This presentation premiered at WaterSmart Innovations

watersmartinnovations.com

Water-Energy Nexus
Survey Pilot Project

Amy Talbot, ISAWWA Water Efficiency Committee Chair

October 5, 2012

Illinois Section
American Water Works Association

Water Efficiency Committee

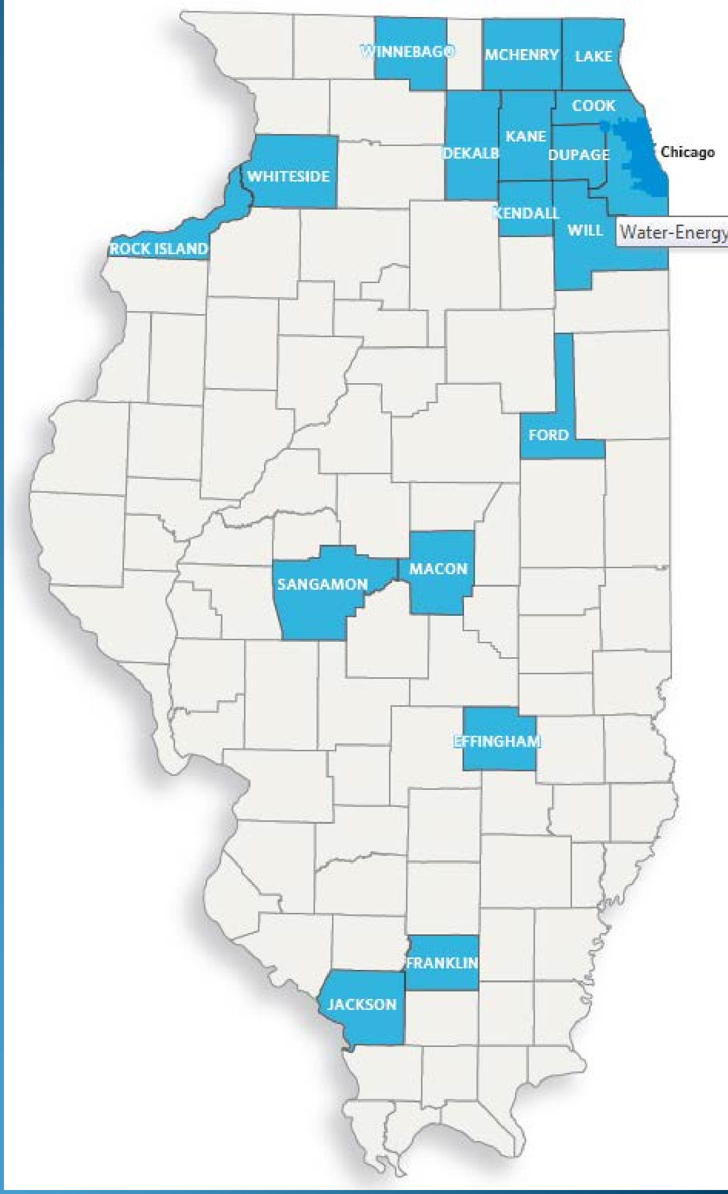
- Formed in 2009
- Over 30 members
  - Utility, non-profit, consultants, and government
- Active volunteer committee
  - Meetings, webinars, presentations, etc.
- Project focused

Water-Energy Nexus Survey

- Why:
  - To better understand the relationship between water and energy in Illinois
  - Energy intensity and cost
  - Educational tool
  - Short- and long-term planning
- Who: Water supply utilities in IL
- What: 2010 data

Survey Respondents

- 52 total
- 44 with usable data
- 5.4 million people, 42%[1]
- 17 counties
- Size
  - Small (18)
  - Medium (15)
  - Large (7)
  - Wholesaler (4)



1 Includes Chicago pop. around 2.7 people.

Survey Components

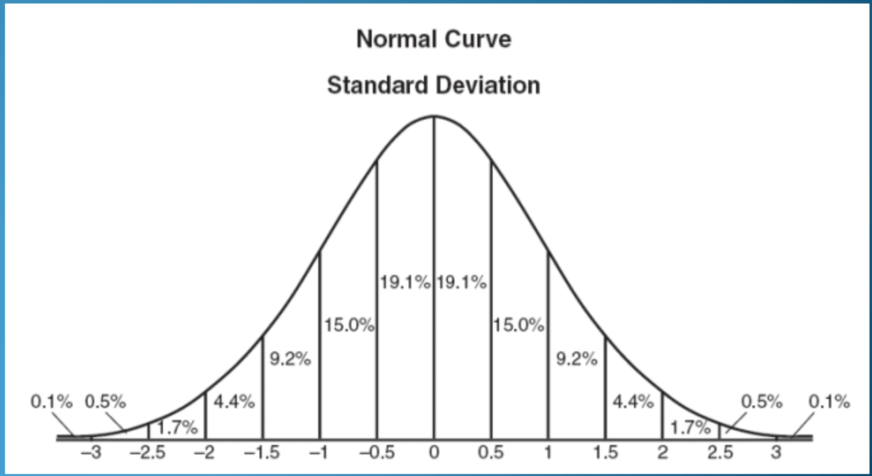
- Connections/population served
- Water supply
  - Water source
  - Production, billed/metered/accounted for water
- Energy
  - Annual energy consumption (electricity and gas) and cost
- Total annual operating expenses
- Treatment

Survey Metrics

- Annual electricity cost
- Electricity cost as % of annual operating budget
- Energy intensity in kWh per MG produced
- Energy production cost in $/MG produced
- Average cost per kWh
- Estimated water loss as %
- Energy cost of water loss

Data Analysis

- Self-reported data
- Outliers removed
  - For normally distributed sample, 99.7% of normally distributed data are within three standard deviations of the mean.
  - Individual outlier data points (i.e., errors) excluded instead of entire data set
- Statistics on remaining data
  - Mean
  - Min
  - Max
- Utility size and source



http://www.regentsprep.org/Regents/math/algtrig/ATS2/NormalLesson.htm

Energy Intensity (kWh/MG)

Illinois AWWA

Utility Size	# of respondents	Mean	Minimum	Maximum
Wholesaler	3	1,946	1,308	2,554
Large (>15,000 connections)	7	1,621	218	3,171
Medium (5,000-15,000 connections)	15	1,560	75	6,361
Small (<5,000 connections)	17	2,912	110	12,890

WI Public Services Commission

Customers Served	# of utilities	Mean	Minimum	Maximum
Over 4,000	98	1,810	21	6,503
1,000-4,000	145	2,036	185	6,401
Fewer than 1,000	317	2,157	1	15,560

USEPA, Region 5 & Indiana Dept. of Environmental Management

Indiana Utility	MGD	kWh/MG
Bloomington Utilities	14	2,198
Mishawaka City Utilities	8	1,653
Valparaiso Flint Lake Plant	4	1,981

Summary of mean and actual data

	# of utilities surveyed	Range of kWh/MG
Illinois	41	1,637-2,912
Wisconsin	560	1,809-2,157
Indiana	3	1,653-2,198

2010 Electricity cost

Utility Size	# of respondents	Mean	Minimum	Maximum
Wholesaler	3	$1,647,705	$190,922	$3,262,345
Large	7	$983,510	$133,015	$1,793,293
Medium	15	$247,732	$1,455	$829,181
Small	17	$37,633	$1,335	$262,156

- Utilities grouped by size
- High cost for larger utilities

Electricity cost % of annual total operating expenses (%)

Utility Size	# of respondents	Mean	Minimum	Maximum
Wholesaler	3	13.2%	3.9%	25.0%
Large	7	8.0%	1.9%	15.7%
Medium	10	9.0%	1.9%	18.3%
Small	16	7.5%	1.0%	23.7%

- Cost as % of total operation expenses is roughly independent of utility size

Energy cost per unit

Per MG				
Utility Size	# of respondents	Mean	Minimum	Maximum
Wholesaler	3	$174	$114	$218
Large	7	$178	$84	$285
Medium	15	$140	$6	$462
Small	17	$314	$44	$1,272

Per kWh				
Utility Size	# of respondents	Mean	Minimum	Maximum
Wholesaler	3	$0.09	$0.08	$0.10
Large	6	$0.09	$0.05	$0.13
Medium	14	$0.09	$0.06	$0.15
Small	17	$0.10	$0.01	$0.16

- Small utilities have higher water production cost from energy
- Similar cost per unit independent of size

Comparing water sources

Total annual cost of electricity ($)				
Utility Water Source	# of respondents	Mean	Minimum	Maximum
Groundwater	17	$92,037	$1,335	$430,435
Lake Michigan	16	$254,421	$1,455	$1,489,847
Surface	8	$845,405	$183,040	$1,622,072
Electricity cost percent of annual total operating expenses (%)				
Utility Water Source	# of respondents	Mean	Minimum	Maximum
Groundwater	17	7.6%	3.3%	14.8%
Lake Michigan	12	8.2%	1.0%	25.0%
Surface	8	14.6%	2.6%	38.0%
Energy intensity of water production, electricity only (kWh/MG)				
Utility Water Source	# of respondents	Mean	Minimum	Maximum
Groundwater	17	2,844	1,014	6,361
Lake Michigan	17	866	75	2,554
Surface	7	2,019	218	3,538
Water production cost from energy, gas+electricity ($/MG)				
Utility Water Source	# of respondents	Mean	Minimum	Maximum
Groundwater	17	$293	$105	$725
Lake Michigan	17	$94	$6	$218
Surface	8	$586	$151	$3,336

- Non-Lake MI surface water utilities tend to dedicate a higher % of budget to energy & pay more for energy per unit of water.
- Groundwater utilities have the highest average energy intensity.

Water Loss

Utility Size Gallons not billed/metered/accounted for per gallons produced				
	# of respondents	Mean	Minimum	Maximum
Wholesaler	3	3.1%	1.9%	5.5%
Large	7	17.3%	3.9%	29.4%
Medium	15	11.4%	2.4%	20.9%
Small	18	7.6%	1.7%	17.7%

Water Source Gallons not billed/metered/accounted for per gallons produced				
	# of respondents	Mean	Minimum	Maximum
Groundwater	18	9.6%	1.7%	19.8%
Lake Michigan	17	8.2%	1.9%	20.9%
Surface	8	16.5%	3.8%	29.4%

Lessons Learned

- No consistent data collection and tracking
- Energy and water data in different places
- Energy use data breakdown by steps
- Short and sweet survey instrument
- Need more!
  - Education/outreach
  - Incentives
  - Staff time and budget

Next Steps

- Include total distribution energy use and treatment
- Promote survey report as case study
- Coordinate with similar efforts/organizations
- Conservation plans

Thank you!

Visit www.isawwa.org for the full report.

Amy Talbot
atalbot@cmap.illinois.gov
312.386.8646

Illinois Section
American Water Works Association

Water-Energy Nexus in Conservation Program Planning

Use water wisely.
It's essential.

Ken Jenkins
Conservation Manager
October 5, 2012

California Water Service Group

- Now serve in 4 states
- Serve nearly 2 million people
- Total of 490,000+ connections

Use water wisely.
It's essential.

California Water Service Company

Use water wisely.
It's essential.

Why Think About Energy When Trying to Save Water?

- Water systems are energy intensive – avoided energy cost is often the primary utility cost savings from water conservation
- Energy savings can be a significant ancillary benefit of participating in a water conservation program
- Synergies between water and energy conservation programs can facilitate water-energy utility partnerships and cost sharing

California Public Utilities Commission (CPUC) Embedded Energy in Water Study

- Urban water systems are energy intensive
- Depending on the system, an acre-foot of water conservation may save between $50 and $425 in annual energy cost*
- Savings even greater when wastewater savings taken into account
- This can produce very attractive payback periods for some conservation programs

* Based on results of CPUC (2010) Embedded Energy in Water Study.

CPUC Embedded Energy in Water Study

Category	Component	kWHr/MG Low	kWHr/MG High	Avoided Cost Range* ($/MG) Low	Avoided Cost Range* ($/MG) High
Supply	Local Surface Water	152	1,213	$23.00	$182.00
Supply	Groundwater	906	2,924	$136.00	$439.00
Supply	Brackish Desalination	1,415	1,824	$212.00	$274.00
Supply	Recycled Water	1,072	3,410	$161.00	$512.00
Treatment	Coag, floc, filtr	44	457	$7.00	$69.00
Treatment	Disinfection	168	272	$25.00	$41.00
Distribution	Booster Pumps	45	1,574	$7.00	$236.00
Distribution	Pressure System Pumps	360	2,569	$54.00	$385.00
Imported Wholesale Water					
	MWD/SDCWA	6,800	7,500	$1,020.00	$1,125.00
	SCVWD	3,380	3,735	$507.00	$560.00

* at $0.15 per kWHr

Use water wisely.
It's essential.

Customers Want to Save Money

- Utility bill savings is a primary driver for program participation
- Customer energy bill savings can exceed water and wastewater bill savings for key indoor and CII programs
- Program marketing should leverage ancillary customer benefits of water conservation programs – such as energy bill savings -- whenever possible

Typical Customer Utility Savings for Key Indoor and CII Programs

	Customer Utility Bill Savings ($/yr)					
Program	**Water**	**Waste Water**	**Gas**	**Electricity**	**Total**	**% Energy**
Residential clothes washer	$10	$6	$2	$6	$24	32%
Residential showerhead	$6	$4	$6	$9	$24	62%
Residential dishwasher	$1	$1	$1	$3	$6	72%
Multi-family Submetering*	$25	$15	$6	$10	$56	29%
Restaurant Pre-rinse Spray Valve	$61	$37	$56	$83	$237	59%
Restaurant Dishwasher						
Undercounter	$30	$19	$44	$75	$169	71%
Door	$65	$40	$93	$158	$355	71%
Conveyor	$205	$127	$264	$448	$1,044	68%
Flight	$296	$182	$379	$634	$1,491	68%

*Bill savings per submeter

Use water wisely.
It’s essential.

California Water Service Co.

Benefits of Energy Utility Partnerships

- Joint program marketing
- Increased rebate amounts and shared program costs
- Shared data from home or business water/energy use surveys

Cal Water Energy Utility Partnerships

- Clothes Washer Rebate Programs
- Showerhead programs
- Industrial Surveys
- Information-based surveys feeding information to partnering utility

Use water wisely.
It’s essential.

Questions?

Use water wisely.

It’s essential.

The Water-Energy Nexus
In California Water Utility Regulation

Stephen St Marie

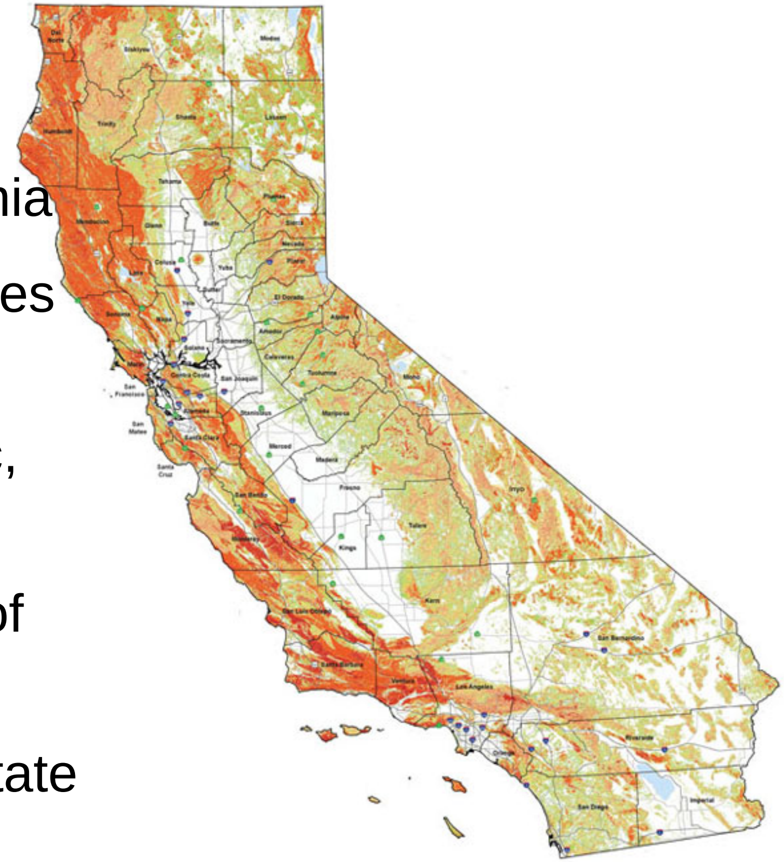
California Public Utilities Commission

WaterSmart Innovations 2012 Conference

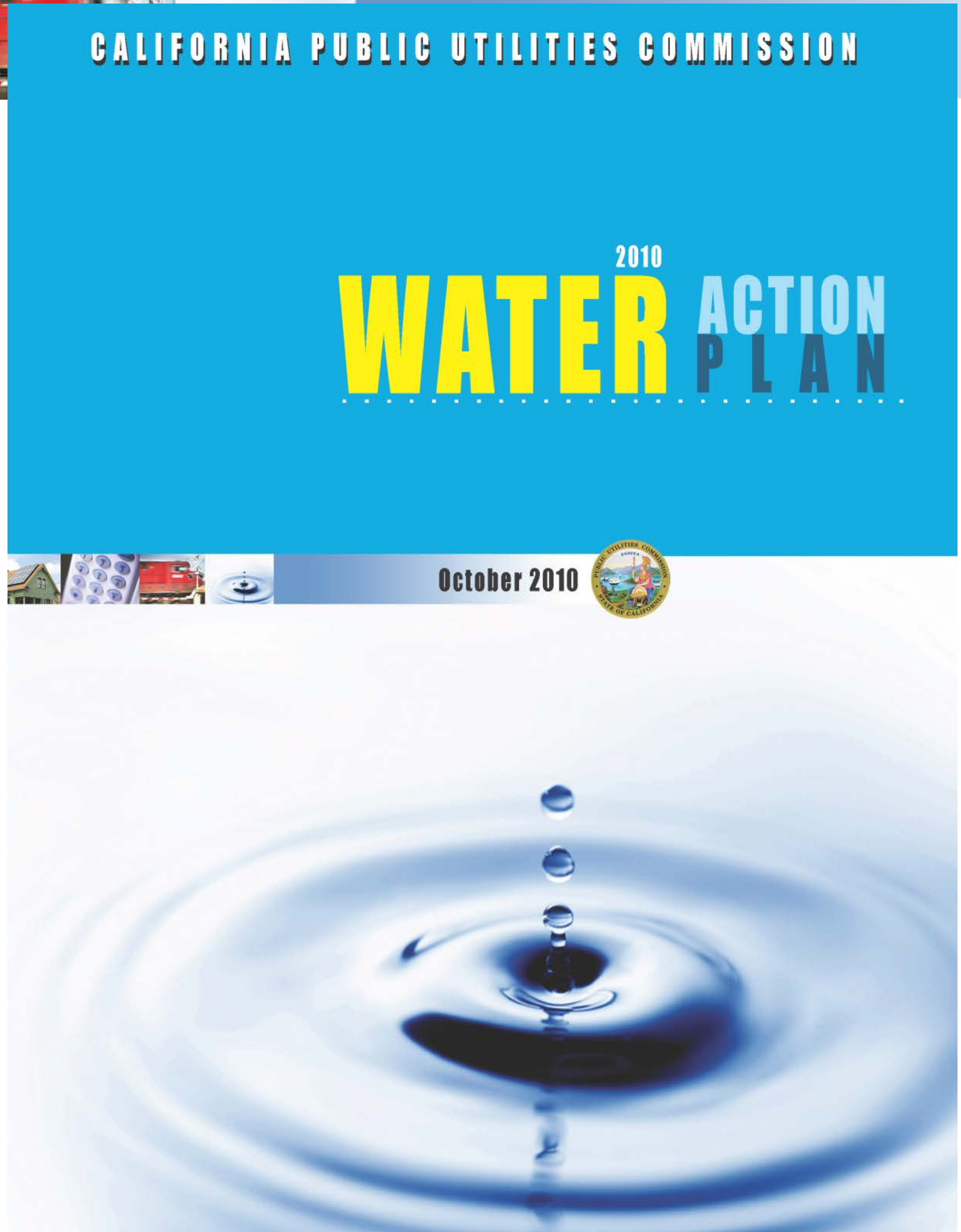
Las Vegas, NV, October 5, 2012

State of California

- 38 million people in California
- 26 million live in Southern California
- Nearly 10 million live in Los Angeles County
- Vast geographic climate, linguistic, cultural, economic diversity
- Rural areas the size of the State of Kentucky
- Rural population the size of the State of Vermont




THE CALIFORNIA PUBLIC UTILITIES COMMISSION
100 YEARS
RESPONSIBILITY ★ VISION ★ SUCCESS ★ PASSION ★ SERVICE ★ STRENGTH
EFFICIENCY STANDARDS ★ UTILITY OVERSIGHT ★ ENVIRONMENT ★ SAFETY
100 YEARS OF LEADERSHIP ★
CONSUMER PROTECTION ★ ADVANCEMENT


CALIFORNIA PUBLIC UTILITIES COMMISSION
2010
WATER ACTION PLAN
October 2010

Water and Energy – The Nexus

- **Water Requires Energy**
  - To “Produce” or “Obtain” it
  - To Move it to where it is needed
  - To Treat it for Potability
  - To Heat it or Cool it

