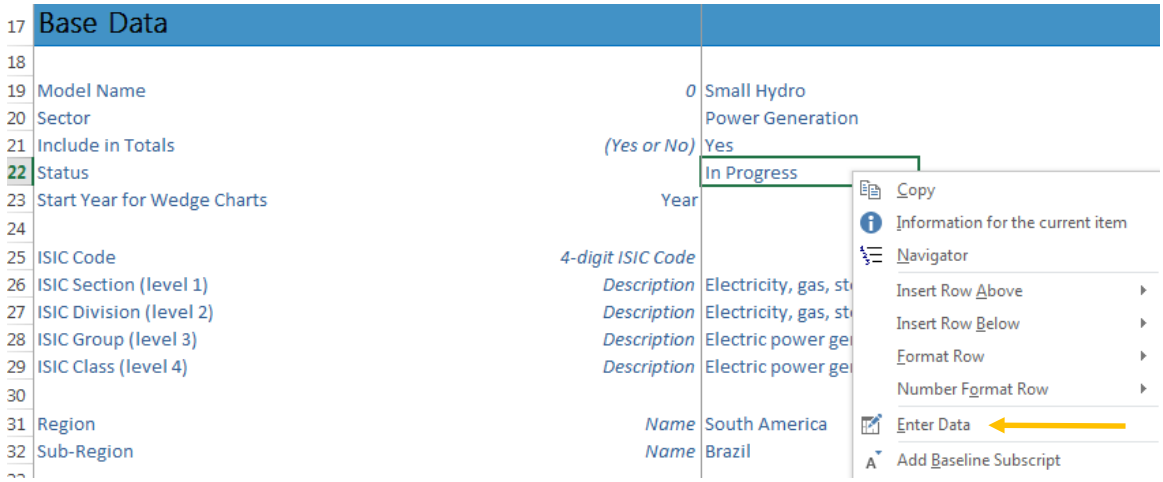
TRANSFERRING THE RESULTS TO THE GRAPHS MODULE

To complete the calculation of the results and ensure that graphs are generated, you need to press **Control + Alt + Shift + F9**. Using this key combination at the right time is the way MACTool avoids automatic recalculation at every step, which would slow down the entire process.

Note: In some cases, a computer is not set up to implement the Control + Alt + Shift + F9 operation or graphs may not be generated even though the required key combination is possible. Troubleshooting for such cases involves the following options: (1) Saving the file under a different name, closing and opening it again; (2) Clicking the Charts tab and then alternately on the "MACC" and "Wedge/MACC" tabs; and (3) Alternating between the types of graphs such as Marginal Abatement Cost and Break-Even Carbon Price.

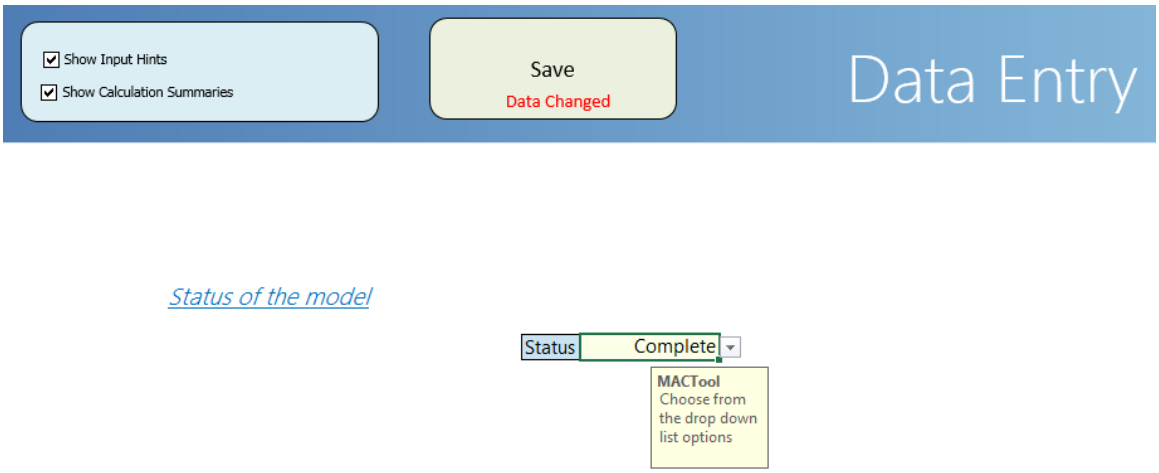
CHANGING THE STATUS

Prior to generating charts, you will need to change the status from "In Progress" to "Complete." The MACTool will not generate charts unless the status has been changed to Complete. There are two ways to change the status. The first is



directly from the "Small Hydro" sheet under the "Base Data" section. From the navigator menu ("Data" tab), select "Small Hydro", click "View", then simply find the "Status" line, right click on the cell containing "In Progress" and select "Enter Data".

In the next screen that opens up, select "Complete" from the pull-down menu and click the "Save" button.



