WEN Calculator Usage Reconsideration

April 18, 2017

RMS ENERGY CONSULTING, LLC

Issue Statements

1. Whether changing the ***Marginal Supply of Water*** within the WEN calculator rises to the level of departing from the default values approved by the CPUC in D.15.09.023?

2. Whether the WEN Calculator is correctly calculating the ***Annual Embedded IOU Electric Energy Savings***?

3. Whether the use of the WEN Calculator should be reconsidered to a more simplified version of the calculator?

Changing Marginal Supply of Water

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CPUC Decision 15-09-023 Regarding Tools for Calculating the Embedded Energy in Water

- Energy efficiency Program Administrators shall use the Water-Energy Calculator and the Avoided Water Capacity Cost Model in preparing their requests for ratepayer funding for measures/programs that reduce water use and thus save embedded energy.

- Energy efficiency Program Administrators (PAs) ***may depart from*** the Water-Energy Calculator and the Avoided Water Capacity Cost Model (collectively, tools) ***defaults where the tools allow***. Where PAs depart from default values, they bear the burden of proving the departure(s) reasonable in all documents submitted to Commission Staff.

- When ***overriding default values*** in the Water-Energy Calculator and the Avoided Water Capacity Cost Model (collectively, tools), ***users should continue to use values for a marginal supply; rather than for historical/existing supplies***, when using the tools in connection with anything that the Commission is reviewing in a proceeding or advice letter.

In adopting the Calculator, the CPUC allowed Users to override the following variables

- Merely changing the marginal supply of water dropdown, on the input tab of the WEN Calculator, ***DOES NOT*** depart from the default values because:

  - ***All marginal supplies of water*** documented in the Navigant Report including but not limited to recycled, groundwater, brackerish desal, and seawater desal were approved by the CPUC as defaults as dropdown selections on the input tab of the WEN Calculator.

  - The default value for water supply. "This feature allows users to enter data for a variety of marginal water supply options, e.g. recycled water with or without purple pipe, desalination, etc. This will allow users to enter marginal supply options that may be most appropriate for their local circumstances. ***When overriding default values, users should continue to use values for a marginal supply; rather than for historical/existing supplies***."

  - IOUs would have to bear the burden of proving the departure from default values when IOUs change the default supply type percentages
    - (i.e. Seawater Desal %IOU default is 94% and IOU decides to change the IOU% to 100%).
    - Ii.e. changing the energy intensity of conventional treatment from 142 kWh/AF to 300 kWh/AF)

Correctly Calculating Annual Embedded IOU Electric Energy Savings?

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WEN Cost-Effectiveness Analysis Revised Final Report April 2015

Originally Overestimated Savings

Table 20. Illustrative Example Measure Analysis Results – Optimistic Conditions

Region	Annual Savings (gallons)	Equipment Cost (2016$)	Program Admin Cost (2016$)	Installation Cost (2016$)	Effective Useful Life (years)	Average Annual IOU Embedded Energy Savings (kWh)	Average Annual Non-IOU Embedded Energy Savings (kWh)	Net Present IOU Avoided Electric Embedded Energy Benefits (2014$)	Net Present Avoided Water Capacity Benefits (2014$)	Net Present Avoided Wastewater Capacity Benefits (2014$)	Combined Total Resource Cost Test Result
NC	8,000	$200	$75	$150	25	50.54	2.74	$76.01	$90.11	$628.27	2.14
SF	8,000	$200	$75	$150	25	62.83	7.52	$91.42	$90.11	$628.27	2.18
CC	8,000	$200	$75	$150	25	49.86	7.47	$76.01	$90.11	$628.27	2.14
SC	8,000	$200	$75	$150	25	53.10	38.44	$76.01	$90.11	$628.27	2.14
SR	8,000	$200	$75	$150	25	40.96	2.11	$61.54	$90.11	$628.27	2.10
SJ	8,000	$200	$75	$150	25	40.42	2.62	$61.54	$90.11	$628.27	2.10
TL	8,000	$200	$75	$150	25	40.09	4.95	$61.54	$90.11	$628.27	2.10
NL	8,000	$200	$75	$150	25	41.01	2.04	$61.54	$90.11	$628.27	2.10
SL	8,000	$200	$75	$150	25	49.50	16.37	$76.01	$90.11	$628.27	2.14
CR	8,000	$200	$75	$150	25	41.94	3.59	$61.54	$90.11	$628.27	2.10

Hydrologic Region Abbreviations:
NC = North Coast, SF = San Francisco Bay, CC = Central Coast, SC = South Coast, SR = Sacramento River, SJ = San Joaquin River, TL = Tulare Lake, NL = North Lahontan, SL = South Lahontan, CR = Colorado River
Source: Navigant analysis using the Water-Energy Calculator

WEN Cost-Effectiveness Analysis
ERRATA to Revised Final Report May 2015

Table ES-5. Illustrative Example Measure Analysis Results – Optimistic Conditions

Region	Annual Savings (gallons)	Equipment Cost (2016$)	Program Admin Cost (2016$)	Installation Cost (2016$)	Effective Useful Life (years)	Average Annual IOU Embedded Energy Savings (kWh)	Average Annual Non-IOU Embedded Energy Savings (kWh)	Net Present IOU Avoided Electric Embedded Energy Benefits (2014$)	Net Present Avoided Water Capacity Benefits (2014$)	Net Present Avoided Wastewater Capacity Benefits (2014$)	Combined Total Resource Cost Test Result
NC	8,000	$200	$75	$150	25	18.65	1.38	$36.15	$90.11	$628.27	2.03
SF	8,000	$200	$75	$150	25	21.70	5.58	$41.18	$90.11	$628.27	2.04
CC	8,000	$200	$75	$150	25	20.60	6.28	$36.15	$90.11	$628.27	2.03
SC	8,000	$200	$75	$150	25	20.76	37.06	$36.15	$90.11	$628.27	2.03
SR	8,000	$200	$75	$150	25	15.38	1.16	$31.44	$90.11	$628.27	2.02
SJ	8,000	$200	$75	$150	25	15.82	1.73	$31.44	$90.11	$628.27	2.02
TL	8,000	$200	$75	$150	25	15.97	4.09	$31.44	$90.11	$628.27	2.02
NL	8,000	$200	$75	$150	25	16.54	1.16	$31.44	$90.11	$628.27	2.02
SL	8,000	$200	$75	$150	25	19.67	15.15	$36.15	$90.11	$628.27	2.03
CR	8,000	$200	$75	$150	25	14.98	2.55	$31.44	$90.11	$628.27	2.02

