ENERGY TRANSITION INITIATIVE

ETI Energy Scenario Tool User Guide

About the ETI Energy Scenario Tool

The ETI Energy Scenario Tool is an Excel-based scenario model that calculates the cost of electricity for custom generation profiles. This tool is intended to model scenarios in Hawaii and other islands.

Data Entry Screens

Scenario Details

The Scenario Details screen serves as the main menu for the Scenario Tool and the starting point for using the tool. On this screen, users can create a new scenario, copy and modify an existing scenario, review an existing scenario, and delete scenarios.

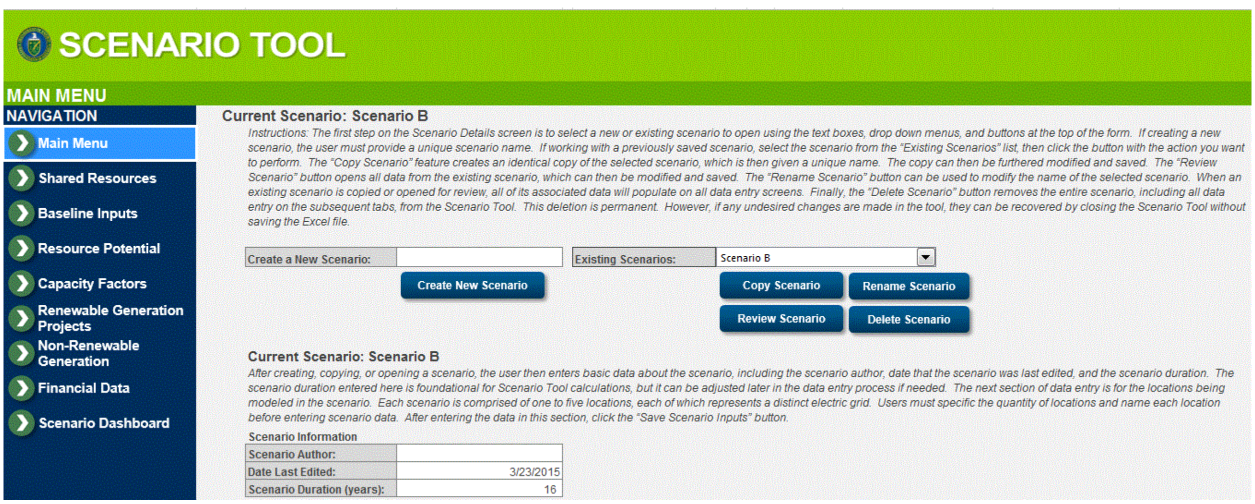


Figure 1: Main Menu

Step 1: Create, Copy, or Open a Scenario

The first step on the Scenario Details screen is to select a new or existing scenario to open using the text boxes, drop down menus, and buttons at the top of the form. If creating a new scenario, the user must provide a unique scenario name. If working with a previously saved scenario, select the scenario from the "Existing Scenarios" list, then click the button with the action you want to perform. The "Copy Scenario" feature creates an identical copy of the selected scenario, which is then given a unique name. The copy can then be further modified and saved. The "Review Scenario" button opens all data from the existing scenario, which can then be modified and saved. The "Rename Scenario" button can be used to modify the name of the selected scenario. When an existing scenario is copied or opened for review, all of its associated data will populate on all data entry screens. Finally, the "Delete Scenario" button removes the entire scenario, including all data entry on the subsequent tabs, from the Scenario Tool. This deletion is permanent. However, if any undesired change is made in the tool, it can be recovered by closing the Scenario Tool without saving the Excel file and then reopening the saved file.

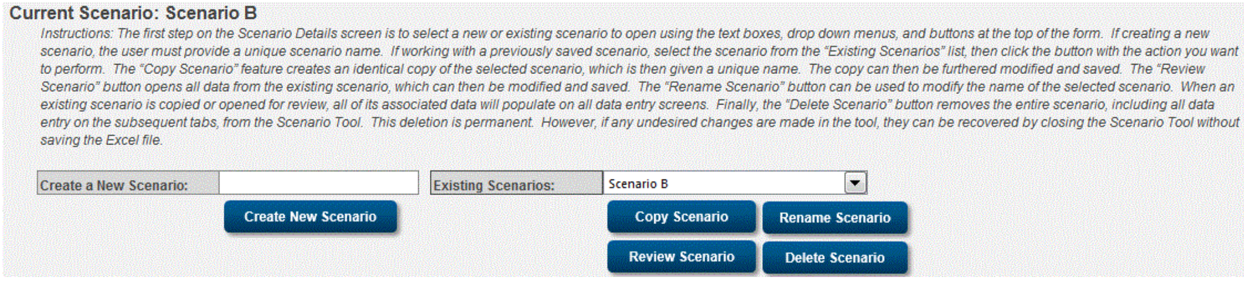


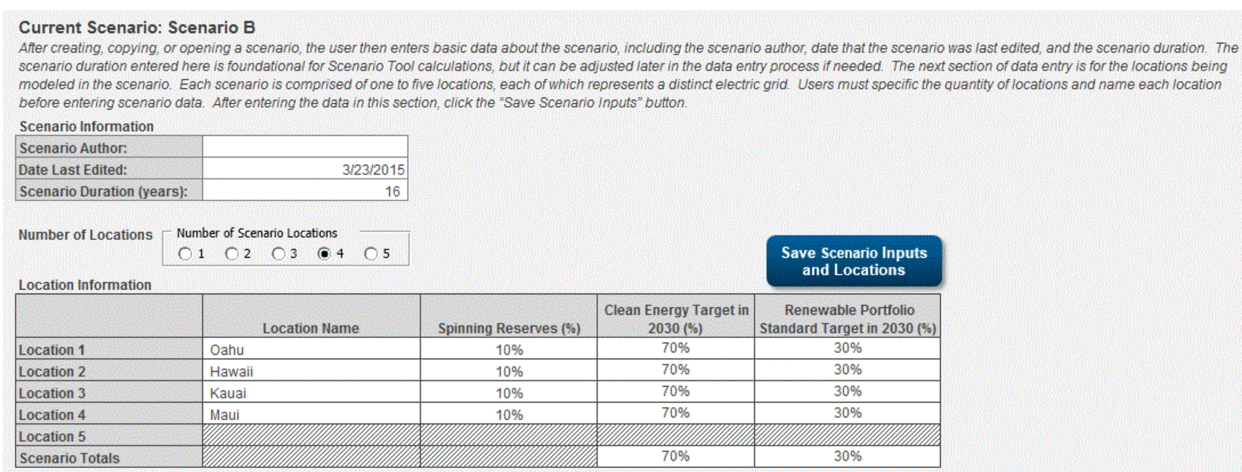
Figure 2: Create, Copy, or Open a Scenario

Step 2: Scenario Information

After creating, copying, or opening a scenario, the user then enters basic data about the scenario, including:

- Scenario author
- Date that the scenario was last edited
- Scenario duration

The scenario duration entered here is foundational for Scenario Tool calculations, but can be adjusted later in the data entry process if needed. The next section of data entry is for the locations being modeled in the scenario. Each scenario is comprised of one to five locations, each one must represent a distinct electric grid. Users must specify the quantity of locations and name each location before entering scenario data. For each location, the user must also enter spinning reserves, which are added to total demand, the clean energy target for the end of the scenario, and the renewable portfolio standard (RPS) target for the end of the scenario. **In the Scenario Tool, clean energy is defined as the combination of renewable energy generation and reductions in demand due to energy efficiency.** Clean energy and renewable portfolio standard targets must also be entered for the overall scenario. After entering the data in this section, click the "Save Scenario Inputs" button.



	Location Name	Spinning Reserves (%)	Clean Energy Target in 2030 (%)	Renewable Portfolio Standard Target in 2030 (%)
Location 1	Oahu	10%	70%	30%
Location 2	Hawaii	10%	70%	30%
Location 3	Kauai	10%	70%	30%
Location 4	Maui	10%	70%	30%
Location 5				
Scenario Totals			70%	30%

Figure 3: Scenario Information

Step 3: Energy Resources

The next step is to designate the energy resources being used in the scenario. The Scenario Tool can be used to model both renewable and non-renewable generation, and the user can pick energy resources from a suggested list or enter custom energy resources. Renewable and non-

While scenario energy resources can be adjusted in the scenario data entry process, modifying the list of energy resources after beginning to enter data is <u>not recommended</u> as the Scenario Tool can take up to a few minutes to make this change when saving.

renewable custom energy resources can be used in the Scenario Tool, and they can also be used to model generation that is shared across multiple locations. Custom energy resources from previously saved scenarios are also available, and they can be selected using the combo boxes at the bottom of the screen. After selecting energy resources to be used for the scenario, click the "Set Scenario Energy Types" button to save.

Figure 4: Energy Resources

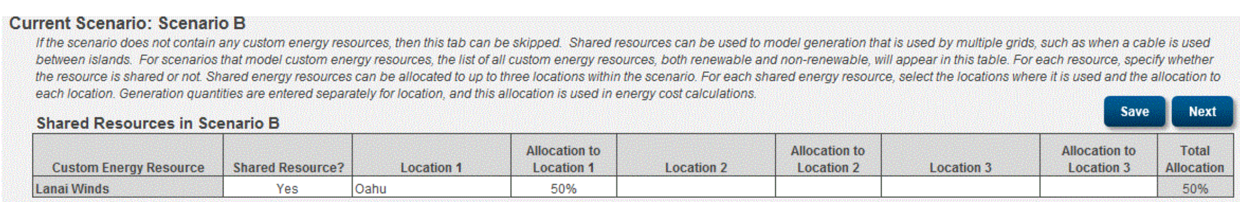
Shared Resources

The Scenario Tool allows for an energy resource to be shared by multiple locations or grids, for example, to model a cable project connecting two islands. Only custom energy resources can be modeled as shared resources.

