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ENERGY

Water-Energy Cost Effectiveness Tools

Public Workshop Presentation

February 11, 2015

Content of Report

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February 11, 2015

1. Overview of Study Goals
2. Overview of Methodology
3. The Water-Energy Calculator

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The goal of our research effort is to develop a method of valuing the monetary benefits of water savings via CPUC cost effectiveness tests.

- CPUC decision 12-05-01 stated it is *"not prudent to spend significant amounts of [energy] ratepayer funds on expanded water-energy nexus programs until the cost-effectiveness of these programs, and particularly the net benefits that accrue to energy utility ratepayers, are better understood."*
- This analysis asks: what future costs associated with water and energy infrastructure can be avoided as a result of water conservation?

California energy IOUs can already rebate high efficiency clothes washers …

… does it benefit energy ratepayers for IOUs to rebate high efficiency toilets?

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Objective: develop tools that can be used to augment existing Cost Effectiveness (CE) frameworks to include consideration of water.

» Existing cost effectiveness frameworks value "Site Energy" savings using the avoided cost (AC) of electricity and natural gas.

$$Benefit\ Cost\ Ratio = \frac{Site\ Energy\ AC}{Equipment\ Cost + Program\ Cost}$$

Where:

$$Site\ Energy\ AC = Site\ Energy\ Savings\ x\ Avoided\ Cost\ of\ Energy$$

» Modifications to the benefits portion of the equation are needed to account for water savings.

$$Benefit\ Cost\ Ratio = \frac{Site\ Energy\ AC + Embedded\ Energy\ AC + Water\ Capacity\ AC + Environmental\ Benefits}{Equipment\ Cost + Program\ Cost}$$

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Scope of the study: examine three benefits of water efficiency not previously considered by the CPUC cost-effectiveness framework.

» Three added benefits
  – **Avoided Cost of Embedded IOU Energy in Water.** The economic value (in dollars) from embedded energy savings.
  – **Avoided Costs of Water Capacity.** The economic value (in dollars) from the avoided investment and fixed operating cost in constructing and operating new capacity in water supply and treatment infrastructure.
  – **Environmental Benefits of Reduced Water Use.** The economic value (in dollars) of environmental services from water that is left in the environment to serve other purposes (e.g., wildlife habitats, instream flows, etc.).

» The scope our study did not include the avoided commodity cost of water

» Scoped with:
  – Developing a set of models and calculators to enable the estimation of these three additional benefits.
  – Populating these models and calculators with reasonable default assumptions based on available secondary data and interviews with experts.

The tools developed in this study should be used to primarily inform energy utility efficiency programs.

» Intended uses:
- Estimate the IOU and non-IOU embedded energy savings that result from joint water-energy programs
- Assess the benefits that accrue to energy utilities and to water utilities from programs and measures that save both energy and water
- Determine if incentivizing measures and programs that save both energy and water is a cost effective use of IOU energy utility funds

» This study does:
- **not** require publicly owned utilities or municipal utilities to use these tools
- **not** require water utilities to change their water supply planning decisions
- **not** require water utilities to fund water efficiency programs
- **not** require energy utilities to fund water efficiency programs (requirements would come from a CPUC decision)
- **not** require water utilities to report their energy use
- **not** dictate any goal or mandate for the level of funding, water savings, or energy savings for joint water energy programs from either energy or water utilities
- **not** consider avoided commodity cost of water

The CPUC currently maintains two core tools to assist the energy utilities in determining the cost effectiveness of energy efficiency programs.

- CPUC Demand Side Avoided Cost Calculator (based on proxy plants)
  - Determines the avoided costs of supplying electricity and natural gas on a per unit basis ($/kWh and $/Therm)
  - Maintains a common set of assumptions about the cost and operation parameters of the proxy resources
  - Outputs avoided costs, these avoided costs serve as inputs to the cost effectiveness calculator
- Cost Effectiveness Calculator
  - Incorporates all costs and benefits to estimate cost effectiveness
  - Users input details about the efficiency measures (savings, cost, lifetime, etc.)
  - Calculator values energy savings using the avoided costs
- These existing tools do not consider the benefits of water savings

The CPUC is considering a multi-part cost-benefit test that is "viewed from multiple perspectives."

	TRC Perspective			
Component	**Energy**	**Water**	**Combined**	**Societal**
Administrative costs to energy utility	Cost		Cost	Cost
Administrative costs to water agency		Cost	Cost	Cost
Avoided costs of supplying electricity and natural gas	Benefit		Benefit	Benefit
Avoided costs of water capacity*		Benefit	Benefit	Benefit
Avoided embedded IOU energy in water*	Benefit	Benefit	Benefit	Benefit
Environmental benefits of reduced water use*				Benefit
Capital (measure) costs to participant	Cost	Cost	Cost	Cost
Capital (measure) costs to energy utility	Cost		Cost	Cost
Capital (measure) costs to water utility		Cost	Cost	Cost
Increased supply costs	Cost	Cost	Cost	Cost
Tax credits	Benefit	Benefit	Benefit	

* New benefits being addressed by this study.