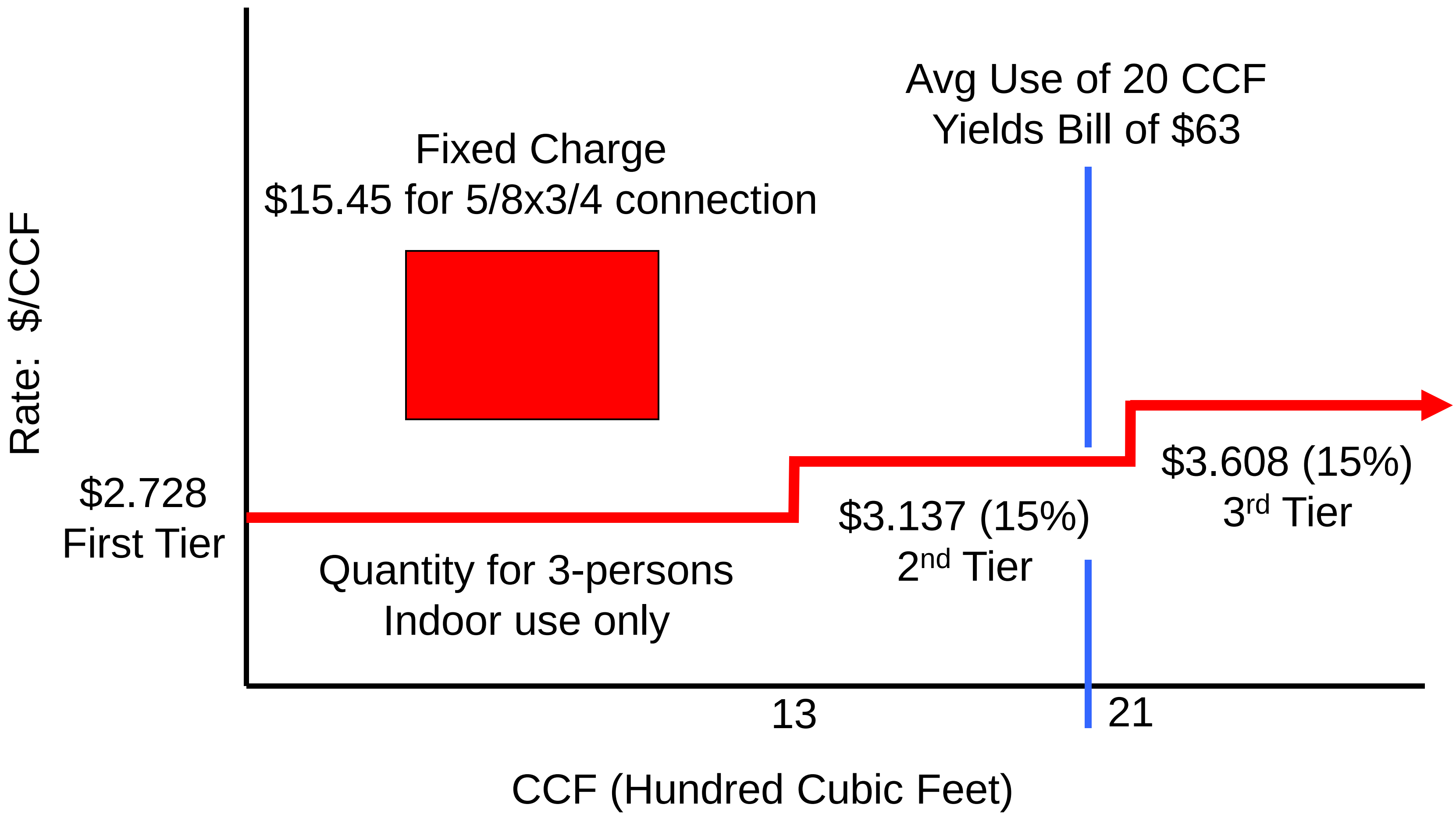
- **Any Steps to Use Less Water or Increase Efficiency in Production and/or Consumption Result in Savings to Society**

Savings in Use of Water

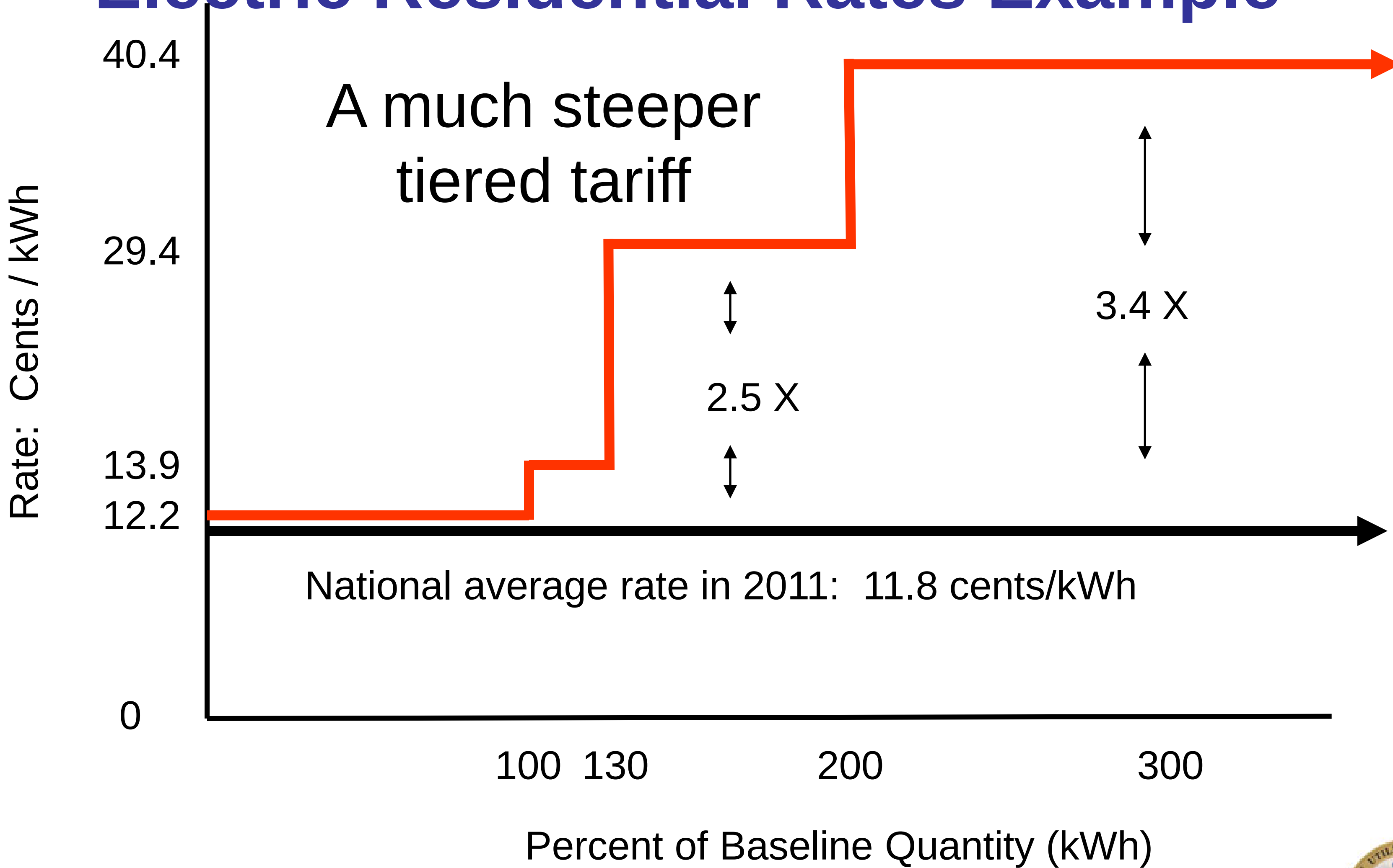
- **State Goal, now State Law, to Reduce Per Capita Consumption by 20-percent by 2020**

- **Progress: Residential water use is declining rapidly**
  - Use of Inclining-block rates (Conservation Rates)
  - Education programs for consumers
  - Garden Replacement Incentives
  - Water Revenue Adjustment Mechanisms remove incentive to sell more – remove financial benefit – Modeled on Energy programs

“Conservation” Rates – Tiers (Example)



Electric Residential Rates Example



Grow Water Wise.

Turn over a new leaf this spring and grow a water wise garden. Water wise gardening can save hundreds of gallons of water a month translating to big savings on your water bill.

Beautify your home with water-saving flowers, plants, and shrubs. Salvia leucantha (Mexican Sage) is just one of many choices to add great color and variety to your garden.

We're Here to Help.

Stop by our office at 511 Forest Lodge Road in Pacific Grove for free water saving devices. You can pick up low-flow showerheads, kitchen and bath aerators, hose nozzles, and more.

Embellezca su jardín en esta primavera con un diseño que ahorre agua. Un jardín de este tipo le ayuda a economizar agua y dinero.

Conserving water is a shared responsibility for our company and our customers – a goal we can achieve together. We're here to help.

CALIFORNIA AMERICAN WATER
WE CARE ABOUT WATER. IT'S WHAT WE DO.
(831) 646-3205 • www.californiaamwater.com

MONTEREY PENINSULA WATER MANAGEMENT DISTRICT
(831) 658-5601 • www.mpwmd.dst.ca.us


Turn Over a New Leaf
Lavender: A great water wise perennial
Grow a Water Wise Garden this Spring.
Turn over a new leaf this year with a low-water garden. Plants needing little water save you money while protecting natural resources.
Dozens of water-saving flowers, plants, and shrubs are available to beautify your home. Lavender from your local nursery or home improvement store is just one of many choices for color and a pleasing aroma around your yard.
We're Here to Help.
You can pick up a free guide to low-water gardens at our office at 511 Forest Lodge Road in Pacific Grove. When you're here, you can also select free water saving devices like low-flow showerheads, kitchen and bath aerators, hose nozzles, and more.
En esta primavera, cultive un jardín de mínimo regadío. Las plantas que necesitan poca agua le ahorran dinero y a la vez protegen los recursos naturales.
Conserving water is a shared responsibility for our company and our customers – a goal we can achieve together.
We're here to help.
CALIFORNIA AMERICAN WATER
WE CARE ABOUT WATER. IT'S WHAT WE DO.®
(831) 646-3205 • www.californiaamwater.com
MONTEREY PENINSULA WATER MANAGEMENT DISTRICT
(831) 658-5601 • www.mpwmd.dst.ca.us

Efficiency in Use of Water

- **Meters are now required and are being installed across the state**
  - All progress begins with careful measurement!

- **Latest Energy Savings Assistance Program (ESAP) Decision, D12-08-044 for Low-Income Consumers**
  - High-Efficiency Showerheads and Faucet Aerators
    - Save Water and Energy for Water Heating
    - Decision did NOT endorse High-Efficiency Toilets
      Lack of Evidence re Energy Savings

Efficiency in Water Production

- **Pilot Programs in Pumping: Operational Efficiency Energy Program**
  - – Difficulties in measurement – Results inconclusive

- **Energy Recovery in Pressure Reduction Systems**
  - – Use of a Turbine-generator to replace a Pressure Reduction Valve
  - – Example: Cal Water Service 325 kW installation under way – Power to be delivered to Edison

Information Sources on Water/Energy

- **CPUC Water Action Plan of 2010**
  - Much information about CPUC's view of Water Regulation
  - Discusses conservation and efficiency
- **SBX7-7 of the 2009-2010 Session**
  - Formal enactment of the 20% Reduction requirement
- **CPUC Decision D12-08-044**
  - Programs for Energy Assistance, including Showerheads and Faucet Aerator replacement
- **Embedded Energy in Water Pilot Programs Impact Evaluation**
  - March 9, 2011
  - Prepared by ECONorthwest
  - Reviews CPUC-sponsored Pilots

Information Sources on Water/Energy

- **CPUC Operational Energy Efficiency Program (OEEP)**
  - Final EM&V Report Sep 30, 2011
  - Prepared by Energy & Environmental Economics
  - A third-party analysis notes measurement difficulties

- **Operational Energy Efficiency Application Guide**
  - December 13, 2011
  - Prepared by Black & Veatch

- **CPUC Resolution W-4854**
  - December 2, 2010
  - Authorized six Pressure-Reducing Valve Modernization Projects

Information Sources on Water/Energy

- **California's Water-Energy Nexus: Pathways to Implementation**
  - September 12, 2012
  - White Paper prepared by GEI Consultants

- **Watch for More from CPUC Policy and Planning Division!**

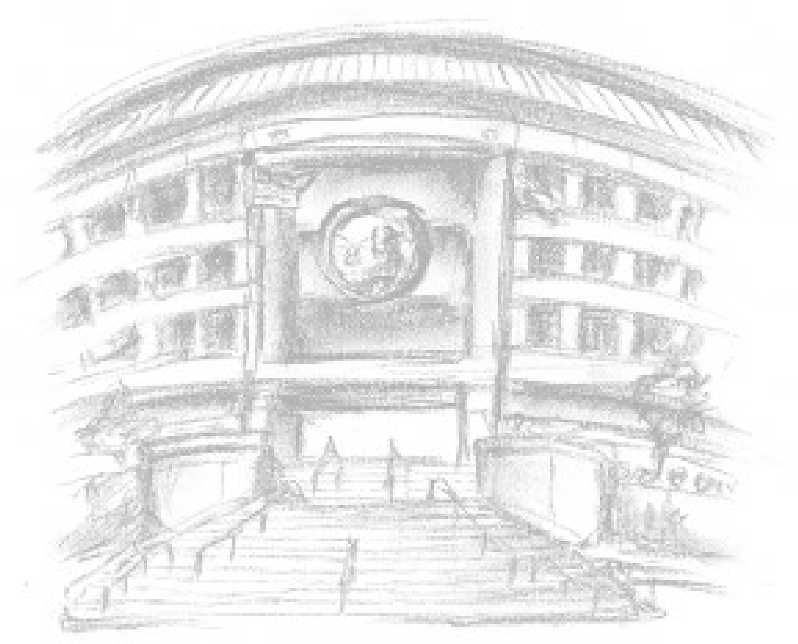
Thank you!

For Additional Information:

www.cpuc.ca.gov

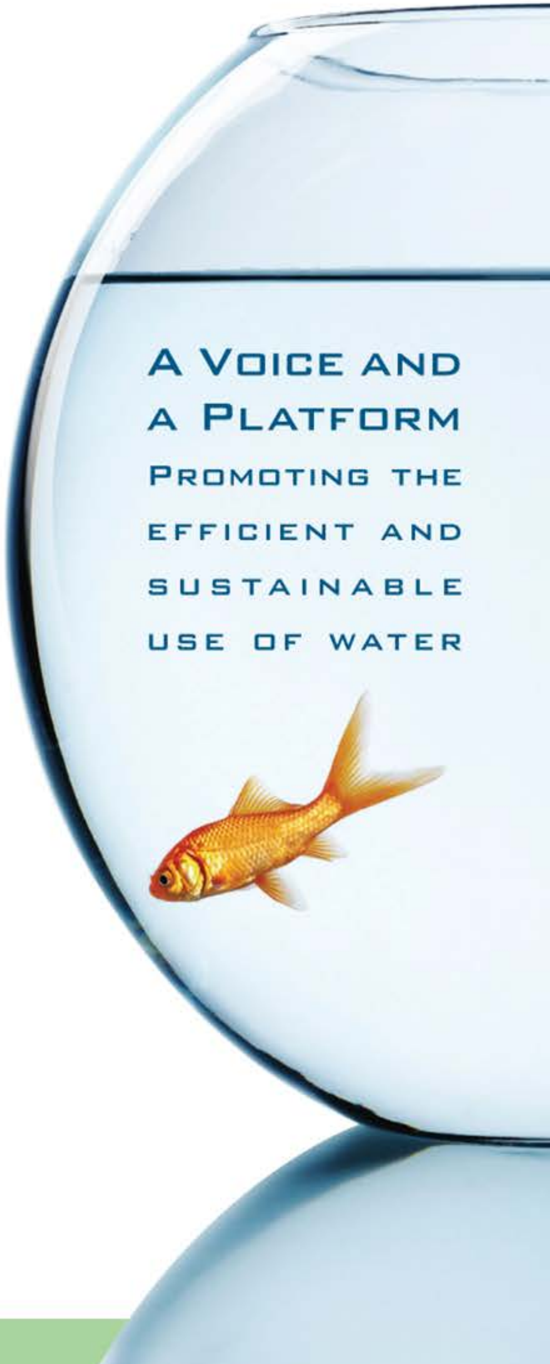
SST@cpuc.ca.gov

415-703-5173



Moving Towards Joint WATER AND ENERGY Programs and Policy

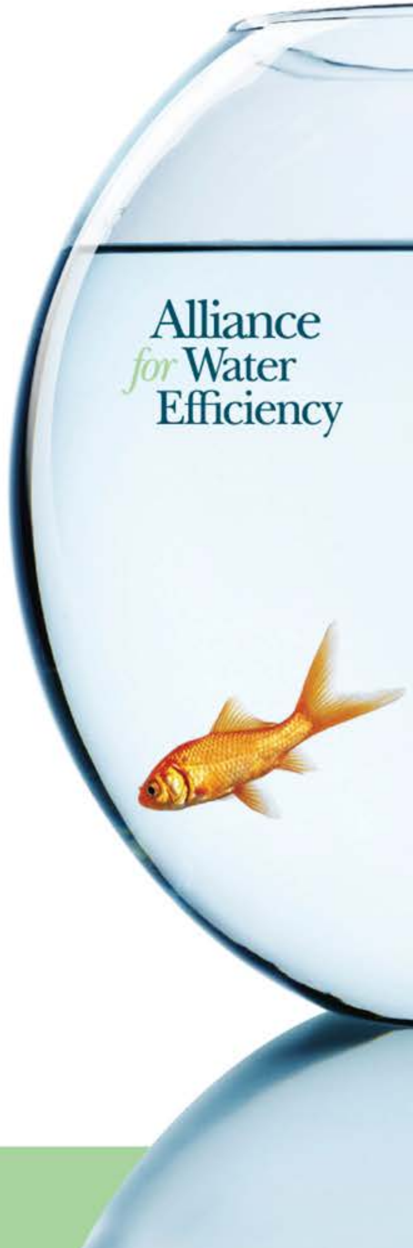
Mary Ann Dickinson
President and CEO



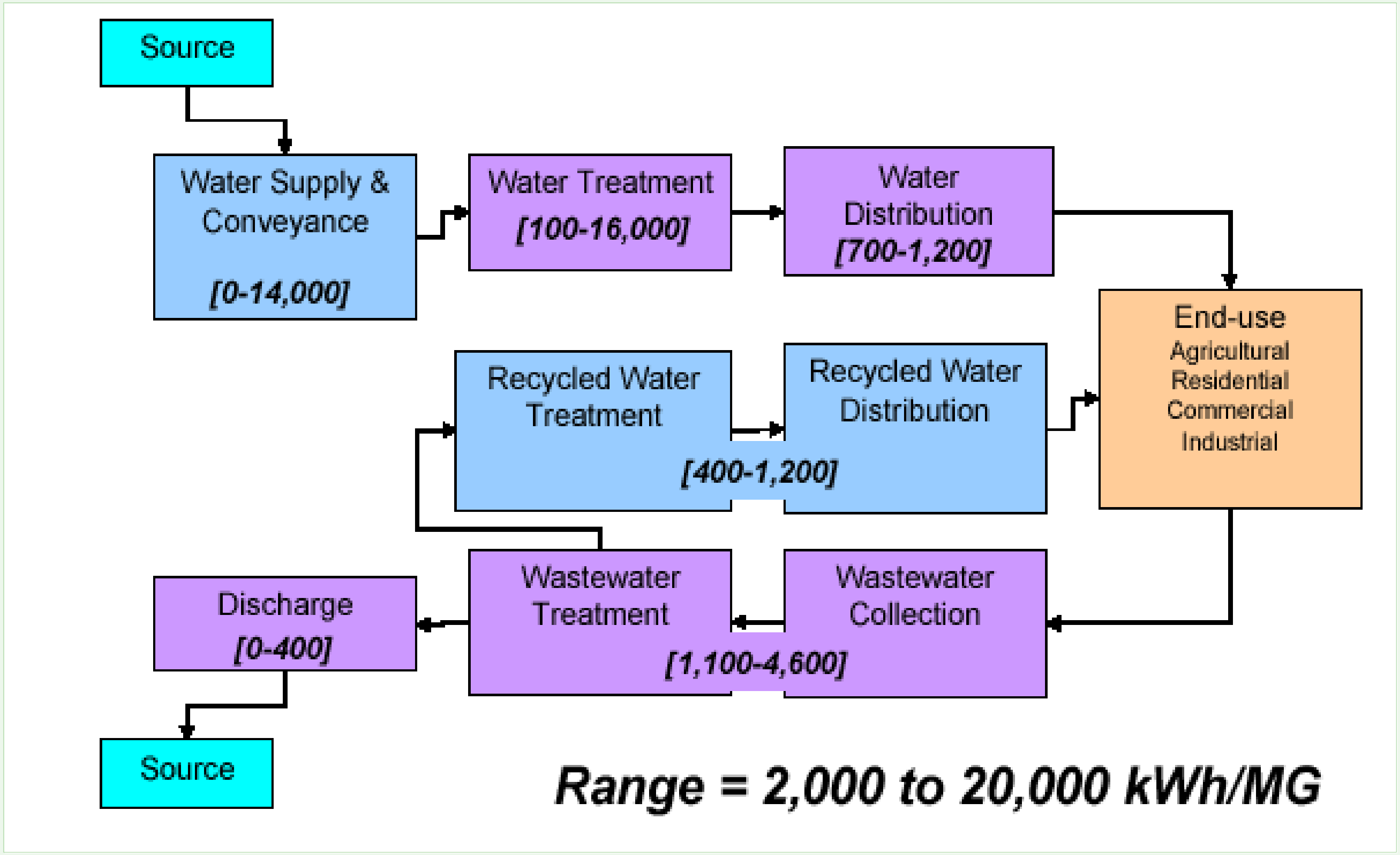
Alliance *for* Water Efficiency

Water Needs Energy

- Energy is embedded in all stages of water supply and treatment, and in the wastewater treatment
- Pumping, treatment, distribution, recycling
- Don’t forget consumer hot water heating!
- California was the first state to look at this connection
- 2005 Integrated Energy Policy Report had entire chapter on the amount of energy needed