Shared Resources Data Entry:

If the scenario does not contain any custom energy resources, then this tab can be skipped. For scenarios that model custom energy resources, the list of all custom energy resources, both renewable and non-renewable, will appear in this table. For each resource, specify whether the resource is shared or not. Shared energy resources can be allocated to up to three locations within the scenario. For each shared energy resource, select the locations where it is used and the allocation to each location. Generation quantities are entered separately for each location, and this allocation is used in energy cost calculations.

After entering data, click the "Save" button before proceeding to the next screen.


Current Scenario: Scenario B

If the scenario does not contain any custom energy resources, then this tab can be skipped. Shared resources can be used to model generation that is used by multiple grids, such as when a cable is used between islands. For scenarios that model custom energy resources, the list of all custom energy resources, both renewable and non-renewable, will appear in this table. For each resource, specify whether the resource is shared or not. Shared energy resources can be allocated to up to three locations within the scenario. For each shared energy resource, select the locations where it is used and the allocation to each location. Generation quantities are entered separately for location, and this allocation is used in energy cost calculations.

Save Next

Shared Resources in Scenario B

Custom Energy Resource	Shared Resource?	Location 1	Allocation to Location 1	Location 2	Allocation to Location 2	Location 3	Allocation to Location 3	Total Allocation
Lanai Winds	Yes	Oahu	50%					50%

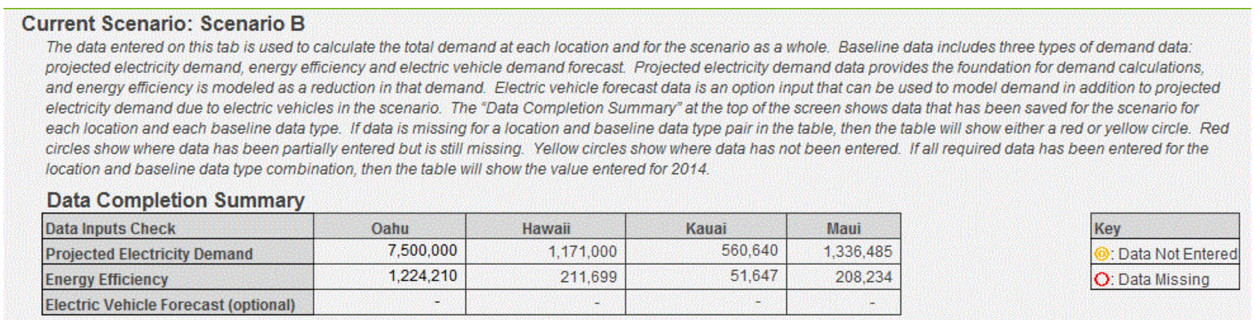
Figure 5: Shared Resources

Baseline Inputs

The data entered on this tab is used to calculate the total demand at each location and for the scenario as a whole. Baseline data includes three types of demand data: projected electricity demand, energy efficiency and electric vehicle demand forecast. Projected electricity demand data provides the foundation for demand calculations, and energy efficiency is modeled as a reduction in that demand. Electric vehicle forecast data is an optional input that can be used to model demand in addition to projected electricity demand due to electric vehicle charging in the scenario.

Baseline Data Entry:

The "Data Completion Summary" at the top of the screen shows data that has been saved for the scenario for each location and each baseline data type. If data is missing for a location and baseline data type pair in the table, then the table will show either a red or yellow circle. Red circles indicate data has been partially entered but is still missing. Yellow circles indicate data has not been entered. If all required data has been entered for the location and baseline data type combination, then the table will show the value entered for 2014.



Current Scenario: Scenario B

The data entered on this tab is used to calculate the total demand at each location and for the scenario as a whole. Baseline data includes three types of demand data: projected electricity demand, energy efficiency and electric vehicle demand forecast. Projected electricity demand data provides the foundation for demand calculations, and energy efficiency is modeled as a reduction in that demand. Electric vehicle forecast data is an option input that can be used to model demand in addition to projected electricity demand due to electric vehicles in the scenario. The "Data Completion Summary" at the top of the screen shows data that has been saved for the scenario for each location and each baseline data type. If data is missing for a location and baseline data type pair in the table, then the table will show either a red or yellow circle. Red circles show where data has been partially entered but is still missing. Yellow circles show where data has not been entered. If all required data has been entered for the location and baseline data type combination, then the table will show the value entered for 2014.

Data Completion Summary

Data Inputs Check	Oahu	Hawaii	Kauai	Maui
Projected Electricity Demand	7,500,000	1,171,000	560,640	1,336,485
Energy Efficiency	1,224,210	211,699	51,647	208,234
Electric Vehicle Forecast (optional)	-	-	-	-

Key
: Data Not Entered
: Data Missing

Figure 6: Data Completion Summary for Baseline Inputs

Baseline data is entered by location for each of the three types of demand. First, choose a location from the "Select a location" drop down menu, then select the baseline type using the radio buttons below.

Energy efficiency data can be entered as total megawatt hours (MWh) or as a percentage of projected electricity demand. Select which mode to use using the radio buttons to the right of the baseline data type selection box.

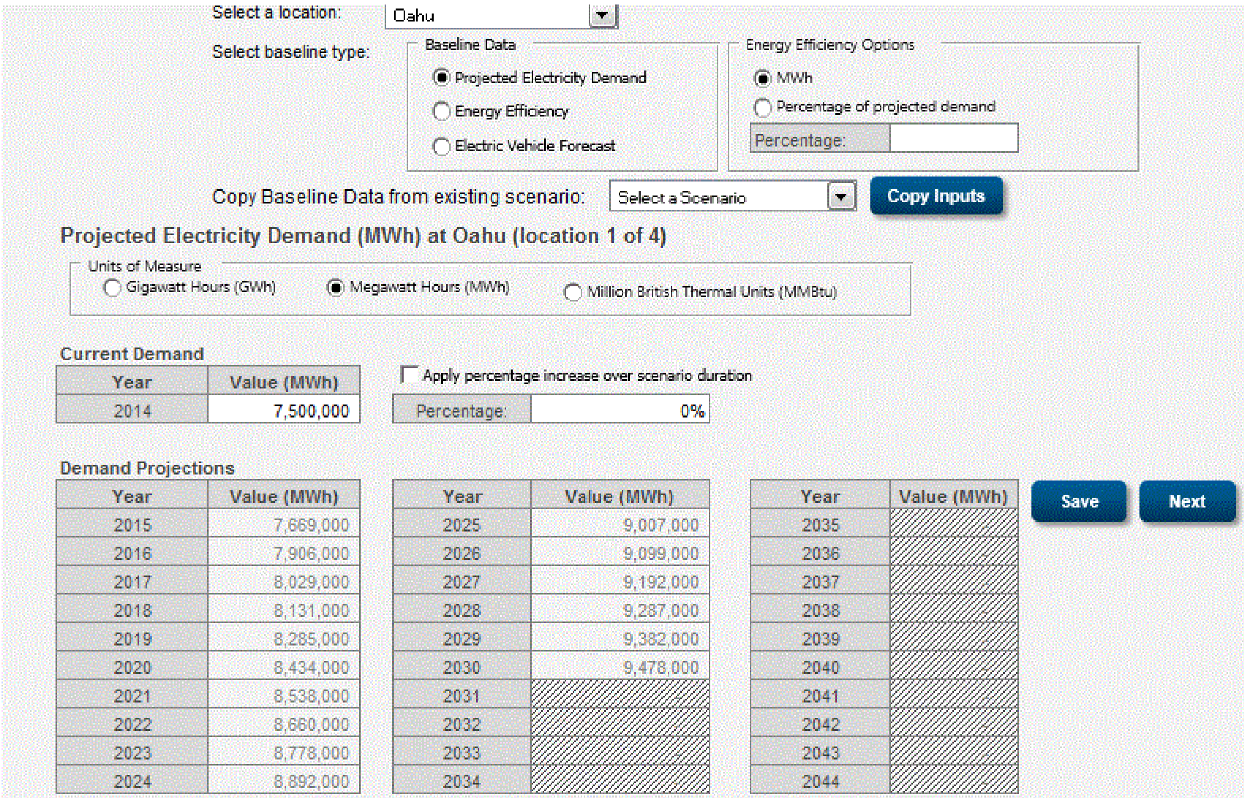


Figure 7: Baseline Inputs Data Entry

Baseline data can also be copied from previously saved scenarios using the "Copy Baseline Data from existing scenario" menu. This list of scenarios includes scenarios with locations that match the selected location. Copying data will duplicate all baseline data from the previously saved scenario.

After selecting a location and baseline data type, enter the data values in the lower portion of the screen. Data can be entered using gigawatt hours (GWh), megawatt hours (MWh), or millions of British thermal units (MMBTU). Baseline data can also be automatically increased over the duration of the scenario using the "Apply percentage increase over scenario" check box and accompanying percentage data field below. This will apply the percentage to the value entered for 2014, increasing by the percentage for each year of the scenario.