CHANGING THE STATUS – NAVIGATOR

The second way to change the status is through the navigator menu. To do this select the Data tab, then expand the drop-down menu under "Small Hydro"; this will show you three sections available in the model: Base Data, Current Baseline, and Low Carbon. Selecting Base Data will provide a second drop-down menu. Then, select Status and click "Enter Data" on the right hand side of the menu. Select "Complete" and save the change.

CHECKING THE KEY OUTPUT VALUES

To make sure that the calculation is complete, go back to the navigator menu by clicking the "Data" tab again, select the "Small Hydro" model, click "View" and, when the Small Hydro sheet opens, scroll down to see the results under the heading "Marginal Abatement Cost (avg. cost/ t CO2)":

396	**Marginal Abatement Cost (Avg. Cost/t CO_2)**		
397	Avg. Cost of avoided CO_2 Emissions	*USD in 2015 /tCO2e*	(6.08)
398			
399	**Baseline GHG Emissions**		
400	Baseline GHG Emissions	*tCO2e*	2,761,290
401	Baseline GHG Emissions	*Million tCO2e*	3
402			
403	**Break-Even Carbon Prices**		
404	Break-Even Incentive	*USD in 2015 /tCO2e*	64.69
405	Break Even Incentive (Incremental Costs Benchmark IRR)	*USD in 2015 /tCO2e*	7.24

The values in lines "Avg. Cost of avoided CO2 Emissions", "Break-Even Incentive", and "Break Even Incentive (Incremental…)" are the key results of the

calculation enabled by MACTool and essential inputs to the three key versions of the MAC curve that it generates.

OUTPUTS – MAC CURVE

The main output of the MACTool is a MAC Curve. To generate charts, select the "Charts" tab on the Navigator. This will generate the MAC Curve, which is the default chart. However, there are other types of charts such as Wedge Chart or combined Wedge and MACC curve.

Note: On the MAC Curve, one can filter by sector, ISIC code, Region, and sub-region. This option can be found on the left hand drop down menu. You can also filter by MACC Chart Type. A very helpful additional feature on this screen is that you can export this chart to PDF, Word, or PowerPoint using the buttons on the bottom right hand corner.

As shown in the first chart below, the marginal abatement cost of the Small Hydro project is a negative value of **-6.08 USD** per ton of carbon dioxide, and the volume of carbon dioxide reduced over the lifetime of the project is about 3 million tons. The negative cost means that the project pays for itself against the alternative of building a coal power plant to generate the equivalent amount of electricity. The MAC calculation is made from an overall economic perspective where expected returns on investment are represented by the discount rate of eight percent in real terms.

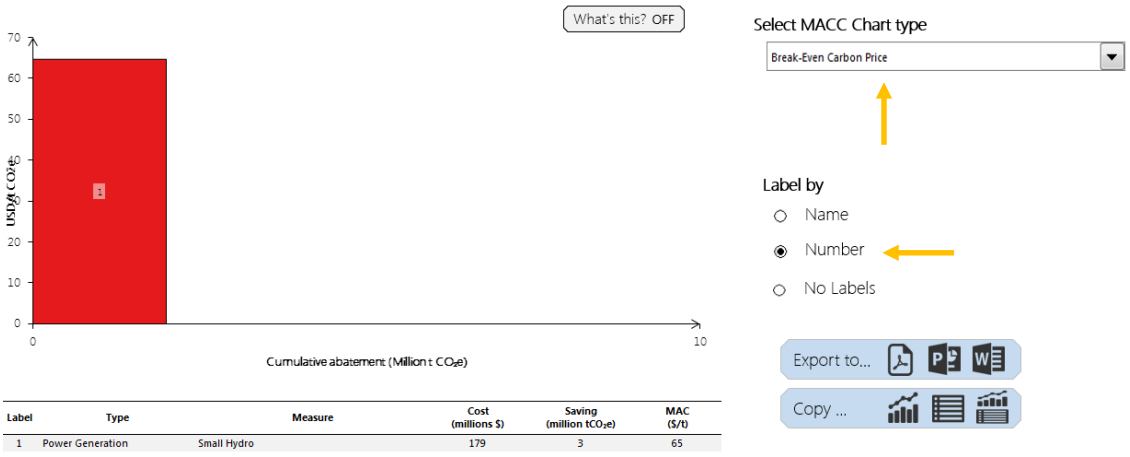
Label	Type	Measure	Cost (millions $)	Saving (million tCO2e)	MAC ($/t)
1	Power Generation	Small Hydro	-17	3	-6

OUTPUTS – BREAK EVEN CARBON PRICE

The second type of MAC Chart type shown is the break-even carbon price which can be found by selecting the MAC Chart Type. In our example, the break-even carbon price illustrates the financial break-even point using the market discount

rate of 15 percent. To generate the chart, select "Break Even Carbon Price" from the drop-down list. The break-even carbon price works out to be 64.69 USD per tonne of carbon dioxide for the same emission reduction of about 3 million tons. It should be noted that, while all break-even carbon price calculations are meant to represent a private investor's perspective, this particular calculation disregards the baseline costs involved (such as the costs of fossil-fuel-based generation) and depends entirely on the costs of the low-carbon project and the revenues it generates.