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1 Overview of Study Goals

2 **Overview of Methodology**

3 The Water-Energy Calculator

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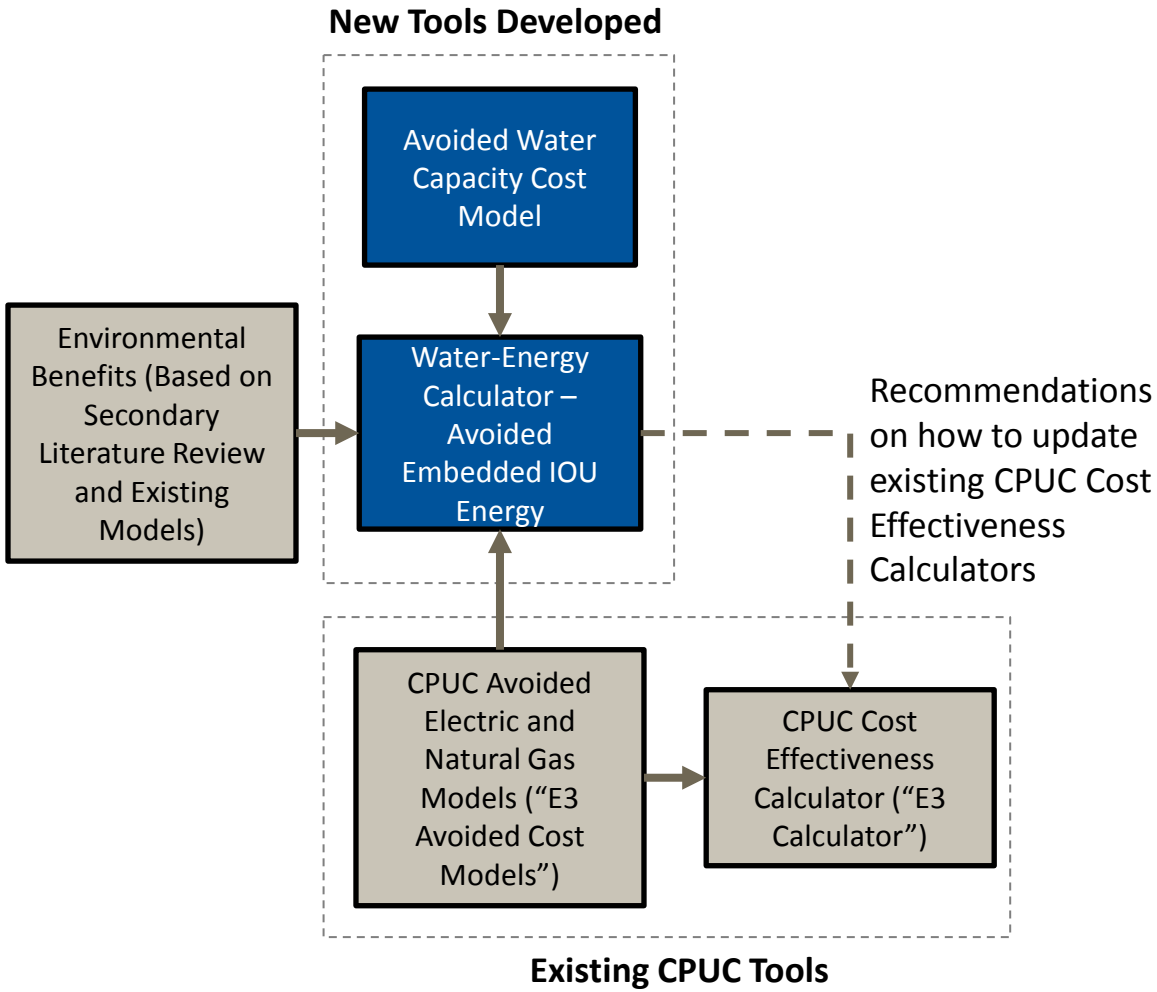
All three water related benefits are combined into one tool that can be used for analyzing the water-related benefits of water efficiency measures: the Water Energy Calculator.



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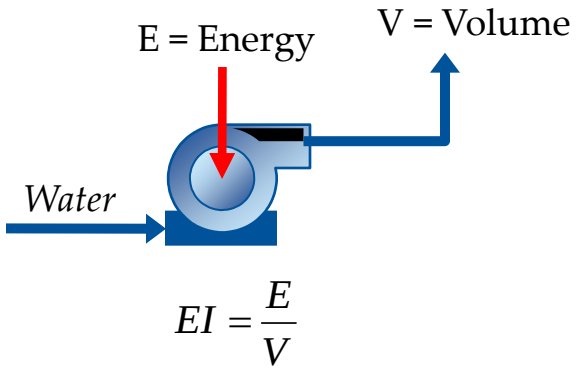
Energy Intensity and Embedded Energy are two terms that are key to understanding the Water-Energy nexus

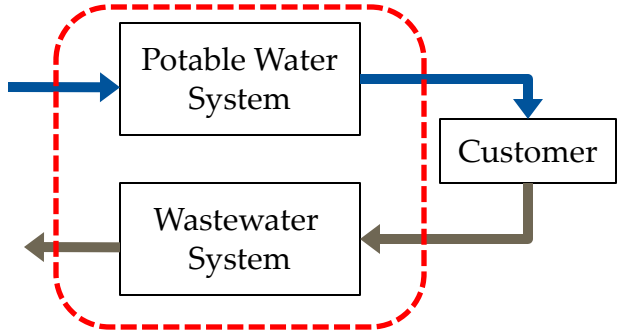
» **Energy Intensity (EI)**
- The average amount of energy needed to transport or treat water or wastewater on a per unit basis (kilowatt hours per acre-foot of water [kWh/AF] or therms/AF)
- Associated with a particular facility
- EIs of successive facilities are additive

» **Energy Embedded in Water**
- Captures the entire energy picture both upstream and downstream of an end use customer
- Embedded energy is not associated with a particular facility but with the water itself
- Calculated by multiplying energy intensity by a volume of water
- Embedded energy savings = EI x Water Savings

Illustrative Energy Intensity Calculation for a Pump



Embedded Energy



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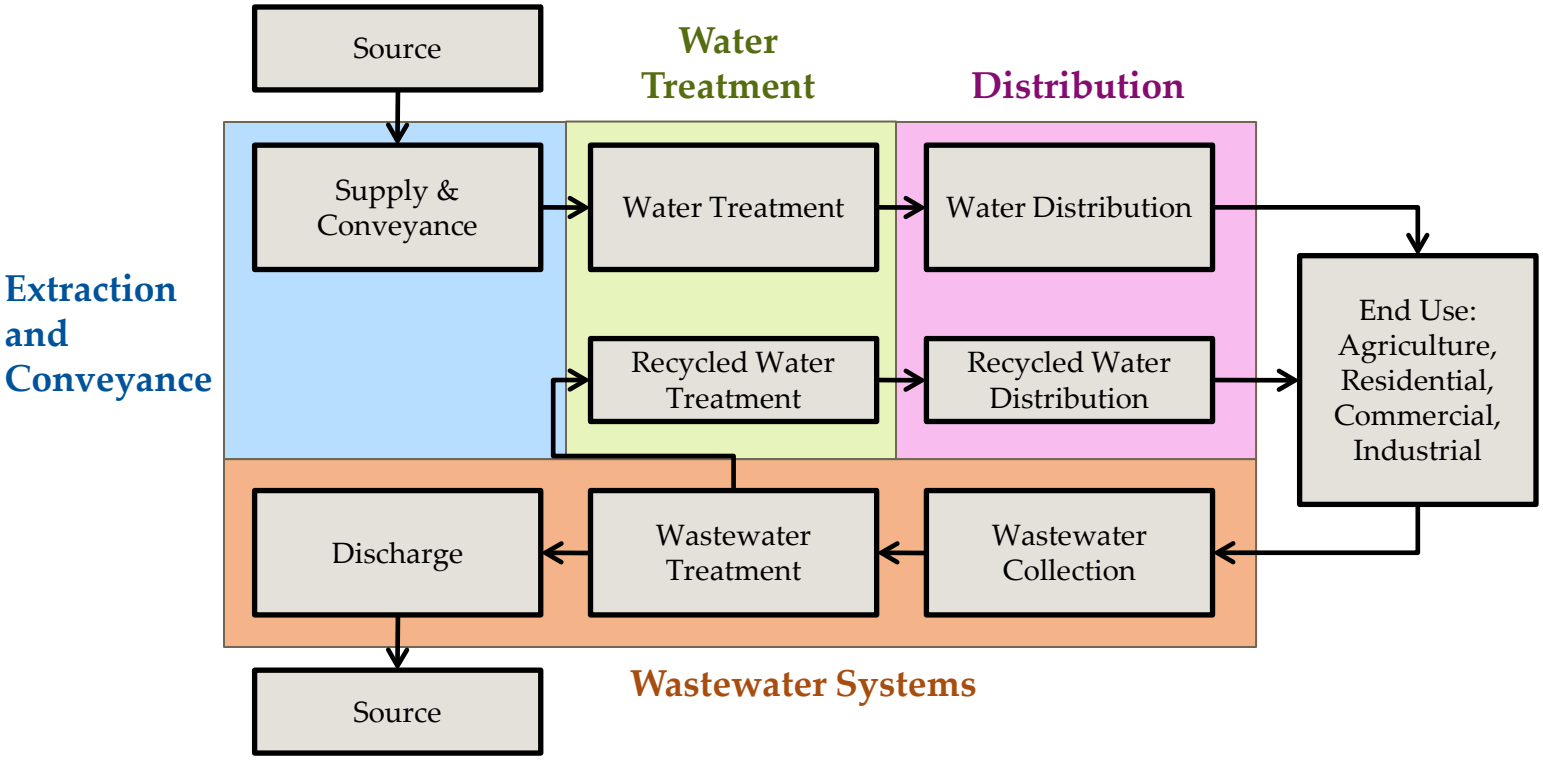
Nomenclature for System Components



