Water Research Foundation

Water & Energy: Reaching for Sustainability

January 12th, 2010

WATER RESEARCH FOUNDATION

ADVANCING THE SCIENCE OF WATER

About the Water Research Foundation

The Water Research Foundation (formerly known as AwwaRF) is the world's largest nonprofit organization dedicated to providing critical drinking water research.

Clarifying Our Mission

- From *"Awwa Research Foundation (AwwaRF)"*
- *To the "Water Research Foundation (Foundation)"*

New Name, Same Mission

Advancing the science of water to improve the quality of life.

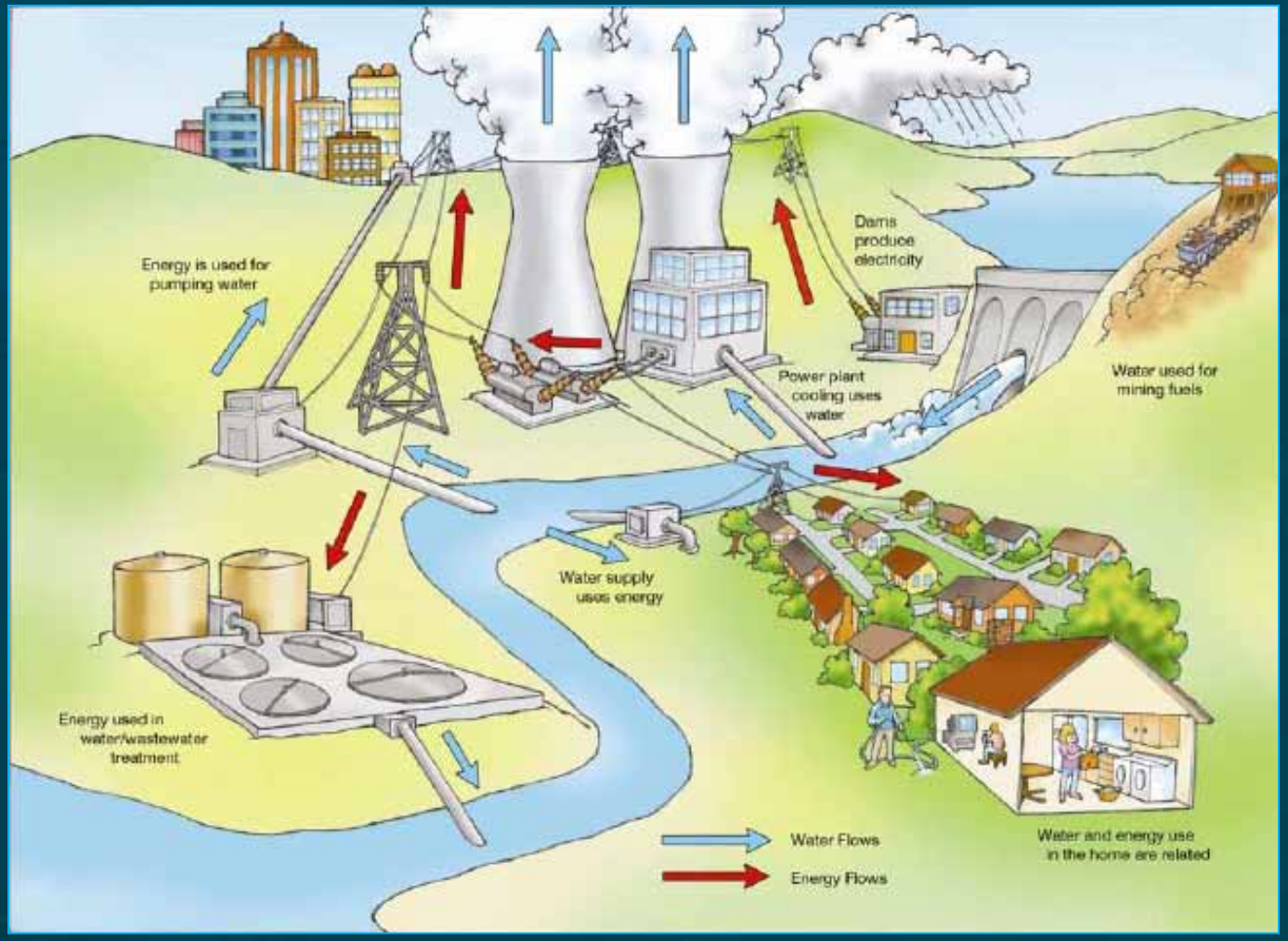


- **Drinking Water Research Program**
  - Centralized coordinated research program
  - Compliments local, regional, and legislative efforts through credible science
  - ~ 1000 Subscribers underwrite research (~900 water utilities)
  - > $500 million dollars worth of research
- **Collaboration**
  - Utility Community plans research
  - Project Advisory Committees & Foundation
  - ~ 1000 Volunteers provide input to projects and programs
- **Knowledge Base**
  - Reports & Projects (~850 published, ~300 ongoing)

Basic Industry Knowledge

- *Hey two plus two is always four*
  And down is south and up is north
  Thirty-two degrees is freezing cold
  You play with fire you end up burned
  The early-bird gets the worm
  But the only thing you really need to know
  Is...