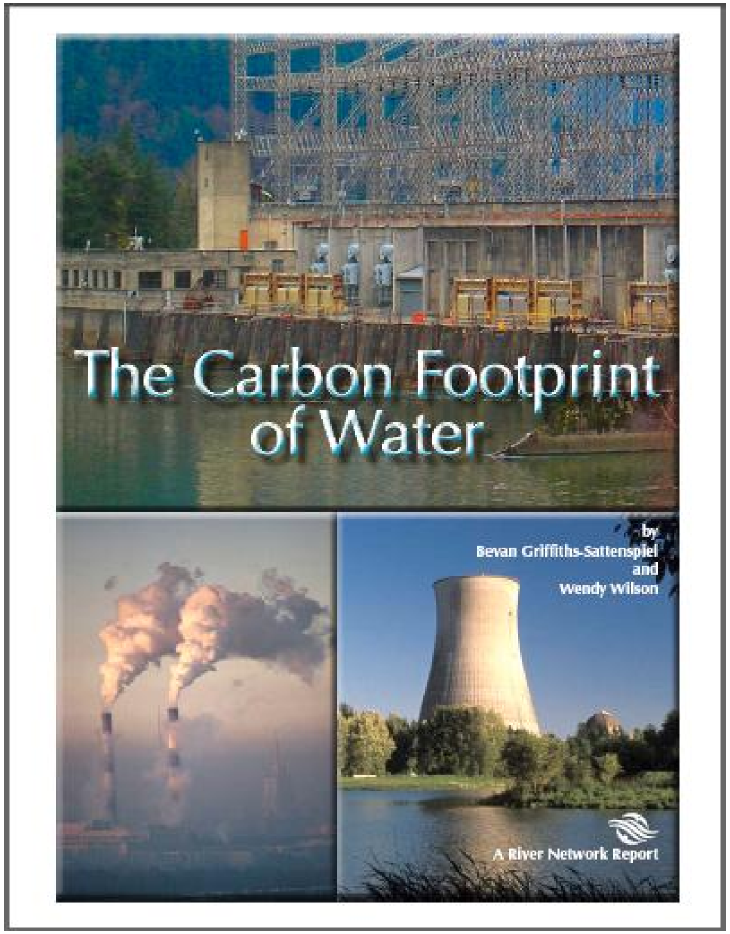
Embedded Energy



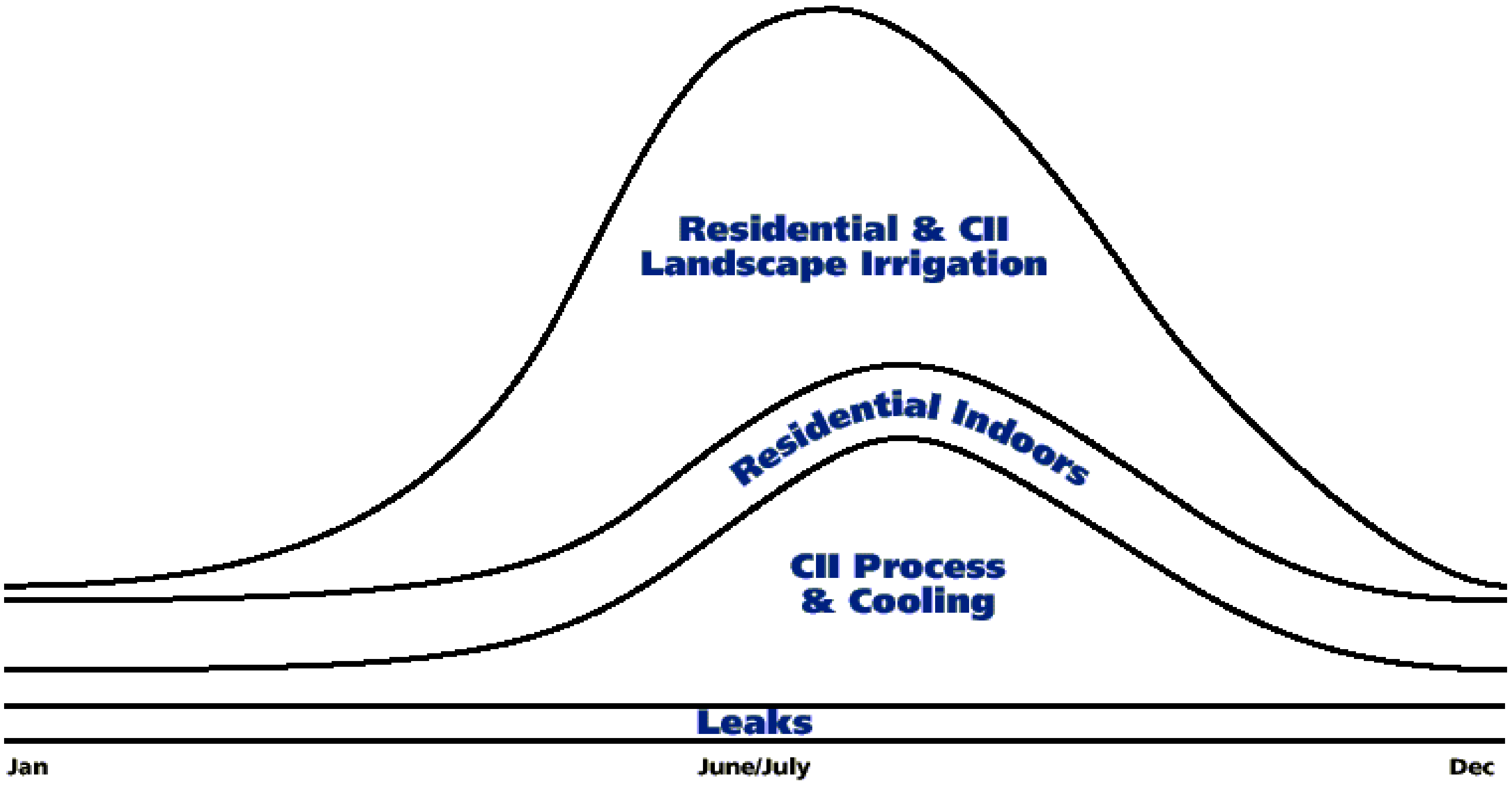
Source: California Energy Commission, 2005 IEPR

One National Estimate

- River Network Report
- Estimates that 13% of national kWh equivalent energy electric load is water related energy use
- Explores potential for energy and carbon emissions reductions through water-oriented approaches
- www.rivernetwork.org

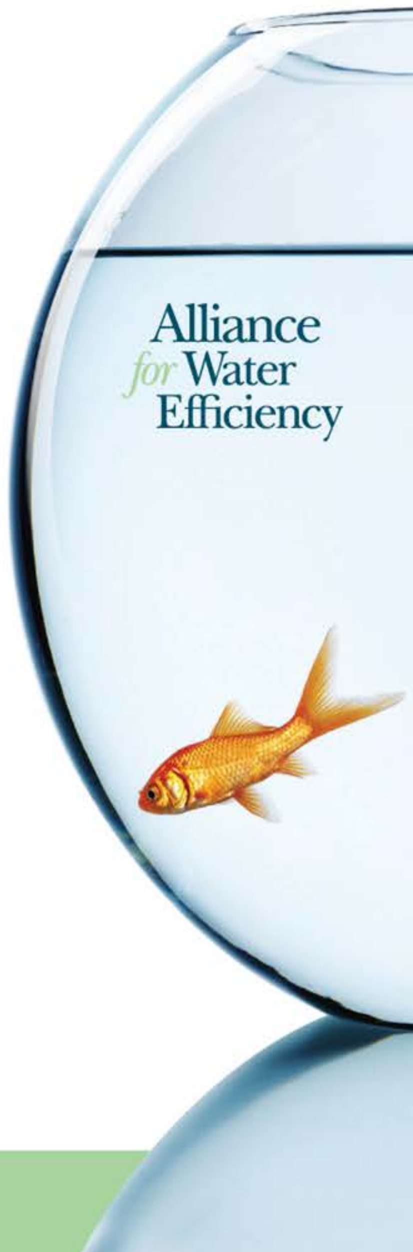


Water Demand Curve



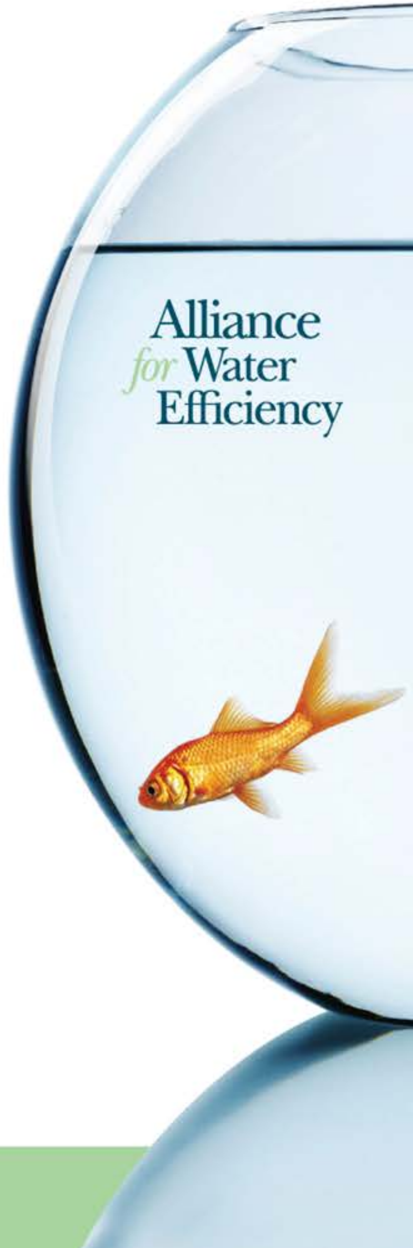
What Does This Mean?

- Saving water saves energy and greenhouse gas emissions
- Water suppliers should optimize drinking water and wastewater energy use (pumping, treatment)
- Partnerships needed across drinking water, wastewater, electric, and gas utilities
- Demand should be managed for both water and energy benefits
- Analyze with benefit/cost models



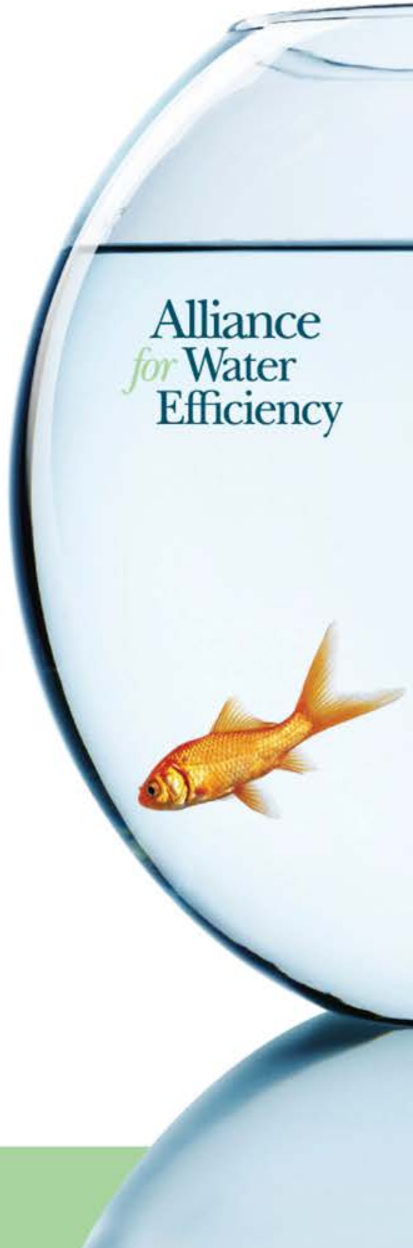
The Benefits of B/C Analysis

- Identifies cost drivers for the utility in operations and capital prams
- Assesses water supply options according to the individual utility profile
- Enables sound conservation planning
- Highlights conservation program options that:
  - Achieve results
  - Minimize risk to the utility
  - Are cost effective for both the utility and the customer

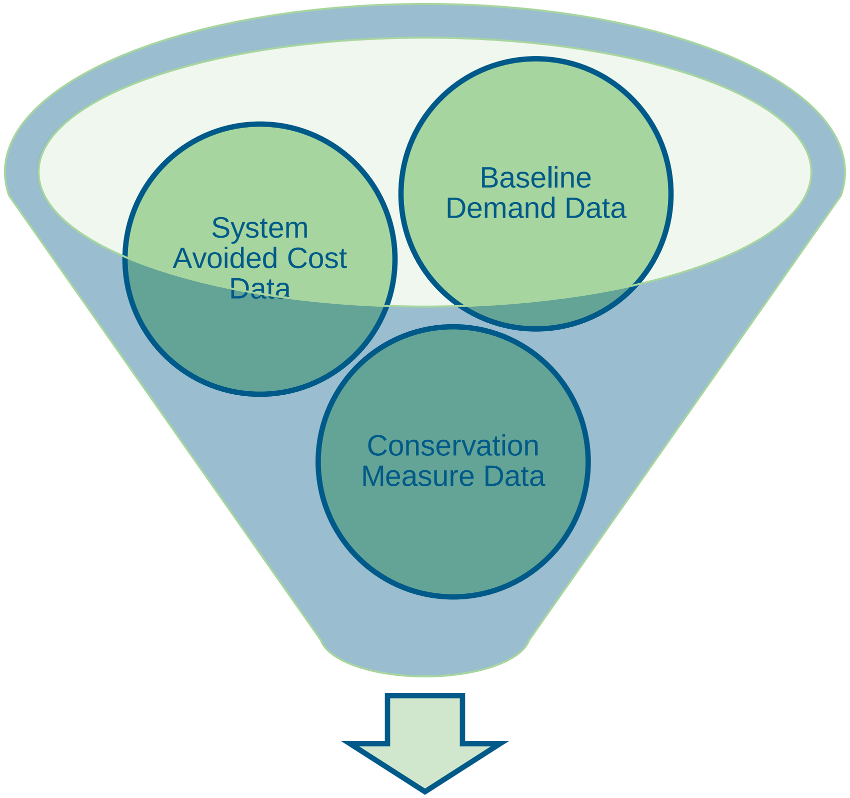


AWE Tracking Tool Model

- Need for consistent and thorough analysis of cost-effective water conservation options
- Tools exist in various forms
- Most are proprietary
- AWE wanted robust but easy to use model with transparent code
- "Tracking Tool" for tracking savings as well as analytical tool for planning joint water and energy programs
- Measures electricity and gas reductions, GHG emission reductions



Tracking Tool Inputs and Outputs



Model Outputs

Savings Analysis Benefit-Cost Analysis Revenue/Rate Impacts Energy Analysis

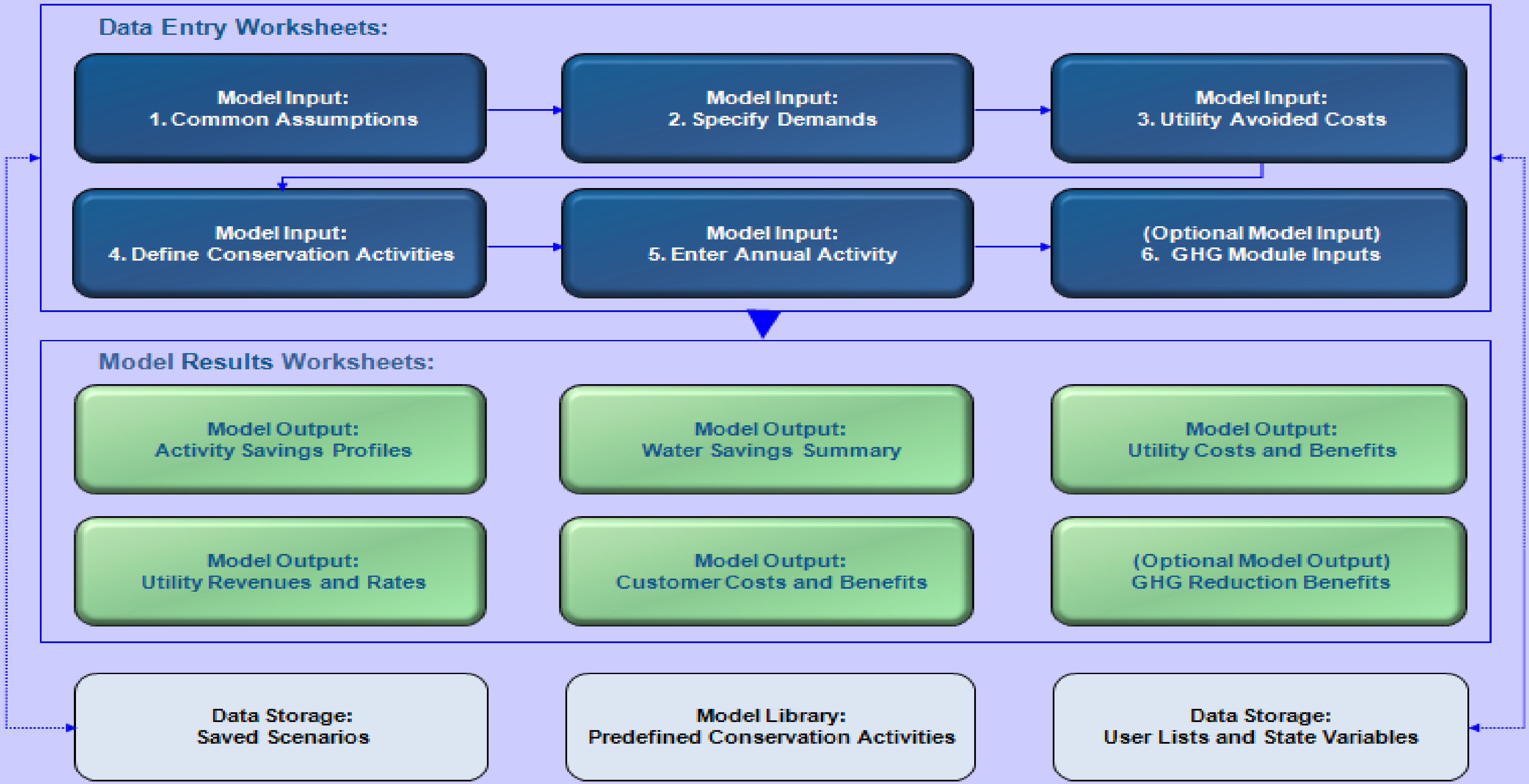
AWE CONSERVATION TRACKING TOOL

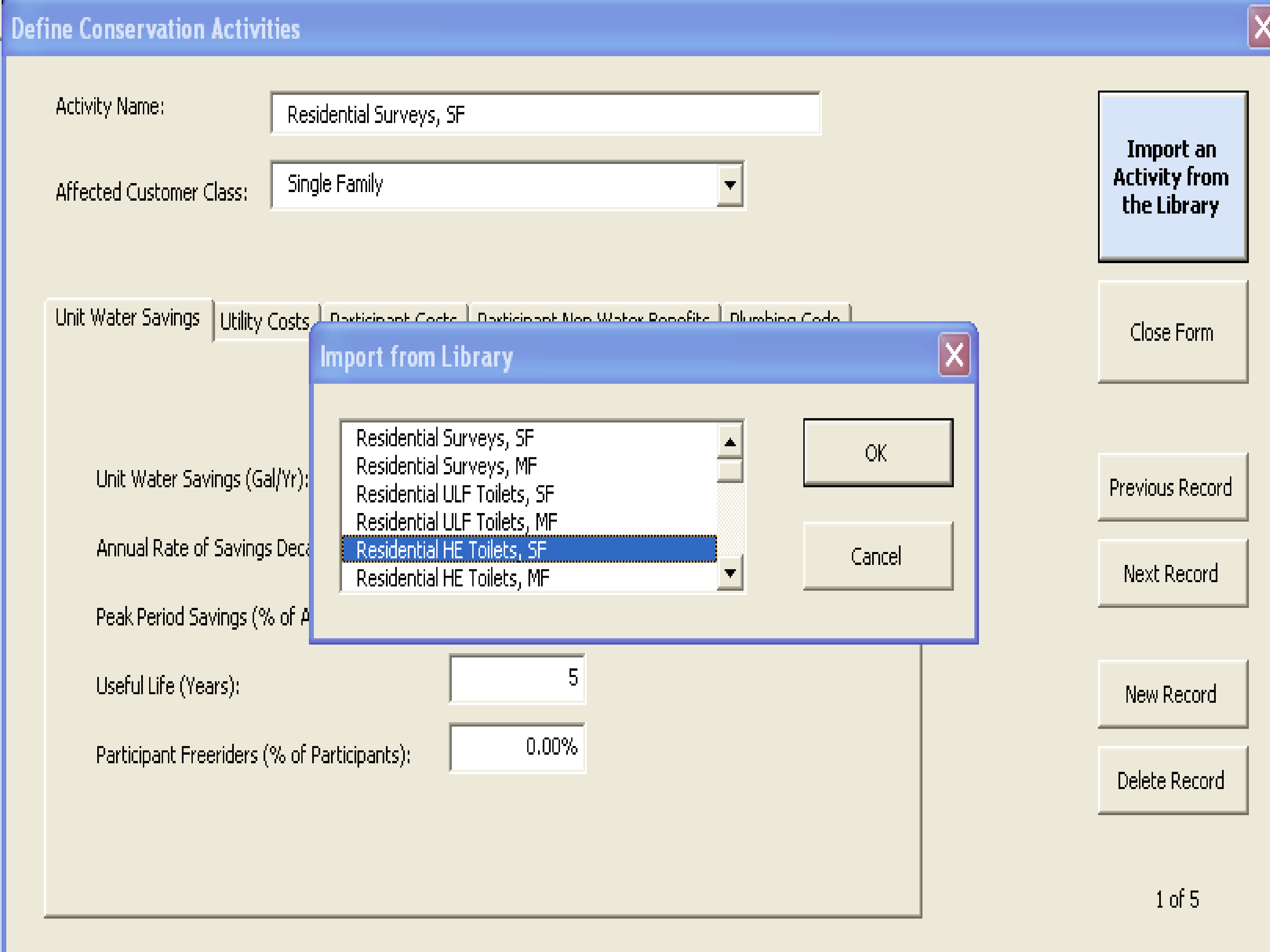
Version 2.0, Standard North American Edition

About Tracking Tool

Getting Started:

1. The model uses a simple worksheet tab color code:
   - Blue Tabs = User Data Entry
   - Green Tabs = Model Outputs/Results
   - Grey Tabs = Data Storage and Library
2. First provide informaton about your system, customers, and water demands. This is done on data entry worksheets 1 thru 3.
3. Next define or import conservation activities and set their annual activity levels. This is done on data entry worksheets 4 and 5.
4. You can save conservation activity scenarios at any time. You access the scenario manager on the Common Assumptions worksheet.
6. You can navigate to model worksheets by clicking on the model schematic below or by clicking on the worksheet tabs at the bottom of the screen.
7. Data entry cells on input worksheets look like this: xx,xxx <u>Only enter data in cells with this color coding</u>.