Resource Potential Inputs

Resource potential is the maximum generation level that theoretically could be installed for each energy resource, in megawatts. For example, the resource potential of a location with strong winds would have a higher resource potential for onshore wind than a location with moderate winds. In the Scenario Tool, resource potentials must be set for each location and energy resource combination, and they serve as an error check for capacity of renewable energy projects. The user should enter data for resource potential before adding generation projects to the scenario to avoid receiving error messages further on. The tool will not allow a scenario to go over the resource potential set for each generation technology, however, it is acceptable to fall under the maximum generation level for each resource type.

On the Resource Potential screen, the Data Completion Summary displays all of the resource potential data for the scenario. To enter data, select a location using the drop down menu, and any saved data for that location will populate in the table. Data can also be copied from previously saved scenarios that include the same location.

Current Scenario: Scenario B

Currently viewing data for Oahu (location 1 of 4)

Resource potential is the maximum power that could theoretically be installed for each energy resource. For example, the resource potential of a location with strong winds would have a higher resource potential for onshore wind than a location with low winds. In the Scenario Tool, resource potentials must be set for each location and energy resource combination, and they serve as an error check for capacity of renewable energy projects. The user should enter data for resource potential before adding generation projects to the scenario to avoid receiving error messages further on. On the Resource Potential screen, the Data Completion Summary displays all of the resource potential data for the scenario. To enter data, select a location using the drop down menu, and any saved data for that location will populate in the table. Data can also be copied from previously saved scenarios that include the same location.

Data Completion Summary

Energy Resource (MW)	Oahu	Hawaii	Kauai	Maui
Biomass	200	200	200	100
Onshore Wind	1000	1000	1000	1000
Offshore Wind	100	100	100	1000
Geothermal	100	100	100	400
Hydro	100	100	100	400
Solar - residential roofs	2000	2000	2000	2000
Solar - commercial roofs	3000	3000	3000	4000
Solar - utility scale	4000	4000	4000	4000
Municipal Solid Waste	500	500	500	100
Ocean Energy	1000	1000	1000	100
Biodiesel	5000	5000	5000	1000
Lanai Winds	1000	500	1000	1000
Diesel Fuel	100000	100000	10000	100000

Key
: Data Not Entered
: Data Missing

Figure 8: Resource Potential Data Completion Summary

Resource Potential Data Entry

To enter data, select a location using the drop down menu, and any saved data for that location will populate in the table. Data can also be copied from previously saved scenarios that include the same location.

Select a Location: Oahu

View Data Sources

Copy Resource Potential Inputs from an Existing Scenario: Scenario B Testing

Copy Inputs

Units of Measure

Gigawatts (GW) Megawatts (MW) Million British Thermal Units per Hour (MMBtus/hr)

Save Next

Resource Type	Resource Potential (MW)	Resource Potential Source
Biomass	200	
Onshore Wind	1000	
Offshore Wind	100	
Geothermal	100	
Hydro	100	
Solar - residential roofs	2000	
Solar - commercial roofs	3000	
Solar - utility scale	4000	
Municipal Solid Waste	500	
Ocean Energy	1000	
Biodiesel	5000	
Lanai Winds	1000	
Diesel Fuel	100000	

Figure 9: Resource Potential Data Entry

Capacity Factor Inputs

Capacity factors represent the maximum electric output a plant can generate under specific conditions, and these inputs are used to account for variations in generation profiles across technologies. For intermittent resources, such as solar or wind, these inputs are especially vital. In the Scenario Tool, capacity factors are percentages applied to the nameplate capacity of generation projects which are added into the tool on the next tab.

The data completion summary table displays the 2014 values for all energy resources at the locations in the scenario and will show where capacity factor data is missing. To enter capacity factor data, first select a location, then select an energy resource using the radio buttons and drop down menus below. After selecting a location and energy resource combination, the table will populate with any previously saved data.

Current Scenario: Scenario B

Currently viewing data for Oahu (location 1 of 4)

Capacity factors represent the portion of time that a resource is generating, and these inputs are used to account for variations in generation profiles across technologies. For intermittent resources, such as solar or wind, these inputs are especially vital. In the Scenario Tool, capacity factors are assumed to be averages, and they are applied to a 365 day, 24 hour/day time frame when calculating annual generation. The data completion summary table displays the 2014 values for all energy resources at the locations in the scenario and will show where capacity factor data is missing. To enter capacity factor data, first select a location, then select an energy resource using the radio buttons and drop down menus below. After selecting a location and energy resource combination, the table will populate with any previously saved data.

Data Completion Summary

Energy Resource	Oahu	Hawaii	Kauai	Maui
Biomass	80.0%	80.0%	80.0%	80.0%
Onshore Wind	40.0%	40.0%	40.0%	40.0%
Offshore Wind	40.0%	40.0%	40.0%	40.0%
Geothermal	90.0%	90.0%	90.0%	90.0%
Hydro	50.0%	50.0%	50.0%	50.0%
Solar - residential roofs	17.3%	17.3%	17.3%	17.3%
Solar - commercial roo	17.3%	17.3%	17.3%	17.3%
Solar - utility scale	22.7%	22.7%	22.7%	22.7%
Municipal Solid Waste	70.0%	70.0%	70.0%	70.0%
Ocean Energy	20.0%	20.0%	20.0%	20.0%
Biodiesel	95.0%	95.0%	95.0%	95.0%
Lanai Winds	42.0%	42.0%	42.0%	42.0%
Diesel Fuel	100.0%	100.0%	100.0%	100.0%

Key
: Data Not Entered
: Data Missing

Figure 10: Capacity Factor Inputs Data Completion Summary

- Use default capacity factors for ALL energy resources at the selected location – this checkbox applies default capacity factors from the tool to each generation technology
- Use default capacity factors for this energy resource at the selected location – this checkbox applies a default capacity factor for the particular energy resource for the specified location only
- Use constant capacity factor over scenario duration – this checkbox allows the user to input on capacity factor and then copy it for every year in the scenario

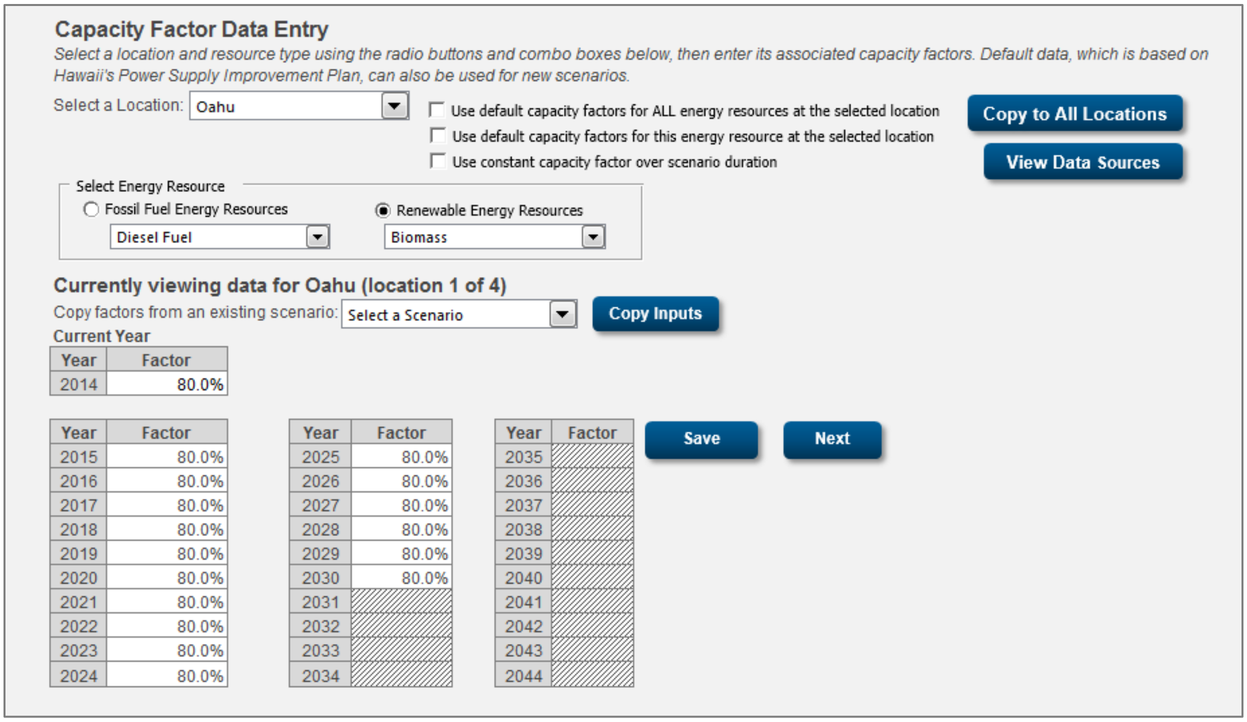
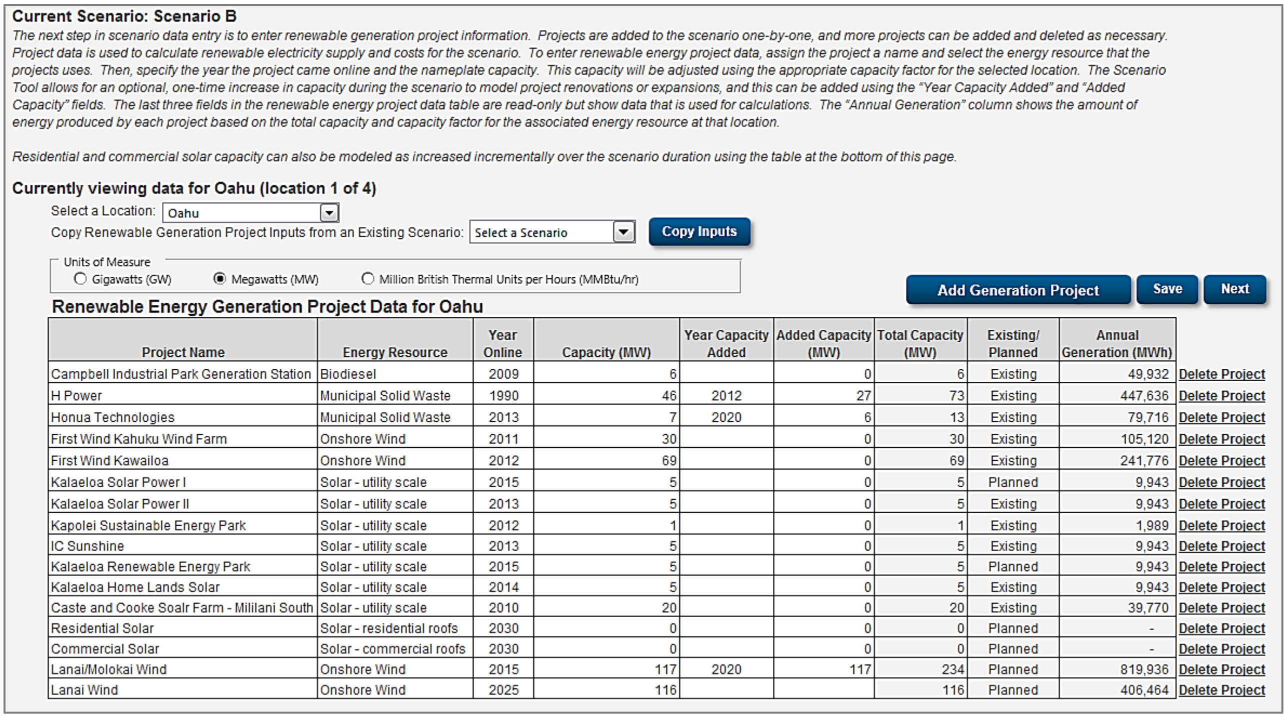