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Average vs. Marginal Energy Intensity

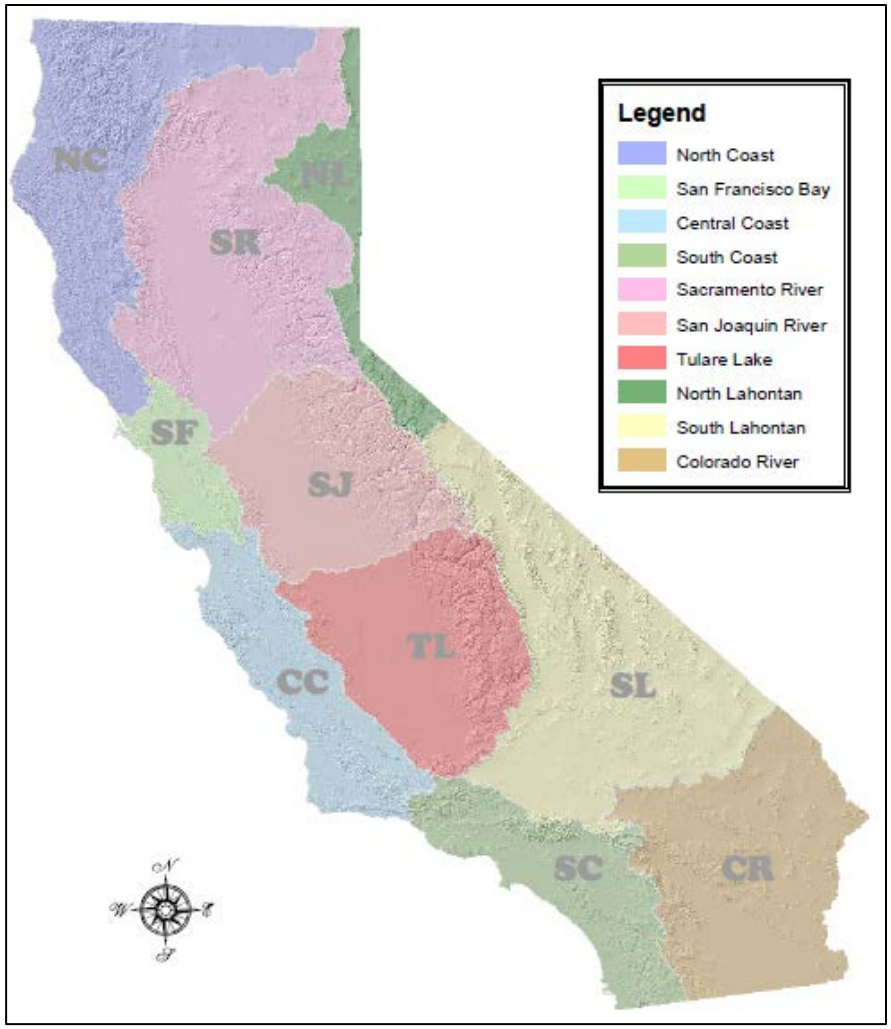
» **Marginal Energy Intensity**
- Energy intensity is the energy intensity of the selected marginal supply (plus appropriate treatment, distribution and wastewater EI)
- Used to value the avoided embedded energy cost
- Represents the energy use of the supply a region is avoiding developing

» **Average Energy Intensity**
- Weighted average of the energy intensity of existing supplies within a region (plus appropriate treatment, distribution and wastewater EI)
- Used to estimate, measure, and evaluate embedded energy savings (kWh or therms)
- Better represents the actual energy savings that will occur
- Analogous to estimating greenhouse gas savings from energy efficiency using an average carbon intensity of the electricity grid

» *The model further breaks down both of these into IOU and non-IOU components.*

The models are set up to conduct analysis at the CA Department of Water Resources (DWR) Hydrologic Region level.

- Selecting DWR Hydrologic Regions allowed the model to be populated with the best publically available data as default values
- Many existing studies and reports already document water supplies and their energy intensities at the hydrologic region
- Users can still change default values