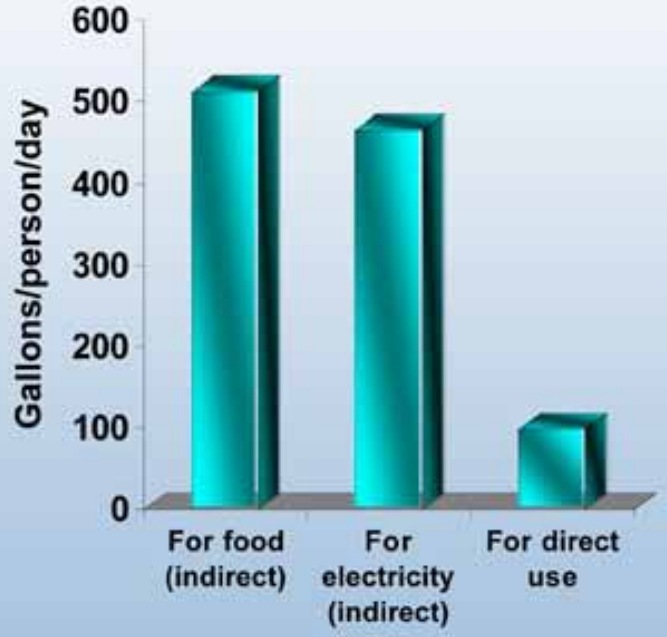
Water and Energy are Connected



•Adopted from "Energy demands on Water Resources" U.S. DOE Report to Congress on the interdependency of energy and water.

Energy Requires Water

Water used to produce household electricity exceeds direct household water use



- 510 for food production
  - includes irrigation and livestock
- 465 to produce household electricity
  - Range: 30 to 600 depending on technology
- 100 direct household use
  - includes bathing, laundry, lawn watering, etc.

Source: derived from Gleick, P. (2002), *World's Water 2002-2003.*

EAO Energy Analysis Office
Understanding Energy Issues

NREL National Renewable Energy Laboratory

•**http://www.nrel.gov/analysis/workshops/water_connect_workshop.html**

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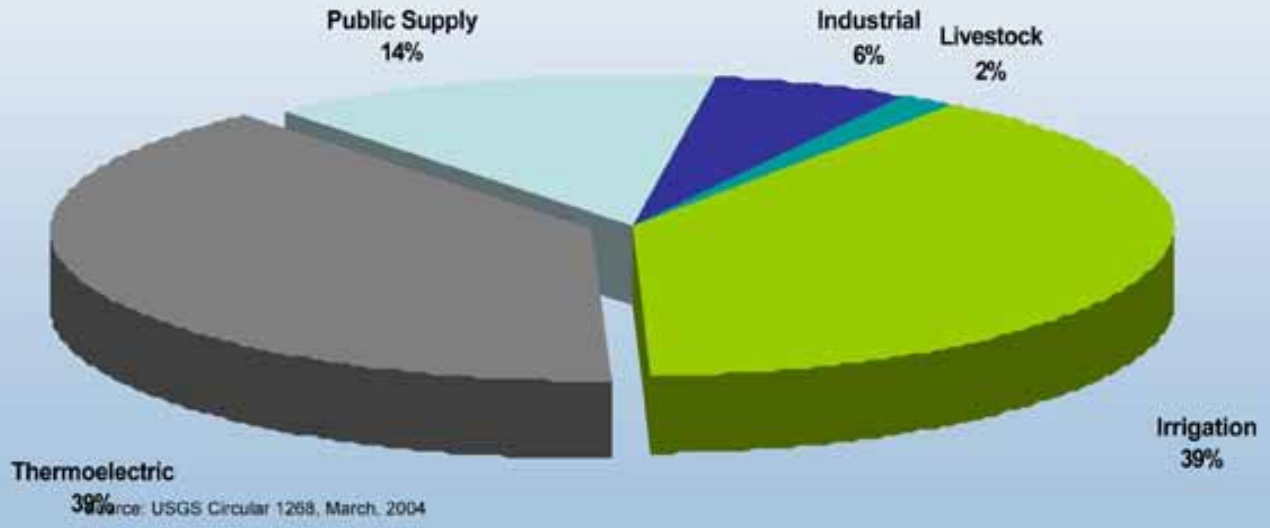
Energy Requires Water