Define Conservation Activities
Activity Name:
Residential Surveys, SF
Affected Customer Class:
Single Family
Import an Activity from the Library
Close Form
Unit Water Savings
Utility Costs
Unit Water Savings (Gal/Yr):
Annual Rate of Savings Deca
Peak Period Savings (% of A
Useful Life (Years):
5
Participant Freeriders (% of Participants):
0.00%
Import from Library
Residential Surveys, SF
Residential Surveys, MF
Residential ULF Toilets, SF
Residential ULF Toilets, MF
Residential HE Toilets, SF
Residential HE Toilets, MF
OK
Cancel
Previous Record
Next Record
New Record
Delete Record
1 of 5

AWE CONSERVATION TRACKING TOOL: ENTER ANNUAL CONSERVATION ACTIVITY WORKSHEET

Enter Annual Conservation Activity

Return to Navigation Sheet   Report Error

Class	Activity Name	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	201
Single Family	Residential Surveys, SF	1000	1000	1000	1000	1000						
Single Family	Residential HE Toilets, SF	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	
CII	CII HE Toilet	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	
Single Family	Residential Irrigation Controller, SF	1000	1000	1000	1000	1000	1000	1000	1000			
Irrigation	Large Land. Irrigation Controller	100	100						100	100		
CII	CII Spray Rinse Valve	100	100	100	100	100						
CII	CII Cooling Tower			25	25	25	25	25	25	25	25	

Effective Conservation Activity

Class	Activity Name	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	201
Single Family	Residential Surveys, SF	1,000	1,800	2,440	2,952	3,362	2,362	1,562	922	410	0	
Single Family	Residential HE Toilets, SF	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000	10,00
CII	CII HE Toilet	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000	10,00
Single Family	Residential Irrigation Controller, SF	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	8,000	8,000	7,00
Irrigation	Large Land. Irrigation Controller	100	200	200	200	200	200	200	300	400	400	30
CII	CII Spray Rinse Valve	100	200	300	400	500	500	500	500	500	500	50
CII	CII Cooling Tower	0	0	25	50	75	100	125	150	175	200	20

Gross Water Savings (AF)

Class	Activity Name	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	201
Single Family	Residential Surveys, SF	37.971343	68.3	92.7	112.1	127.6	89.7	59.3	35.0	15.6	0.0	0.
Single Family	Residential HE Toilets, SF	27.8	55.7	83.5	111.4	139.2	167.0	194.9	222.7	250.6	278.4	278.
CII	CII HE Toilet	35.5	71.0	106.5	142.1	177.6	213.1	248.6	284.1	319.6	355.1	355.
Single Family	Residential Irrigation Controller, SF	61.6	123.1	184.7	246.3	307.8	369.4	431.0	492.5	492.5	492.5	431.
Irrigation	Large Land. Irrigation Controller	134.1	268.2	268.2	268.2	268.2	268.2	268.2	402.3	536.4	536.4	402.
CII	CII Spray Rinse Valve	8.7	17.4	26.0	34.7	43.4	43.4	43.4	43.4	43.4	43.4	43.
CII	CII Cooling Tower	0.0	0.0	28.5	57.0	85.5	114.0	142.5	171.0	199.5	228.0	228.
Total Gross Water Savings		**305.7**	**603.7**	**790.1**	**971.7**	**1,149.3**	**1,264.8**	**1,387.8**	**1,651.0**	**1,857.5**	**1,933.8**	**1,738.**

Peak Gross Water Savings (AF)

Class	Activity Name	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	201
Single Family	Residential Surveys, SF	24.7	44.4	60.2	72.9	83.0	58.3	38.5	22.7	10.1	0.0	0.
Single Family	Residential HE Toilets, SF	11.7	23.5	35.2	47.0	58.7	70.5	82.2	94.0	105.7	117.5	117.

AWE CONSERVATION TRACKING TOOL: WATER SAVINGS SUMMARY WORKSHEET

Water Demand Summary

Return to Navigation Sheet   Report Error

Service Area Demands	Units	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Baseline Demands	AF	67,822	68,112	68,404	68,633	68,863	69,093	69,325	69,557	69,790	70,023
Baseline - Code Savings	AF	67,822	67,876	67,942	67,955	67,921	67,902	67,897	67,906	67,927	67,961
Baseline - Code Savings - Program Savings	AF	67,517	67,275	67,160	67,000	66,799	66,677	66,564	66,326	66,158	66,133

Per Capita Demands	Units	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Baseline Demands	GPD	173.0	173.0	173.0	173.0	173.0	173.0	173.0	173.0	173.0	173.0
Baseline - Code Savings	GPD	173.0	172.4	171.8	171.3	170.6	170.0	169.4	168.9	168.4	167.9
Baseline - Code Savings - Program Savings	GPD	172.2	170.9	169.8	168.9	167.8	166.9	166.1	165.0	164.0	163.4

Service Area Water Savings	Units	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Code Water Savings	AF	0.0	236.9	461.7	677.6	942.1	1,191.7	1,427.5	1,650.4	1,862.2	2,062.6
Program Water Savings	AF	305.7	600.8	781.5	954.8	1,121.7	1,224.1	1,332.7	1,580.3	1,769.8	1,827.9
Total Water Savings	**AF**	**305.7**	**837.7**	**1,243.2**	**1,632.4**	**2,063.7**	**2,415.8**	**2,760.2**	**3,230.7**	**3,632.0**	**3,890.6**
% of Baseline Demands	**%**	**0.5%**	**1.2%**	**1.8%**	**2.4%**	**3.0%**	**3.5%**	**4.0%**	**4.6%**	**5.2%**	**5.6%**

Class Water Savings	Units	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Single Family	AF	127.4	405.0	667.3	917.8	1,205.6	1,428.1	1,647.4	1,862.6	2,012.3	2,157.1
Multi Family	AF	-	54.4	106.0	155.7	212.9	267.1	318.3	366.9	413.1	457.0
CII	AF	44.2	110.2	201.8	290.7	377.1	452.4	526.4	598.9	670.2	740.2
Irrigation	AF	134.1	268.2	268.2	268.2	268.2	268.2	268.2	402.3	536.4	536.4
Water Losses	AF	-	-	-	-	-	-	-	-	-	-
Total	**AF**	**305.7**	**837.7**	**1,243.2**	**1,632.4**	**2,063.7**	**2,415.8**	**2,760.2**	**3,230.7**	**3,632.0**	**3,890.6**

Year forecasted peak season demand equals existing peak season delivery capacity		Deferred Expansion (Years)	Deferred Capacity (MGD)	Benefit of Deferred Expansion ($)	Avoided Capacity (MGD)	Benefit of Avoided Expansion ($)
Baseline Demands	**2020**	N/A	N/A	N/A	N/A	N/A
Baseline - Code Savings	**2031**	**11**	6.4	$9,144,908	0.0	$0
Baseline - Code Savings - Program Savings	**2039**	**19**	6.4	$14,198,213	0.0	$0

Select Chart to View

Per Capita Demands

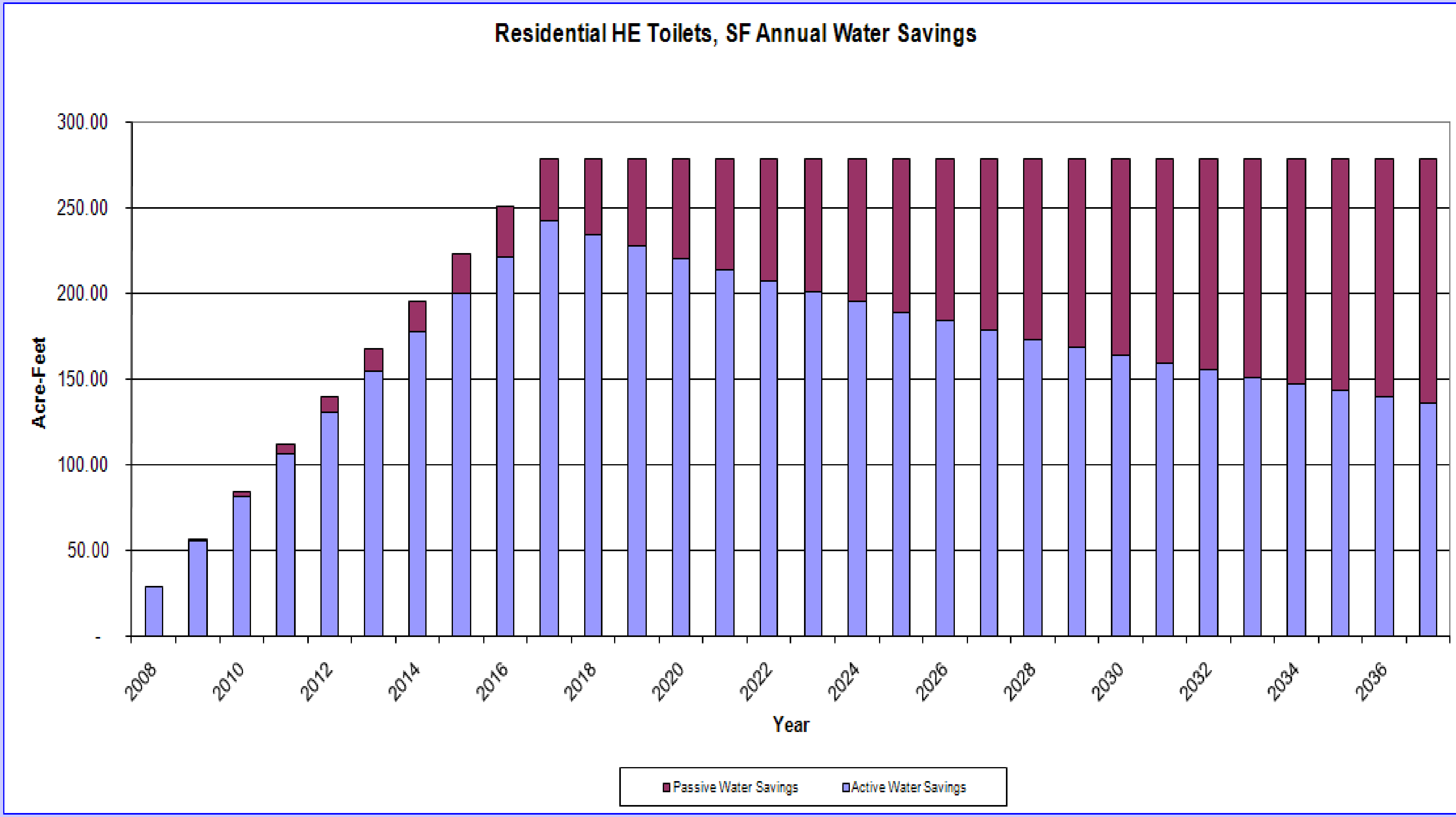
Chart Explanations

3. Enter Utility Avoided Costs | 4. Define Activities | 5. Enter Annual Activity | Activity Savings Profiles | Water Savings Summary | Utility Costs and B

AWE CONSERVATION TRACKING TOOL: ACTIVITY SAVINGS PROFILES WORKSHEET

Activity Name Residential HE Toilets, SF

Return to Navigation Sheet   Report Error



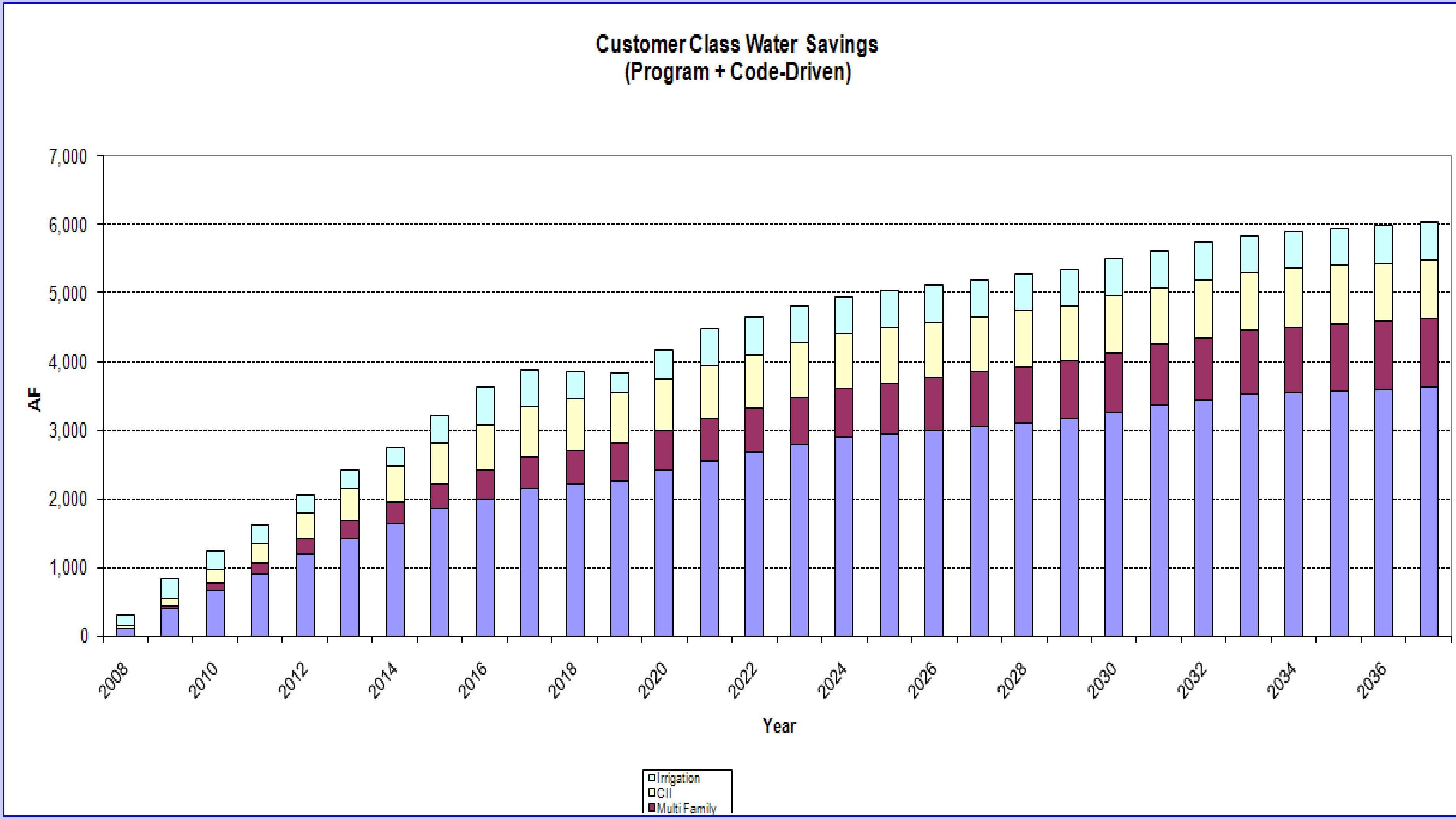
Residential HE Toilets, SF	Gross	Active	Passive
Lifetime Water Savings (AF)	**15,452**	7,957	7,495
Average Annual Water Savings (AF)	**258**	133	125

2. Specify Demands | 3. Enter Utility Avoided Costs | 4. Define Activities | 5. Enter Annual Activity | Activity Savings Profiles | Water Savings Summary

Select Chart to View

Total Class Savings

Chart Explanations

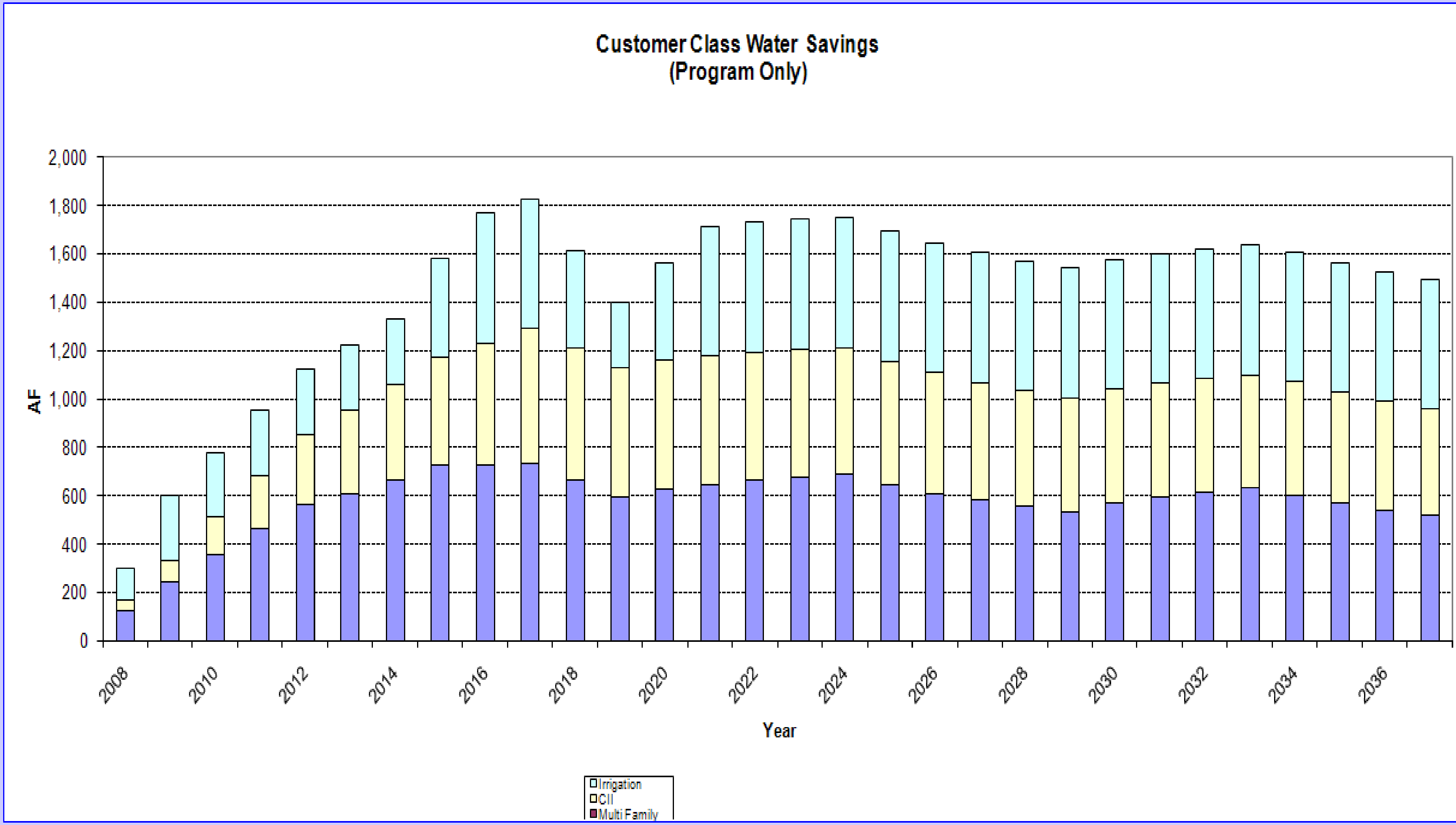


3. Enter Utility Avoided Costs | 4. Define Activities | 5. Enter Annual Activity | Activity Savings Profiles | **Water Savings Summary** | Utility Costs and B

Select Chart to View

Program Class Savings

Chart Explanations



3. Enter Utility Avoided Costs | 4. Define Activities | 5. Enter Annual Activity | Activity Savings Profiles | Water Savings Summary | Utility Costs and B

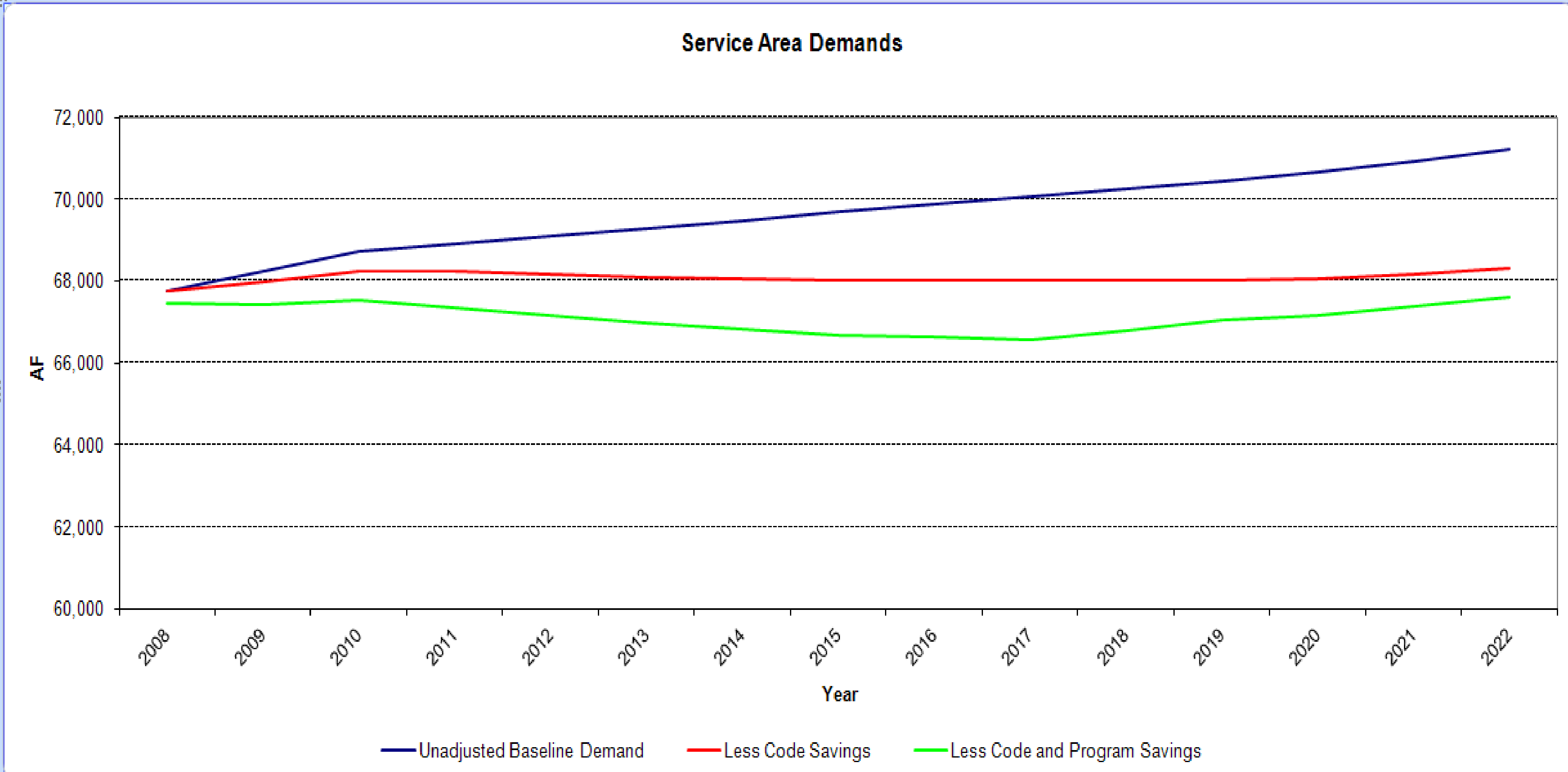
Year forecasted peak season demand equals existing peak season delivery capacity		Deferred Expansion (Years)	Deferred Capacity (MGD)	Benefit of Deferred Expansion ($)	Avoided Capacity (MGD)	Benefit of Avoided Expansion ($)
Baseline Demands	**2014**	N/A	N/A	N/A	N/A	N/A
Baseline - Code Savings	**2025**	**11**	5.8	$9,764,491	0.0	$0
Baseline - Code Savings - Program Savings	**2027**	**13**	5.8	$11,231,717	0.0	$0

Select Chart to View

Service Area Demands

No. of Years to Display 15 yrs

Chart Explanations



6. GHG Module Inputs | Activity Savings Profiles | Water Savings Summary | Utility Costs and Benefits | Utility Revenues and Rates | Customer C