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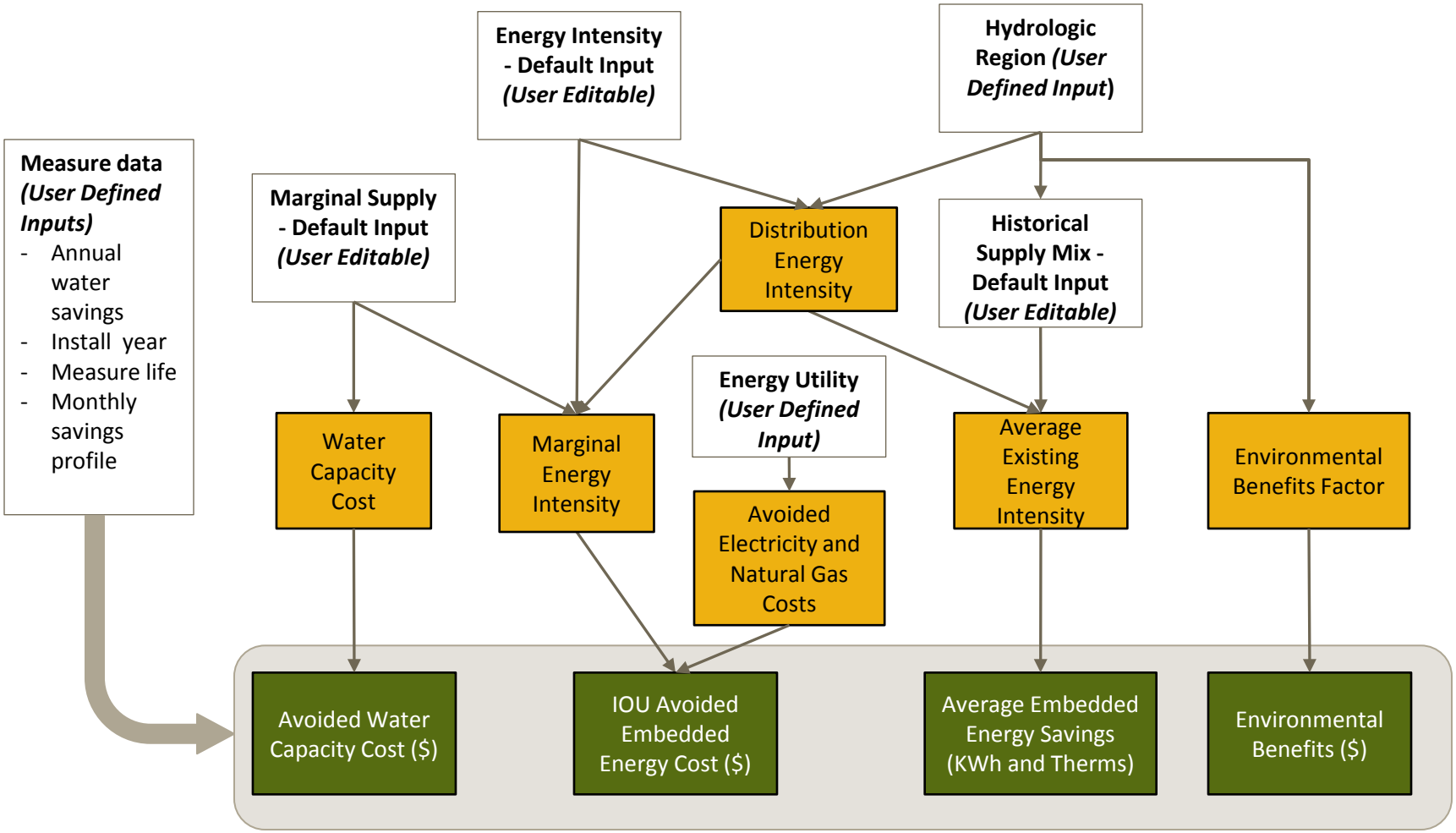
Relationship of Key Inputs, Calculations, and Outputs



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1 Overview of Study Goals

2 Overview of Methodology

3 **The Water-Energy Calculator**

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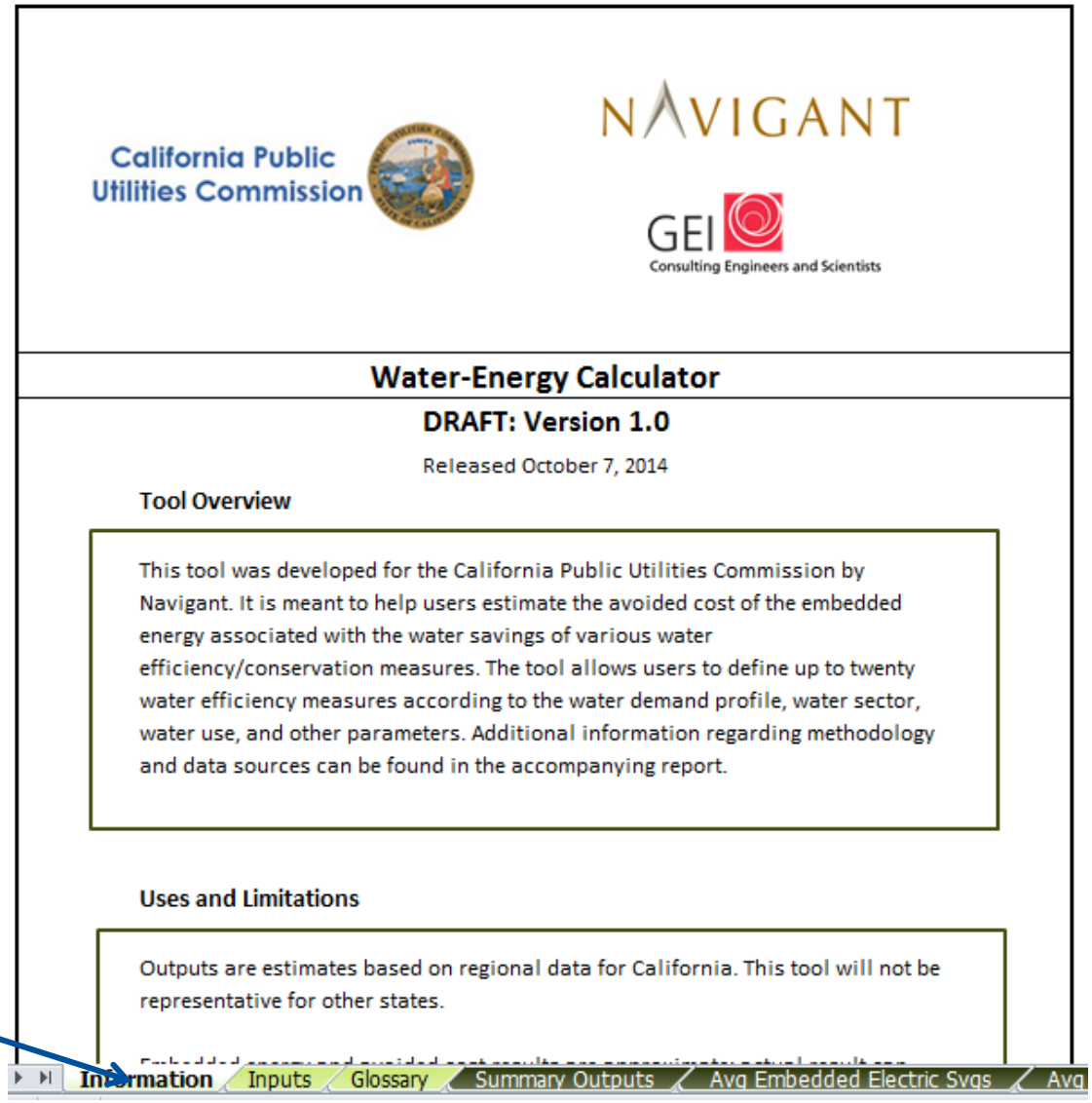
Having established a methodology for tools, the Navigant team sought out estimates of default data to populate the tools.

