

**CALMAC Study ID CPU0035.01
Volume 14 of 15
Appendix M**

**Embedded Energy in Water Studies
Study 1: Statewide and Regional Water-Energy Relationship**

**Prepared by
GEI Consultants/Navigant Consulting, Inc.**

**Prepared for the
California Public Utilities Commission
Energy Division**

**Managed by
California Institute for Energy and Environment**

August 31, 2010

Appendix M Model User's Manual

Water Energy Model Manual

Introduction

The Water Energy model is composed of two interacting pieces. The core of the model is a spreadsheet file (Spreadsheet Model) that can operate independently. The Spreadsheet Model can be downloaded and run on any computer using Excel 2003. The Spreadsheet Model interacts with a Web Interface that serves as a graphical portal to explore the model. Both the Spreadsheet Model and the Web Interface enable users to utilize the same input and scenario modeling capabilities. While there are numerous outputs presented in the Web Interface, the Spreadsheet Model allows users to view several additional output graphs.

Web Interface

Introduction Page

The introduction page contains a disclaimer about the model, please read and then click accept to continue.

CPUC Study 1: Wholesale Water-Energy Model

Welcome to the California Wholesale Water-Energy Model

Developed as a part of:
Embedded Energy in Water Studies Study 1: Statewide and Regional Water-Energy Relationship

Prepared for:
California Public Utilities Commission's Energy Division

Developed By:
GEI Consultants and **NAVIGANT CONSULTING**

Disclaimer

This report was prepared as an account of work sponsored by the California Public Utilities Commission. It does not necessarily represent the views of the Commission or any of its employees except to the extent, if any, that it has formally been approved by the Commission at a public meeting. For information regarding any such action, communicate directly with the Commission at 505 Van Ness Avenue, San Francisco, California 94102. Neither the Commission nor the State of California, nor any officer, employee, or any of its subcontractors makes any warranty, express or implied, or assumes any legal liability whatsoever for the contents of this document.

Basic Instruction Page

After accepting the terms of use, users will be directed to the basic instruction page. This page can be reached at any time, click "Help" at the top of the screen.

CPUC Study 1: Wholesale Water-Energy Model [Hydrologic Region Profile](#) | [Model](#) | [Help](#)

Toggle Layer

- Facilities
- County
- Elec. Service Areas

Map data ©2010 Europa Technologies, Google, INEGI - Terms of Use

Hydrologic Region Profile | Model | Help

This model allows users to project future energy use by the California Wholesale water system under a user defined future scenario.

To return to this instruction screen at any time, click "Help" above.

Navigate this interface using the selections above "Hydrologic Region Profile", "Model", and "Help"

First, explore the hydrologic regions and wholesale water facilities by clicking on "Hydrologic Region Profiles" above or clicking on any region on the map. This will display the characteristics of each region for informational purposes.

Additional map features allow you to view wholesale water facilities and canals, county boundaries, and electric utility service areas. To view these layers, click on the appropriate checkboxes for each layer on at the bottom right corner of the map.

When the facility layer is enabled you can view specifics of each wholesale water facility including the energy intensity of pump and power stations. To view this information click on any facility after the facilities layer has been activated.

When you are done exploring the regions and facilities, enter the Model by clicking on "Model"

Download the [User's Manual](#) to have a hard copy of all instructions.

From this page users can explore the hydrologic regions and wholesale water facilities by clicking on "Hydrologic Region Profiles" above or clicking on any region on the map. This will display the characteristics of each region for informational purposes.

CPUC Study 1: Wholesale Water-Energy Model [Hydrologic Region Profile](#) | [Model](#) | [Help](#)

Hydrologic Region Profile: Tulare Lake

Summary

The Tulare Lake Hydrologic Region is in the southern end of the San Joaquin Valley. This region includes all of Tulare and Kings Counties and large portions of Fresno and Kern counties. The valley is broad and flat, and is surrounded by the Diablo and Coast Ranges to the west, the Sierra Nevada to the east, and the Tehachapi Mountains to the south. The valley portion of the region is hot and dry in summer with long, sunny days and cooler nights. Winters are wet and often blanketed with dense fog.