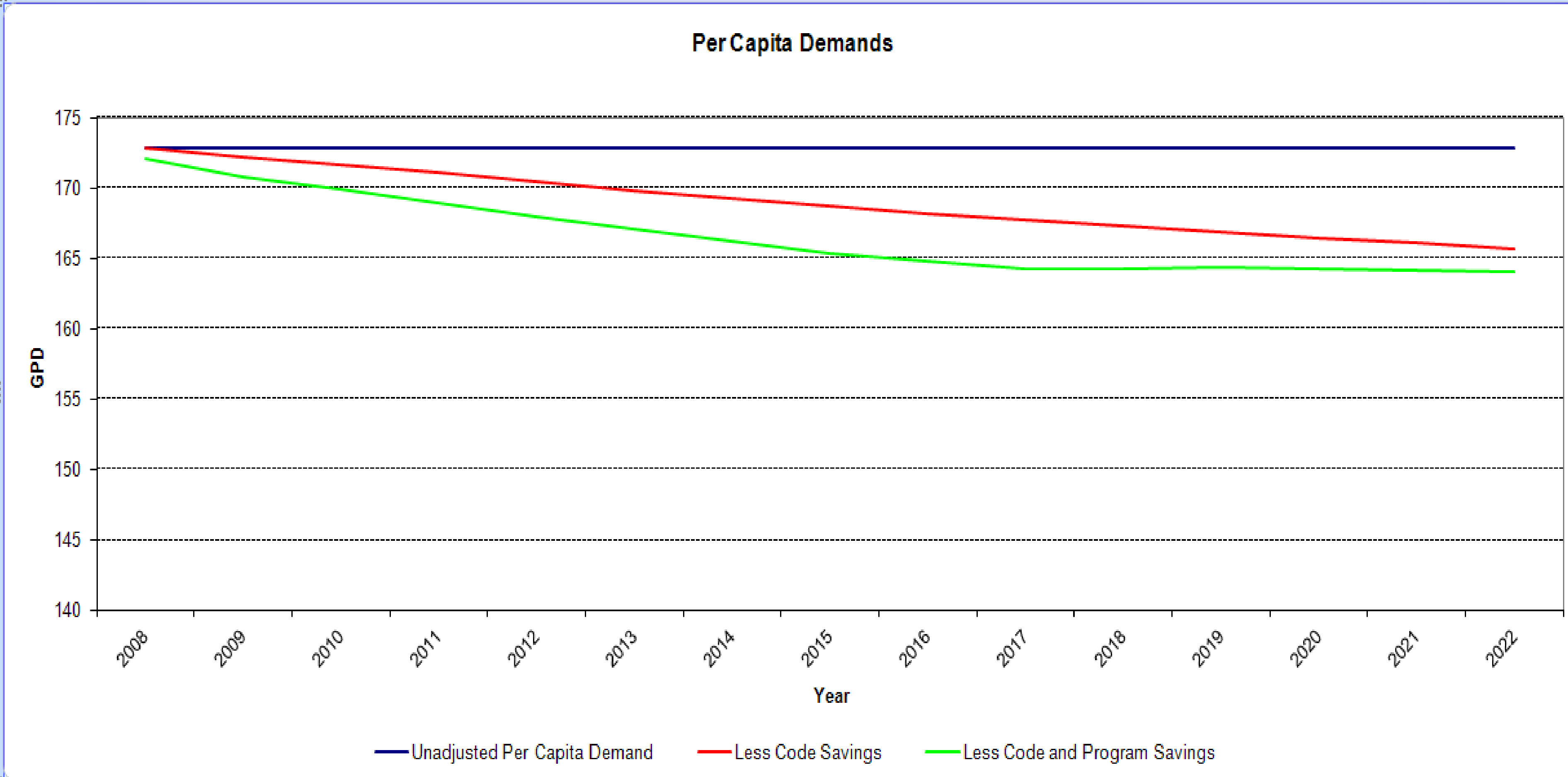
Year forecasted peak season demand equals existing peak season delivery capacity		Deferred Expansion (Years)	Deferred Capacity (MGD)	Benefit of Deferred Expansion ($)	Avoided Capacity (MGD)	Benefit of Avoided Expansion ($)
Baseline Demands	**2014**	N/A	N/A	N/A	N/A	N/A
Baseline - Code Savings	**2025**	**11**	5.8	$9,764,491	0.0	$0
Baseline - Code Savings - Program Savings	**2027**	**13**	5.8	$11,231,717	0.0	$0

Select Chart to View

Per Capita Demands

No. of Years to Display 15 yrs

Chart Explanations



6. GHG Module Inputs | Activity Savings Profiles | **Water Savings Summary** | Utility Costs and Benefits | Utility Revenues and Rates | Customer C

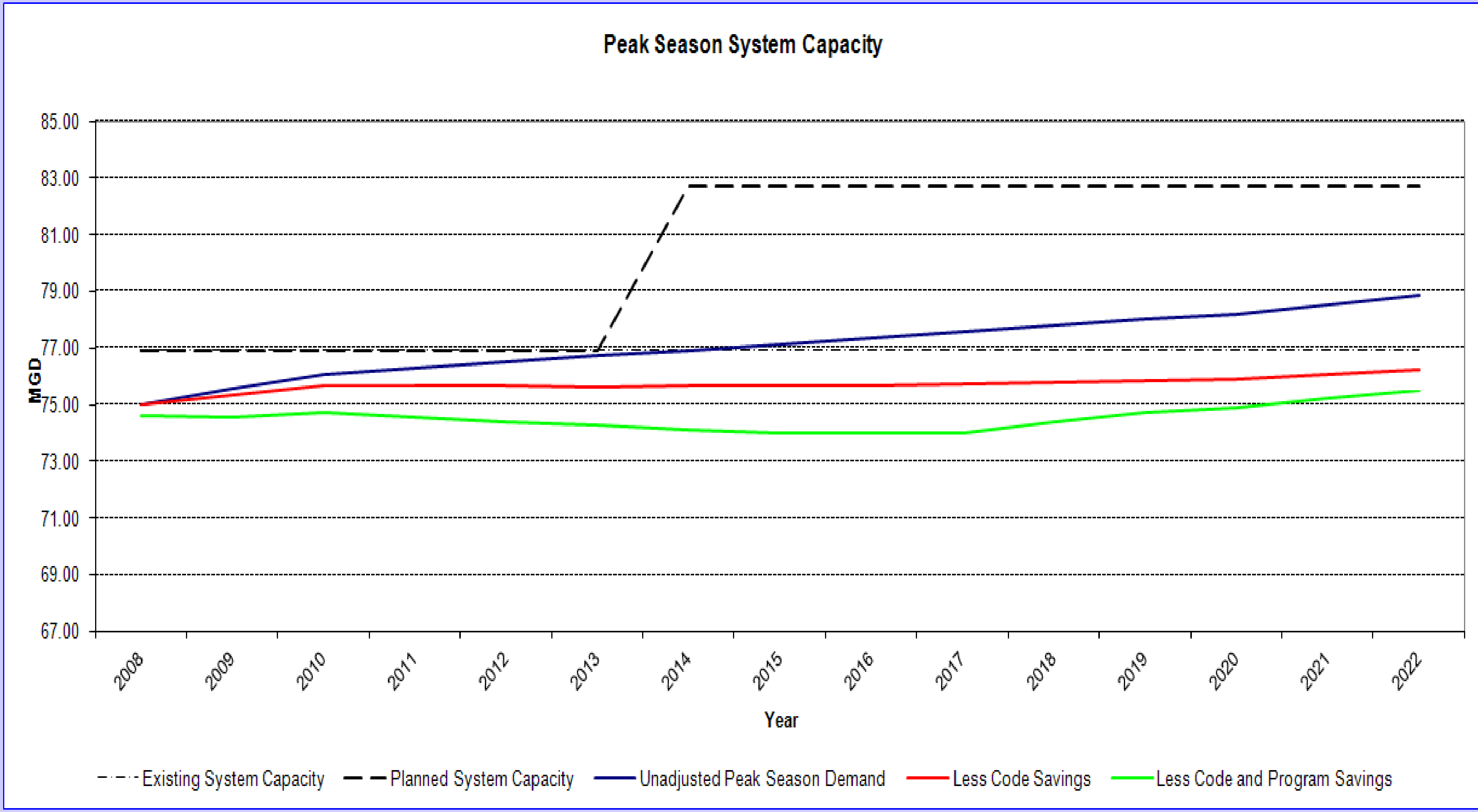
Year forecasted peak season demand equals existing peak season delivery capacity		Deferred Expansion (Years)	Deferred Capacity (MGD)	Benefit of Deferred Expansion ($)	Avoided Capacity (MGD)	Benefit of Avoided Expansion ($)
Baseline Demands	**2014**	N/A	N/A	N/A	N/A	N/A
Baseline - Code Savings	**2025**	**11**	5.8	$9,764,491	0.0	$0
Baseline - Code Savings - Program Savings	**2027**	**13**	5.8	$11,231,717	0.0	$0

Select Chart to View

Peak Season Capacity

No. of Years to Display: 15 yrs

Chart Explanations



AWE CONSERVATION TRACKING TOOL: UTILITY COSTS & BENEFITS WORKSHEET

Show Budget Table

Return to Navigation Sheet   Report Error

Conservation Program Cost Analysis (2010 Dollars)

Amort. Years: 20

Class	Activity Name	Unit Cost ($/AF)	PV Cost	Amortized Cost
Single Family	Residential Surveys, SF	$ 832	$ 1,469,277	$ 97,962
Single Family	Residential HE Toilets, SF	$ 403	$ 1,694,499	$ 112,979
CII	CII HE Toilet	$ 787	$ 4,220,334	$ 281,386
Single Family	Residential Irrigation Controller, SF	$ 783	$ 7,687,606	$ 512,563
Irrigation	Large Land. Irrigation Controller	$ 193	$ 2,520,977	$ 168,083
CII	CII Spray Rinse Valve	$ 324	$ 318,207	$ 21,216
CII	CII Cooling Tower	$ 201	$ 1,055,409	$ 70,368
Subtotal Conservation Activities		**$ 469**	**$18,966,309**	**$ 1,264,557**
Total With Overhead & Public Information		**$ 469**	**$18,966,309**	**$ 1,264,557**

Conservation Benefit Analysis (2010 Dollars)

Class	Activity Name	Unit Benefit ($/AF)	PV Benefit	Avoided Supply	Avoided Wastewater	Capacity Benefit
Single Family	Residential Surveys, SF	$ 662	$ 1,167,828	$ 898,505	$ 40,596	$ 228,728
Single Family	Residential HE Toilets, SF	$ 676	$ 2,841,271	$ 2,280,326	$ 240,463	$ 320,482
CII	CII HE Toilet	$ 676	$ 3,624,397	$ 2,908,842	$ 306,741	$ 408,815
Single Family	Residential Irrigation Controller, SF	$ 620	$ 6,089,920	$ 4,773,421	$ -	$ 1,316,499
Irrigation	Large Land. Irrigation Controller	$ 634	$ 8,295,971	$ 6,369,481	$ -	$ 1,926,490
CII	CII Spray Rinse Valve	$ 695	$ 683,579	$ 536,074	$ 57,006	$ 90,499
CII	CII Cooling Tower	$ 748	$ 3,927,857	$ 2,862,134	$ 303,931	$ 761,792
Total		**$ 658**	**$26,630,822**	**$20,628,782**	**$ 948,736**	**$ 5,053,304**

Utility Conservation Program NPV and B/C Ratio (2010 Dollars)

Class	Activity Name	NPV ($)	B/C Ratio
Single Family	Residential Surveys, SF	$ (301,449)	0.79
Single Family	Residential HE Toilets, SF	$ 1,146,772	1.68
CII	CII HE Toilet	$ (595,937)	0.86
Single Family	Residential Irrigation Controller, SF	$ (1,597,686)	0.79
Irrigation	Large Land. Irrigation Controller	$ 5,774,994	3.29
CII	CII Spray Rinse Valve	$ 365,371	2.15
CII	CII Cooling Tower	$ 2,872,448	3.72
Subtotal Conservation Activities		**$ 7,664,513**	**1.40**
Total With Overhead & Public Information		**$ 7,664,513**	**1.40**

Select Chart to View

Unit Costs Sorted

Chart Explanations

4. Define Activities | 5. Enter Annual Activity | Activity Savings Profiles | Water Savings Summary | **Utility Costs and Benefits** | Utility

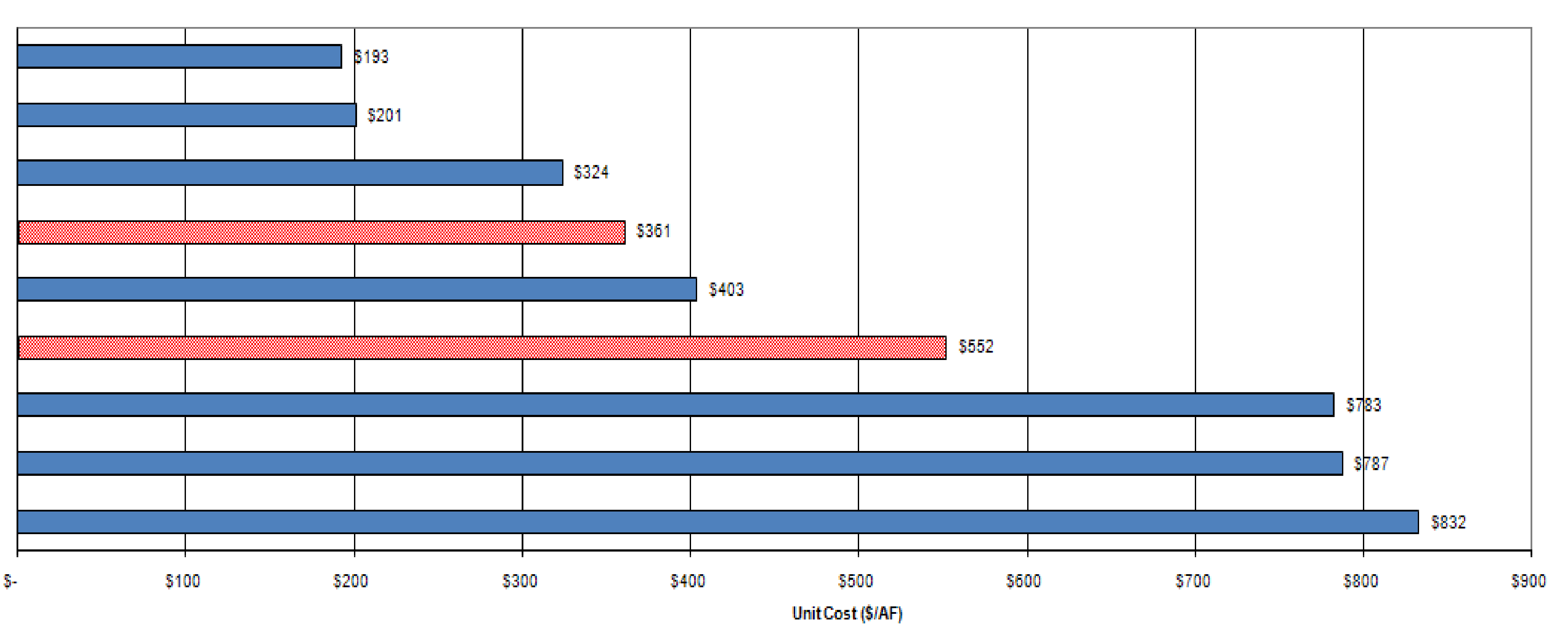
Utility Conservation Program NPV and B/C Ratio (2010 Dollars)

Class	Activity Name	NPV ($)	B/C Ratio
Single Family	Residential Surveys, SF	$ (301,449)	0.79
Single Family	Residential HE Toilets, SF	$ 1,146,772	1.68
CII	CII HE Toilet	$ (595,937)	0.86
Single Family	Residential Irrigation Controller, SF	$ (1,597,686)	0.79
Irrigation	Large Land. Irrigation Controller	$ 5,774,994	3.29
CII	CII Spray Rinse Valve	$ 365,371	2.15
CII	CII Cooling Tower	$ 2,872,448	3.72
Subtotal Conservation Activities		**$ 7,664,513**	**1.40**
Total With Overhead & Public Information		**$ 7,664,513**	**1.40**

Select Chart to View

Unit Costs Sorted

Chart Explanations



*Low and high unit cost represent the 90% confidence interval for average unit cost of 7 U.S. water loss control programs, as reported in Thornton and Sturm (2007).

4. Define Activities | 5. Enter Annual Activity | Activity Savings Profiles | Water Savings Summary | Utility Costs and Benefits | Utility Revenues and R

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O

AWE CONSERVATION TRACKING TOOL: UTILITY REVENUES & RATES WORKSHEET

Last Loaded Scenario: "Sample Scenario (English Units)" loaded on 9/16/2011 11:58:00 AM

Return to Navigation Sheet   Report Error

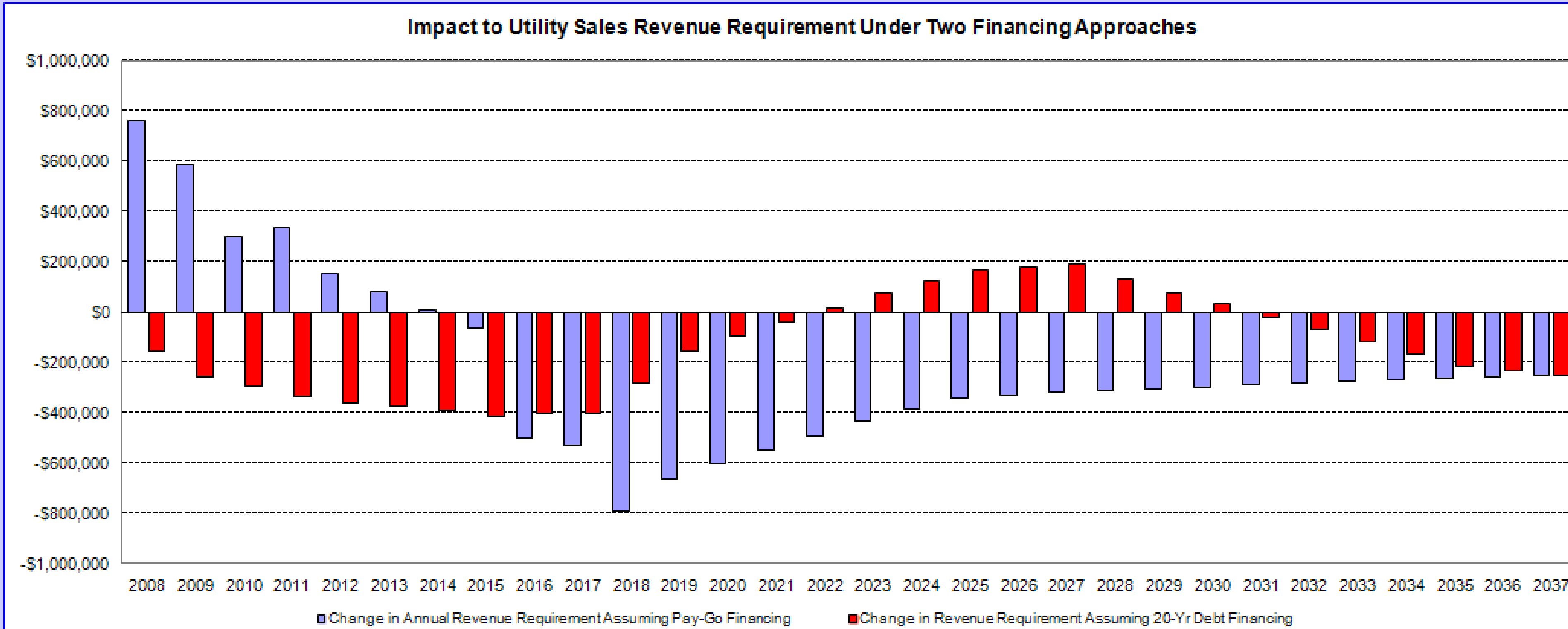
Utility Revenue Requirement and Rate Impacts

Program Impact on...	Baseline	With Conserv.	Change to Baseline
Water Utility Annual Sales Revenue Requirement	49,742,591	$49,562,581	($180,010)
		% change from baseline	-0.36%
Avg. Water Rate ($/Thou Gal)	$2.17	$2.29	$0.13
		% change from baseline	5.86%
Annualized Bill Impact ($/Mo.)	46.86	$46.69	($0.16)
		% change from baseline	-0.35%

Select Impact Chart to View

Revenue Requirement

Chart Explanations



6. GHG Module Inputs | Activity Savings Profiles | Water Savings Summary | Utility Costs and Benefits | Utility Revenues and Rates | Customer C

AWE CONSERVATION TRACKING TOOL: GHG MODULE INPUTS WORKSHEET

Last Loaded Scenario: "GHG Scenario" loaded on 4/19/2011 6:11:20 PM

Return to Navigation S

Select eGRID Region:

In which eGRID Region are you located? (See map)	RFCE

Average Generation Emission Rates	lb/MWhr
CO_2	1,139
CH_4	0.03027
SO_2	7.7918
NO_x	1.6307
N_2O	0.01871
Hg	0.0000387

eGRID Subregion Representational Map

Energy Used for Water Supply and Wastewater Treatment:

Average Energy Intensity For:	KWh/AF
Water Supply Withdrawal, Treatment, and Distribution	2,200
Wastewater Pumping and Treatment	850

Tables for Estimating Water and Wastewater Embedded Energy

Water Supply, Treatment, and Distribution Energy Intensity Default Values

Local Water Supply Sources	KWh/AF	% of Local Supply
Local Surface Water	222	40%
Groundwater	624	40%
Brackish Desalination	528	0%
Recycled Water	730	10%
Seawater Desalination	4,497	10%
	Total:	100%

Average Energy Intensity of Local Water Supply	861	KWh/AF

Imported Water Supply Sources	KWh/AF	Default Value	
Select the imported water energy intensity level	High		
Average Energy Intensity of Imported Water Supply		2,473	KWh/AF
Imported Water Supply as % of Total Supply	40%		
Local Water Supply as % of Total Supply	60%		

Imported Water Energy Intensity Key

Low - Transmission mostly via gravity with limited pumping. More likely raw than trea

Moderate - Some transmission pumping required. Source may be groundwater. De

High - Transmission involves significant pumping. Source may be groundwater. De

Average Energy Intensity per AF of Total Supply	**1,506**	**KWh/AF**

		% of Total Supply

6. GHG Module Inputs | Activity Savings Profiles | Water Savings Summary | Utility Costs and Benefits | Utility R

A	C	D	E	F	G	H	I	J	K

Tables for Estimating Water and Wastewater Embedded Energy

Water Supply, Treatment, and Distribution Energy Intensity Default Values

Local Water Supply Sources	KWh/AF	% of Local Supply
Local Surface Water	222	40%
Groundwater	624	40%
Brackish Desalination	528	0%
Recycled Water	730	10%
Seawater Desalination	4,497	10%
	Total:	100%

Average Energy Intensity of Local Water Supply	861	KWh/AF

Imported Water Supply Sources	KWh/AF	Default Value	
Select the imported water energy intensity level	High		
Average Energy Intensity of Imported Water Supply		2,473	KWh/AF
Imported Water Supply as % of Total Supply	40%		
Local Water Supply as % of Total Supply	60%		