- The Navigant team's scope was to primarily develop tools and methodology
- Inputs serve as reasonable default values based on available secondary data
- Many inputs can be edited by users to conduct custom analysis

- Key energy intensity data sources include:
  - CPUC Embedded Energy in Water Study 1 and Study 2
  - DWR Draft Water Plan
  - Water-Energy Simulator (WESim) Model
- Key avoided water capacity cost data sources include:
  - Integrated Regional Water Management Plans (IRWMP)
  - Capital Improvement Plans (CIPs)
  - California Department of Water Resources (DWR)
  - State and Local Agency Engineering Reports
  - Investor Owned Water Utility reports filed to the CPUC
- Environmental benefits data was sourced completely from the CUWCC's Environmental Benefits Model

The Water-Energy Calculator is designed to be simple to use.

- Users have the option to customize the analysis.
- A users guide is contained in the appendix of our final report.
- **Note: Excel Macros must be enabled**



Users can navigate the tool by clicking through various Excel tabs

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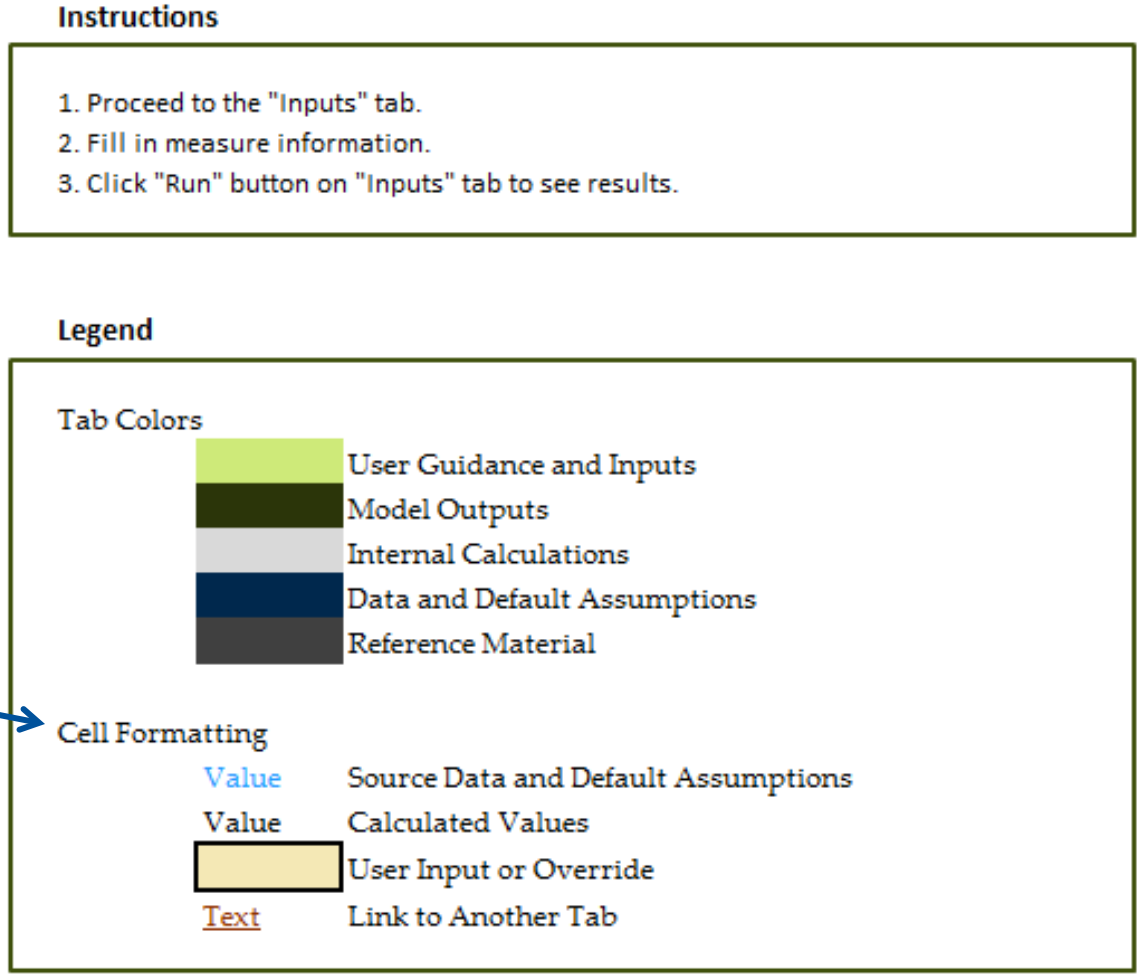
Basic instructions and a legend can be found on the "Information" tab by scrolling down.



Cell formatting indicates where users can edit data

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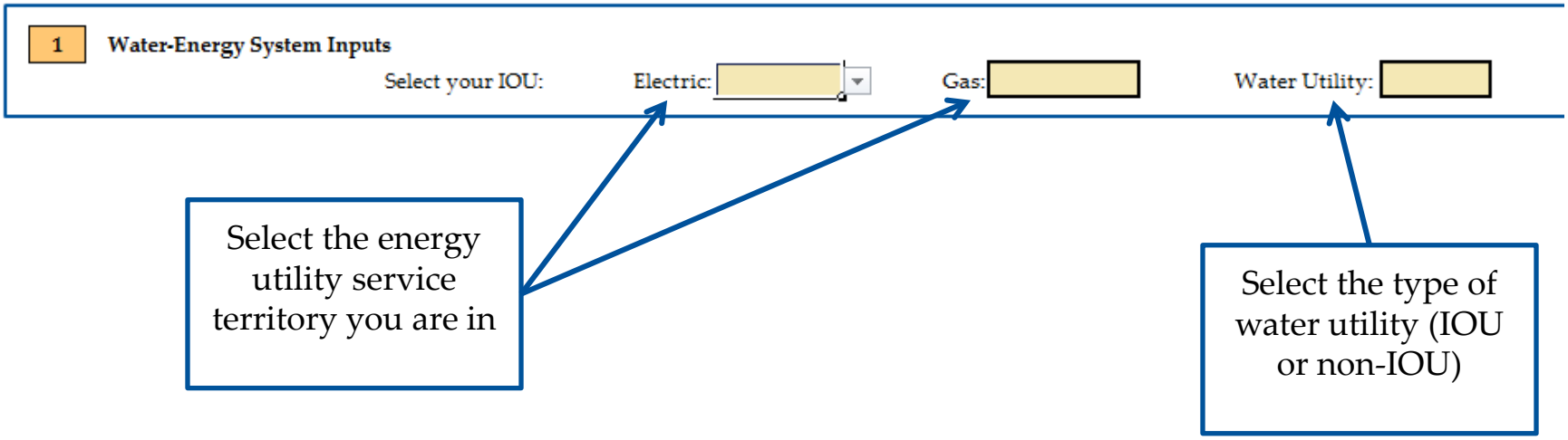
"Inputs" tab: Section 1 contains basic inputs for the utility service territory being analyzed.