Hydrologic Region Abbreviations:
NC = North Coast, SF = San Francisco Bay, CC = Central Coast, SC = South Coast, SR = Sacramento River, SJ = San Joaquin River, TL = Tulare Lake, NL = North Lahontan, SL = South Lahontan, CR = Colorado River
Source: Navigant analysis using the Water-Energy Calculator

WEN Calculator Input Tab for High Efficiency Toilet Calculation Check

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
1	High Efficiency Toilets	8,000	20	2016	Constant	NC	Urban	Indoor
2	High Efficiency Toilets	8,000	20	2016	Constant	SF	Urban	Indoor
3	High Efficiency Toilets	8,000	20	2016	Constant	CC	Urban	Indoor
4	High Efficiency Toilets	8,000	20	2016	Constant	SC	Urban	Indoor
5	High Efficiency Toilets	8,000	20	2016	Constant	SR	Urban	Indoor
6	High Efficiency Toilets	8,000	20	2016	Constant	SJ	Urban	Indoor
7	High Efficiency Toilets	8,000	20	2016	Constant	TL	Urban	Indoor
8	High Efficiency Toilets	8,000	20	2016	Constant	NL	Urban	Indoor
9	High Efficiency Toilets	8,000	20	2016	Constant	SL	Urban	Indoor
10	High Efficiency Toilets	8,000	20	2016	Constant	CR	Urban	Indoor

WEN Calculator Output Tab for High Efficiency Toilet Calculation Check

1

Average Embedded Energy and Avoided Cost of 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	Average Annual Embedded Non-IOU Electric Energy	Average Annual Embedded Gas Energy	Avoided IOU Electric Energy Cost (2014$)	Avoided Gas Energy Cost (2014$)
1	High Efficiency Toilets	18.65	1.38	-	$31.49	$ -
2	High Efficiency Toilets	21.70	5.58	-	$35.86	$ -
3	High Efficiency Toilets	20.60	6.28	-	$31.49	$ -
4	High Efficiency Toilets	20.76	37.06	-	$31.49	$ -
5	High Efficiency Toilets	15.38	1.16	-	$27.38	$ -
6	High Efficiency Toilets	15.82	1.73	-	$27.38	$ -
7	High Efficiency Toilets	15.97	4.09	-	$27.38	$ -
8	High Efficiency Toilets	16.54	1.16	-	$27.38	$ -
9	High Efficiency Toilets	19.67	15.15	-	$31.49	$ -
10	High Efficiency Toilets	14.98	2.55	-	$27.38	$ -
11		-	-	-	-	-
12		-	-	-	-	-
13		-	-	-	-	-
14		-	-	-	-	-
15		-	-	-	-	-
16		-	-	-	-	-
17		-	-	-	-	-
18		-	-	-	-	-
19		-	-	-	-	-
20		-	-	-	-	-
Total		180.06	76.14	-	$ 298.71	$ -

Matches ERRATA Revised Final Report May 2015 Values on slide 8

WEN Calculator Good Right?

NO!

Underestimates Savings for Indoor Water Use Measures

RMS ENERGY CONSULTING, LLC

WEN Cost-Effectiveness Analysis
ERRATA to Revised Final Report May 2015
Underestimates Savings for Indoor Water Use Measures
How?

Table ES-5. Illustrative Example Measure Analysis Results – Optimistic Conditions

Region	Annual Savings (gallons)	Equipment Cost (2016$)	Program Admin Cost (2016$)	Installation Cost (2016$)	Effective Useful Life (years)	Average Annual IOU Embedded Energy Savings (kWh)	Average Annual Non-IOU Embedded Energy Savings (kWh)	Net Present IOU Avoided Electric Embedded Energy Benefits (2014$)	Net Present Avoided Water Capacity Benefits (2014$)	Net Present Avoided Wastewater Capacity Benefits (2014$)	Combined Total Resource Cost Test Result
NC	8,000	$200	$75	$150	25	18.65	1.38	$36.15	$90.11	$628.27	2.03
SF	8,000	$200	$75	$150	25	21.70	5.58	$41.18	$90.11	$628.27	2.04
CC	8,000	$200	$75	$150	25	20.60	6.28	$36.15	$90.11	$628.27	2.03
SC	8,000	$200	$75	$150	25	20.76	37.06	$36.15	$90.11	$628.27	2.03
SR	8,000	$200	$75	$150	25	15.38	1.16	$31.44	$90.11	$628.27	2.02
SJ	8,000	$200	$75	$150	25	15.82	1.73	$31.44	$90.11	$628.27	2.02
TL	8,000	$200	$75	$150	25	15.97	4.09	$31.44	$90.11	$628.27	2.02
NL	8,000	$200	$75	$150	25	16.54	1.16	$31.44	$90.11	$628.27	2.02
SL	8,000	$200	$75	$150	25	19.67	15.15	$36.15	$90.11	$628.27	2.03
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NC = North Coast, SF = San Francisco Bay, CC = Central Coast, SC = South Coast, SR = Sacramento River, SJ = San Joaquin River, TL = Tulare Lake, NL = North Lahontan, SL = South Lahontan, CR = Colorado River
Source: Navigant analysis using the Water-Energy Calculator

Issue 1: Underestimate Savings for Indoor Water Use Measures

- In adopting the Calculator, the CPUC allowed Users to override the resource balance year (e.g. 2016).
  - *"2016 is a reasonable choice for the resources balance year as water agencies and utilities are currently facing choices about where and how they will produce water supply."*

- The WEN Calculator ***incorrectly uses Historical Supply Information*** to calculate Annual Embedded IOU Electric Energy Savings ***because it pulls in the wrong Resource balance year*** (e.g. 2014 instead of 2016).

Issue 1: Underestimates Savings for Indoor Water Use Measures

- Incorrectly uses Historical Supply Information to calculate Annual Embedded IOU Electric Energy Savings for ***Indoor Water Use Measures because it pulls in the wrong Resource balance year.***
  - Input tab shows installation year: 2016
  - WEN Calculator pulls historical supply information assuming the installation year is ***before*** 2016 (pulls 2014 data instead of 2016).
  - Resulting in ***lower*** Annual Embedded IOU Electric Energy savings because the WEN Calculator is pulling the historical average energy intensities (EI) and not the marginal electric EI by measure intensities.