See Table 1 below for additional information on the Tulare Lake Hydrologic Region

Table 1- Tulare Lake Hydrologic Region Profile

Size	17,033 square miles (10.7% of State)	Population (2000)	1,884,675
Projected Population (2030)	3,121,625	Percent Growth	66%
Reservoir Storage Capacity	2,046 TAF	Average Annual Precipitation	15.2 inches
Land Use	The State and federal government agencies own about 30 percent of the land in the region, including about 1.7 million acres of national forest, 0.8 million acres of national parks and recreation areas, and 1 million acres of land managed by the U.S. Bureau of Land Management. Privately owned land totals about 7.4 million acres. Irrigated agriculture accounts for more than 3 million acres of the private land, while urban areas take up over 350,000 acres. Other agricultural lands and areas with native vegetation represent an additional 1.4 million acres in the region.		
Water Supply	The region receives most of its surface water runoff from four main rivers that flow out of the Sierra Nevada, which are the Kings, Kaweah, Tule, and Kern rivers. Major water conveyance facilities in the region include the California Aqueduct, the Friant-Kern Canal, and the Cross Valley Canal. Water diversions from the San Joaquin River at Friant Dam are also a significant supply source for all uses in the Tulare Lake region.		
Water Use	In the year 2000, a "normal" water year, agriculture accounts for about 97% percent of the region's water use, while urban use is about 3% percent.		
	Urban	236.1 TAF	
	Agricultural	8,104.9 TAF	
	Total	8,340.9 TAF	

Toggle Layer

- Facilities
- County
- Elec. Service Areas

Map data ©2010 Europa Technologies, Google, INEGI - Terms of Use

Additional map features allow users to view wholesale water facilities and canals, county boundaries, and electric utility service areas. To view these layers, click on the appropriate checkboxes for each layer on at the bottom right corner of the map.

CPUC Study 1: Wholesale Water-Energy Model [Hydrologic Region Profile](#) | [Model](#) | [Help](#)

Facility Information

Division	Facility Name	Location	Plant Energy Intensity (kWh/AF)
Southern	Pearblossom Pumping Plant	East Branch	683

Hydrologic Region Profile: South Coast

Summary

The South Coast Hydrologic Region comprises the southwest portion of the state and is California's most urbanized and populous region. The topography includes a series of nearly flat coastal plains and valleys, many broad but gentle interior valleys, and several mountain ranges of low and moderate elevation. The region has a mild, dry subtropical climate where summers are virtually rainless, except in the mountains where late summer thunderstorms sometimes occur.

See Table 1 below for additional information on the South Coast Hydrologic Region

Table 1- South Coast Hydrologic Region Profile

Size	10,925 square miles (6.9% of State)	Population (2000)	18,223,425
Projected Population (2030)	23,827,075	Percent Growth	24%
Reservoir Storage Capacity	3,059 TAF	Average Annual Precipitation	17.6 inches
Land Use	The expansion of new single- and multi-family homes, commercial services, businesses, and highway systems into the warmer sections of the region continues onto lands that were historically pastoral, if not agricultural. Although pockets of open space and agricultural uses still exist, the urban area now extends southward from Ventura County to the international border with Mexico and eastward from the coast to beyond Riverside and San Bernardino. Irrigated agriculture now occupies only one-seventh as much land as urban uses.		
Water Supply	The region has developed a diverse mix of both local and imported water supply sources. Local water resources development over the last 15 years has included water recycling, groundwater storage and conjunctive use, conservation, brackish water desalination, water transfer and storage, and infrastructure enhancements to complement imported water supplies. The region imports water through the State Water Project (SWP), the Colorado River Aqueduct (CRA), and the Los Angeles Aqueduct (LAA). This diverse mix of sources provides flexibility in managing supplies and resources in wet and dry years.		
Water Use	In the year 2000, a "normal" water year, agriculture accounts for about 17% percent of the region's water use, while urban use is about 83% percent.		
	Urban	3,860.4 TAF	
	Agricultural	795.9 TAF	
	Total	4656.3 TAF	

When the facility layer is enabled you can view specifics of each wholesale water facility including the energy intensity of pump and power stations. To view this information click on any facility after the facilities layer has been activated.