- Energy IOU selection determines which electric and natural gas avoided costs to use in the analysis
- Water utility type selection impacts the assumptions about the cost of capital



"Inputs" tab: Section 2 contains water efficiency measure details.

» Up to 20 measures can be analyzed at once. Key measure inputs include:
- Annual Water Savings
- Measure Life
- Installation Year
- Monthly Savings Profile (Customizable)
- Hydrologic Region
- Sector (Urban vs. Agriculture)
- Water Use (Indoor vs. Outdoor)
- Rebate
- Costs (Installation, Incremental Equipment, Program Administration)

2 **Measure-Specific Inputs**

Note: all metrics are on a per unit basis (Example: per low-flow shower head)

Measure ID#	Measure Name	Annual Water Savings (gallons)	Measure Life (years)	Installation Year	Savings Profile	Hydrologic Region	Sector	Water Use	Rebate ($)	Installation Cost ($)	Incremental Equipment Cost ($)	Program Administration Cost ($)
1												
2												
3												
4												
5												

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Water savings profile can be customized on the "Water Svgs Profiles" tab

Water Savings Profiles			Click to Return to Inputs tab		
Month	Constant	Irrigation	Cooling Tower	Custom 1	Custom 2
January	8.3%	3.2%	3.0%		
February	8.3%	2.5%	3.1%		
March	8.3%	4.2%	3.8%		
April	8.3%	8.7%	8.2%		
May	8.3%	12.0%	12.1%		
June	8.3%	13.4%	11.9%		
July	8.3%	14.5%	10.8%		
August	8.3%	12.8%	13.1%		
September	8.3%	11.5%	13.8%		
October	8.3%	8.9%	10.0%		
November	8.3%	6.6%	7.1%		
December	8.3%	1.8%	3.0%		
	Source: CSA (2012)				
Total Check				ERROR: Values must add up to 100%	ERROR: Values must add up to 100%

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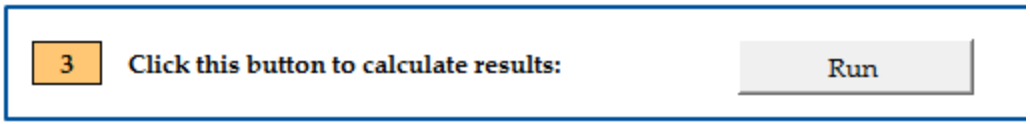
Once basic inputs in Section 1 and 2 are completed, the model can be run with its default assumptions; outputs can be viewed on the "Summary Outputs" tab.



1 **Average Embedded Energy and Avoided Cost of Marginal Embedded Energy**

Note: all metrics are on a per unit basis (Example: per low-flow shower head)

Measure ID#	Measure Name	Average Annual Embedded IOU Electric Energy (kWh)	Average Annual Embedded Non-IOU Electric Energy (kWh)	Average Annual Embedded Gas Energy (therms)	Avoided IOU Electric Energy Cost (2014$)	Avoided Gas Energy Cost (2014$)
1		-	-	-	$ -	$ -
2		-	-	-	$ -	$ -
3		-	-	-	$ -	$ -
4		-	-	-	$ -	$ -

Uses can also further customize the model, departing from the default inputs…

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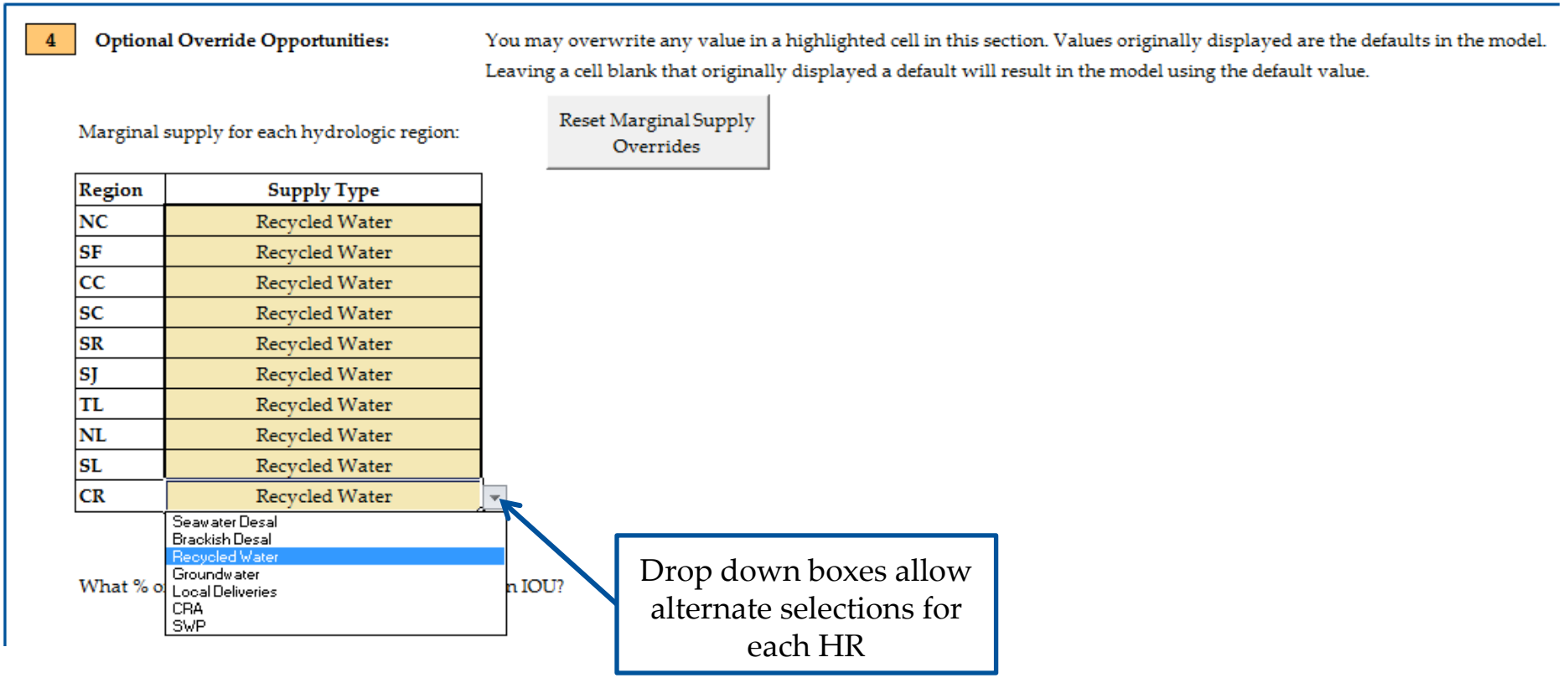
"Inputs" tab: Section 4 displays all default assumptions and allows the user to edit default inputs and settings.