Figure 11: Capacity Factor Inputs Data Entry

Renewable Generation Project Inputs

The next step in scenario data entry is to enter renewable generation project information. Projects are added to the scenario one-by-one using the "Add Generation Project" button, and more projects can be added or deleted at any point. Project data is used to calculate renewable electricity supply and costs for the scenario. To enter renewable energy project data, assign the project a name and select the energy resource that the projects uses. Then, specify the year the project came online and the nameplate capacity. This capacity will be adjusted using the appropriate capacity factor for the selected location. The Scenario Tool allows for an optional, one-time increase in project installed capacity during the scenario to model project renovations or expansions, and this can be added using the "Year Capacity Added" and "Added Capacity" fields. The last three fields in the renewable energy project data table are read-only but show data that is used for calculations. The "Annual Generation" column shows the amount of energy produced by each project based on the total capacity and capacity factor for the associated energy resource at that location.


Current Scenario: Scenario B

The next step in scenario data entry is to enter renewable generation project information. Projects are added to the scenario one-by-one, and more projects can be added and deleted as necessary. Project data is used to calculate renewable electricity supply and costs for the scenario. To enter renewable energy project data, assign the project a name and select the energy resource that the projects uses. Then, specify the year the project came online and the nameplate capacity. This capacity will be adjusted using the appropriate capacity factor for the selected location. The Scenario Tool allows for an optional, one-time increase in capacity during the scenario to model project renovations or expansions, and this can be added using the "Year Capacity Added" and "Added Capacity" fields. The last three fields in the renewable energy project data table are read-only but show data that is used for calculations. The "Annual Generation" column shows the amount of energy produced by each project based on the total capacity and capacity factor for the associated energy resource at that location.

Residential and commercial solar capacity can also be modeled as increased incrementally over the scenario duration using the table at the bottom of this page.

Currently viewing data for Oahu (location 1 of 4)

Select a Location: Oahu

Copy Renewable Generation Project Inputs from an Existing Scenario: Select a Scenario | Copy Inputs

Units of Measure: ○ Gigawatts (GW) ◉ Megawatts (MW) ○ Million British Thermal Units per Hours (MMBtu/hr)

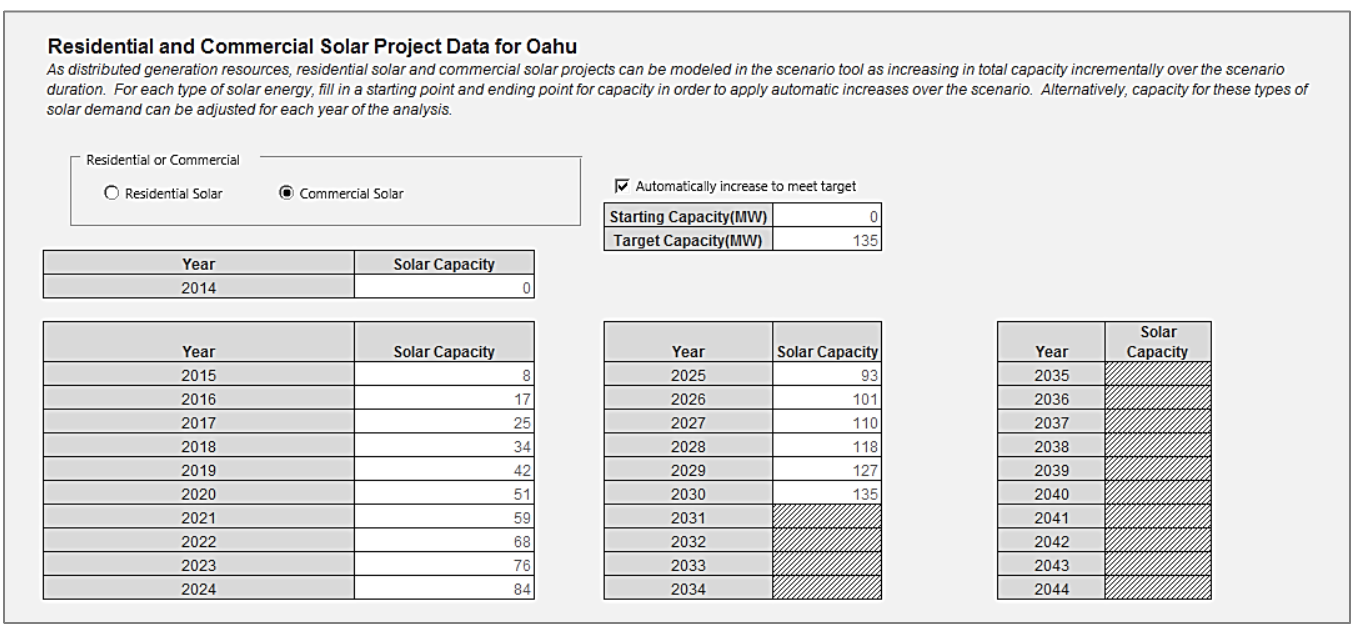
Add Generation Project | Save | Next

Renewable Energy Generation Project Data for Oahu

Project Name	Energy Resource	Year Online	Capacity (MW)	Year Capacity Added	Added Capacity (MW)	Total Capacity (MW)	Existing/ Planned	Annual Generation (MWh)	
Campbell Industrial Park Generation Station	Biodiesel	2009	6		0	6	Existing	49,932	Delete Project
H Power	Municipal Solid Waste	1990	46	2012	27	73	Existing	447,636	Delete Project
Honua Technologies	Municipal Solid Waste	2013	7	2020	6	13	Existing	79,716	Delete Project
First Wind Kahuku Wind Farm	Onshore Wind	2011	30		0	30	Existing	105,120	Delete Project
First Wind Kawailoa	Onshore Wind	2012	69		0	69	Existing	241,776	Delete Project
Kalaeloa Solar Power I	Solar - utility scale	2015	5		0	5	Planned	9,943	Delete Project
Kalaeloa Solar Power II	Solar - utility scale	2013	5		0	5	Existing	9,943	Delete Project
Kapolei Sustainable Energy Park	Solar - utility scale	2012	1		0	1	Existing	1,989	Delete Project
IC Sunshine	Solar - utility scale	2013	5		0	5	Existing	9,943	Delete Project
Kalaeloa Renewable Energy Park	Solar - utility scale	2015	5		0	5	Planned	9,943	Delete Project
Kalaeloa Home Lands Solar	Solar - utility scale	2014	5		0	5	Existing	9,943	Delete Project
Caste and Cooke Soalr Farm - Mililani South	Solar - utility scale	2010	20		0	20	Existing	39,770	Delete Project
Residential Solar	Solar - residential roofs	2030	0		0	0	Planned	-	Delete Project
Commercial Solar	Solar - commercial roofs	2030	0		0	0	Planned	-	Delete Project
Lanai/Molokai Wind	Onshore Wind	2015	117	2020	117	234	Planned	819,936	Delete Project
Lanai Wind	Onshore Wind	2025	116			116	Planned	406,464	Delete Project

Figure 12: Renewable Generation Project Inputs

The Scenario Tool also allows for incremental increases of residential solar and commercial solar generation. For these two energy resources, the user can input the total generation capacity on an annual basis. These capacities are included in the total installed generation capacity calculations, and residential and commercial solar generation can also be modeled as projects. The same cost factors are applied to this annual increase in generation capacity and to solar generation that is modeled as projects. Users can also use the "Automatically increase to meet target" option to model a linear increase in generation capacity over the scenario duration from the "Starting Capacity" to the "Target Capacity" in the final year of the scenario duration.