Issue 1: Underestimates Savings for Indoor Water Use Measures

R10 | =IFERROR(IF($B10<$H$1,

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Monthly Marginal EI by Measure						Resource Balance Year	2016					
2													
3		Units: kWh/AF		Measure ID#									
4		Year	Month	1	2	3	4	5	6	7	8	9	10
5		2014	January	760	884	839	845	626	644	650	674	801	610
6		2014	February	760	884	839	845	626	644	650	674	801	610
7		2014	March	760	884	839	845	626	644	650	674	801	610
8		2014	April	760	884	839	845	626	644	650	674	801	610
9		2014	May	760	884	839	845	626	644	650	674	801	610
10		2014	June	760	884	839	845	626	644	650	674	801	610
11		2014	July	760	884	839	845	626	644	650	674	801	610
12		2014	August	760	884	839	845	626	644	650	674	801	610
13		2014	Septembe	760	884	839	845	626	644	650	674	801	610
14		2014	October	760	884	839	845	626	644	650	674	801	610
15		2014	Novembe	760	884	839	845	626	644	650	674	801	610
16		2014	Decembe	760	884	839	845	626	644	650	674	801	610
17		2015	January	760	884	839	845	626	644	650	674	801	610
18		2015	February	760	884	839	845	626	644	650	674	801	610
19		2015	March	760	884	839	845	626	644	650	674	801	610
20		2015	April	760	884	839	845	626	644	650	674	801	610
21		2015	May	760	884	839	845	626	644	650	674	801	610
22		2015	June	760	884	839	845	626	644	650	674	801	610
23		2015	July	760	884	839	845	626	644	650	674	801	610
24		2015	August	760	884	839	845	626	644	650	674	801	610
25		2015	Septembe	760	884	839	845	626	644	650	674	801	610
26		2015	October	760	884	839	845	626	644	650	674	801	610
27		2015	Novembe	760	884	839	845	626	644	650	674	801	610
28		2015	Decembe	760	884	839	845	626	644	650	674	801	610
29		2016	January	1,049	1,195	1,049	1,049	912	912	912	912	1,049	912
30		2016	February	1,049	1,195	1,049	1,049	912	912	912	912	1,049	912
31		2016	March	1,049	1,195	1,049	1,049	912	912	912	912	1,049	912
32		2016	April	1,049	1,195	1,049	1,049	912	912	912	912	1,049	912

Resource Balance Year should be 2016 per the formula

However, based on the final output, the WEN calculator is pulling from the historical supply of 760 and not 1,049 kWh/AF.

Calculator should be pulling 2016 data instead because the resource balance years is 2016 and not 2014

Issue 1: Underestimates Savings for Indoor Water Use Measures

Water Savings Profiles — Click to Return to Inputs tab

Month	Constant	Irrigation	Cooling Tower	Custom 1	Custom 2	Custom 3	Custom 4	Custom 5
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%	13.1%	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)

			Check that Values Add to 100%					
Total Check				Values must add up to 100%	Values must add up to 100%	Values must add up to 100%	Values must add up to 100%	Values must add up to 100%

When calculating embedded energy savings, the WEN Calculator should only use water savings profiles when the resource balance year is 2014 or 2015.

However, despite an install year of 2016, the formulas used to estimate embedded energy incorrectly includes the water savings profile.

Issue 1: Underestimates Savings for Indoor Water Use Measures

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Average Embedded Electrical Energy in Water Savings by Measure												
2													
3	Units: kWh												
4				Measure ID#									
5	IOU vs. Non-IOU	Year	Month	1	2	3	4	5	6	7	8	9	10
6	IOU	2014	January	1.55	1.81	1.72	1.73	1.28	1.32	1.33	1.38	1.64	1.25
7	IOU	2014	February	1.55	1.81	1.72	1.73	1.28	1.32	1.33	1.38	1.64	1.25
8	IOU	2014	March	1.55	1.81	1.72	1.73	1.28	1.32	1.33	1.38	1.64	1.25
9	IOU	2014	April	1.55	1.81	1.72	1.73	1.28	1.32	1.33	1.38	1.64	1.25
10	IOU	2014	May	1.55	1.81	1.72	1.73	1.28	1.32	1.33	1.38	1.64	1.25
11	IOU	2014	June	1.55	1.81	1.72	1.73	1.28	1.32	1.33	1.38	1.64	1.25
12	IOU	2014	July	1.55	1.81	1.72	1.73	1.28	1.32	1.33	1.38	1.64	1.25
13	IOU	2014	August	1.55	1.81	1.72	1.73	1.28	1.32	1.33	1.38	1.64	1.25
14	IOU	2014	September	1.55	1.81	1.72	1.73	1.28	1.32	1.33	1.38	1.64	1.25
15	IOU	2014	October	1.55	1.81	1.72	1.73	1.28	1.32	1.33	1.38	1.64	1.25
16	IOU	2014	November	1.55	1.81	1.72	1.73	1.28	1.32	1.33	1.38	1.64	1.25
17	IOU	2014	December	1.55	1.81	1.72	1.73	1.28	1.32	1.33	1.38	1.64	1.25
18	Non-IOU	2014	January	0.12	0.46	0.52	3.09	0.10	0.14	0.34	0.10	1.26	0.21
19	Non-IOU	2014	February	0.12	0.46	0.52	3.09	0.10	0.14	0.34	0.10	1.26	0.21
20	Non-IOU	2014	March	0.12	0.46	0.52	3.09	0.10	0.14	0.34	0.10	1.26	0.21
21	Non-IOU	2014	April	0.12	0.46	0.52	3.09	0.10	0.14	0.34	0.10	1.26	0.21
22	Non-IOU	2014	May	0.12	0.46	0.52	3.09	0.10	0.14	0.34	0.10	1.26	0.21

Information | Inputs | Water IOU Data | Glossary | Summary Outputs | Avg Embedded Electric Svgs | Avg Embedded Gas Svgs

Ready

Average: 1.55 Count: 12 Sum: 18.65

WEN Calculator sums up the monthly average embedded electrical energy for the wrong resource balance year (2014 instead of 2016)

The sum matches the output values shown in slides 10 and 12.

The WEN should be summing 2016 monthly Electric Energy Savings data not summing 2014 Electric Energy Savings data as shown here.

Issue 1: Underestimates Savings for Indoor Water Use Measures

- Embedded Energy Savings (kWh) for **Indoor Urban High Efficiency Toilets** using Recycled Water (RW) Marginal Supply
  - 8,000 gallons saved*
  - (1/325,851 AF/gallon) *
  - 8.3% constant load profile (2014 data)*
  - 760 kWh/AF (2014 Monthly Energy Intensity data)*
  - 12 Months

END RESULT = 18.6 kWh Annual Embedded Energy Savings

(same as output on the Navigant Report and output on the WEN Calculator)

Theoretical Calculations for Annual IOU Embedded Electric Energy

- Embedded Energy Savings (kWh) =

- Gallons saved *
- conversion from gallons to Acre Feet *
- Marginal Supply Energy Intensity (kWh/AF)

Sample Calculation Annual IOU Embedded Electric Energy for High Efficiency Toilet

- Embedded Energy Savings (kWh) =

- 8,000 Gallons saved *(1 AF/325,851 gallons)* 1,049 kWh/AF (Marginal Supply EI of Recycled Water for North Coast Hydro Region)

- **25.7 kWh** Annual IOU Embedded Electric Energy Savings

- **The WEN Calculator is reporting 18.6 kWh** based on incorrect assumptions including resource balance year, average energy intensities and water savings profiles not applicable to the calculation.