Imported Water Energy Intensity Key

Low - Transmission mostly via gravity with limited pu

Moderate - Some transmission pumping required. S

High - Transmission involves significant pumping. S

Average Energy Intensity per AF of Total Supply	**1,506**	**KWh/AF**

Local Water Treatment	KWh/AF	% of Total Supply Receiving This Treatment
Coagulation, Flocculation, Filtration	82	80%
Microfiltration	153	60%
Disinfection (Ozone)	72	50%

AverageTreatment Energy Intensity per AF of Delivered Water	**193**	**KWh/AF**

Water Distribution	KWh/AF
Choose a terrain that best describes your service area	Flat
Average Booster Pump Energy Intensity per AF of Delivered Water	18
Average Pressure System Pumps per AF of Delivered Water	477

Average Distribution Energy Intensity per AF of Delivered Water	**495**	**KWh/AF**

Average Energy Intensity of Delivered Water	KWh/AF

C	D	E	F	G	H	I	J	K	L

AWE CONSERVATION TRACKING TOOL: GHG REDUCTION BENEFITS WORKSHEET

Last Loaded Scenario: "GHG Scenario" loaded on 4/19/2011 6:11:20 PM

Summary of Calculated Energy Savings

Utility-Side Energy Savings From	**Units**	2015	2020	2025	2030	2035	2040	2045	2050
Plumbing Codes	MWh/Yr	3,605	6,484	8,720	10,462	11,855	12,968	13,864	14,593
Utility Conservation Programs	MWh/Yr	3,019	3,242	1,663	1,202	1,046	920	817	733
Subtotal	*MWh/Yr*	*6,624*	*9,726*	*10,383*	*11,664*	*12,901*	*13,888*	*14,680*	*15,325*

Customer-Side Energy Savings From	**Units**	2015	2020	2025	2030	2035	2040	2045	2050
Plumbing Codes									
Electricity	MWh/Yr	238	442	581	676	746	798	838	869
Natural Gas	10^3 Therms/Yr	364,894	633,301	805,984	917,329	996,240	1,052,188	1,093,313	1,125,685
Utility Conservation Programs									
Electricity	MWh/Yr	121	101	0	0	0	0	0	0
Natural Gas	10^3 Therms/Yr	144,858	98,602	0	0	0	0	0	0

Total Annual Energy Savings	**Units**	2015	2020	2025	2030	2035	2040	2045	2050
Electricity	MWh/Yr	6,983	10,269	10,964	12,340	13,648	14,686	15,518	16,195
Natural Gas	10^3 Therms/Yr	509,753	731,903	805,984	917,329	996,240	1,052,188	1,093,313	1,125,685

Cumulative Energy Savings Since 2010	**Units**	2015	2020	2025	2030	2035	2040	2045	2050
Electricity	GWh	25	72	125	183	249	321	397	476
Natural Gas	10^6 Therms	1,840	5,053	9,015	13,398	18,233	23,389	28,778	34,344

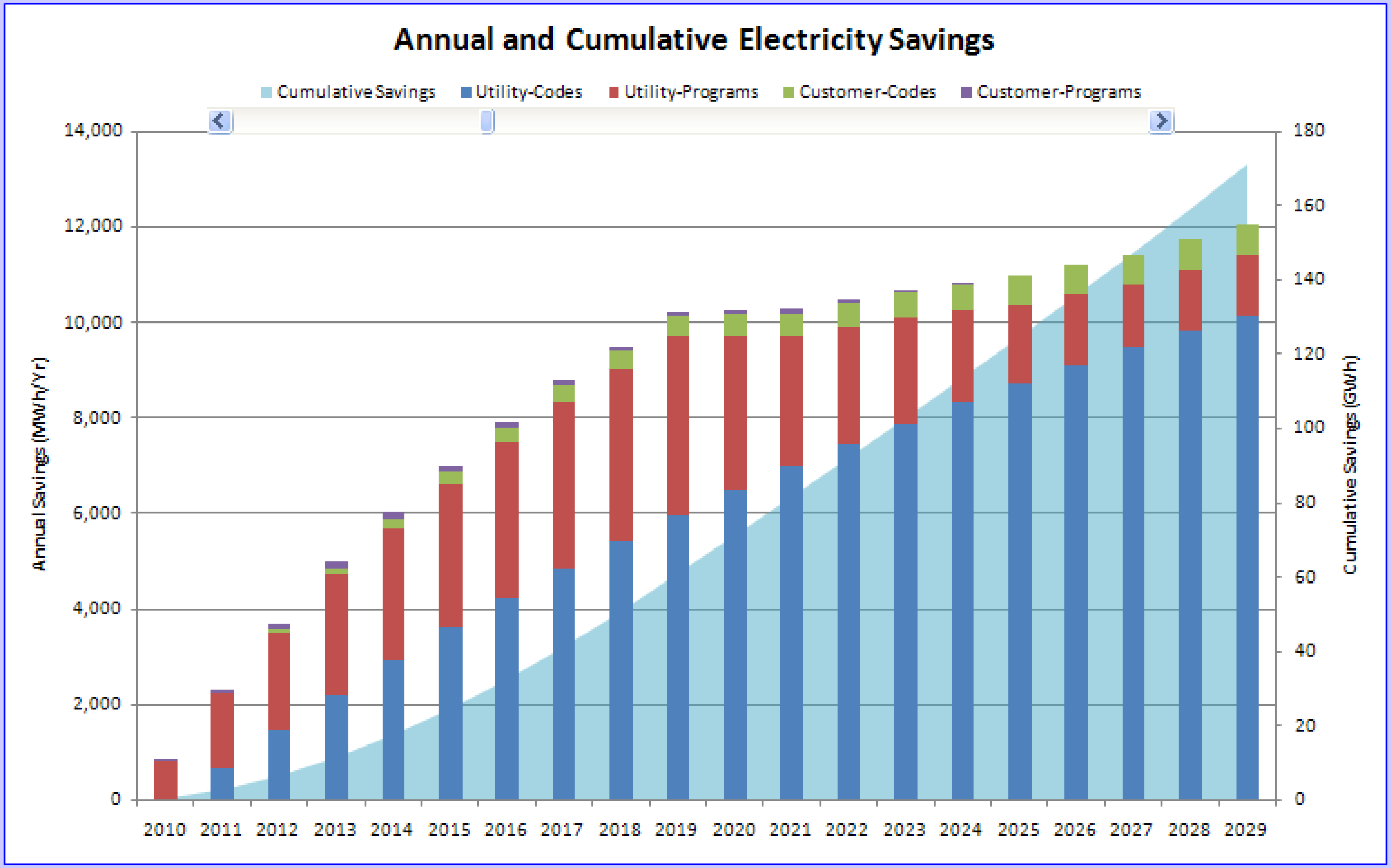
Summary of Calculated Emission Reductions

Carbon Dioxide

Utility-Side CO_2 Reductions From	**Units**	2015	2020	2025	2030	2035	2040	2045	2050
Plumbing Codes	Tons/Yr	2,053	3,693	4,967	5,959	6,752	7,386	7,896	8,311
Utility Conservation Programs	Tons/Yr	1,719	1,846	947	684	596	524	465	417
Subtotal	*Tons/Yr*	*3,772*	*5,539*	*5,913*	*6,643*	*7,348*	*7,910*	*8,361*	*8,728*
Customer-Side CO_2 Reductions From									
Plumbing Codes	Tons/Yr	0	0	0	0	0	0	0	0
Utility Conservation Programs	Tons/Yr	2,282	3,977	5,072	5,781	6,285	6,644	6,908	7,117
Subtotal	*Tons/Yr*	*2,282*	*3,977*	*5,072*	*5,781*	*6,285*	*6,644*	*6,908*	*7,117*

Utility Revenues and Rates | Customer Costs and Benefits | **GHG Reduction Benefits** | User Lists and State Variable

O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF

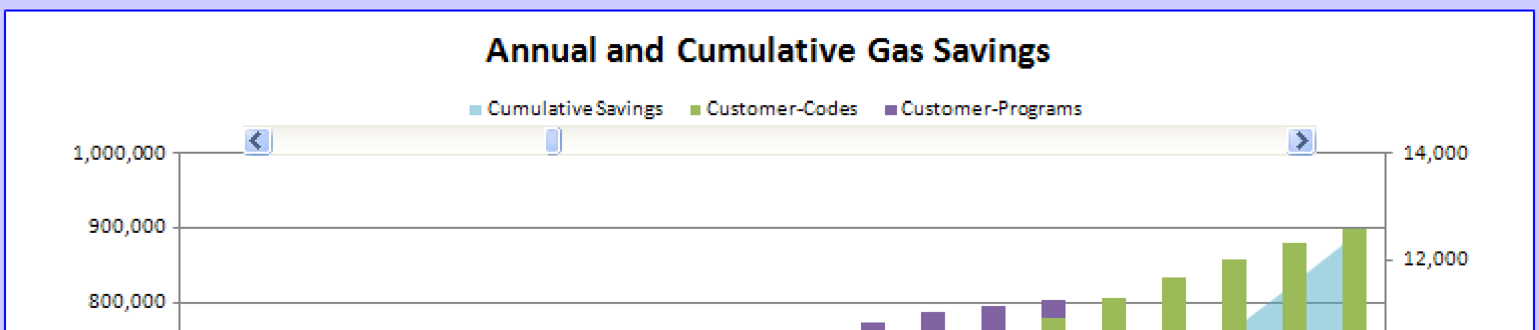


Show Series

- ☑ Utility-Codes
- ☑ Utility-Programs
- ☑ Customer-Codes
- ☑ Customer-Program
- ☑ Cumulative Savings-All

Years to Display: 20

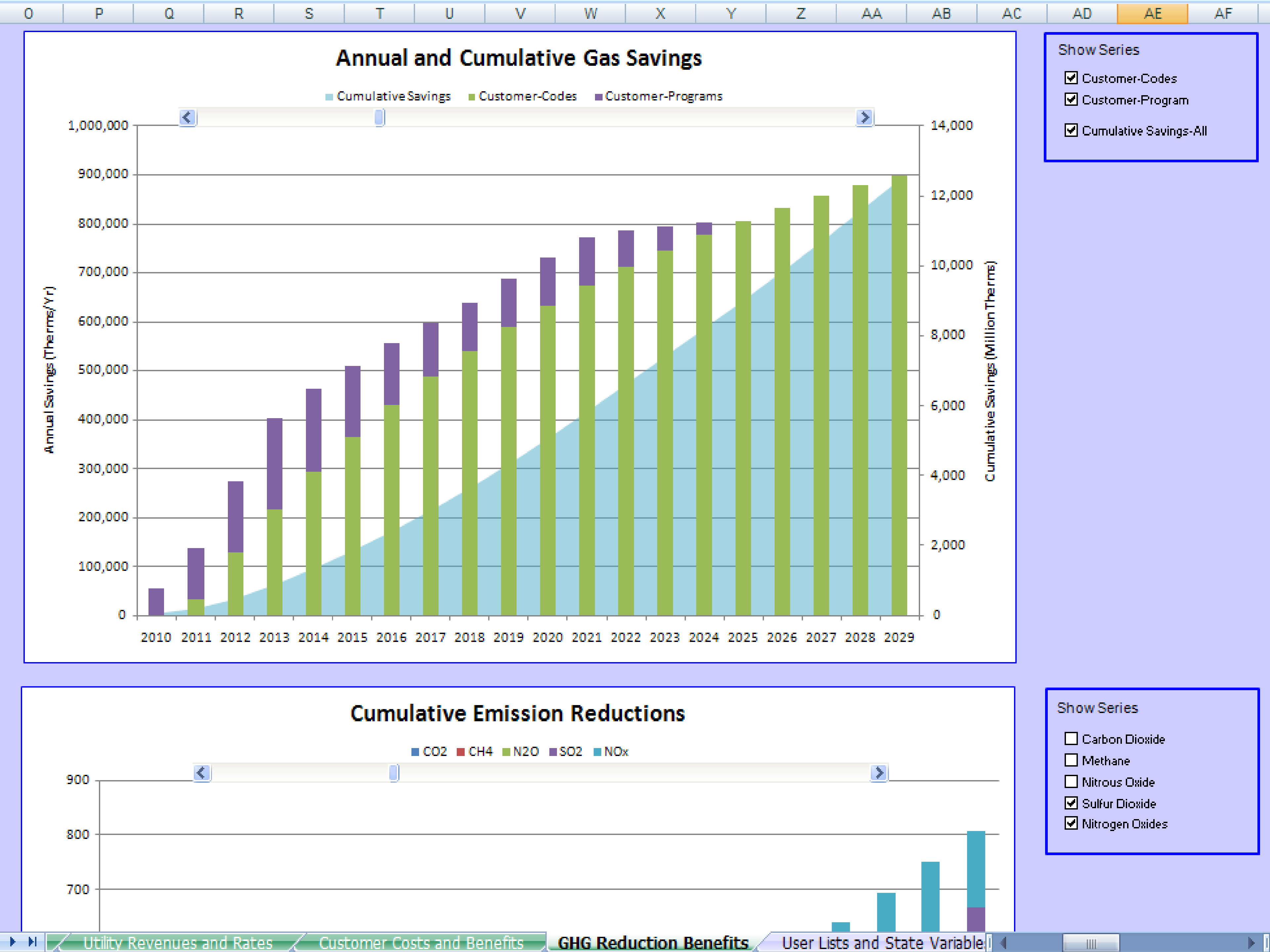
Use the slider in the chart to set the number of years to display. Or enter a whole number between 5 a 60 in the box above.



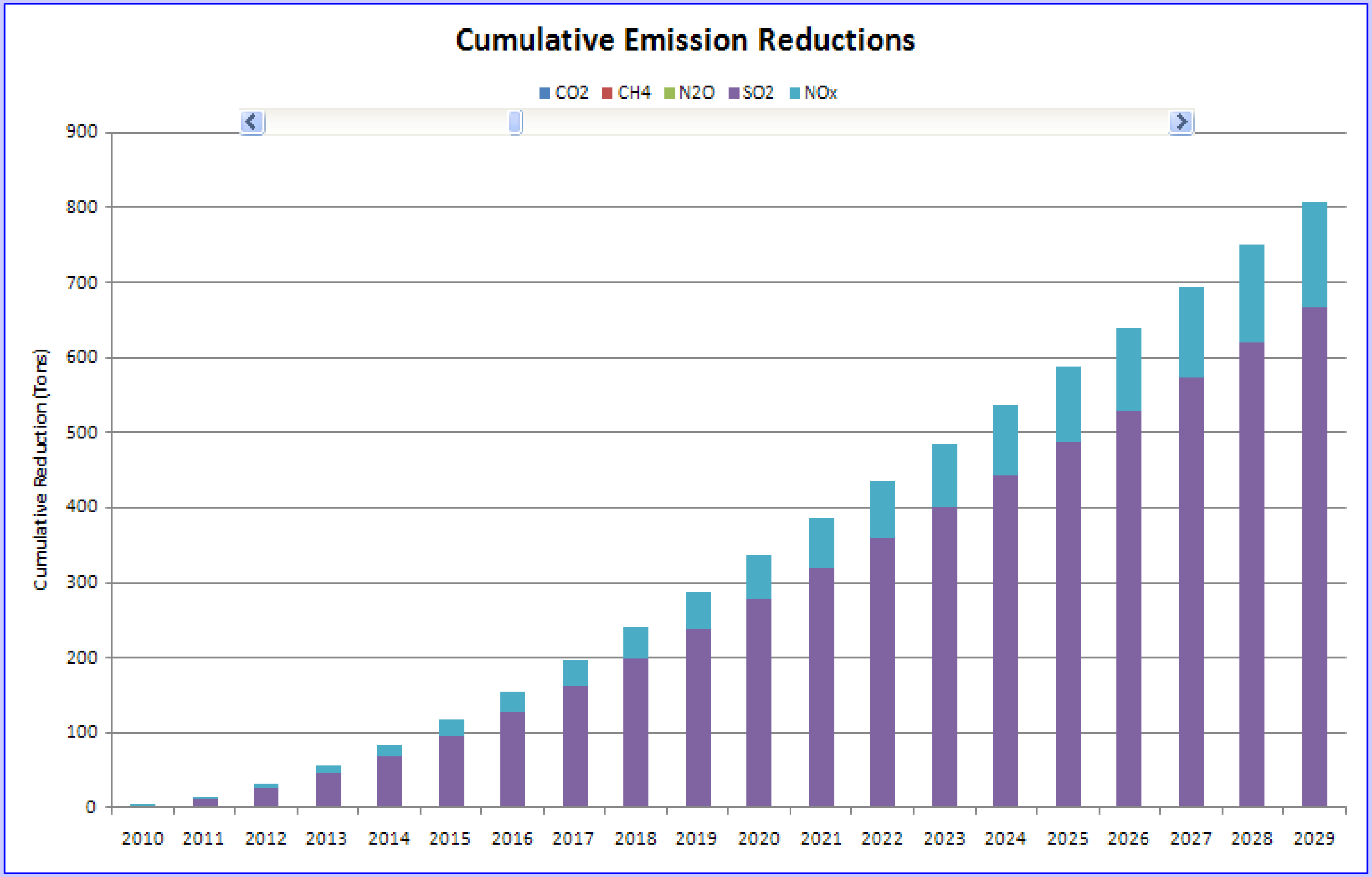
Show Series

- ☑ Customer-Codes
- ☑ Customer-Program
- ☑ Cumulative Savings-All

Utility Revenues and Rates | Customer Costs and Benefits | **GHG Reduction Benefits** | User Lists and State Variable



O P Q R S T U V W X Y Z AA AB AC AD AE AF
Annual and Cumulative Gas Savings
Cumulative Savings
Customer-Codes
Customer-Programs
Annual Savings (Therms/Yr)
Cumulative Savings (Million Therms)
1,000,000
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029
Show Series
Customer-Codes
Customer-Program
Cumulative Savings-All
Cumulative Emission Reductions
CO2
CH4
N2O
SO2
NOx
900
800
700
Show Series
Carbon Dioxide
Methane
Nitrous Oxide
Sulfur Dioxide
Nitrogen Oxides
Utility Revenues and Rates
Customer Costs and Benefits
GHG Reduction Benefits
User Lists and State Variable



Show Series

- [ ] Carbon Dioxide
- [ ] Methane
- [ ] Nitrous Oxide
- [x] Sulfur Dioxide
- [x] Nitrogen Oxides

Utility Revenues and Rates | Customer Costs and Benefits | **GHG Reduction Benefits** | User Lists and State Variable

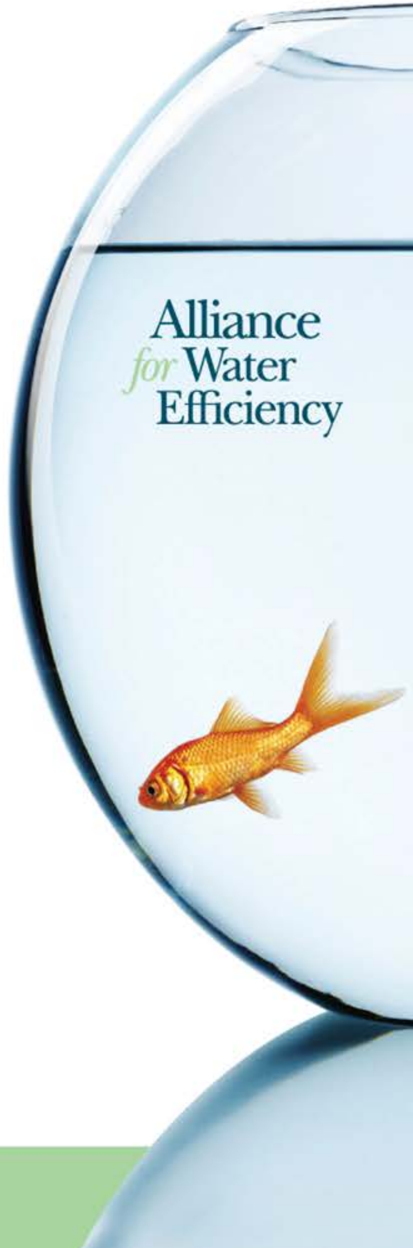
Joint Opportunities

HOT WATER RESIDENTIAL

- Combined water/energy audits
- Clothes washers
- Showerheads and Faucets/Aerators

HOT WATER COMMERCIAL

- Combined water/energy audits
- Clothes washers
- Dishwashers
- Connectionless Steamers
- Pre-rinse spray valves



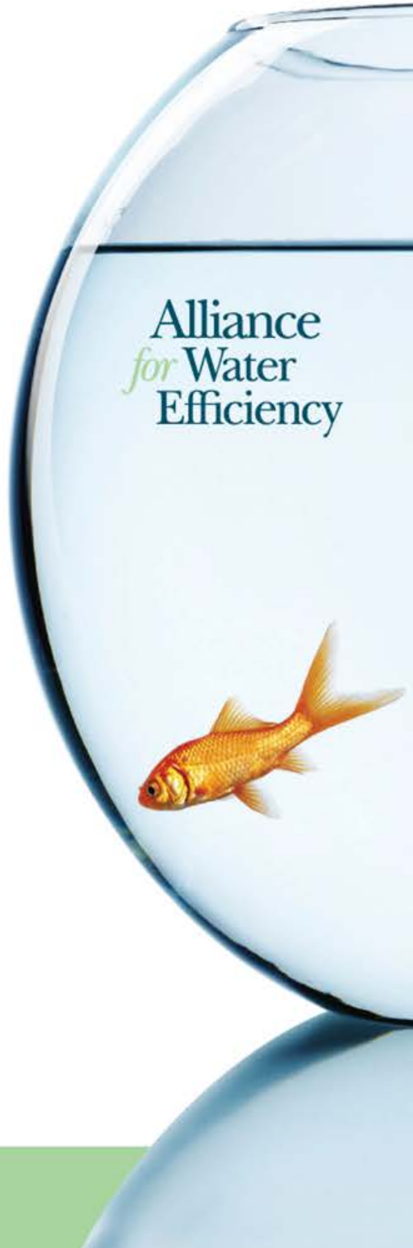
Joint Opportunities

COLD WATER: RESIDENTIAL

- High efficiency toilets
- Landscape irrigation efficiency

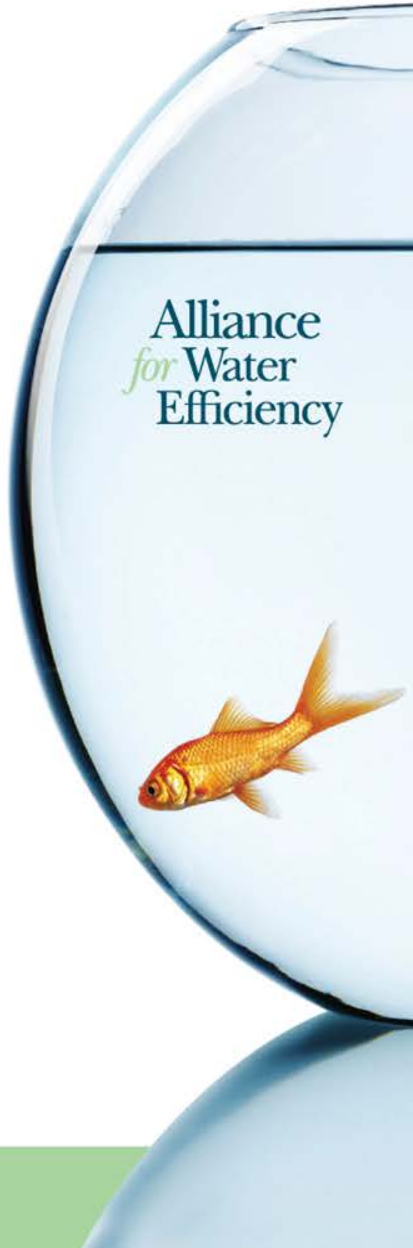
COLD WATER: COMMERCIAL

- High efficiency toilets
- Landscape irrigation efficiency
- Cooling Tower Management
- Icemakers