Residential and Commercial Solar Project Data for Oahu

As distributed generation resources, residential solar and commercial solar projects can be modeled in the scenario tool as increasing in total capacity incrementally over the scenario duration. For each type of solar energy, fill in a starting point and ending point for capacity in order to apply automatic increases over the scenario. Alternatively, capacity for these types of solar demand can be adjusted for each year of the analysis.

Residential or Commercial: ○ Residential Solar ◉ Commercial Solar

☑ Automatically increase to meet target

Starting Capacity(MW)	0
Target Capacity(MW)	135

Year	Solar Capacity
2014	0

Year	Solar Capacity
2015	8
2016	17
2017	25
2018	34
2019	42
2020	51
2021	59
2022	68
2023	76
2024	84

Year	Solar Capacity
2025	93
2026	101
2027	110
2028	118
2029	127
2030	135
2031	
2032	
2033	
2034	

Year	Solar Capacity
2035	
2036	
2037	
2038	
2039	
2040	
2041	
2042	
2043	
2044	

Figure 13: Residential and Commercial Solar Generation

Non-Renewable Generation Inputs

Unlike renewable generation, non-renewable generation is modeled as the total amount of generation rather than as projects. This allows the tool to show the decrease in necessary non-renewable generation over the scenario as renewable generation projects are added.

Current Scenario: Scenario B

Unlike renewable generation, non-renewable generation is modeled as a total amount of generation rather than as projects. This allows the tool to show the decrease in necessary non-renewable generation over the scenario as renewable generation projects are added. On this tab, enter the total non-renewable generation capacity and the distribution among non-renewable energy types in the two tables below.

Data Completion Summary

Non-Renewable Generation	Oahu	Hawaii	Kauai	Maui
Total Demand in 2030	7,339,297	1,226,401	537,491	1,206,328
Renewable Supply in 2030	2,446,642	697,506	291,858	534,439
Non-Renewable Supply in 2030	4,892,655	528,895	245,633	671,889
Unmet Demand in 2030	Demand Met	Demand Met	Demand Met	Demand Met

Key
: Data Not Entered
: Data Missing

Figure 14: Non-Renewable Generation Data Completion Summary

On the Non-Renewable Generation input screen, data is entered in two tables that capture the total amount of all non-renewable generation capacity and the distribution of that capacity across fuel types, respectively. In the "Non-Renewable Generation over Scenario Duration" table, the user enters the total combined amount of non-renewable generation at each location in the scenario. The user can change the units of measure for this table using the radio buttons above the table.

The user can also use the "Use Non-Renewable Generation to meet demand" checkbox to automatically calculate the difference between annual electricity demand and supply met by renewable generation projects. The tool then enters this difference into the annual capacity fields in the table. In order to use this feature, capacity factor data must be entered for the non-renewable energy resources. If renewable generation projects or capacity factor data is changed after using this feature, the amount of non-renewable generation needed to meet demand may change, and the user can check this box again to rerun the autofill calculations.

Non-Renewable Generation Capacity

On the Non-Renewable Generation input screen, data is entered in two tables that capture the tot across fuel types, respectively. In the "Non-Renewable Generation over Scenario Duration" table location in the scenario. The user can change the units of measure for this table using the radio b meet demand" checkbox to automatically calculate the amount difference between annual dema difference into the annual capacity fields in the table. In order to use this feature, capacity factor c projects or capacity factor data is changed after using this feature, the amount of non-renewable g again to rerun the autofill calculations.

Units of Measure
○ Gigawatts (GW) ◉ Megawatts (MW) ○ Million British Thermal Units per Hour

Current Non-Renewable Generation

Year	Non-Renewable Generation Capacity (MW)
2014	679

Use Non-Renewable Generation to Meet Demand

Non-Renewable Generation over Scenario Duration

Year	Non-Renewable Generation Capacity (MW)	Year	Non-Renewable Generation Capacity (MW)
2015	634	2025	583
2016	656	2026	579
2017	658	2027	575
2018	660	2028	570
2019	669	2029	565
2020	624	2030	559
2021	625	2031	0
2022	628	2032	0
2023	629	2033	0
2024	630	2034	0

Figure 15: Non-Renewable Generation Data Entry, Generation Capacity

The second table on for non-renewable generation data is the "Non-Renewable Energy Distribution" table on the lower half of the screen. For each type of non-renewable generation, the percentage of the total allocation to that type must be entered, and the total must equal 100%. This data is required to calculate the amount of each type of fuel used in the scenario and the cost of each type of non-renewable generation. The Scenario Tool allows for a change in the distribution over the length of the scenario. The "Use constant distribution over scenario duration" checkbox above this table can also be checked to speed up data entry and use the same distribution for each year of the scenario.

Non-Renewable Energy Distribution ☑ Use constant distribution over scenario duration

The second table on for non-renewable generation data is the "Non-Renewable Energy Distribution" table on the lower half of the screen. For each type of non-renewable generation, the percentage of non-renewable capacity, not total capacity, must be entered. This data is required to calculate the amount of each type of fuel used in the scenario and the cost of each type of non-renewable generation. The Scenario Tool allows for a change in the distribution over the length of the scenario. The "User constant distribution over scenario duration" checkbox above this table can also be used to speed up data entry and use the same distribution for each year of the scenario.

Year	Diesel Fuel
2014	100%
2015	100%
2016	100%
2017	100%
2018	100%
2019	100%
2020	100%
2021	100%
2022	100%
2023	100%
2024	100%
2025	100%
2026	100%
2027	100%
2028	100%
2029	100%
2030	100%
2031	
2032	
2033	

Figure 16: Non-Renewable Generation Data Entry, Energy Distribution

Financial Inputs

Scenario energy costs are calculated for renewable generation, fuel-based generation, energy efficiency, and grid upgrade investments, and all financial data for these four categories is entered on the Financial Inputs screen. Similar to the other data entry screens, financial data is entered for each location in the scenario individually. However, once data for a single location has been entered, that data can be copied to the other locations in the scenario using the "Copy Financial Inputs to All Locations" button.

Current Scenario: Scenario B

Scenario energy costs are calculated for renewable generation, fuel-based generation, energy efficiency, and grid upgrade investments, and all financial data for these four categories is entered on the Financial Inputs screen. Similar to the other data entry screens, financial data is entered for each location in the scenario individually. However, once data for a single location has been entered, that data can be copied to the other locations in the scenario using the "Copy Financial Inputs to All Locations" button.

Data Completion Summary

Energy Resource	Oahu	Hawaii	Kauai	Maui
Biomass	$ 6,100,000	$ 6,100,000	$ 6,100,000	$ 6,100,000
Onshore Wind	$ 3,100,000	$ 3,100,000	$ 3,100,000	$ 3,100,000
Offshore Wind	$ 3,100,000	$ 3,100,000	$ 3,100,000	$ 3,100,000
Geothermal	$ 5,300,000	$ 5,300,000	$ 5,300,000	$ 5,300,000
Hydro	$ 3,600,000	$ 3,600,000	$ 3,600,000	$ 3,600,000
Solar - residential roofs	$ 5,800,000	$ 5,800,000	$ 5,800,000	$ 5,800,000
Solar - commercial roofs	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000
Solar - utility scale	$ 4,100,000	$ 4,100,000	$ 4,100,000	$ 4,100,000
Municipal Solid Waste	$ 9,900,000	$ 9,900,000	$ 9,900,000	$ 9,900,000
Ocean Energy	$ 10,000,000	$ 10,000,000	$ 10,000,000	$ 10,000,000
Biodiesel	$ -	$ -	$ -	$ -
Lanai Winds	$ 3,100,000	$ 3,100,000	$ 3,100,000	$ 3,100,000
Diesel Fuel	$ -	$ -	$ -	$ -

Key
◎: Data Not Entered
○: Data Missing

Figure 17: Financial Inputs Data Completion Summary

Financial data for renewable energy investments is entered based on a per megawatt basis. For each type of renewable energy in the scenario, the user should enter the capital cost and annual operations and maintenance costs based on the cost per megawatt of installed capacity. These costs are then applied to the total amount of installed capacity based on the projects entered for each renewable energy resource type. Useful life data is also required for each type of energy resource. Next, there are four data elements used to calculate the cost of financing renewable energy investments: the debt to equity ratio, cost of equity, interest rate, and loan duration.

View Data Sources | Save | Next

Renewable Energy Financial Data

Financial data for renewable energy investments is entered based on per megawatt costs. For each type of renewable energy in the scenario, the user should enter the capital cost and annual operations and maintenance costs based on the cost per megawatt of installed capacity. These costs are then applied to the total amount of installed capacity based on the projects entered for each renewable energy resource type. Useful life data is also entered for each type of energy resource. Next, there are four data elements used to calculate the cost of financing renewable energy investments: the debt to equity ratio, cost of equity, interest rate, and loan duration.