- The WEN Calculator is not correctly calculating the embedded savings because it is pulling the average energy intensities and not the marginal electric EI by measure intensities due to the incorrect resource balance year.

Overestimates Savings for Outdoor Water Use Measures

RMS ENERGY CONSULTING, LLC

Issue 2: Overestimates Savings for Outdoor Water Use Measures

- Embedded Energy Savings (kWh) for **Outdoor Irrigation Soil Moisture Sensor (each; < 1 acre)** using Recycled Water (RW) Marginal Supply and **Conventional Treatment** for RW
  - 13,490 gallons saved*
  - (1/325,851 AF/gallon) *
  - [irrigation load profile changes based on month (2014 data)]*
  - **354** kWh/AF (2014 Monthly Energy Intensity data for North Coast)

END RESULT =

0.47+0.36+0.61+1.28+1.76+1.97+2.12+1.88+1.68+1.3+0.96+0.26 kWh

END RESULT = 14.66 kWh Annual Embedded Energy Savings

WEN Calculator Input Tab for Soil Moisture Sensor (each; < 1 acre)

Calculation Check

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
1	Soil Moisture Sensor (each; < 1 acre)	13,490	10	2016	Irrigation	NC	Urban	Outdoor
2	Soil Moisture Sensor (each; < 1 acre)	13,490	10	2016	Irrigation	SF	Urban	Outdoor
3	Soil Moisture Sensor (each; < 1 acre)	13,490	10	2016	Irrigation	CC	Urban	Outdoor
4	Soil Moisture Sensor (each; < 1 acre)	13,490	10	2016	Irrigation	SC	Urban	Outdoor
5	Soil Moisture Sensor (each; < 1 acre)	13,490	10	2016	Irrigation	SR	Urban	Outdoor
6	Soil Moisture Sensor (each; < 1 acre)	13,490	10	2016	Irrigation	SJ	Urban	Outdoor
7	Soil Moisture Sensor (each; < 1 acre)	13,490	10	2016	Irrigation	TL	Urban	Outdoor
8	Soil Moisture Sensor (each; < 1 acre)	13,490	10	2016	Irrigation	NL	Urban	Outdoor
9	Soil Moisture Sensor (each; < 1 acre)	13,490	10	2016	Irrigation	SL	Urban	Outdoor
10	Soil Moisture Sensor (each; < 1 acre)	13,490	10	2016	Irrigation	CR	Urban	Outdoor

WEN Calculator Input Tab for Soil Moisture Sensor (each; < 1 acre)

Calculation Check

1

Average Embedded Energy and Avoided Cost of 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	Average Annual Embedded Non-IOU Electric Energy	Average Annual Embedded Gas Energy	Avoided IOU Electric Energy Cost (2014$)	Avoided Gas Energy Cost (2014$)
1	Soil Moisture Sensor (each; < 1	14.66	1.81	-	$21.80	$ -
2	Soil Moisture Sensor (each; < 1	19.80	8.88	-	$26.74	$ -
3	Soil Moisture Sensor (each; < 1	17.94	10.07	-	$21.80	$ -
4	Soil Moisture Sensor (each; < 1	18.20	61.97	-	$21.80	$ -
5	Soil Moisture Sensor (each; < 1	9.13	1.44	-	$17.16	$ -
6	Soil Moisture Sensor (each; < 1	9.88	2.40	-	$17.16	$ -
7	Soil Moisture Sensor (each; < 1	10.13	6.37	-	$17.16	$ -
8	Soil Moisture Sensor (each; < 1	11.10	1.44	-	$17.16	$ -
9	Soil Moisture Sensor (each; < 1	16.38	25.02	-	$21.80	$ -
10	Soil Moisture Sensor (each; < 1	8.46	3.78	-	$17.16	$ -
11		-	-	-	-	-
12		-	-	-	-	-
13		-	-	-	-	-
14		-	-	-	-	-
15		-	-	-	-	-
16		-	-	-	-	-
17		-	-	-	-	-
18		-	-	-	-	-
19		-	-	-	-	-
20		-	-	-	-	-
Total		135.68	123.19	-	$ 199.74	$ -

Sample Calculation Annual IOU Embedded Electric Energy for Soil Moisture Sensor (each; < 1 acre)

- Embedded Energy Savings (kWh) =

- 13,490 Gallons saved *(1 AF/325,851 gallons)* 155 kWh/AF
(Marginal Supply EI of **Recycled Water** for North Coast Hydro Region)

- **6.42 kWh** Annual IOU Embedded Electric Energy Savings

- **The WEN Calculator is reporting 14.66 kWh** based on incorrect assumptions to include conventional tertiary treatment as part of potable treatment for recycled water resulting in overestimated EI's for outdoor use measures.

- The WEN Calculator is not correctly calculating the embedded savings because it is pulling the average energy intensities and water savings profiles and not the marginal electric EI by measure intensities due to the incorrect resource balance year selection being hard coded.

Sample Calculation Annual IOU Embedded Electric Energy for Soil Moisture Sensor (each; < 1 acre)

- Embedded Energy Savings (kWh) =

- 13,490 Gallons saved *(1 AF/325,851 gallons)* 260kWh/AF (Marginal Supply EI of **Groundwater** for North Coast Hydro Region)

- **10.76 kWh** Annual IOU Embedded Electric Energy Savings

- **The WEN Calculator reports 14.66 kWh despite changing the marginal supply to Groundwater** based on incorrect assumptions including resource balance year, average energy intensities and water savings profiles not applicable to the calculation.

- The WEN Calculator is not correctly calculating the embedded savings because it is pulling the average energy intensities and not the marginal electric EI by measure intensities due to the incorrect resource balance year.