When you are done exploring the regions and facilities, enter the Model by clicking on "Model"

Model Input Page

The model inputs should now appear on the map to the right. These are basic inputs to the model, advance inputs can also be made by clicking on "advanced inputs"

CPUC Study 1: Wholesale Water-Energy Model
[Hydrologic Region Profile](#) | [Model](#) | [Help](#)

The model inputs are displayed on the map to the right.

To return to this screen at anytime, click "Model" above.

To run the model, first, select a future water use scenario, select the Demand Scenario from the drop down menu. There are two options (Low Demand and High Demand) based on DWR projections.

Second, select the amount of water to be delivered by the Colorado River Aqueduct: Low, Average or High.

Third input the projected reductions in delta outflow in 2020 and 2030. Inputting a percentage value will increase or decrease the withdrawals made by the State Water Project and the Central Valley Project form the Bay Delta. A positive number indicates a reduction in delta flow, a negative number implies an increase in delta flow.

Finally, advanced inputs can be defined by users by clicking on the "Advanced Inputs" button. Advance inputs allow users to:

- Increase or decrease water use in each sector in each region for both 2020 and 2030. Inputs are in the form of a percent change, a negative number decreased use while a positive number increases use.
- Increase local supply options (Recycled Water, Seawater Desalination, Brackish Desalination, Local Surface Storage). Increase represent new supply capacity beyond existing capacity and are entered as the annual capacity in thousand acre-feet.

Further explanation of all inputs and their values are documented in the Study 1 report and Appendices.

When you have finished making all adjustments to inputs. Click on the "Run Model" button.

Basic Inputs

First, select a future water use scenario; select the Demand Scenario from the drop down menu. There are two options (Low Demand and High Demand) based on DWR projections.

Second, select the amount of water to be delivered by the Colorado River Aqueduct: Low, Average or High.

Third input the projected reductions in delta outflow in 2020 and 2030. Inputting a percentage value will increase or decrease the withdrawals made by the State Water Project and the Central Valley Project form the Bay Delta. A positive number indicates a reduction in delta flow; a negative number implies an increase in delta flow.

Advanced Inputs

Advanced inputs can be defined by users by clicking on the "Advanced Inputs" button.

CPUC Study 1: Wholesale Water-Energy Model [Hydrologic Region Profile](#) | [Model](#) | [Help](#)

The model inputs are displayed on the map to the right.

To return to this screen at anytime, click "Model" above.

To run the model, first, select a future water use scenario, select the Demand Scenario from the drop down menu. There are two options (Low Demand and High Demand) based on DWR projections.

Second, select the amount of water to be delivered by the Colorado River Aqueduct: Low, Average or High.

Advanced Inputs Editor

	North Coast		San Francisco		Central Coast		South Coast		Sacramento River		San Joaquin		Tulare Lake		North Lahontan		South Lahontan		Colorado River	
	2020	2030	2020	2030	2020	2030	2020	2030	2020	2030	2020	2030	2020	2030	2020	2030	2020	2030	2020	2030
Percent Change in Demand																				
Urban																				
Large Landscape	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Commercial	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Industrial	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Residential - Interior	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Residential - Exterior	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Agriculture																				
Applied Water - Crop Production	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
New Construction of Supply (TAF)																				
Recycled Water	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Seawater Desalination	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brackish Desalination	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Local Surface Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Advanced inputs allow users to:

- Increase or decrease water use in each sector in each region for both 2020 and 2030. Inputs are in the form of a percent change, a negative number decreased use while a positive number increases use.
- Increase local supply options (Recycled Water, Seawater Desalination, Brackish Desalination, and Local Surface Storage). Increase represent new supply capacity beyond existing capacity and are entered as the annual capacity in thousand acre-feet.