Cumulative Water Use for Electricity Production Equals Water Use for Irrigation

Estimated Freshwater Withdrawals by Sector, 2000



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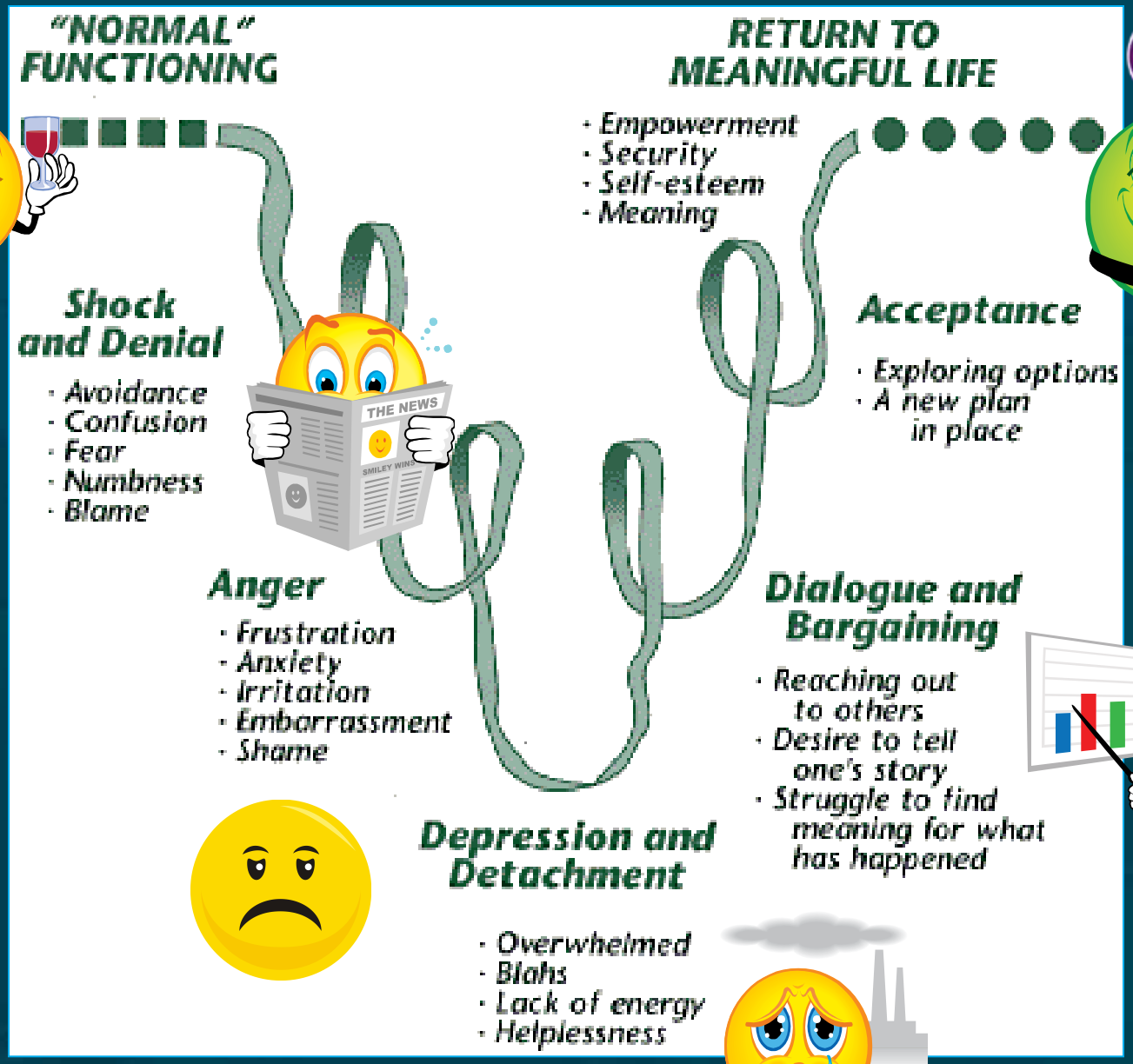
Fun Factoids

- 2.0 to 2.5 gallons of water = 1 gallon of petroleum
- 1,700 – 2,500 gallons of water = 1 gallon of ethanol
- 0.5 to 0.7 gallons of water = kilowatt
- 60 watt light bulb x 12 hrs/day x 365 days = 3,000 – 6,000 gallons of water



*University of Minnesota Extension

Society Has to Come Along

- One thing to remember though - it's not like water is "destroyed" or "used up" in most of the uses above, especially cooling purposes. It's not like we're burning water like coal. Still, we obviously have a challenge on our hands keeping it clean and not contaminating what we've got!
  - Noree (Comment on water/energy nexus posting, July 2009)