Underestimates Savings when Changing Treatment from Conventional to Membrane

RMS ENERGY CONSULTING, LLC

Issue 3: Underestimates Savings when Changing Treatment from Conventional to Membrane

- Embedded Energy Savings (kWh) for **Outdoor Irrigation Soil Moisture Sensor (each; < 1 acre)** using Recycled Water Marginal Supply and changes to Conventional Treatment to **Membrane Treatment**
  - 13,490 gallons saved*
  - (1/325,851 AF/gallon) *
  - [irrigation load profile changes based on month (2014 data)]*
  - **504** kWh/AF (2014 Monthly Energy Intensity data for North Coast)

END RESULT =

0.67+0.51+0.87+1.82+2.50+2.81+3.02+2.68+2.40+1.86+1.37+0.37 kWh

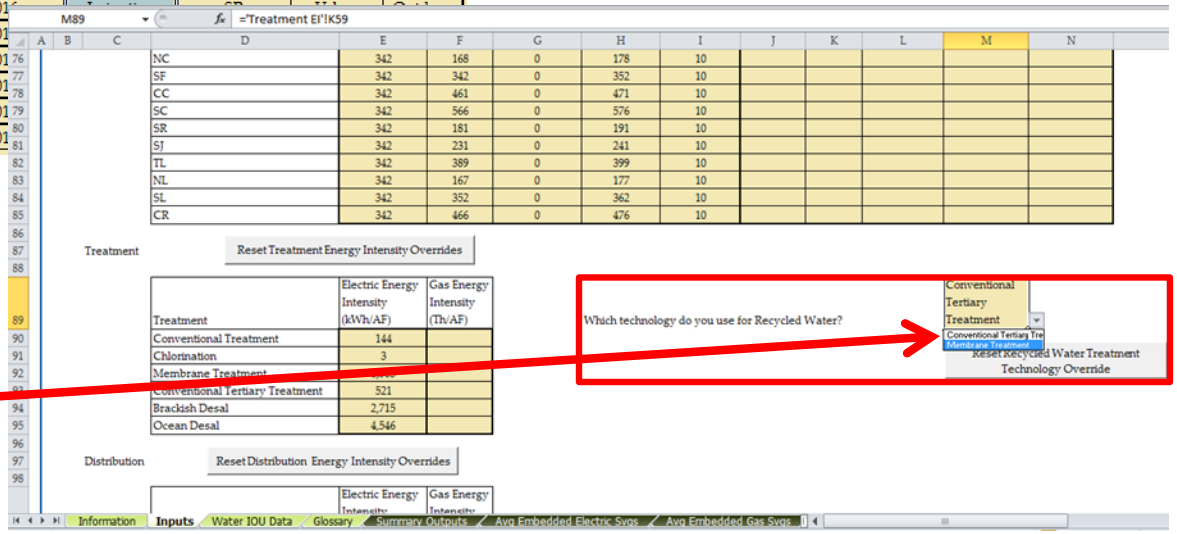
END RESULT = 20.86 kWh Annual Embedded Energy Savings

WEN Calculator Input Tab for Soil Moisture Sensor (each; < 1 acre) Calculation Check

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
1	Soil Moisture Sensor (each; < 1 acre)	13,490	10	2016	Irrigation	NC	Urban	Outdoor
2	Soil Moisture Sensor (each; < 1 acre)	13,490	10	2016	Irrigation	SF	Urban	Outdoor
3	Soil Moisture Sensor (each; < 1 acre)	13,490	10	2016	Irrigation	CC	Urban	Outdoor
4	Soil Moisture Sensor (each; < 1 acre)	13,490	10	2016	Irrigation	SC	Urban	Outdoor
5	Soil Moisture Sensor (each; < 1 acre)	13,490	10	201				
6	Soil Moisture Sensor (each; < 1 acre)	13,490	10	201				
7	Soil Moisture Sensor (each; < 1 acre)	13,490	10	201				
8	Soil Moisture Sensor (each; < 1 acre)	13,490	10	201				
9	Soil Moisture Sensor (each; < 1 acre)	13,490	10	201				
10	Soil Moisture Sensor (each; < 1 acre)	13,490	10	201				



Changing Treatment Dropdown from Conventional to Membrane on Input Tab of WEN Calculator

WEN Calculator Input Tab for Soil Moisture Sensor (each; < 1 acre)

Calculation Check

1 **Average Embedded Energy and Avoided Cost of 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	Average Annual Embedded Non-IOU Electric Energy	Average Annual Embedded Gas Energy	Avoided IOU Electric Energy Cost (2014$)	Avoided Gas Energy Cost (2014$)
1	Soil Moisture Sensor (each; < 1	20.86	2.21	-	$46.70	$ -
2	Soil Moisture Sensor (each; < 1	20.78	8.94	-	$51.64	$ -
3	Soil Moisture Sensor (each; < 1	20.46	10.23	-	$46.70	$ -
4	Soil Moisture Sensor (each; < 1	21.24	62.16	-	$46.70	$ -
5	Soil Moisture Sensor (each; < 1	15.28	1.83	-	$42.07	$ -
6	Soil Moisture Sensor (each; < 1	16.97	2.85	-	$42.07	$ -
7	Soil Moisture Sensor (each; < 1	13.66	6.60	-	$42.07	$ -
8	Soil Moisture Sensor (each; < 1	21.47	2.10	-	$42.07	$ -
9	Soil Moisture Sensor (each; < 1	21.09	25.32	-	$46.70	$ -
10	Soil Moisture Sensor (each; < 1	11.81	4.00	-	$42.07	$ -
11		-	-	-	-	-
12		-	-	-	-	-
13		-	-	-	-	-
14		-	-	-	-	-
15		-	-	-	-	-
16		-	-	-	-	-
17		-	-	-	-	-
18		-	-	-	-	-
19		-	-	-	-	-
20		-	-	-	-	-
Total		183.63	126.25	-	$ 448.80	$ -

WEN Calculator Input Tab for Soil Moisture Sensor (each; < 1 acre)

Calculation Check

Z5 =SUMIFS('Distribution EI'!$D$7:$D$26,'Distribution EI'!$A$7:$A$26,$E5,'Distribution EI'!$B$7:$B$26,$A5)