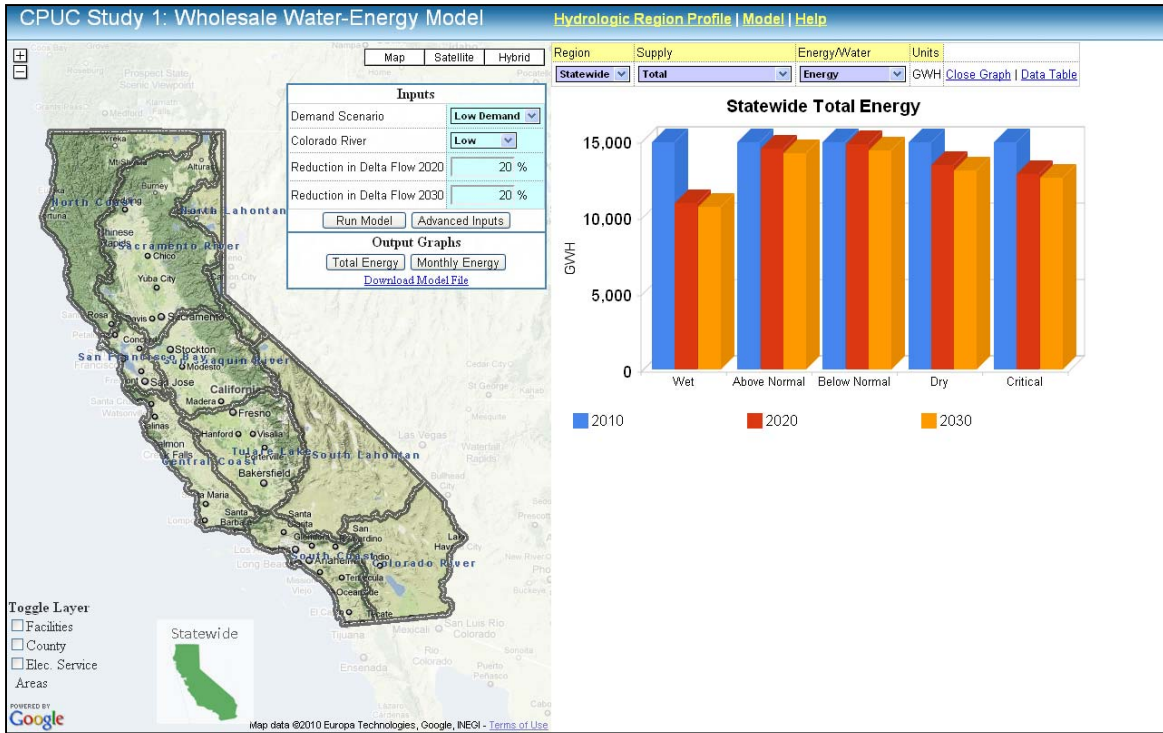
Further explanation of all inputs and their values are documented in the Study 1 report and Appendices.

When you have finished making all adjustments to inputs, click on the "Run Model" button.