In addition, all break-even carbon price calculations assume a fixed price of carbon received by the project over time. Since all the cashflows, including the carbon revenue, are subject to discounting from an investor's financial perspective, the fixed price of carbon needs to be set high enough in anticipation of a similarly high private discount rate. The effect of applying a break-even carbon price formula is thus similar to applying the same discount rate to emission reductions that applies to costs. This is an important difference between the break-even carbon price and the standard MAC calculated earlier, where only costs but not emission reductions are discounted, and – in addition – the applicable discount rate is a much lower, real discount rate typically applied to public investments.



Label	Type	Measure	Cost (millions $)	Saving (million tCO2e)	MAC ($/t)
1	Power Generation	Small Hydro	179	3	65

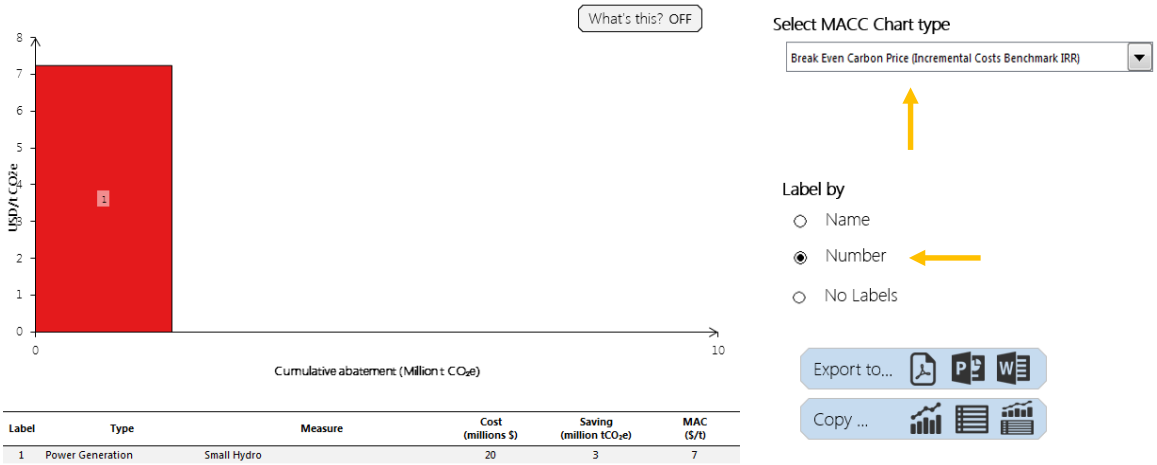
OUTPUTS – BREAK EVEN CARBON PRICE (INCREMENTAL)

The third type of MACC Chart type shown is the break-even carbon price where the cost is calculated against the same baseline as in the original MAC calculation, but the discounting is done using the market discount rate of 15 percent. To generate the chart, select "Break Even Carbon Price (Incremental … IRR) from the drop-down list.

As in the previous version of the break-even carbon price calculation, all the cashflows, including the carbon revenue, are discounted. The effect of applying

a break-even carbon price formula is thus similar to applying the same discount rate to emission reductions that applies to costs.

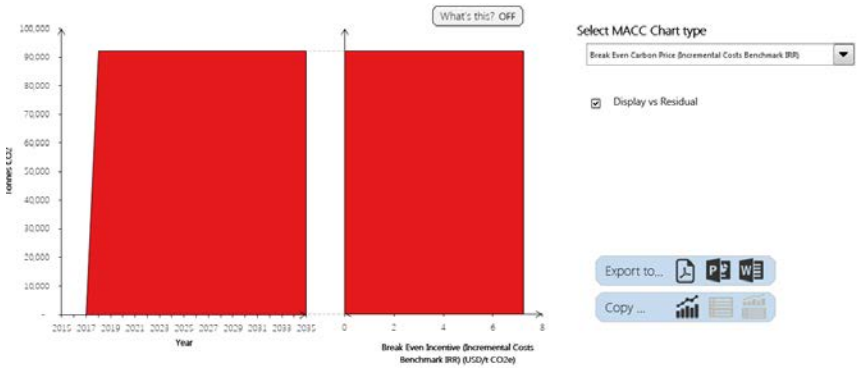
In this third and last calculation for the Small Hydro case, the break-even carbon price turns out to be 7.24 USD per tonne of carbon dioxide, for the same emission reduction of about 3 million tons.



Label	Type	Measure	Cost (millions $)	Saving (million tCO2e)	MAC ($/t)
1	Power Generation	Small Hydro	20	3	7

OUTPUTS – WEDGE CHART

Finally, the same results can be presented using different chart types. For example, another chart that can be generated is the Wedge/MAC Curve. This allows a user to view cumulative emissions over the years the projects are active versus the marginal abatement curve. To create this chart, click the "Wedge/MACC" tab above the current graph. For example, the Wedge/MAC graph corresponding to the calculation with the break-even carbon price of 7.24 USD/tCO2 looks as follows:



SUMMARY

In this tutorial you have learned how to:

- Create a new power sector model template

- Customize your data for a sector such as a specific country power system
- Input data into the template based on specific low-carbon project features in the power sector
- Obtain and interpret MAC results for a low-carbon power sector project from a public/social and private perspectives.