	Extraction and Conveyance							Treatment											
	Recycled Water	Groundwater	Local Deliveries	Local Imported Deliveries	CRA	CVP and Other Federal	SWP	Seawater Desal	Brackish Desal	Recycled Water	Groundwater	Local Deliveries	Local Imported Deliveries	CRA	CVP and Other Federal	SWP	Seawater Desal	Brackish Desal	Recycled Water
5	-	105	3	3	-	-	-	4,273	2,552	1,225	3	136	136	136	136	136	153	153	153
6	-	208	3	12	-	-	-	4,273	2,552	1,225	3	136	136	136	136	136	153	153	153
7	-	278	3	-	-	-	-	4,273	2,552	1,225	3	136	136	136	136	136	153	153	153
8	-	340	3	3	-	-	-	4,273	2,552	1,225	3	136	136	136	136	136	153	153	153
9	-	113	3	-	-	-	-	4,273	2,552	1,225	3	136	136	136	136	136	17	17	17
10	-	142	3	-	-	-	-	4,273	2,552	1,225	3	136	136	136	136	136	17	17	17
11	-	235	3	-	-	-	-	4,273	2,552	1,225	3	136	136	136	136	136	17	17	17
12	-	104	3	-	-	-	-	4,273	2,552	1,225	3	136	136	136	136	136	17	17	17
13	-	214	3	-	-	-	-	4,273	2,552	1,225	3	136	136	136	136	136	153	153	153
14	-	281	3	-	-	-	-	4,273	2,552	1,225	3	136	136	136	136	136	17	17	17
15	-	105	3	3	-	-	-	4,273	2,552	1,225	-	-	-	-	-	-	153	153	153
16	-	208	3	12	-	-	-	4,273	2,552	1,225	-	-	-	-	-	-	299	299	299
17	-	278	3	-	-	-	-	4,273	2,552	1,225	-	-	-	-	-	-	153	153	153
18	-	340	3	3	-	-	-	4,273	2,552	1,225	-	-	-	-	-	-	153	153	153
19	-	113	3	-	-	-	-	4,273	2,552	1,225	-	-	-	-	-	-	17	17	17
20	-	142	3	-	-	-	-	4,273	2,552	1,225	-	-	-	-	-	-	17	17	17
21	-	235	3	-	-	-	-	4,273	2,552	1,225	-	-	-	-	-	-	17	17	17
22	-	104	3	-	-	-	-	4,273	2,552	1,225	-	-	-	-	-	-	17	17	17
23	-	214	3	-	-	-	-	4,273	2,552	1,225	-	-	-	-	-	-	153	153	153
24	-	281	3	-	-	-	-	4,273	2,552	1,225	-	-	-	-	-	-	17	17	17
25	-	105	3	3	-	-	-	4,273	2,552	1,225	3	136	136	136	136	136	153	153	153
26	-	208	3	12	-	-	-	4,273	2,552	1,225	3	136	136	136	136	136	299	299	299
27	-	278	3	-	-	-	-	4,273	2,552	1,225	3	136	136	136	136	136	153	153	153
28	-	340	3	3	-	-	-	4,273	2,552	1,225	3	136	136	136	136	136	153	153	153
29	-	113	3	-	-	-	-	4,273	2,552	1,225	3	136	136	136	136	136	17	17	17
30	-	142	3	-	-	-	-	4,273	2,552	1,225	3	136	136	136	136	136	17	17	17

AC Water Capacity | AC WW Capacity | Env Benefits | Marg Elec EI by Measure | All EI | Monthly Water Svgs | Env Ben | Wat

Ready Average: 460 Sum: 1,379 68%

The correct sum of outdoor EI's = Extraction and Conveyance, Treatment and Distribution should be 1,379 kWh/AF (0+1,225+153) for Membrane Treatment.

Sample Calculation Annual IOU Embedded Electric Energy for Soil Moisture Sensor (each; < 1 acre)

- Embedded Energy Savings (kWh) =

- 13,490 Gallons saved *(1 AF/325,851 gallons)* 1,379 kWh/AF (Marginal Supply EI of **Recycled Water** for North Coast Hydro Region)

- **57.08 kWh** Annual IOU Embedded Electric Energy Savings

- **The WEN Calculator is reporting 20.86 kWh** based on incorrect assumptions including resource balance year, average energy intensities and water savings profiles not applicable to the calculation.

- The WEN Calculator is not correctly calculating the embedded savings because it is pulling the average energy intensities and not the marginal electric EI by measure intensities due to the incorrect resource balance year.

Non-IOU Energy Intensities for 2 Hydro Zones Appear Significantly High

RMS ENERGY CONSULTING, LLC

Issue 4: Non-IOU Energy Intensities for 2 Hydro Zones Appear Significantly High

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Historical Energy Intensity															
2																
3	Model Data															
4																
5	Electric Energy Intensity (kWh/AF)					Extraction + Conveyance, Treatment, and Distribution										
6	Region	Year	Urban vs. Ag	Indoor vs. Outdoor	IOU vs. Non-IOU	Seawater Desal	Brackish Desal	Recycled Water	Groundwater	Local Deliveries	Local Imported Deliveries	CRA	CVP and Other Federal Deliveries	SWP	WW Systems	Total
47	NC	2014	Urban	Indoor	Non-IOU	-	-	8	24	7	0	-	4	-	13	56
48	SF	2014	Urban	Indoor	Non-IOU	0	1	2	31	5	22	-	37	116	13	227
49	CC	2014	Urban	Indoor	Non-IOU	-	-	3	161	1	-	-	20	58	13	256
50	SC	2014	Urban	Indoor	Non-IOU	-	4	4	76	1	1	531	0	879	13	1,509
51	SR	2014	Urban	Indoor	Non-IOU	-	-	7	16	5	-	-	7	0	13	47
52	SJ	2014	Urban	Indoor	Non-IOU	-	-	8	31	5	0	-	14	1	13	71
53	TL	2014	Urban	Indoor	Non-IOU	-	-	4	82	3	0	-	28	38	13	167
54	NL	2014	Urban	Indoor	Non-IOU	-	-	11	16	7	-	-	-	-	13	47
55	SL	2014	Urban	Indoor	Non-IOU	-	-	6	101	2	-	-	-	495	13	617
56	CR	2014	Urban	Indoor	Non-IOU	-	-	4	17	0	-	8	-	63	13	104

Hydro Zones SC and SL have significantly higher kWh/AF Energy Intensities compared to the other 8 hydro zones