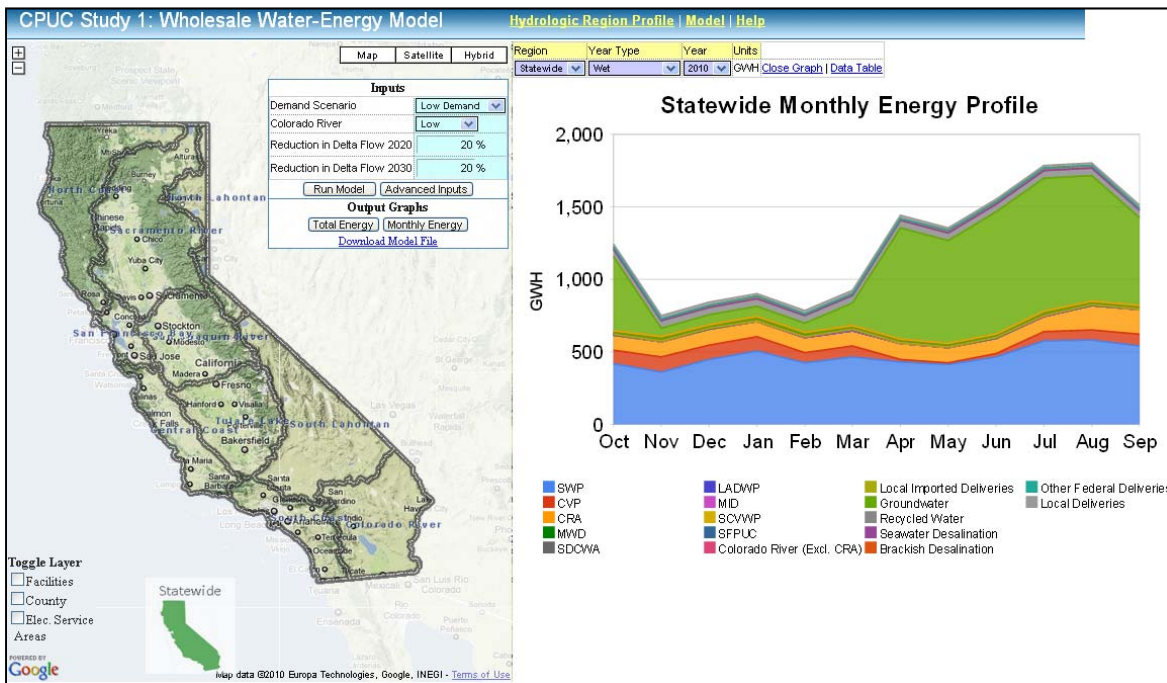
Model Output Page

Output can be viewed after the model has successfully run. Output options should now appear below the basic inputs. Users can select one of two graph types, "Total Energy" or "Monthly Energy."

Total Energy will display total energy use and total water deliveries in five different water year types in 2010, 2020, and 2030. Once the graph appears, users can select certain subsets of the data from drop-down menus above it. Users can select to view results at the statewide or regional level, view results specific to a wholesaler or supply, or switch between energy use and water delivery results.



Monthly Energy will display the monthly energy use by each wholesaler or supply in a specified year. Once the graph appears, users can customize the graph by using the drop-down menus above it. Users can select to see results at the statewide or regional level; results in 2010, 2020, or 2030; and results in a Wet, Above Normal, Below Normal, Dry, and Critical water year type.





The Spreadsheet Model with the last user inputs can be downloaded by clicking on “Download Model File.” Instruction following will help you navigate the Spreadsheet Model.

Spreadsheet Model

The Excel based model is comprised of multiple sheets including those used for inputs, outputs, and calculations. User interacts with sheets (tabs) in particular: Information, Input, and Output Viewer. These are described in more detail below

“Introduction” Tab

The introduction tab is the first thing users view after the spreadsheet file is opened. It contains basic instructions to use the spreadsheet model; however these instructions are summarized in more detail in this document. The input tab is illustrated below.