- Marginal Water Supply
- Fraction of energy provided by energy IOUs
- Energy Intensity
  - Extraction and Conveyance
  - Treatment
  - Distribution
  - Wastewater Systems
- Historical (Average) Water Supply Mix

- Default values are displayed in the tool and can be overwritten by users.
- Default values can be restored by clicking on "Reset" buttons
- The sources and justification for selection of all default values can be found in the Draft Final Report (dated October 7, 2014)

Marginal Supply Override

» The default marginal water supply is selected to be Tertiary Treated Recycled Water



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Percent IOU Energy Override

» Not all water systems are powered by an IOU; thus, the energy IOUs may not be able claim credit for all embedded energy savings.

What % of your system's electricity comes from an IOU?

Reset % IOU Overrides

		% IOU
Extraction and Conveyance	Seawater Desal	94%
	Brackish Desal	94%
	Recycled Water	97%
	Groundwater	59%
	Local Deliveries	27%
Treatment		94%
Distribution		95%
Wastewater Systems		97%

Please Note:

Where override values may be entered for different supply types, Local Imported Deliveries, CRA, CVP and Other Federal Deliveries, and SWP have not been included because these supplies represent specific systems. Navigant Team researched these systems and this model uses their known values.

Users can simply type in a new value in any of these highlighted cells

Important note: State Water Project, Central Valley Project, and Colorado River Aqueduct are not powered by IOU Energy

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Extraction and Conveyance Energy Intensity Override

» Not all water systems are powered by an IOU; thus, the energy IOUs may not be able claim credit for all embedded energy savings.

The denominator for energy intensity values provided should be the total system throughput, not just the throughput for the electric or gas portion of the system.

Extraction and Conveyance | Reset Extraction and Conveyance Energy Intensity Overrides

	Electric Energy Intensity (kWh/AF)					Gas Energy Intensity (Th/AF)				
Region	Seawater Desal	Brackish Desal	Recycled Water	Groundwater	Local Deliveries	Seawater Desal	Brackish Desal	Recycled Water	Groundwater	Local Deliveries
NC	342	168	0	178	10					
SF	342	342	0	352	10					
CC	342	461	0	471	10					
SC	342	566	0	576	10					
SR	342	181	0	191	10					
SJ	342	231	0	241	10					
TL	342	389	0	399	10					
NL	342	167	0	177	10					
SL	342	352	0	362	10					
CR	342	466	0	476	10					

Default assumes no gas use, limited data was publically available to determine default values.

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Treatment Energy Intensity Override

Treatment

Reset Treatment Energy Intensity Overrides

Treatment	Electric Energy Intensity (kWh/AF)	Gas Energy Intensity (Th/AF)
Conventional Treatment	443	
Chlorination	3	
Membrane Treatment	1303	
Conventional Tertiary Treatment	521	
Brackish Desal	2715	
Ocean Desal	4546	

Which technology do you use for Recycled Water?

Conventional Tertiary Treatment

Reset Recycled Water Treatment Technology Override

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Distribution and Wastewater System Energy Intensity Overrides

Distribution

Reset Distribution Energy Intensity Overrides

Region	Electric Energy Intensity (kWh/AF)	Gas Energy Intensity (Th/AF)
NC	501	
SF	977	
CC	501	
SC	501	
SR	54	
SJ	54	
TL	54	
NL	54	
SL	501	
CR	54	

Wastewater Systems

Reset Wastewater Systems Energy Intensity

Technology	Electric Energy Intensity (kWh/AF)	Gas Energy Intensity (Th/AF)
"Primary + Secondary"	1055	
"Primary + Secondary + Tertiary"	2808.5	
Wastewater Collection Pumps	228.5	

Does urban runoff enter your sewer system? No

Reset Urban Runoff Override

Default assumes no gas use, limited data was publically available to determine default values.

Determines if wastewater treatment energy use is considered when analyzing outdoor water savings

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Historical (Average) Supply Mix Overrides

- Used to estimate, measure, and evaluate embedded energy savings (kWh or therms)
- Better represents the actual energy savings that will occur today
- Must sum to 100%

Historical Supply Mix | Reset Historical Supply Mix Override

Region	Seawater Desal	Brackish Desal	Recycled Water	Groundwater	Local Deliveries	Local Imported Deliveries	CRA	CVP and Other Federal Deliveries	SWP	Check that Values Add to 100%
NC	0.0%	0.0%	20.4%	28.8%	27.7%	1.5%	0.0%	21.5%	0.0%	100%
SF	0.1%	0.3%	3.2%	19.1%	14.9%	38.0%	0.0%	12.2%	12.2%	100%
CC	0.0%	0.0%	8.3%	79.1%	2.5%	0.0%	0.0%	7.5%	2.7%	100%
SC	0.0%	1.7%	10.0%	31.0%	3.7%	5.1%	21.1%	0.2%	27.2%	100%
SR	0.0%	0.0%	20.2%	19.8%	31.0%	0.0%	0.0%	28.8%	0.2%	100%
SJ	0.0%	0.0%	23.3%	31.0%	29.1%	0.1%	0.0%	16.4%	0.2%	100%
TL	0.0%	0.0%	11.6%	49.6%	16.2%	0.1%	0.0%	15.0%	7.6%	100%
NL	0.0%	0.0%	34.1%	22.0%	43.9%	0.0%	0.0%	0.0%	0.0%	100%
SL	0.0%	0.0%	15.5%	63.7%	6.7%	0.0%	0.0%	0.0%	14.1%	100%
CR	0.0%	0.0%	11.0%	8.9%	0.1%	0.0%	78.6%	0.0%	1.4%	100%