Issue 4: Non-IOU Energy Intensities for 2 Hydro Zones Appear Significantly High

1

Average Embedded Energy and Avoided Cost of Embedded Energy

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

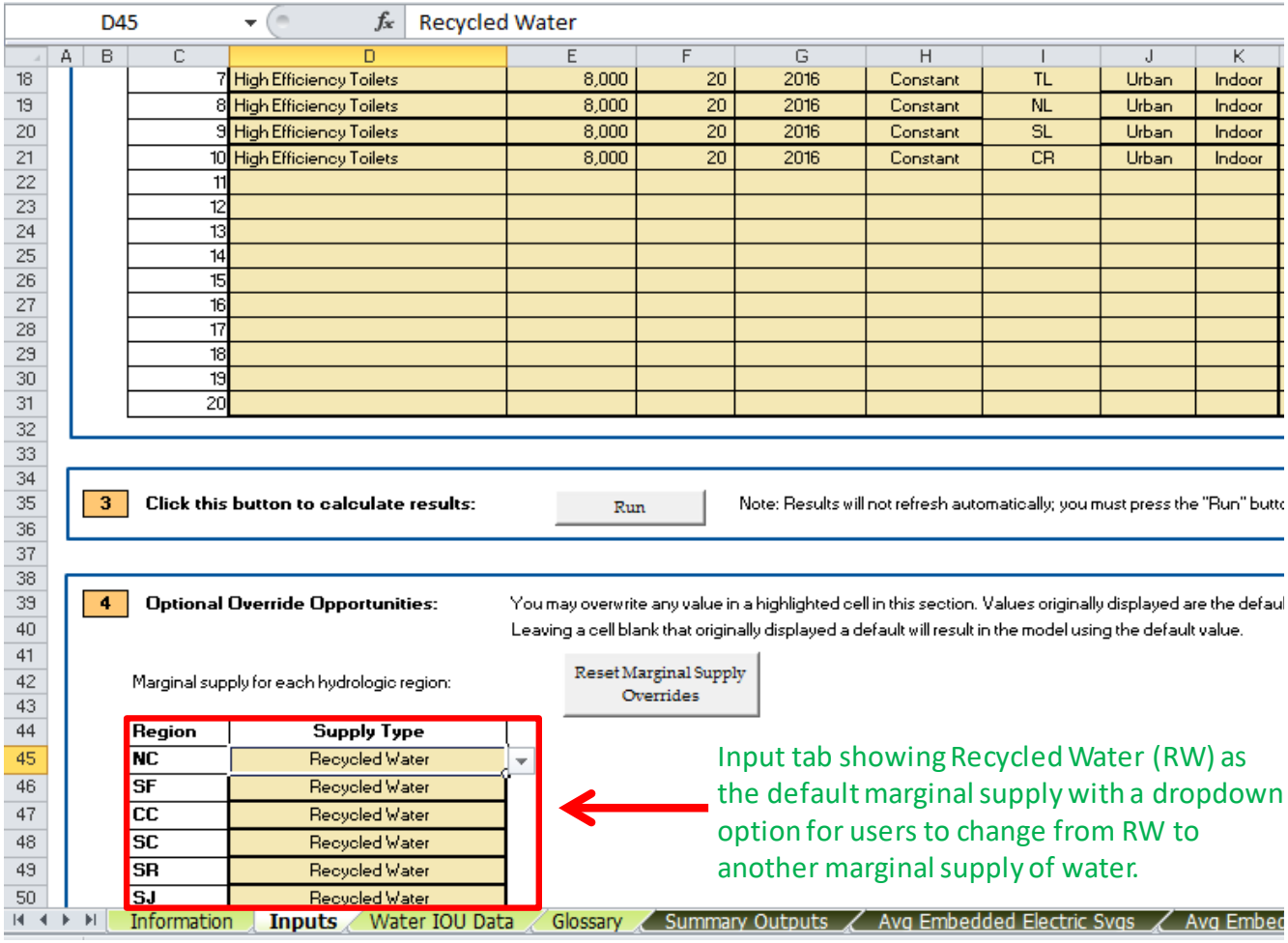
Measure ID#	Measure Name	Average Annual Embedded IOU Electric Energy (kWh)	Average Annual Embedded Non-IOU Electric Energy (kWh)	Average Annual Embedded Gas Energy (therms)	Avoided IOU Electric Energy Cost (2014$)	Avoided Gas Energy Cost (2014$)
1	High Efficiency Toilets	18.65	1.38	-	$31.49	$ -
2	High Efficiency Toilets	21.70	5.58	-	$35.86	$ -
3	High Efficiency Toilets	20.60	6.28	-	$31.49	$ -
4	High Efficiency Toilets	20.76	37.06	-	$31.49	$ -
5	High Efficiency Toilets	15.38	1.16	-	$27.38	$ -
6	High Efficiency Toilets	15.82	1.73	-	$27.38	$ -
7	High Efficiency Toilets	15.97	4.09	-	$27.38	$ -
8	High Efficiency Toilets	16.54	1.16	-	$27.38	$ -
9	High Efficiency Toilets	19.67	15.15	-	$31.49	$ -
10	High Efficiency Toilets	14.98	2.55	-	$27.38	$ -

Significantly Higher Energy Intensities for Hydro Zones SC and SL compared to the other 8 hydro zones regardless of marginal supply results in **HIGHER** Annual Embedded **Non-IOU** Electric Energy Savings (kWh) **BUT NOT HIGHER** Annual Embedded **IOU** Electric Energy Savings (kWh).
That doesn't seem right.

Changing Marginal Supply Changes Avoided Costs but not Embedded Energy Savings

RMS ENERGY CONSULTING, LLC

Issue 5: Changing Marginal Supply Changes Avoided Costs but not Embedded Energy Savings



Input tab showing Recycled Water (RW) as the default marginal supply with a dropdown option for users to change from RW to another marginal supply of water.

Issue 5: Changing Marginal Supply Changes Avoided Costs but not Embedded Energy Savings

1

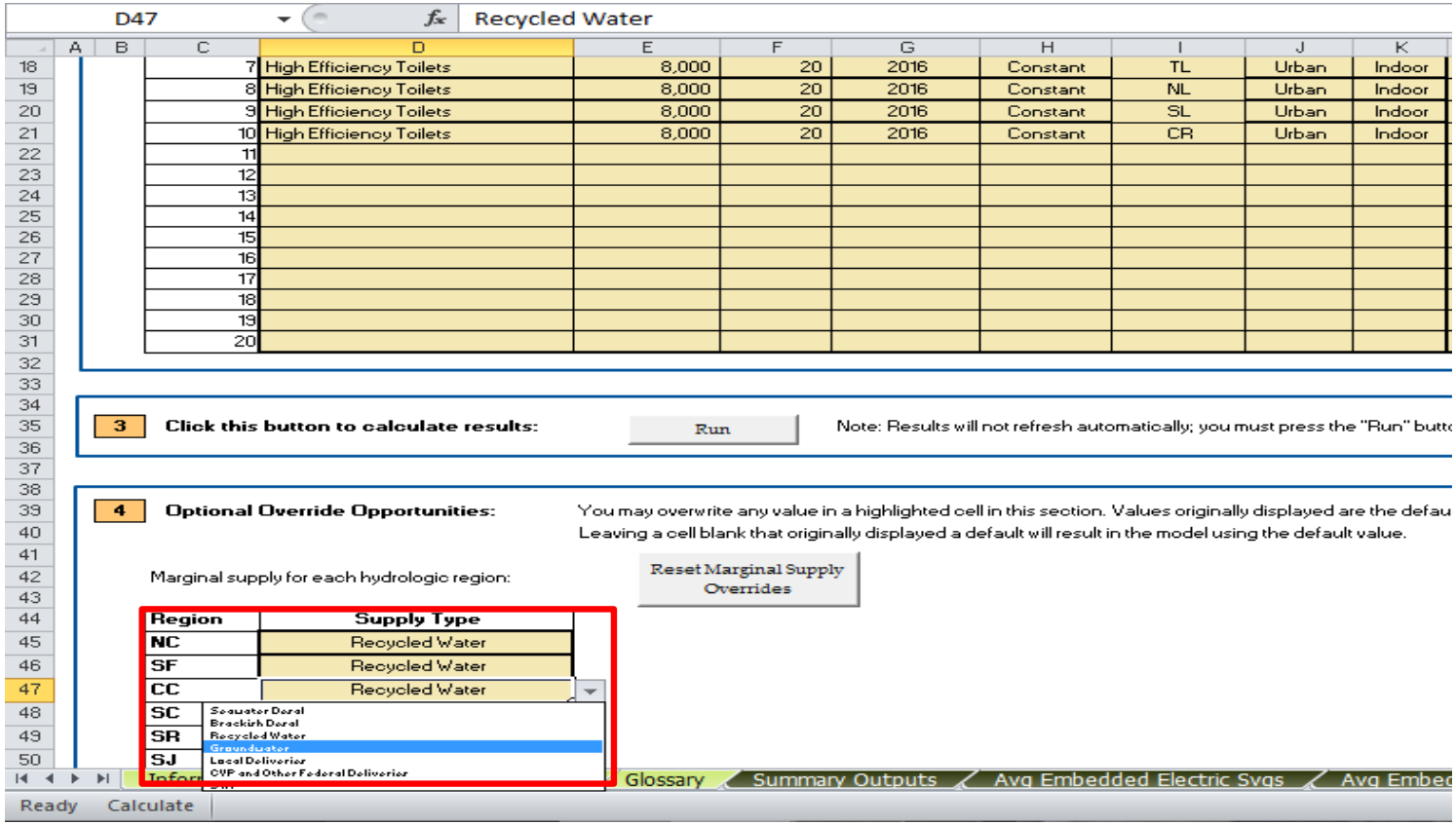
Average Embedded Energy and Avoided Cost of Embedded Energy