<p>California Wholesale Water-Energy Model</p> <p>Developed as a part of: Embedded Energy in Water Studies Study 1: Statewide and Regional Water-Energy Relationship</p>
<p>Prepared for: California Public Utilities Commission’s Energy Division</p>
<p>Developed By:</p> <div style="display: flex; justify-content: space-around; align-items: center;"><div style="text-align: center;"><p>GEI Consultants</p></div><div style="text-align: center;"><p>NAVIGANT CONSULTING</p></div></div>
<p>Instructions:</p> <div style="border: 1px solid #ccc; padding: 10px; background-color: #f9f9f9;"><p>Inputs</p><p>User inputs are located on the "Input Tab". Users can specify Statewide inputs:</p><ul style="list-style-type: none">- A demand Scenario from a dropdown box- The level of transfers available via the CRA from a dropdown box- Level of delta flow restrictions in 2020 and 2030<p>Regional inputs are also specified including:</p><ul style="list-style-type: none">- Incremental percent change in demand sector in each region and each year- New construction of local water supplies in each year (inputs in TAF)<p>Running the Model</p><p>After inputs are specified, press the "Run" button and the Excel macro will calculate results</p><p>Output</p><p>Users can view outputs on the "Output Viewer" Tab. Graphs can be altered to view user defined datasets that are specified in the blue dropdown boxes.</p><p>For more information, See Users Manual and Model Documentation</p></div>


“Input” Tab

Below is the model input view. This is where all of the model’s user-defined inputs are entered.

Inputs																											
Basic Inputs:																											
Demand Scenario	Baseline	North Coast		San Francisco		Central Coast		South Coast		Sacramento River		San Joaquin		Tulare Lake		North Lahontan		South Lahontan		Colorado River							
Colorado River Aqueduct	Average	NC	SF	CC	SC	SR	SI	TL	NL	SL	CR	2020	2030	2020	2030	2020	2030	2020	2030	2020	2030	2020	2030	2020	2030	2020	2030
Reduction in Delta Flow 2020	20%	Run																									
Reduction in Delta Flow 2030	20%																										
Advanced Inputs:																											
DEMAND (Percent change - Postive indicated increases, negative indicated decreases)																											
Urban																											
Large Landscape	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%						
Commercial	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%						
Industrial	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%						
Residential - Interior	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%						
Residential - Exterior	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%						
Agriculture																											
Applied Water - Crop Production	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%						
SUPPLY - NEW CONSTRUCTION (TAF)																											
Recycled Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						
Seawater Desalination	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						
Brackish Desalination	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						
Local Surface Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						

Drop down options

Inputs	
Basic Inputs:	
Demand Scenario	Baseline 1
Colorado River Aqueduct	Average 2
Reduction in Delta Flow 2020	20% 3
Reduction in Delta Flow 2030	20% 3



1. To set future water use, select the Demand Scenario from the drop down menu. The three options (Baseline, Low Demand and High Demand) are explained in depth in the report appendices.
2. Select the amount of water to be delivered by the Colorado River Aqueduct: Low, Average or High. Further explanation is available in the report appendices.
3. The two options for Reduction in Delta Flow 2020/2030 are derivative of the Wanger Decision. Reducing Delta outflow will constrict the water flow from the Bay Delta to SWP and some CVP facilities. Entries will be limited to between 100% and -50%. A positive number indicates a reduction in delta flow; a negative number implies an increase in delta flow. Further explanation is available in the report appendices.

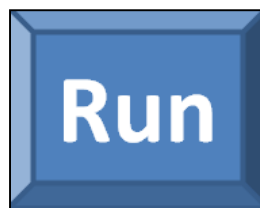
Inputs

Below is the section for manual inputs into the model for water supply and demand.

		North Coast	
		NC	
		2020	2030
Advanced Inputs:			
DEMAND (Per			
Urban			
Large Landscape		-20%	-20%
Commercial		-20%	-20%
Industrial		-20%	-20%
Residential - Interior		-20%	-20%
Residential - Exterior		-20%	-20%
Agriculture			
Applied Water - Crop Production		0%	0%
Recycled Water		3.3	5.0
Seawater Desalination		0.0	0.0
Brackish Desalination		0.0	0.0
Local Surface Storage		0.0	0.0

1. For each hydrologic region, enter the percentage change for each sub-item in Urban and Agriculture Demand. Entries will be limited to between 50% and -50%. A negative number indicates a reduction in demand; a positive number implies an increase in demand. Further explanation is available in the report appendices.
2. Then enter any new supply construction in thousand acre-feet. Because they are landlocked regions and have no access to the ocean, you may not enter values for Seawater Desalination for regions of Sacramento River, San Joaquin River, Tulare Lake, North Lahontan, South Lahontan, or Colorado River. Further explanation is available in the report appendices.