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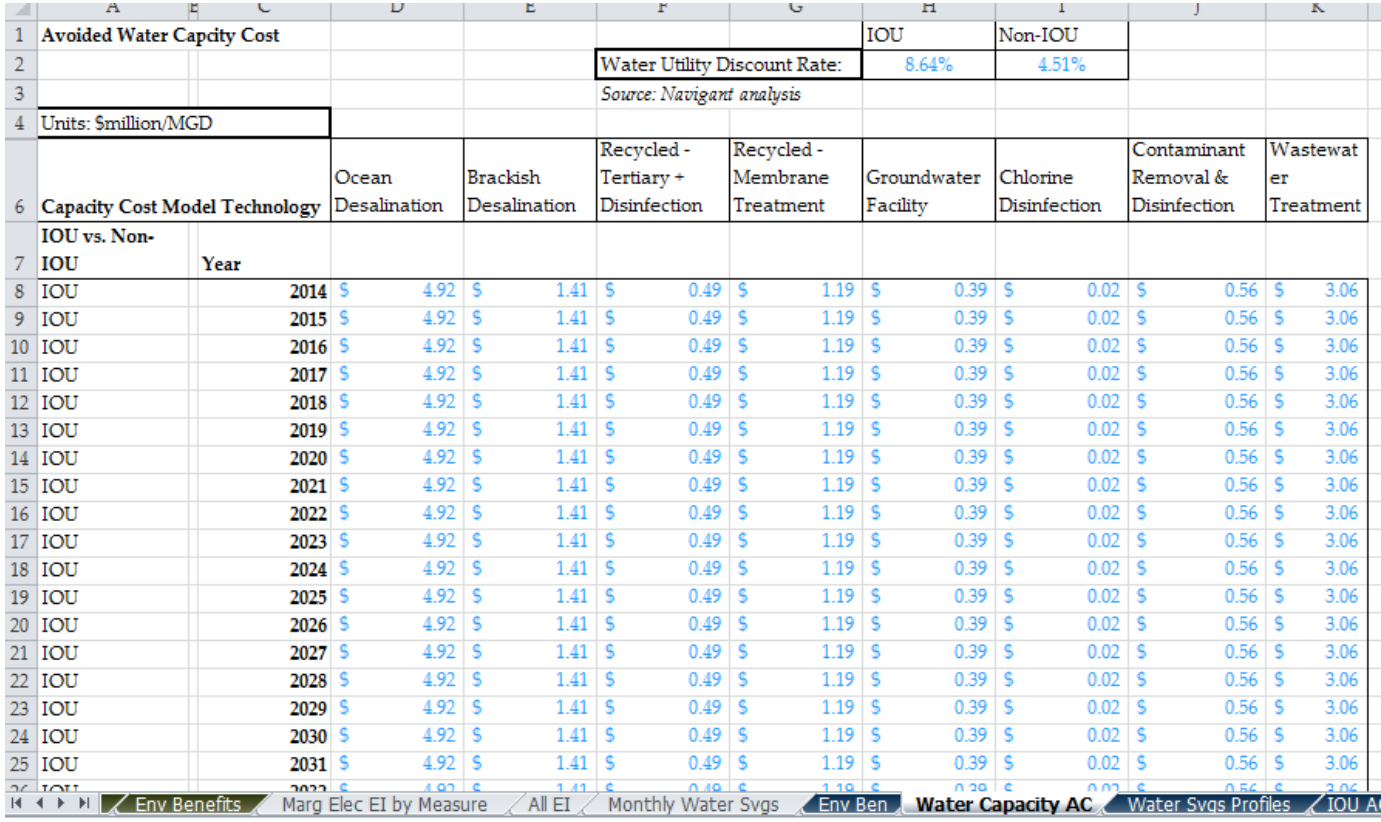
Avoided Capacity Cost

- Avoided Capacity costs are calculated in a separate model and imported to the water-energy calculator
- Calculated for each marginal supply option as well as treatment and wastewater treatment under an IOU and non-IOU cost of capital structure.
- Details can be found in the final report.



1	**Avoided Water Capcity Cost**							IOU	Non-IOU		
2							Water Utility Discount Rate:	8.64%	4.51%		
3							*Source: Navigant analysis*				
4	Units: $million/MGD										
6	**Capacity Cost Model Technology**		Ocean Desalination	Brackish Desalination	Recycled - Tertiary + Disinfection	Recycled - Membrane Treatment	Groundwater Facility	Chlorine Disinfection	Contaminant Removal & Disinfection	Wastewater Treatment	
7	**IOU vs. Non-IOU**	**Year**									
8	IOU	2014	$ 4.92	$ 1.41	$ 0.49	$ 1.19	$ 0.39	$ 0.02	$ 0.56	$ 3.06	
9	IOU	2015	$ 4.92	$ 1.41	$ 0.49	$ 1.19	$ 0.39	$ 0.02	$ 0.56	$ 3.06	
10	IOU	2016	$ 4.92	$ 1.41	$ 0.49	$ 1.19	$ 0.39	$ 0.02	$ 0.56	$ 3.06	
11	IOU	2017	$ 4.92	$ 1.41	$ 0.49	$ 1.19	$ 0.39	$ 0.02	$ 0.56	$ 3.06	
12	IOU	2018	$ 4.92	$ 1.41	$ 0.49	$ 1.19	$ 0.39	$ 0.02	$ 0.56	$ 3.06	
13	IOU	2019	$ 4.92	$ 1.41	$ 0.49	$ 1.19	$ 0.39	$ 0.02	$ 0.56	$ 3.06	
14	IOU	2020	$ 4.92	$ 1.41	$ 0.49	$ 1.19	$ 0.39	$ 0.02	$ 0.56	$ 3.06	
15	IOU	2021	$ 4.92	$ 1.41	$ 0.49	$ 1.19	$ 0.39	$ 0.02	$ 0.56	$ 3.06	
16	IOU	2022	$ 4.92	$ 1.41	$ 0.49	$ 1.19	$ 0.39	$ 0.02	$ 0.56	$ 3.06	
17	IOU	2023	$ 4.92	$ 1.41	$ 0.49	$ 1.19	$ 0.39	$ 0.02	$ 0.56	$ 3.06	
18	IOU	2024	$ 4.92	$ 1.41	$ 0.49	$ 1.19	$ 0.39	$ 0.02	$ 0.56	$ 3.06	
19	IOU	2025	$ 4.92	$ 1.41	$ 0.49	$ 1.19	$ 0.39	$ 0.02	$ 0.56	$ 3.06	
20	IOU	2026	$ 4.92	$ 1.41	$ 0.49	$ 1.19	$ 0.39	$ 0.02	$ 0.56	$ 3.06	
21	IOU	2027	$ 4.92	$ 1.41	$ 0.49	$ 1.19	$ 0.39	$ 0.02	$ 0.56	$ 3.06	
22	IOU	2028	$ 4.92	$ 1.41	$ 0.49	$ 1.19	$ 0.39	$ 0.02	$ 0.56	$ 3.06	
23	IOU	2029	$ 4.92	$ 1.41	$ 0.49	$ 1.19	$ 0.39	$ 0.02	$ 0.56	$ 3.06	
24	IOU	2030	$ 4.92	$ 1.41	$ 0.49	$ 1.19	$ 0.39	$ 0.02	$ 0.56	$ 3.06	
25	IOU	2031	$ 4.92	$ 1.41	$ 0.49	$ 1.19	$ 0.39	$ 0.02	$ 0.56	$ 3.06	

Env Benefits | Marg Elec EI by Measure | All EI | Monthly Water Svgs | Env Ben | **Water Capacity AC** | Water Svgs Profiles | IOU A

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