Energy Resource	Default or Custom	Capital Cost ($/MW)	Annual O&M Cost ($/MW)	Useful Life	Debt to Equity Ratio	Cost of Equity (%)	Interest Rate	Loan Duration (years)
Biomass	Custom	$6,100,000	$713,700	25	0.7	10%	7%	12
Onshore Wind	Custom	$3,100,000	$62,000	20	0.75	10%	7%	20
Offshore Wind	Custom	$3,100,000	$62,000	20	0.75	10%	7%	20
Geothermal	Custom	$5,300,000	$413,400	30	0.5	10%	7%	15
Hydro	Custom	$3,600,000	$39,600	50	0.7	10%	7%	13
Solar - residential roofs	Custom	$5,800,000	$58,000	25	0.75	10%	7%	10
Solar - commercial roofs	Custom	$5,000,000	$50,000	25	0.75	10%	7%	10
Solar - utility scale	Custom	$4,100,000	$41,000	25	0.75	10%	7%	20
Municipal Solid Waste	Custom	$9,900,000	$603,900	40	0.7	10%	7%	14
Ocean Energy	Custom	$10,000,000	$300,000	25	0.7	10%	7%	10
Biodiesel	Custom	$0	$72,244	40	0.7	10%	7%	15
Lanai Winds	Custom	$3,100,000	$62,000	20	0.75	10%	7%	20

Figure 18: Financial Inputs Data Entry, Renewable Energy Financial Data

The next category of costs on the financial inputs screen is fuel data. The fuel costs entered here are used to calculate the total cost of fuel consumption for the scenario. This category includes non-renewable energy, such as fossil fuels, and fuel costs for renewable fuel types, including biodiesel and biogas. Users should not include the cost of fuel in the operations and maintenance cost for biodiesel and biogas if also entering a separate cost of fuel to avoid double-counting.

For fuel costs, the user must enter:

1. Units of measure for each fuel type, either barrels or cubic feet, and the fuel consumption, which should be entered based on how many units of measure are required to produce one megawatt hour of energy for that energy resource type,
2. Fuel cost, as a cost per the unit of measure selected for the energy resource type,
3. Optional fuel escalation percentage if the cost of the fuel is predicted to increase over the scenario duration, which is applied to each year of the analysis and results in a compounding increase in fuel price.

Fuel Data

The next category of costs on the financial inputs screen is fuel data. The fuel costs entered here are used to calculate the total fuel consumption for the scenario. This category includes non-renewable energy, such as fossil fuels, and fuel costs for renewable fuel types, including biodiesel and biogas. For biodiesel and biogas, this allows modeling of both project investment costs and ongoing fuel costs, and users should not include the cost of fuel in the operations and maintenance cost if also entering a fuel cost in order to avoid double counting. For fuel costs, the user must enter the units of measure for each fuel type, either barrels or cubic feet, and the fuel consumption, which should be entered based on how many units of measure are required to produce one megawatt hour of energy for that energy resource type. Next, the user should enter the fuel cost, as a cost per the unit of measure selected for the energy resource type. Finally, the user can apply an option fuel escalation percentage if the cost of the fuel is predicted to increase over the scenario duration. This escalation percentage is applied to each year of the analysis and results in a compounding increase in fuel price.

** Fuel consumption in Fuel Units of Measure/MWh produced, **Cost of fuel in $/Fuel Unit of Measure*

Energy Resource	Default or Custom	Fuel Unit of Measure	Fuel Consumption*	Fuel Cost**	Fuel Escalation % (Optional)
Biodiesel	Custom	Gallons	1	$602.03	0%
Diesel Fuel	Custom	Gallons	1	$126.07	1%

Figure 19: Financial Inputs Data Entry, Fuel Data

The third category of costs captured on the financial inputs screen is for energy efficiency. **Costs for energy efficiency are entered as a cost per megawatt hour of avoided demand**, and they can be entered for each year of the scenario in order to model a change in energy efficiency upgrades over time. The user can also apply the same cost to each year of the analysis using the "Use constant cost of energy efficiency in scenario" check box above the table.

Energy Efficiency

The third category of costs captured on the financial inputs screen is for energy efficiency. Costs for energy efficiency are entered as a cost per megawatt hour of avoided demand, and they can be entered for each year of the scenario in order to model a change in energy efficiency upgrades over time. The user can also apply the same cost to each year of the analysis using the "Use constant cost of energy efficiency in scenario" check box above the table.

Year	Cost of Energy Efficiency ($/MWh)
2014	$61.00

Use constant cost of energy efficiency over scenario

Year	Cost of Energy Efficiency ($/MWh)
2015	$61.00
2016	$61.00
2017	$61.00
2018	$61.00
2019	$61.00
2020	$61.00
2021	$61.00
2022	$61.00
2023	$61.00
2024	$61.00

Year	Cost of Energy Efficiency ($/MWh)
2025	$61.00
2026	$61.00
2027	$61.00
2028	$61.00
2029	$61.00
2030	$61.00
2031	$61.00
2032	$61.00
2033	$61.00
2034	$61.00

Year	Cost of Energy Efficiency ($/MWh)
2035	$61.00
2036	$61.00
2037	$61.00
2038	$61.00
2039	$61.00
2040	$61.00
2041	$61.00
2042	$61.00
2043	$61.00
2044	$61.00

Figure 20: Financial Inputs Data Entry, Energy Efficiency

The fourth and final financial data type entered on this screen is for investments in grid upgrades. These costs are modeled as flat additional costs incurred each year of the scenario. A portion of these costs is included in the total cost of electricity per kilowatt hour on the scenario dashboard.

Investments in Grid Upgrades

The fourth and final financial data type entered on this screen is for investments in grid upgrades. These costs are modeled as additional costs per year. A portion of these costs is included in the total cost of electricity per kilowatt hour on the scenario dashboard.

Year	Investments in Grid Upgrades ($)
2014	

Year	Investments in Grid Upgrades ($)
2015	
2016	
2017	
2018	
2019	
2020	
2021	
2022	
2023	
2024	

Year	Investments in Grid Upgrades ($)
2025	
2026	
2027	
2028	
2029	
2030	
2031	
2032	
2033	
2034	

Year	Investments in Grid Upgrades ($)
2035	
2036	
2037	
2038	
2039	
2040	
2041	
2042	
2043	
2044	

Figure 21: Financial Inputs Data Entry, Investments in Grid Upgrades

Scenario Dashboard

The scenario dashboard displays the status of data entry for the scenario and shows output metrics. All information on this screen is read-only and shows data that has been entered and saved previously. In the top right corner of the screen, the "Data Requirements" table shows the status of data entry for the scenario – red circles in the table indicate missing data, yellow circles indicate incomplete data. The first table on the scenario dashboard shows the scenario start year and duration for reference, and the second table shows the scenario clean energy and renewable portfolio standard targets for each location and for the scenario overall as well as the actual percentage for each.

The scenario dashboard can also be used to export scenario reports, which are explained in more detail in the next section.

Current Scenario: Scenario B

Scenario Information	
Scenario Start Year	2014
Scenario Duration	16

Data Requirements Check		
Baseline Data	●	Data Complete
Resource Potential	●	Data Complete
Capacity Factors	●	Data Complete
Generation Projects	●	Data Complete
Financial Data	●	Data Complete
Scenario Targets	●	Data Complete

Scenario Reports

Export Scenario Inputs Report

Export Scenario Outputs Report

Scenario Energy Targets

Scenario Targets	Clean Energy Target (%)	Clean Energy Actual (%)	Renewable Portfolio Standard Target (%)	Renewable Portfolio Standard Actual (%)
Scenario Target: Oahu	70%	45%	30%	22%
Scenario Target: Hawaii	70%	71%	30%	47%
Scenario Target: Kauai	70%	63%	30%	41%
Scenario Target: Maui	70%	58%	30%	34%
Scenario Target:				
Scenario Total Target	70%	50%	30%	27%

Scenario Energy Costs for Scenario Totals

Scenario Investments	
Renewable Energy Investments (Planned Projects)	$ 3,070,189,255
Energy Efficiency Investments	$ 2,893,287,139
Grid Upgrade Investments	$ -
Total Energy Investments	$ 5,963,476,393
Other Scenario Energy Costs	
Renewable Energy costs (Existing projects)	$ 6,543,695,036
Non-Renewable Energy Costs	$ 14,890,258,033
Total Other Scenario Energy Costs	$ 21,433,953,069
Total Scenario Energy Costs	$ 27,397,429,463

View Scenario Totals or Results for a Location: Scenario Totals

Currently Viewing Outputs Data for Scenario Totals

Figure 22: Scenario Dashboard

Below the Scenario Targets table is a drop-down menu that controls the view of the tables below it. This menu allows the output metrics to be viewed as Scenario Totals or as an individual view for each location. The Electricity Demand and Supply table shows the projected demand, energy efficiency, non-renewable generation supply, renewable generation supply, percentage of clean energy, percentage of renewable energy, and any unmet demand for the selected location or scenario total. If there is unmet demand, the user should either add more renewable generation projects or increase the amount of non-renewable generation. The next table shows supply and cost outputs for each of the energy resource types in the scenario.