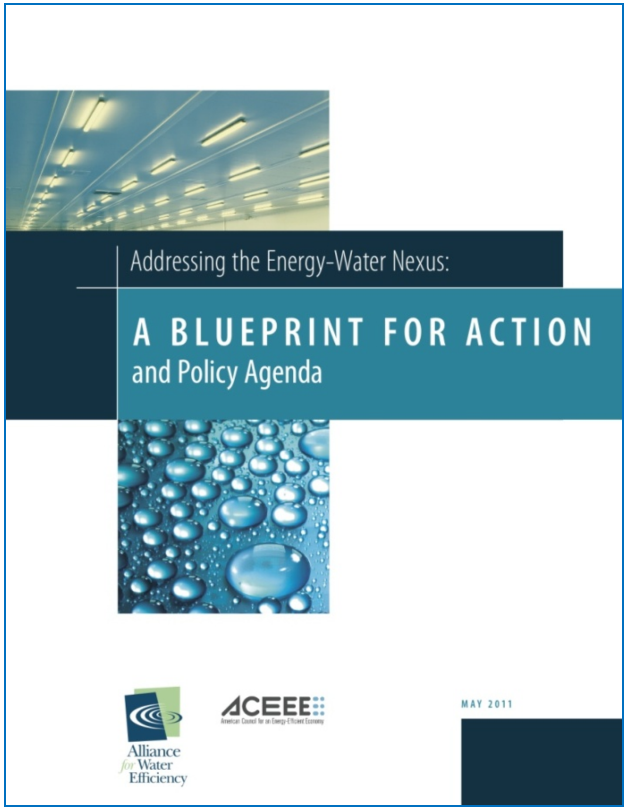


Need for Better Integration

- 30 years of energy conservation and increases in efficiency of energy use.
- 20 years of water conservation and increases in efficiency of water use.
- Saving a drop of water saves energy; saving a unit of energy saves water.
- Yet the two communities have historically not worked much together.
- Opportunity for business and policy integration



Blueprint

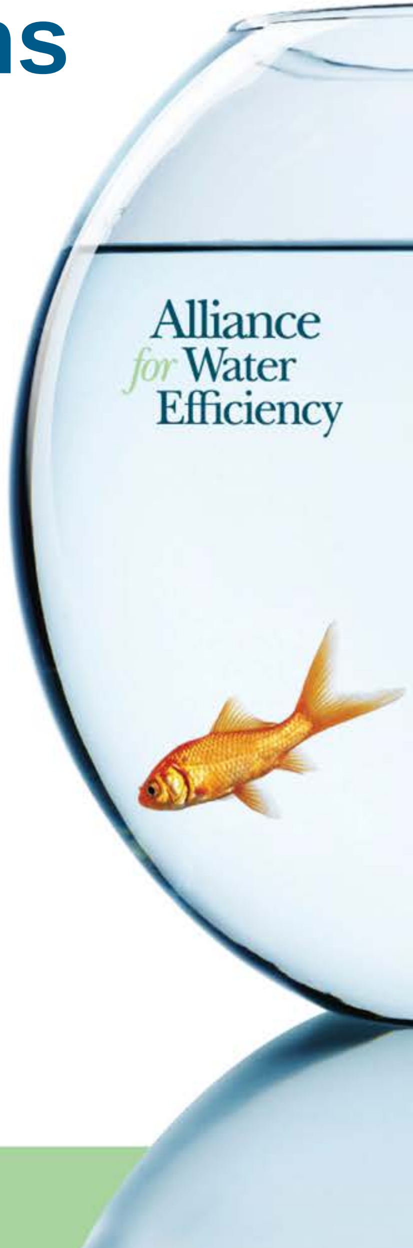


- Joint effort of AWE and ACEEE.
- Supported by funding from the Turner Foundation.
- Purpose: to identify the major research, program, and policy needs of the water-energy nexus for decision-makers and funders.
- Establish the beginning of a national long term energy-water community.

http://www.allianceforwaterefficiency.org/blueprint.aspx

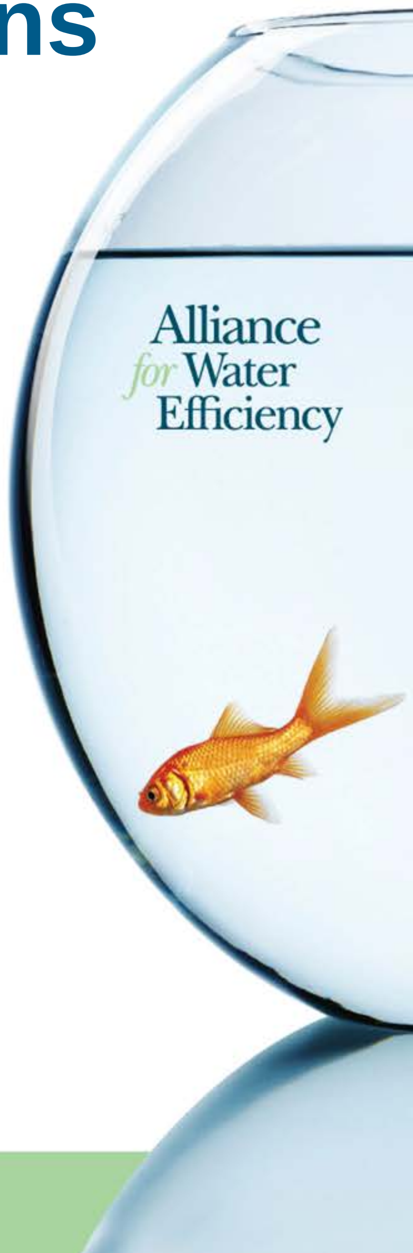
8 Themes of Recommendations

1. Increase the level of collaboration between the water and energy communities in planning and implementing programs.
2. Achieve a deeper understanding of the energy embedded in water and the water embedded in energy.
3. Learn from and replicate best practice integrated energy-water efficiency programs.
4. Integrate water into energy research efforts and vice versa.



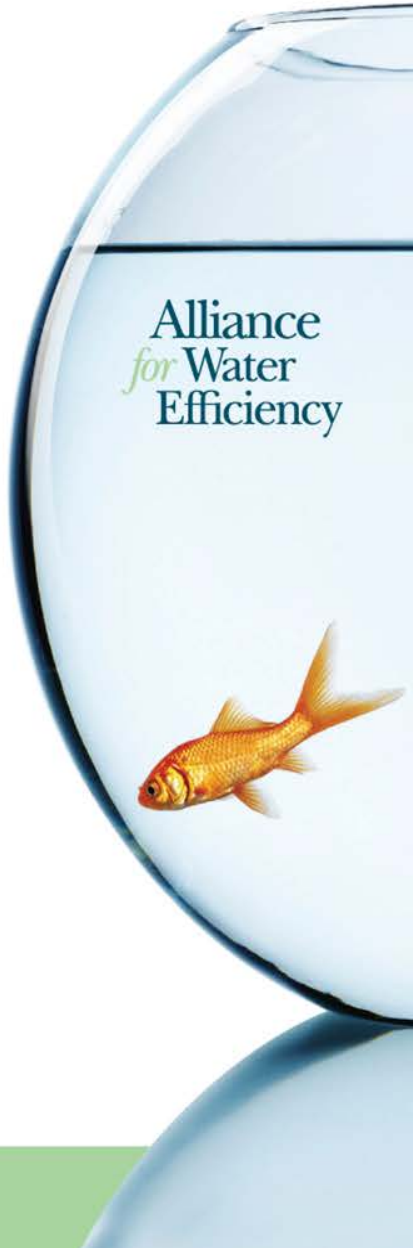
8 Themes of Recommendations

5. Separate water utility revenues from unit sales, and consider regulatory structures that provide an incentive for investing in end-use water and energy efficiency.
6. Leverage existing and upcoming voluntary standards that address the energy-water nexus.
7. Implement codes and mandatory standards that address the energy-water nexus.
8. Pursue education and awareness opportunities for various audiences and stakeholders.



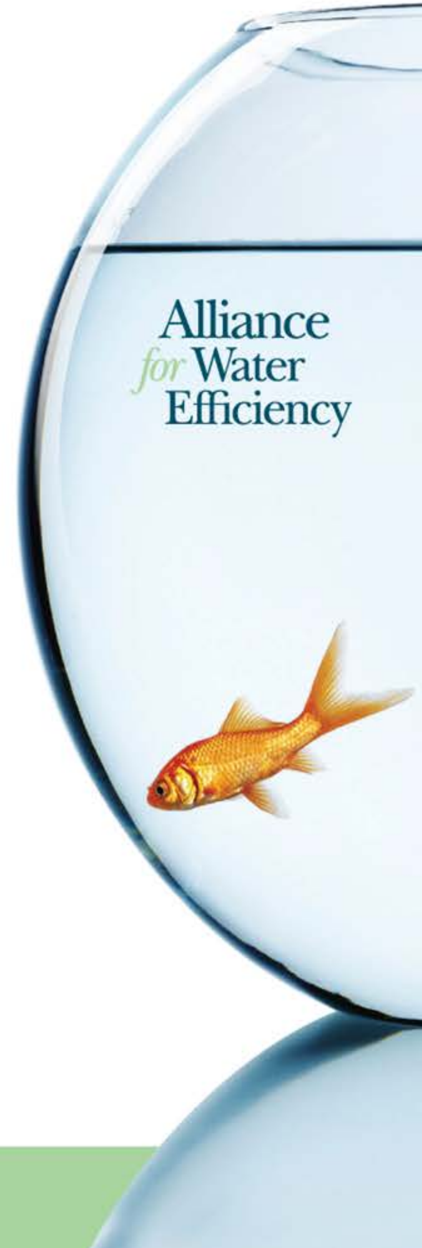
9 Policy Needs

1. Regulatory structures and incentives that reward water and energy efficiency.
2. DOE Appliance and Equipment Standards for water-using appliances and equipment.
3. Building Codes that recognize water and energy efficiency.
4. Specific energy-water elements to add to existing legislation.
5. Tax incentives for water and energy efficiency.



9 Policy Needs

6. Collection of water and energy end-use data by federal agencies.
7. Better communication between regulatory and governance bodies.
8. Collaboration among federal, state, and local agencies in integrating water and energy in grant funding research, regulation, and technical assistance.
9. Coordination in new power plant siting or significant expansion of existing plants.



homewaterworks

A project of the Alliance for Water Efficiency

Calculator | Water Saving Tips | Indoor Water Use | Landscape & Irrigation | Water & Energy | About Us | Blog

Explore Your Water Usage With Our Water Calculator

How much water do I use? How do I compare? Estimate daily and annual water use with the Water Calculator.

Answer a few simple questions and the Water Calculator does the rest. It's quick and easy. Once you have an estimate of your water usage, the calculator can help you identify ways to conserve water based on your usage.

Blog

- Happy Friday! We end this week with an inspiring image shot at Yellowstone Park.
- Cool picture we made with Frametastic
- Bravo to those who made the top green U.S. cities list! Are you on the list?

More

Does Your Landscape Have a Drinking Problem?

Read about outdoor water conservation for helpful information on how to keep your landscape looking beautiful while staying water efficient.

Quick & Easy Tips For Saving Water at Home and Work

Looking for quick and easy ways to save water? Read our water conservation and saving tips to see how easy it can be to conserve water at home and in the workplace!

How much water do you use?

Let's Get Started!

Click an area on the home to input how much water you use, and learn how you can conserve water there. Answer for yourself only, and assume you are in your home for a 24-hour cycle.

My Daily Usage
Roll over for results

Carbon Footprint:

(lbs. CO_2 /year)

Percent Complete

Areas to Complete
Roll over for number of questions


Alliance for Water Efficiency
A Voice and
a Platform
Promoting the
efficient and
sustainable
use of water
www.a4we.org
(773) 360-5100
CHICAGO

Brownstein Hyatt Farber Schreck

The Critical Nexus Between Energy and Water Savings

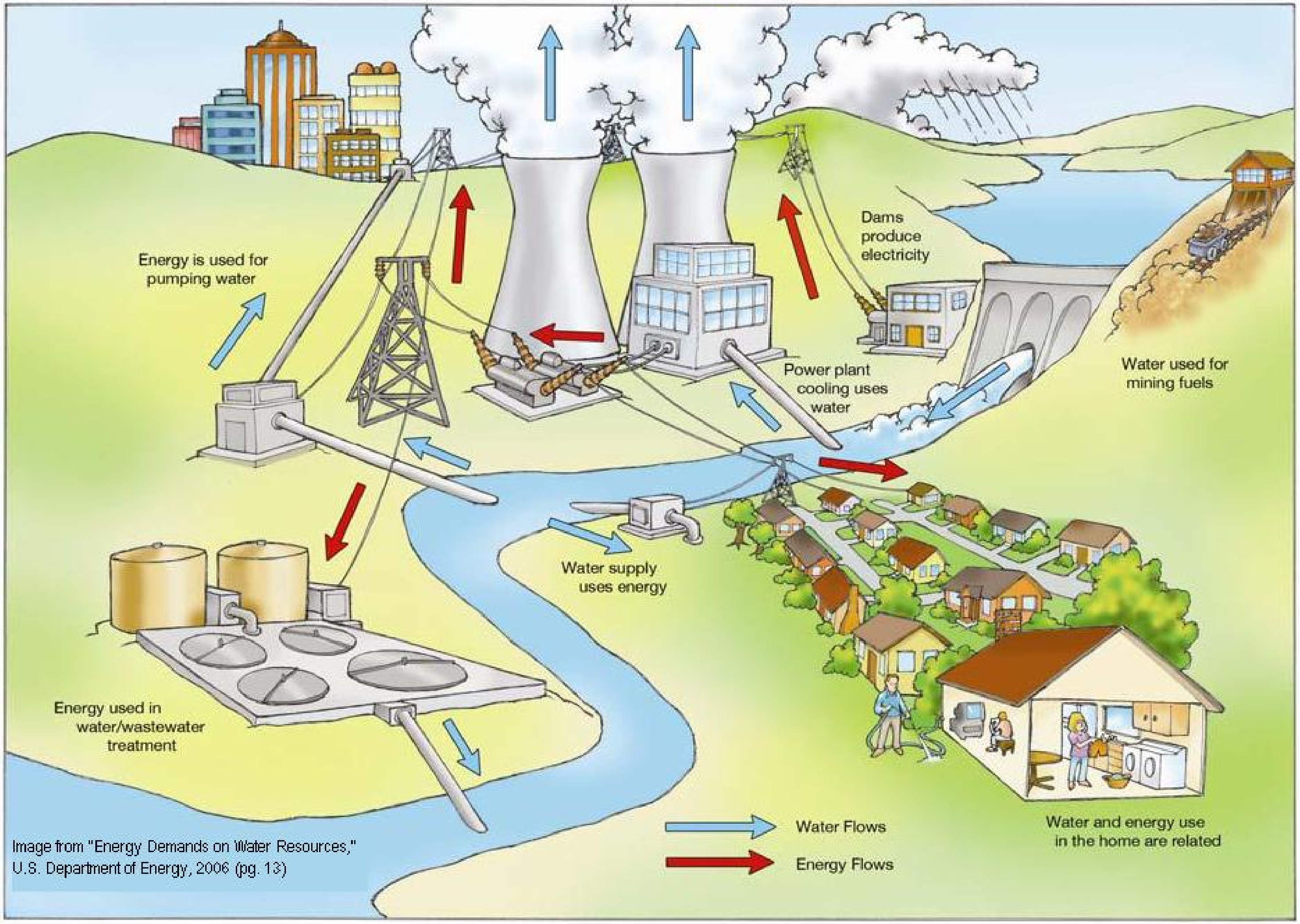
Presented by
Scott Slater
October 5, 2012

Always There™

Overview

- The use of water and the use of energy are intricately intertwined. The extraction, treatment, distribution, and use of water followed by the collection and treatment of wastewater require a lot of energy; likewise, the production of energy—particularly hydroelectric and thermometric power generation— requires a lot of water.
- Energy is used in five stages in the water cycle:
  - **Extracting and conveying water:** Extracting water from rivers and streams or pumping it from aquifers, and then conveying it over hills and into storage facilities is a highly energy intensive process. In California, the State Water Project (SWP) pumps water almost 2000 ft over the Tehachapi Mountains. The SWP is the largest single user of energy in California. It consumes an average of 5 billion kWh/yr, accounting for about 2 to 3 percent of all electricity consumed in California.
  - **Treating water:** Water treatment facilities use energy to pump and process water.
  - **Distributing water:** Energy is needed to transport water.
  - **Using water:** End users consume energy to treat water with softeners or filters, to circulate and pressurize water with circulation pumps and irrigation systems, and to heat and cool water.
  - **Collecting and treating wastewater**: Energy is used to pump wastewater to the treatment plant, and to aerate and filter it at the plant. On average, wastewater treatment in California uses 500 to 1,500 kilowatt-hours per acre-foot.
- By reducing the amount of water we use, we use lessen our demand on the energy-intensive systems that deliver and treat water.
- Policy integration

The Water-Energy Nexus

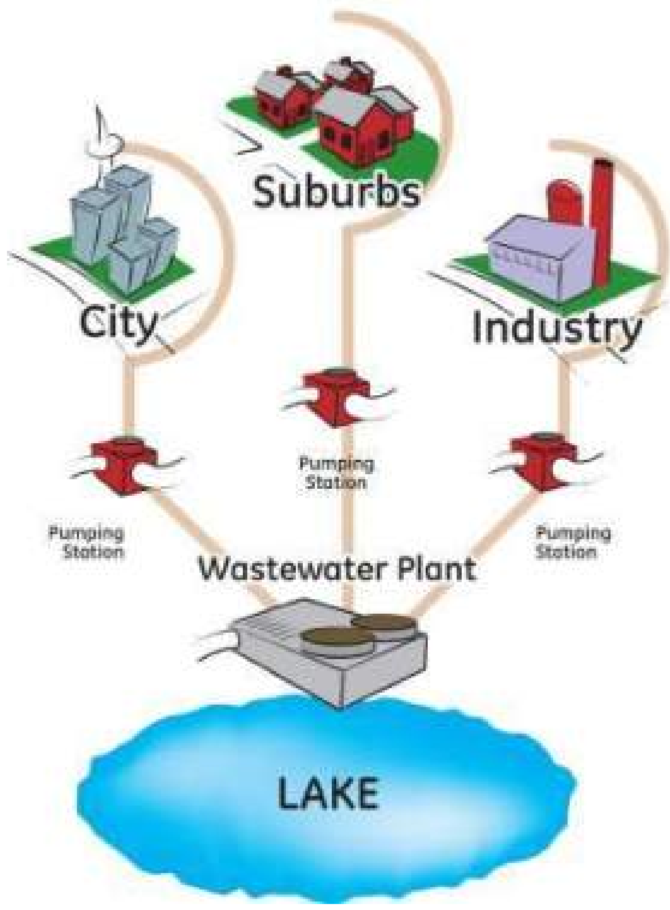


Water-Energy Use in California: An Example

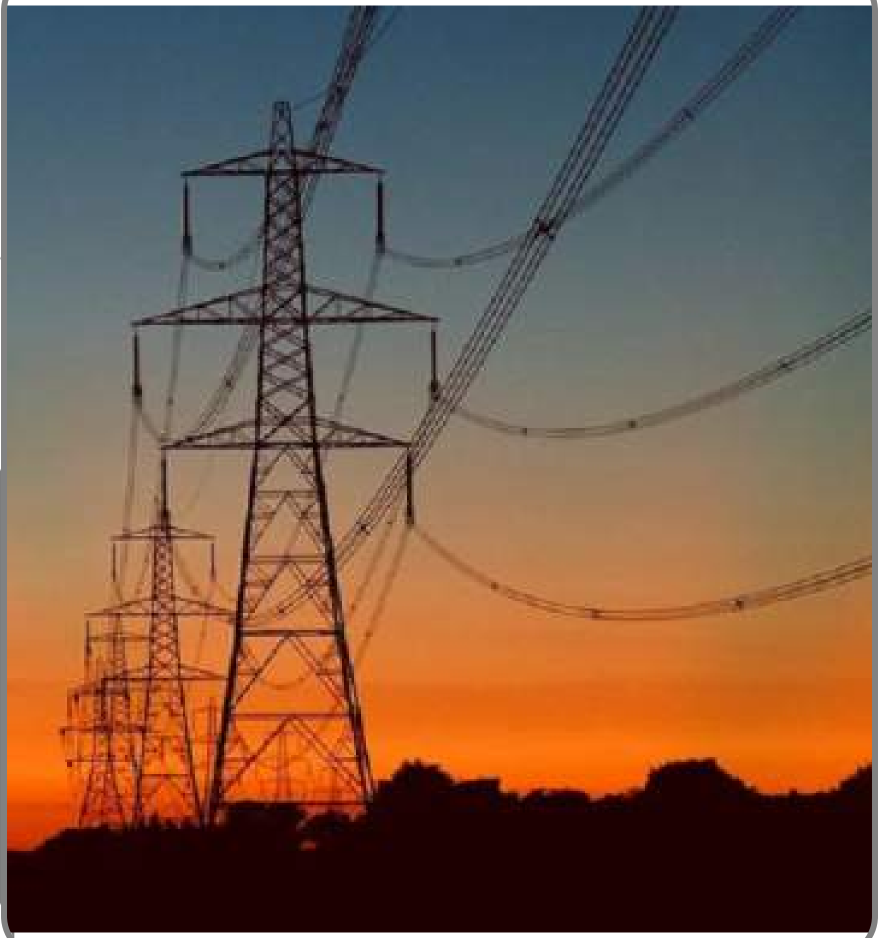
- **Energy demand associated with water use in CA is high for three reasons:**
  - **Most of demand is located at considerable distance from source (State Water Project)**
  - **Water is heavy and moving it is energy intensive**
  - **Water used for consumption must be treated, another energy intensive process**
- **Annual water consumption is over 40 million acre-feet (one acre-foot = 326,000 gallons)**
- **Energy required annually to pump and treat water exceeds 15,000 GWh, approximately 6.5% of total electricity used in the state per year**

Brownstein | Hyatt
Farber | Schreck

WATER



ENERGY



Energy Needed to Treat Water

An estimate for California suggests that: wastewater treatment requires between 1.0 and 3.0 kWh per 1000 gallons of treated waste.