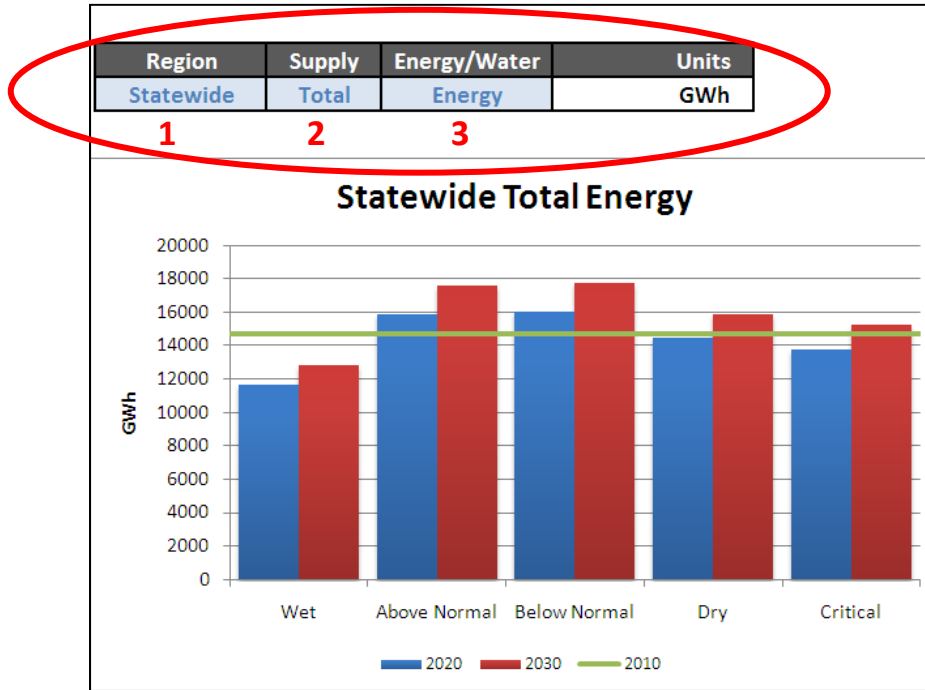
Once the desired data is input, press the Run button to run the model and update the stored data set. The model will stop on the Output Viewer tab.



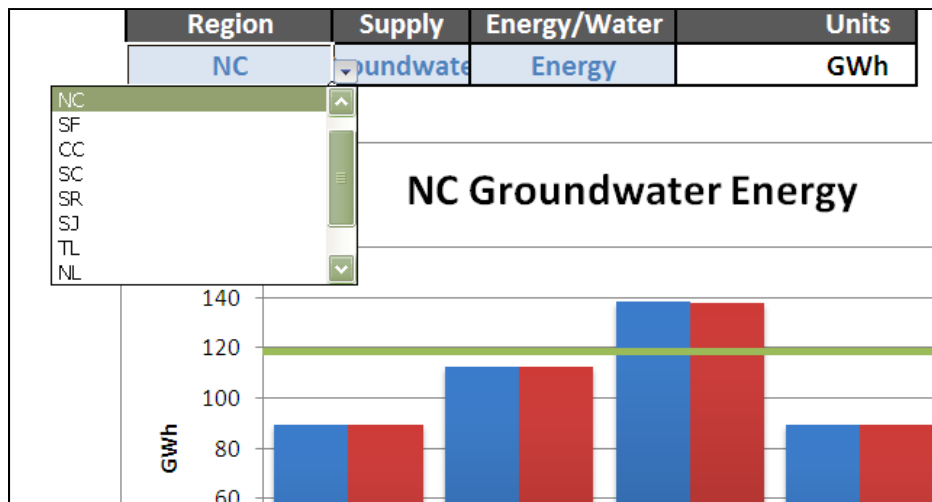
“Output Viewer” Tab

There are four graphs representing the model outputs in different ways. For further explanation of the calculations, assumptions, and inputs, please see the report appendices.