View Scenario Totals or Results for a Location: Scenario Totals

Total Scenario Energy Costs	$ 38,750,484,332

Currently Viewing Outputs Data for Scenario Totals

Electricity Demand and Supply

Electricity Demand	Scenario Totals (MWh)
Projected Demand	206,203,160
Energy Efficiency	47,430,937
Fossil Fuel Energy Supply	117,595,771
Renewable Energy Supply	57,391,627
Total Supply	222,418,334
Clean Energy %	51%
Renewable Energy %	28%
Avoided Fossil Fuel Consumption (MWI	12,333,356
Avoided Fossil Fuel Cost	$ 2,721,015,902
Unmet Demand	Demand Met

Add Generation Project(s)

Distribution by Energy Resource

Energy Type	Energy Resource	Total Installed Capacity in 2030 (MW)	Supply in 2030 (MWh)	Total Scenario Supply (2014-2030) (MWh)	Percentage of Total Supply (%)	Percentage of Total Resource Potential (%)	Total Scenario Energy Cost (Planned and Existing Projects)	Cost per kWh (¢/kWh)
Renewable	Biomass	64	449,914	7,368,211	4%	4%	$ 1,350,178,441	18.32¢
Renewable	Onshore Wind	553	1,935,960	25,570,440	19%	18%	$ 3,336,781,875	13.05¢
Renewable	Offshore Wind	-	-	-	0%	0%	$ -	
Renewable	Geothermal	38	299,592	5,093,064	3%	5%	$ 612,289,567	12.02¢
Renewable	Hydro	32	137,970	2,345,490	1%	1%	$ 142,155,972	6.06¢
Renewable	Solar - residential roofs	38	95,475	810,782	1%	1%	$ 297,888,000	36.74¢
Renewable	Solar - commercial roofs	135	337,952	2,874,866	3%	2%	$ 910,560,000	31.67¢
Renewable	Solar - utility scale	70	139,793	2,355,998	1%	1%	$ 568,348,560	24.12¢
Renewable	Municipal Solid Waste	101	619,332	10,123,932	6%	5%	$ 2,176,323,435	21.50¢
Renewable	Ocean Energy	-	-	-	0%	0%	$ -	
Renewable	Biodiesel	6	49,932	848,844	0%	0%	$ 518,398,441	61.07¢
Renewable	Lanai Winds	-	-	-	0%	0%	$ -	
Non-Renewable	Diesel Fuel	552	6,281,484	117,595,771	61%	0%	$ 25,944,272,903	22.06¢
	Grid Upgrade Investments			-	N/A	N/A	$ -	0.00¢
	Total Supply	1,588	10,347,404	174,987,398	100%	0%	$ 35,857,197,193	20.49¢

Figure 23: Scenario Dashboard

Below all of these two tables are two charts that display the energy distribution for the scenario and the amount of total supply over the duration of the scenario. The pie chart, which shows the distribution of energy types for the final year of the scenario, can be viewed for all energy types, renewable energy only, or non-renewable energy only using the radio buttons above it. In the area chart, energy efficiency is displayed as having a negative impact on demand.

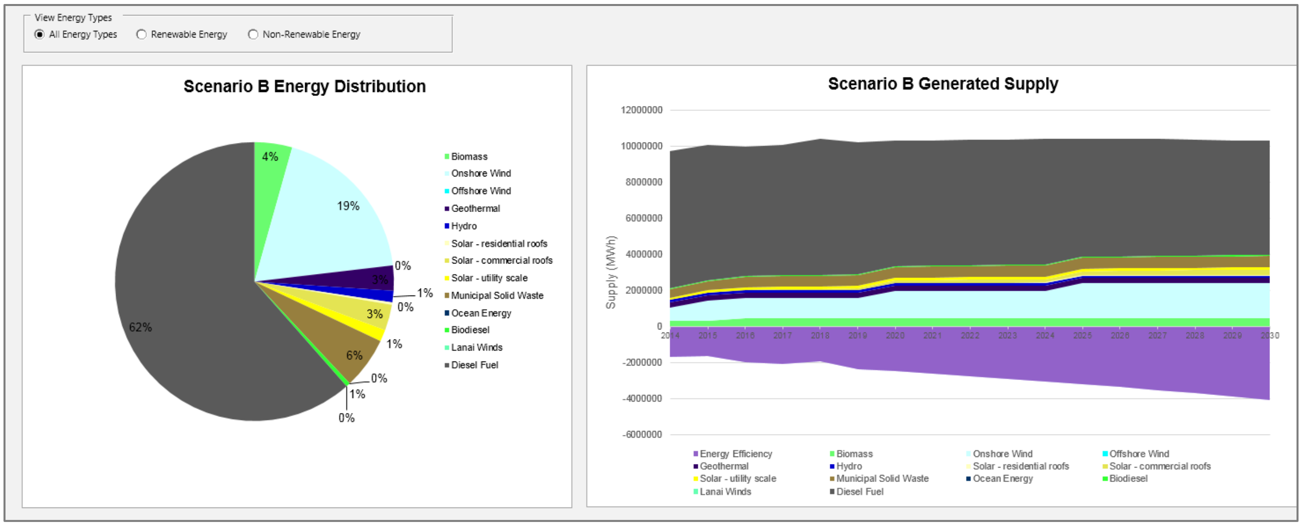


Figure 24: Scenario Dashboard Charts

The final table on the scenario dashboard shows more detailed financial outputs for the scenario. As with the other tables on the dashboard, this table can be viewed for the entire scenario or for an individual location using the drop down menu towards the top of the screen. This table shows supply and cost outputs, separated by new projects and existing projects.

Financial Details for Scenario Totals

Energy Type	Energy Resource	Supply in 2030 from new projects (MWh)	Total Supply in 2030 (MWh)	Total Scenario Supply (2014-2030) (MWh)	Investment in New Projects	Cost of Existing Projects	Total Scenario Cost	Cost per kWh (¢/kWh)
Renewable	Biomass	140,160	449,914	7,368,211	$ 420,616,337	$ 929,562,104	$ 1,350,178,441	18.32¢
Renewable	Onshore Wind	1,226,400	1,935,960	25,570,440	$ 2,113,798,473	$ 1,222,983,402	$ 3,336,781,875	13.05¢
Renewable	Offshore Wind	-	-	-	$ -	$ -	$ -	
Renewable	Geothermal	-	299,592	5,093,064	$ -	$ 612,289,567	$ 612,289,567	12.02¢
Renewable	Hydro	-	137,970	2,345,490	$ -	$ 142,155,972	$ 142,155,972	6.06¢
Renewable	Solar - residential roofs	-	28,794	242,477	$ -	$ -	$ 89,088,000	36.74¢
Renewable	Solar - commercial roofs	-	309,158	2,589,955	$ -	$ -	$ 820,320,000	31.67¢
Renewable	Solar - utility scale	20,482	139,793	2,355,998	$ 83,271,553	$ 485,077,007	$ 568,348,560	24.12¢
Renewable	Municipal Solid Waste	128,772	619,332	10,123,932	$ 452,502,892	$ 1,723,820,543	$ 2,176,323,435	21.50¢
Renewable	Ocean Energy	-	-	-	$ -	$ -	$ -	
Renewable	Biodiesel	-	49,932	848,844	$ -	$ 518,398,441	$ 518,398,441	61.07¢
Renewable	Lanai Winds	-	-	-	$ -	$ -	$ -	
Non-Renewable	Diesel Fuel		6,339,072	118,111,034	$ -	$ 14,890,258,033	$ 14,890,258,033	12.61¢
	Grid Upgrade Investments			-	$ -	$ -	$ -	0.00¢
	Total Supply	1,515,814	10,309,517	174,649,446	$ 3,070,189,255	$ 20,524,545,069	$ 24,504,142,324	14.03¢

Figure 25: Scenario Dashboard, Financial Details

Reports

The Scenario Tool produces two reports for completed scenarios so that users can output key input and output metrics. Both of these reports can be generated from the Scenario Dashboard using the buttons on the top, right hand side of the screen. The scenario reports are separate Excel files, and they are saved to the same folder location as the Scenario Tool. These reports allow the user to capture key input and output metrics and share the results of their scenarios.

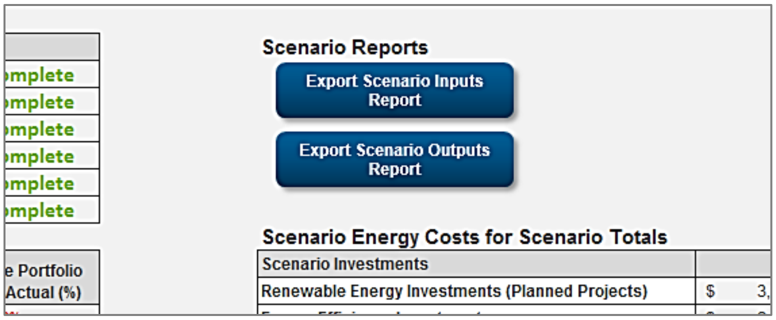


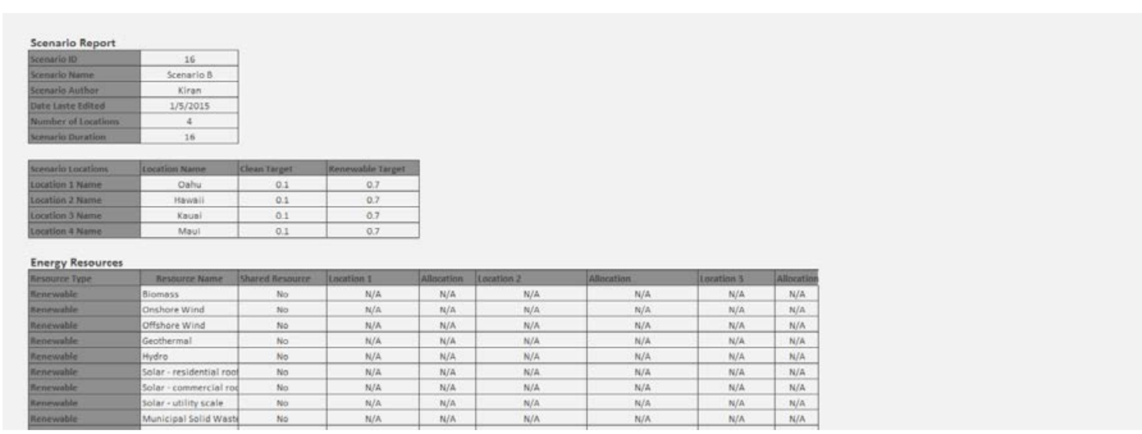
Figure 26: Scenario Report Buttons

Scenario Inputs Report

The Scenario Inputs Report shows the input data entered by the user on all tabs. Inputs are shown in the order in which they are entered in the Scenario Tool, and they include whether default or custom data was used, where available.