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	Average Annual Embedded Non-IOU Electric Energy	Average Annual Embedded Gas Energy	Avoided IOU Electric Energy Cost (2014$)	Avoided Gas Energy Cost (2014$)
1	High Efficiency Toilets	18.65	1.38	-	$31.49	$ -
2	High Efficiency Toilets	21.70	5.58	-	$35.86	$ -
3	High Efficiency Toilets	20.60	6.28	-	$31.49	$ -
4	High Efficiency Toilets	20.76	37.06	-	$31.49	$ -
5	High Efficiency Toilets	15.38	1.16	-	$27.38	$ -
6	High Efficiency Toilets	15.82	1.73	-	$27.38	$ -
7	High Efficiency Toilets	15.97	4.09	-	$27.38	$ -
8	High Efficiency Toilets	16.54	1.16	-	$27.38	$ -
9	High Efficiency Toilets	19.67	15.15	-	$31.49	$ -
10	High Efficiency Toilets	14.98	2.55	-	$27.38	$ -
11		-	-	-	-	-
12		-	-	-	-	-
13		-	-	-	-	-
14		-	-	-	-	-
15		-	-	-	-	-
16		-	-	-	-	-
17		-	-	-	-	-
18		-	-	-	-	-
19		-	-	-	-	-
20		-	-	-	-	-
Total		180.06	76.14	-	$ 298.71	$ -

Results of using the default Recycled Water (RW) marginal supply of water. Changing the Marginal Supply from the default of RW to Groundwater **should increase BOTH** Avoided Costs and Embedded Energy Savings because the Eis are higher for groundwater

Issue 5: Changing Marginal Supply Changes Avoided Costs but not Embedded Energy Savings



Changing the Marginal Supply from the default of Recycled Water to Groundwater
Should Increase BOTH Avoided Costs and Embedded Energy Savings

Issue 5: Changing Marginal Supply Changes Avoided Costs but not Embedded Energy Savings

1 **Average Embedded Energy and Avoided Cost of 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	Average Annual Embedded Non-IOU Electric Energy	Average Annual Embedded Gas Energy	Avoided IOU Electric Energy Cost (2014$)	Avoided Gas Energy Cost (2014$)
1	High Efficiency Toilets	18.65	1.38	-	$133.49	$ -
2	High Efficiency Toilets	21.70	5.58	-	$35.86	$ -
3	High Efficiency Toilets	20.60	6.28	-	$325.46	$ -
4	High Efficiency Toilets	20.76	37.06	-	$394.25	$ -
5	High Efficiency Toilets	15.38	1.16	-	$137.90	$ -
6	High Efficiency Toilets	15.82	1.73	-	$170.66	$ -
7	High Efficiency Toilets	15.97	4.09	-	$274.18	$ -
8	High Efficiency Toilets	16.54	1.16	-	$128.73	$ -
9	High Efficiency Toilets	19.67	15.15	-	$254.04	$ -
10	High Efficiency Toilets	14.98	2.55	-	$324.63	$ -
11		-	-	-	-	-
12		-	-	-	-	-
13		-	-	-	-	-
14		-	-	-	-	-
15		-	-	-	-	-
16		-	-	-	-	-
17		-	-	-	-	-
18		-	-	-	-	-
19		-	-	-	-	-
20		-	-	-	-	-
Total		180.06	76.14	-	$ 2,179.20	$ -

Notice here, changing the Marginal Supply from the default of Recycled Water to Groundwater **ONLY Increased** Avoided Costs **BUT NOT** Embedded Energy Savings

Should WEN Calculator be reconsidered and simplified?

RMS ENERGY CONSULTING, LLC

Recommendations and Rationale

1. WEN Calculator should be reconsidered as the tool to calculate embedded energy savings because the tool

- **underestimates savings for Indoor Water Use Measures** by not accurately calculating savings based on incorrect assumptions including resource balance year, average energy intensities and water savings profiles not applicable to the calculation;
- **overestimates savings for Outdoor Water Use Measures** by including conventional tertiary treatment as part of potable treatment for recycled water resulting in overestimated EI's for outdoor use measures;
- **underestimates savings when Changing Treatment from Conventional to Membrane** based on incorrect assumptions including resource balance year, average energy intensities and water savings profiles not applicable to the calculation;
- appears to calculate higher energy intensities for hydro zones SC and SL regardless of marginal supply resulting in **HIGHER** Annual Embedded for **Non-IOU** Electric Energy Savings (kWh) **BUT NOT HIGHER** Annual Embedded **IOU** Electric Energy Savings (kWh); and
- is calculating **INCREASES** in Avoided Costs **BUT NOT** Embedded Energy Savings when changing marginal supplies.

Recommendations and Rationale

1. A simplified version of the tool can be used based on the CPUC approved energy intensity defaults for each marginal supply only

2. Historical data should not be used anywhere in the calculation as described in D.15.09.023.

3. The WEN Calculator calculates cost-effectiveness and avoided costs that
   - is not well understood;
   - not easily implementable into the CET; and
   - poses unnecessary redundancies in avoided cost and TRC calculations.