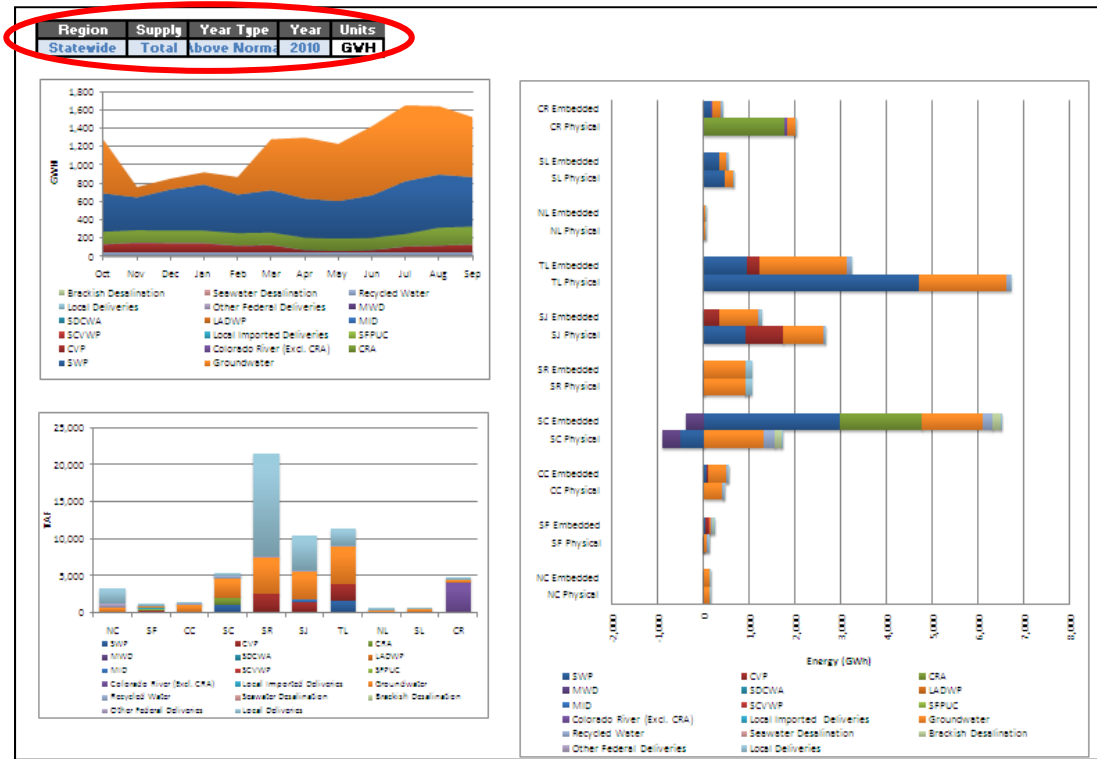
The top graph represents data by water year type across the two different future years (2020 and 2030), with the current situation in 2010 being represented by a green base line.



1. The graph can be toggled to change to view statewide data or individual regions.
2. The graph can toggle between the different supply types, or show the total amount.
3. The graph can also display either water or energy information. The Units section displays GWh for energy and TAF for water deliveries.



Scroll down for the next three graphs, which are all derivative of the single toggle section highlighted below. The toggles effect the region specification, the supply source, year type and scenario year.



1. The top left graph represents the monthly energy profile by source.
Note: When an agency shows net negative energy consumption (i.e. energy generation) for a period of time, the graph stacks positive energy consumption on top and might cover up the negative values.