The Scenario Inputs Report includes the following tables:

- Scenario Information
- Scenario Locations
- Energy Resources
- Baseline Inputs
- Resource Potential Inputs
- Capacity Factor Inputs
- Generation Project Inputs (separate table for each location)
- Residential Solar and Commercial Data
- Non-Renewable Generation Inputs
- Financial Inputs (separate table for each location)
- Energy Efficiency Inputs
- Grid Upgrade Investment Data



Scenario Report

Scenario ID	16
Scenario Name	Scenario B
Scenario Author	Kiran
Date Laste Edited	1/5/2015
Number of Locations	4
Scenario Duration	16

Scenario Locations	Location Name	Clean Target	Renewable Target
Location 1 Name	Oahu	0.1	0.7
Location 2 Name	Hawaii	0.1	0.7
Location 3 Name	Kauai	0.1	0.7
Location 4 Name	Maui	0.1	0.7

Energy Resources

Resource Type	Resource Name	Shared Resource	Location 1	Allocation	Location 2	Allocation	Location 3	Allocation
Renewable	Biomass	No	N/A	N/A	N/A	N/A	N/A	N/A
Renewable	Onshore Wind	No	N/A	N/A	N/A	N/A	N/A	N/A
Renewable	Offshore Wind	No	N/A	N/A	N/A	N/A	N/A	N/A
Renewable	Geothermal	No	N/A	N/A	N/A	N/A	N/A	N/A
Renewable	Hydro	No	N/A	N/A	N/A	N/A	N/A	N/A
Renewable	Solar - residential roof	No	N/A	N/A	N/A	N/A	N/A	N/A
Renewable	Solar - commercial roc	No	N/A	N/A	N/A	N/A	N/A	N/A
Renewable	Solar - utility scale	No	N/A	N/A	N/A	N/A	N/A	N/A
Renewable	Municipal Solid Waste	No	N/A	N/A	N/A	N/A	N/A	N/A

Figure 27: Scenario Inputs Report

Scenario Outputs Report

The Scenario Outputs Report displays the Distribution by Energy Resource from the Scenario Dashboard, with a tab for Scenario Totals and individual tabs for each location. The Energy Distribution and Generated Supply charts are also included in the Scenario Outputs Report.

Scenario Report

Scenario ID	16
Scenario Name	Scenario B
Scenario Author	Kiran
Date Laste Edited	1/5/2015
Number of Locations	4
Scenario Duration	16

Scenario Locations	Location Name	Clean Target	Renewable Target
Location 1 Name	Oahu	0.1	0.7
Location 2 Name	Hawaii	0.1	0.7
Location 3 Name	Kauai	0.1	0.7
Location 4 Name	Maui	0.1	0.7

Energy Type	Energy Resource	Supply in 2030 (MWh)	Total Scenario Supply (2014-2030) (MWh)	Percentage of Total Supply (%)	Percentage of Total Resource Potential (%)	Total Scenario Energy Cost (Planned and Existing Projects)	Cost per kWh (¢/kWh)
Renewable	Biomass	449,914	7,368,211	4%	4%	$1,350,178,441	18.32¢
Renewable	Onshore Wind	1,935,960	25,570,440	19%	18%	$3,336,781,875	13.05¢
Renewable	Offshore Wind	-	-	0%	0%	$0	
Renewable	Geothermal	299,592	5,093,064	3%	5%	$612,289,567	12.02¢
Renewable	Hydro	137,970	2,345,490	1%	1%	$142,155,972	6.06¢
Renewable	Solar - residential roo	28,794	242,477	0%	0%	$89,088,000	36.74¢
Renewable	Solar - commercial roo	309,158	2,589,955	3%	1%	$820,320,000	31.67¢
Renewable	Solar - utility scale	139,793	2,355,998	1%	1%	$568,348,560	24.12¢
Renewable	Municipal Solid Wast	619,332	10,123,932	6%	5%	$2,176,323,435	21.50¢
Renewable	Ocean Energy	-	-	0%	0%	$0	
Renewable	Biodiesel	49,932	848,844	0%	0%	$518,398,441	61.07¢
Renewable	Lanai Winds	-	-	0%	0%	$0	
Non-Renewable	Diesel Fuel	6,339,072	118,111,034	61%	0%	$14,890,258,033	12.61¢
	Grid Upgrade Investments		-	N/A	N/A	$0	0.00¢
	Total Supply	10,309,517	174,649,446	100%	0%	$24,504,142,324	14.03¢

Figure 28: Scenario Outputs Report

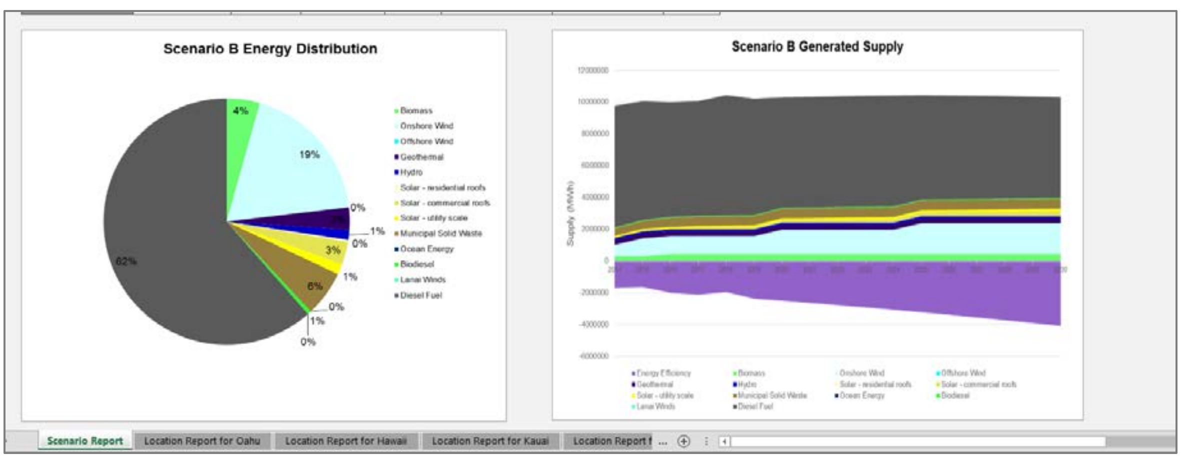


Figure 29: Scenario Outputs Report

Calculations

Demand

Electricity demand is calculated as the sum of projected electricity demand and electric vehicle demand, less the avoided demand caused by energy efficiency. Demand is calculated separately for each location in the scenario.

$$\begin{aligned} &Annual\ Scenario\ Demand \\ &\quad = \sum_{Locations} (Projected\ Electricity\ Demand + Electric\ Vehicle\ Demand \\ &\quad - Energy\ Efficiency) \times (1 + Spinning\ Reserves) \end{aligned}$$

Supply

Electricity supply is calculated for each energy resource in the scenario using the total installed capacity and location-specific capacity factor.

$$\begin{aligned} &Annual\ Electricity\ Supply \\ &\quad = \sum Capacity\ Factor_{Energy\ Resource} \times Installed\ Capacity_{Energy\ Resource} \end{aligned}$$

Electricity Cost

Electricity costs are calculated for both new and existing generation in the Scenario Tool, and they include the capital cost, annual operations and maintenance cost, debt service cost, cost of equity, and fuel cost (if applicable). Since non-renewable energy is not modeled at the project level in the Scenario Tool, non-renewable energy costs only include the cost of fuel over the scenario.

$$\begin{aligned} &Annual\ Electricity\ Cost \\ &\quad = Installed\ Capacity \\ &\quad \times \Big(Capital\ Cost\ \Big({}^{1}\!/_{Useful\ Life} + Debt\ to\ Equity\ Ratio \times Interest\ Rate \\ &\quad \times \Big({}^{Loan\ Duration}\!/_{Useful\ Life}\Big) + (1 - Debt\ to\ Equity\ Ratio) \times Cost\ of\ Equity\Big) \\ &\quad + Annual\ Operations\ \&Maintenance\ Cost + Fuel\ Consumption \\ &\quad \times Cost\ of\ Fuel \times Escalation\ \%^{t-2014}\Big) \end{aligned}$$