- **Most water treatment options require energy levels of 2-3 feet of head. At a given flow rate, you can use the first example (slide # 25) to calculate the power required. This number would cover options such as simple filtration or ion exchange.**
- **An operation such as ozonization is more dependent on water quality and can require more energy.**
- **Average energy use for water treatment drawn from Southern California studies: 652 kWh/AF**

<u>Note</u>: in many remote parts of the world, treatment must be very basic and inexpensive. This requires a different approach to treatment than implied above.

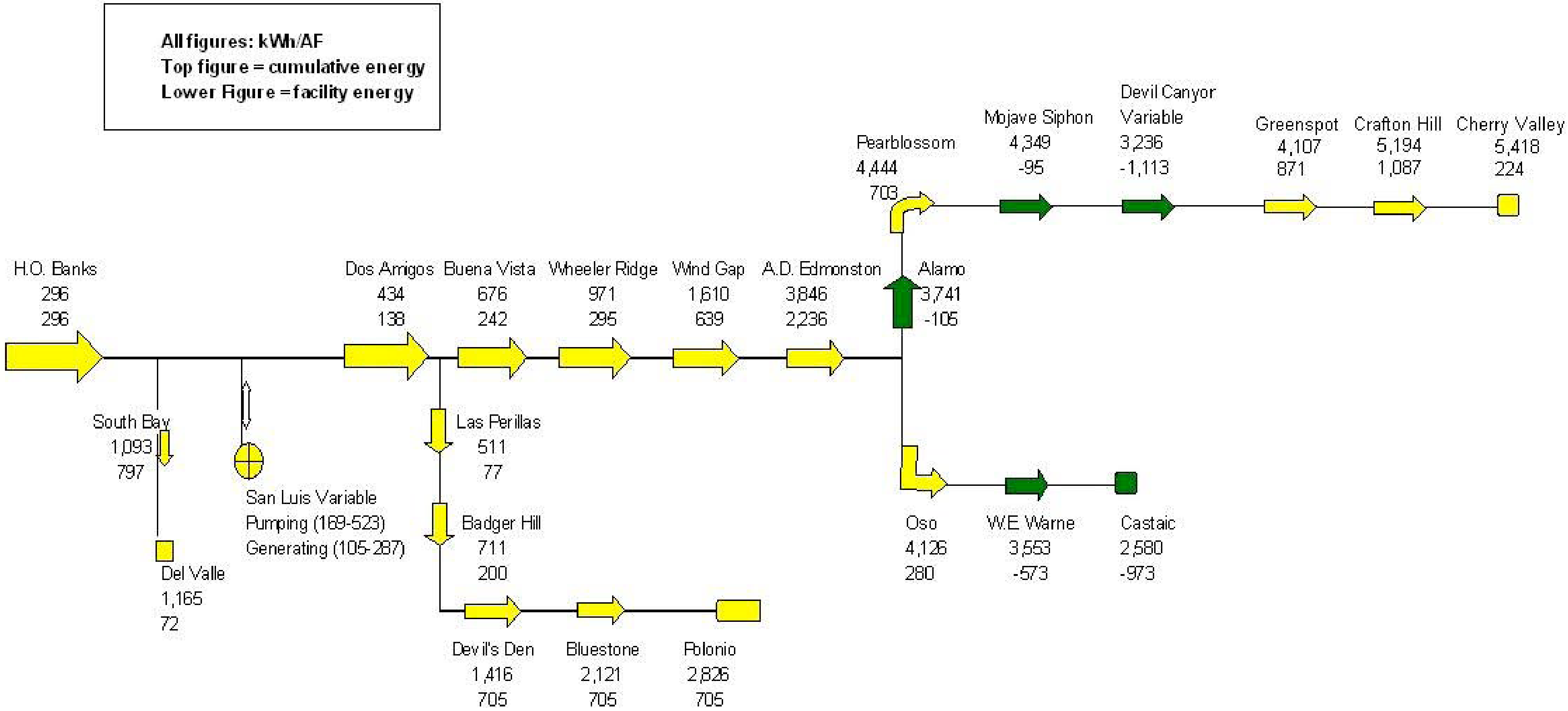
Energy Needed to Transport Water

In California, pumping an acre-foot of water through the entire State Water Project uses between 1,800 and 2,800 kWh of electricity (between 5.5 and 8.6 kWh per 1000 gallons).

- **Power = (water flow rate) x (water density) x (H + HL)**
  - H is lift of water from pump to outflow (positive if pumping uphill and negative if pumping downhill), and
  - HL is the effective head loss from the water flow in the pipe:
    - HL = (F) x (L/D) x (V^2/g)
    - F = friction coefficient (from table)
    - L = length of pipe
    - D = diameter of pipe
    - V = water flow rate
    - g = acceleration due to gravity (32.2 ft/sec^2)

State Water Project

State Water Project Incremental and Cumulative Energy Inputs and Generation



Source: Wilkinson, 2008

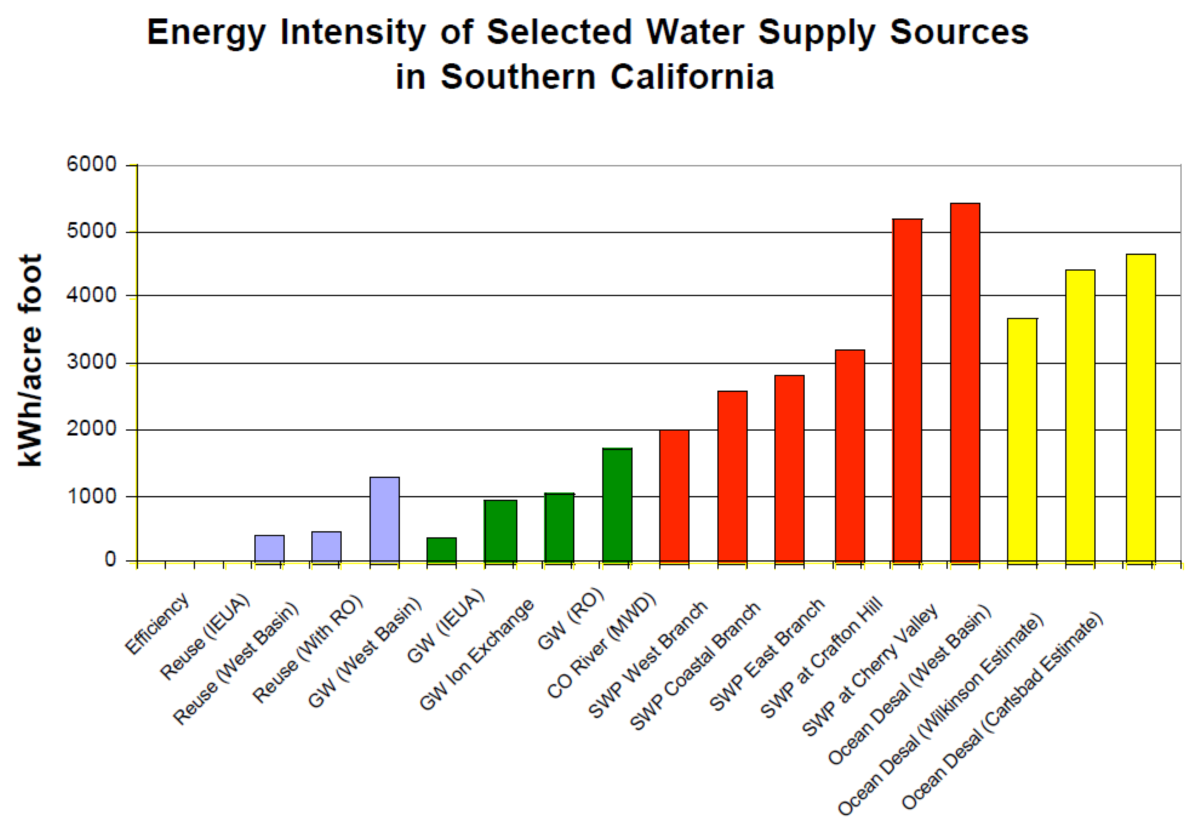
Energy Needed for Desalination

- **Reverse Osmosis:**
  - **Pressure (200-600psi) applied to intake water, forcing water through semi-permeable membrane. Salt molecules do not pass through membrane. Product water is potable.**
  - **On average, energy (electrical) accounts for about 40% of total cost.**
  - **5,800-12,000 kWh/AF (4.7-5.7 kWh/m^3)***
- **Distillation:**
  - **Intake water heated to produce steam. Steam condensed to produce product water with low salt concentration.**
  - **Energy requirements for distillation (electrical + thermal) are much higher than for reverse osmosis.**
  - **28,500-33,000 kWh/AF (23-27 kWh/m^3)***

----

* Does not include energy required for pre-treatment, brine disposal and water transport.

Energy Intensity of So Cal Water Supply Sources



Source: Wilkinson, 2008

Energy System Implications

- The kind of energy system chosen to provide water for drinking and sanitation will be a function of local circumstances:
  - What kind of water resources are available, locally and at a distance (local wells, streams, lakes, aquifers, water that can be piped from a distance)?
  - What is the quality of those resources, and what treatment will be required to make the water safe to use (fresh or brackish water, pollution level and nature of pollutants)?
  - What energy resources are available (grid, diesel, renewable,human)?
  - What financial resources are available to provide the needed water infrastructure and related energy needs
  - What level of training is needed to maintain water and energy systems?

Water-Related Energy Use

	Electricity (GWh)	Natural Gas (Mill. Therms)	Diesel (Mill. Gallons)
Water Supply and Treatment			
Urban	7,554	19	?
Agricultural	3,188		
End Uses			
Agricultural	7,372	18	88
Residential Commercial Industrial	27,887	4,220	?
Wastewater Treatment	2,012	27	?
TOTAL	48,012	4,284	88
2001 Consumption	250,494	13,571	?
Percent of Statewide Energy Use	19%	32%	?

Source: California Urban Water Conservation Council

California's Water Conservation Potential

- "Our best estimate is that one-third of California's current urban water use – more than 2.3 million acre-feet (AF) – can be saved with existing technology. At least 85% of this can be saved at costs below what it would cost to tap into new sources of supply and without the many social, environmental, and economic consequences that any major water project will bring."
- "Even without improvements in technology, we estimate that indoor residential use could be reduced by approximately 890,000 AF/yr. – almost 40 percent – by replacing remaining inefficient toilets, washing machines, showerheads, and dishwashers, and by reducing the level of leaks. All of these savings are cost-effective and have important co-benefits like saving energy and decreasing the amount of waste water created."

- Pacific Institute

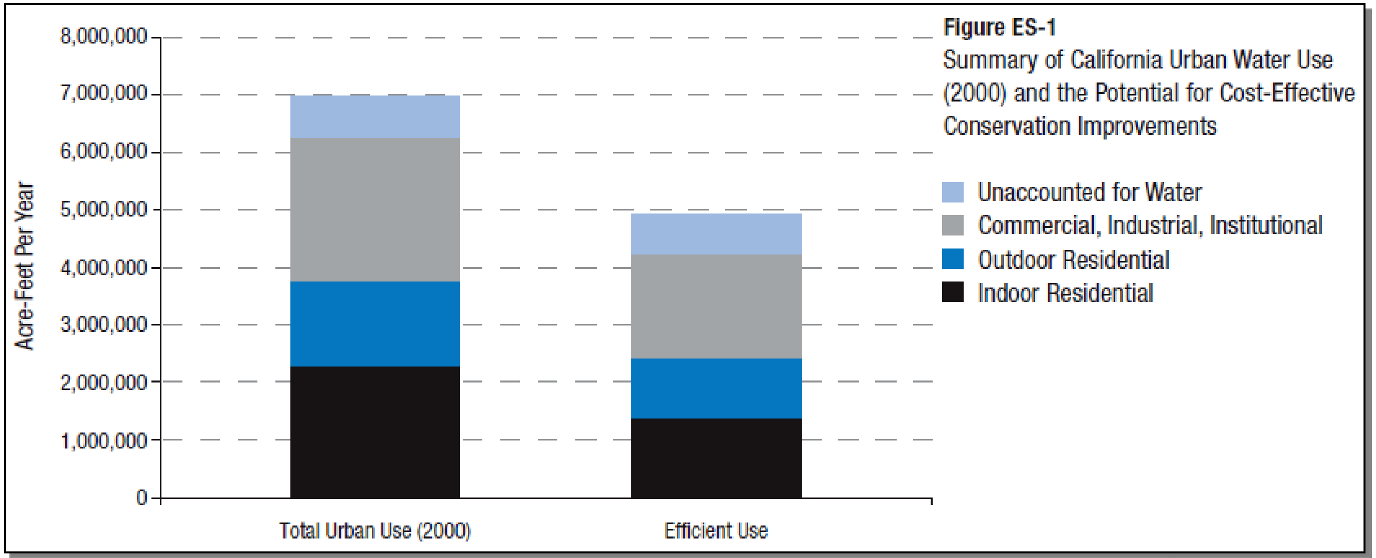
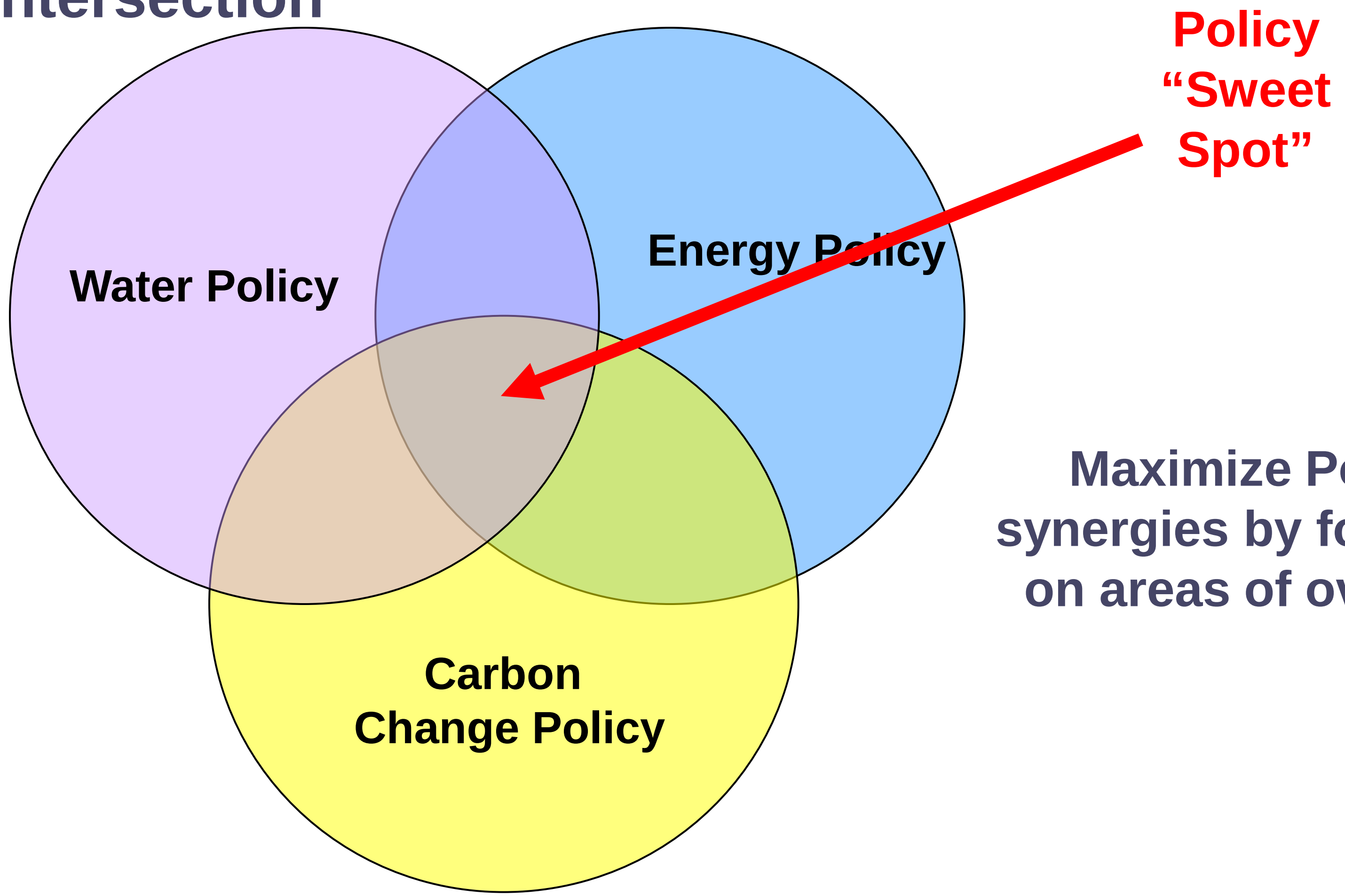


Figure ES-1
Summary of California Urban Water Use (2000) and the Potential for Cost-Effective Conservation Improvements

Driving Questions in Policy

- Are water-efficient technologies for residential units really efficient in terms of energy?
- What are the long-term savings of water and energy?
- What are the cost efficiencies?

Water, Energy and Climate Change Policy Intersection



Maximize Policy synergies by focusing on areas of overlap.

Pacific Institute (2010) Estimated Savings from Efficiency

Efficiency Measure	Number Installed	Water Savings (AF)	Electricity Savings (GWh)	Natural Gas Savings (million therms)
Residential toilet (1.28 gpf)	3,500,000	93,500	306	-
Showerhead (1.5 gpm)	3,500,000	47,500	985	59.3
Residential front-loading clothes washer	425,000	13,300	188	8.86
Faucet aerator (1.5 gpm)	3,500,000	6,750	74.5	3.75
Pre-rinse spray valve (1.0 gpm)	20,000	3,070	76.9	3.70
Connectionless food steamer	7,000	3,440	24.9	1.31
Commercial dishwasher	8,500	1,300	56.4	2.90
Commercial front-loading clothes washer	90,000	10,500	148	6.98
Commercial urinal (0.5 gpf)	750,000	51,800	170	-
Commercial toilet (1.28 gpf)	750,000	31,300	103	-
Cooling tower pH controller	5,500	21,900	71.8	-
Pressurized water broom	50,000	7,670	20.3	-
Replace lawn with low-water-use plants	12,000 acres	28,400	75.4	-
Total		**320,000**	**2,300**	**86.8**

Pacific Institute (2010) Estimated Costs

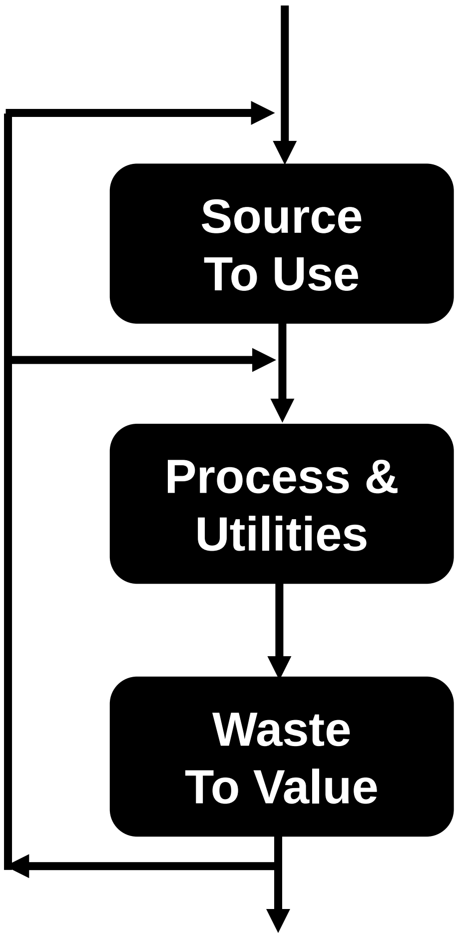
Conservation Measure	Device Cost ($/device)		Incremental Cost	Incremental Plus Administrative Cost
	Efficient	Standard		
Residential toilet (1.28 gpf)	$ 200	$ 150	$ 50	$ 63
Showerhead (1.5 gpm)	$ 40	$ 20	$ 20	$ 25
Residential front-loading clothes washer	$ 750	$ 492	$ 258	$ 323
Faucet aerator (1.5 gpm)	$ 8	$ -	$ 8	$ 10
Restaurant pre-rinse spray valve (1.0 gpm)	$ 70	$ 50	$ 20	$ 25
Connectionless food steamer	$ 6,000	$2,500 (elec.); $3,800 (natural gas)	$ 3,230	$ 4,040
Commercial dishwasher	$ 9,000	$ 6,950	$ 2,050	$ 2,560
Commercial front-loading clothes washer	$ 750	$ 492	$ 258	$ 323
Commercial urinal (0.5 gpf)	$ 550	$ 540	$ 10	$ 13
Commercial toilet (1.28 gpf)	$ 200	$ 150	$ 50	$ 63
Cooling tower pH controller	$ 2,250	$ -	$ 2,250	$ 2,810
Pressurized water broom	$ 250	$ -	$ 250	$ 313
Replace 1 acre of lawn with low-water-use plants	$ 43,600	$ -	$ 43,600	$ 54,500

Cost Savings Allocation

- Capturing savings requires initial investment.
- Efficiency improvements may pay for themselves, including reductions in water and energy bills.
- Distribution of benefits amongst customers, public, water and energy utilities.
- Energy utilities can partner with water utilities to provide rebates and other financial incentives to low-income housing.
- Benefits to landlords and owners of multi-family housing benefit tenants by cheaper utility bills.

Brownstein | Hyatt
Farber | Schreck

Reduced water consumption per MW produced



Align optimum water source with consumption need

Optimize water & energy consumption in boiler, cooling and fuel systems

Convert waste streams into value & minimize risk

1) Baseline water & energy footprint

2) Identify efficiency opportunities

3) Prepare optimization plan & engage stakeholders

4) Execute & calibrate

The Big Questions

- How can we decouple water and energy systems where there are high costs, stresses, damages, or vulnerabilities to systems?
- How can we maximize water and energy efficiency and productivity to reduce demands on each and maximize benefits to society?

Concluding Remarks

- **Considerable effort must be expended to identify and characterize water resources, and design supply systems appropriate to local circumstances**
- **Water issues cannot be separated from energy issues in policy**
- **Careful effort must be expended to identify appropriate energy options needed to meet water security needs**
- **Explore creative market solutions**
- **Flexibility is key**