•http://www.triplepundit.com/2009/05/the-energy-water-nexus/

Good Intentions Gone Bad

- Energy Independence and Scarcity Act of 2007
  - Requires that 7.5 billion gallons of ethanol replace fossil fuels by 2012
  - Plants capable of producing 12 billion gallons/year planned
  - 48 billion gallons of water will be required just for production

Water and Energy Integration Act (S. 531)

- **National Academy Energy-Water Study** – Requires a study to assess water use associated with developing fuels in the transportation sector, and the water consumed in different types of electricity-generation.
- **Power Plant Water and Energy Efficiency**– directs DOE to identify best available technologies and other strategies maximize water and energy efficiency in producing electricity.
- **Reclamation Water Conservation & Energy Savings Study** – directs the Bureau of Reclamation (BOR) to evaluate energy use in storing and delivering water from Reclamation projects, and identify ways to reduce such use through conservation, improved operations, and renewable energy integration.

Water and Energy Integration Act (S. 531)

- **BOR Brackish Groundwater Desalination Facility**– Organic legislation to establish research priorities for this existing Facility, including renewable energy integration with desalination technologies.
- **EIA Energy Use for Water Assessment** – a requirement for Energy Information Administration to continually report on the energy consumed in water treatment and delivery activities.
- **Energy-Water Roadmap** – directs the Secretary of Energy to develop an Energy-Water Research and Development Roadmap to address water-related challenges to sustainable energy generation and production.
- As of March 2009 this bill was incorporated into S. 1462

•**http://www.rivernetwork.org/blog/7/2009/03/09/energyh2o-bill-introduced-senate**

Energy and Water Research Integration Act (H.R. 3598)

Energy Water Architecture Council

- (1) make recommendations on the development of data collection and data communication standards and protocols to agencies and entities currently engaged in collecting the data for the energy required to provide water supplies and the water required to provide reliable energy supplies throughout the United States;
- (2) recommend ways to make improvements to Federal water use data to increase understanding of trends in energy generation and fuel production;

Energy and Water Research Integration Act (H.R. 3598)

- (3) recommend best practices for utilizing information from existing monitoring networks to provide nationally uniform water and energy use and infrastructure data; and
- (4) conduct annual technical workshops, including at least one regional workshop annually, to facilitate information exchange among Federal, State, and private sector experts on technologies that encourage the conservation and efficient use of water and energy.

Utility Energy Consumption

Water and Wastewater Systems = ~4% of total electrical demand in US

-EPRI 2002 "*Water and Sustainability(Vol 4): US Electricity Consumption for Water Supply and Treatment – The next Half Century*"

Drinking Water Utilities Spend as much as 35% of their annual operating costs on energy. 85% of this amount is used for pumping alone

- Foundation Report #3066 "*Water Consumption Forecasting to Improve Energy Efficiency of Pumping Operations*

Utility Energy Consumption

Water and Wastewater Systems spend ~$4 Billion/year to collect, treat, and convey water. Energy consumption at utilities will grow by more than 20% in the next 15 years.

-Forbes: *http://www.forbescustom.com/EnergyPgs/WaterMgmentP1.html*

Range of power usage for 1 – 70 MGD plants = 338 – 4500 kWh/MG (Average 2240 kWh/MG)

-JAWWA 1998 Arora,LeChevallier "*Energy management opportunities*"

The Big Picture

- Due to growing population we will need 393,000 megawatts of new energy by 2020 = 1300 – 1900 new power plants
- That is one plant per week for 25 years.
- 70 million new people over next 25 years will increase energy by 53% = enough water for energy to supply 53 million people.

Reasons For Increased Energy Demand

- Increased regulation
- Increased use of impaired source waters (i.e. Desalination)
- Use of advanced treatment
- Increasing land development

Advanced Treatment Energy Consumption

UV

Ozonation

Membrane Processes

Ultrafiltration

Reverse osmosis

Membrane Bioreactors

Energy Consumption

20 - 160 kWh / MG

500 – 7500 kWh / MG

-Foundation Project #3056 "*Evaluation of Dynamic Energy Consumption of Advanced Water and Wastewater Treatment Technologies*"

Conventional Vs. Advanced Treatment

- Example

Conventional Treatment → *Increased Energy Consumption* → **UV**

70 -100 kWh/MG

-Foundation Project #3056 "*Evaluation of Dynamic Energy Consumption of Advanced Water and Wastewater Treatment Technologies*"

Energy Management

Best Practices for Energy Management (#2621)

Identified 19 Best Management Practices

Energy Procurement

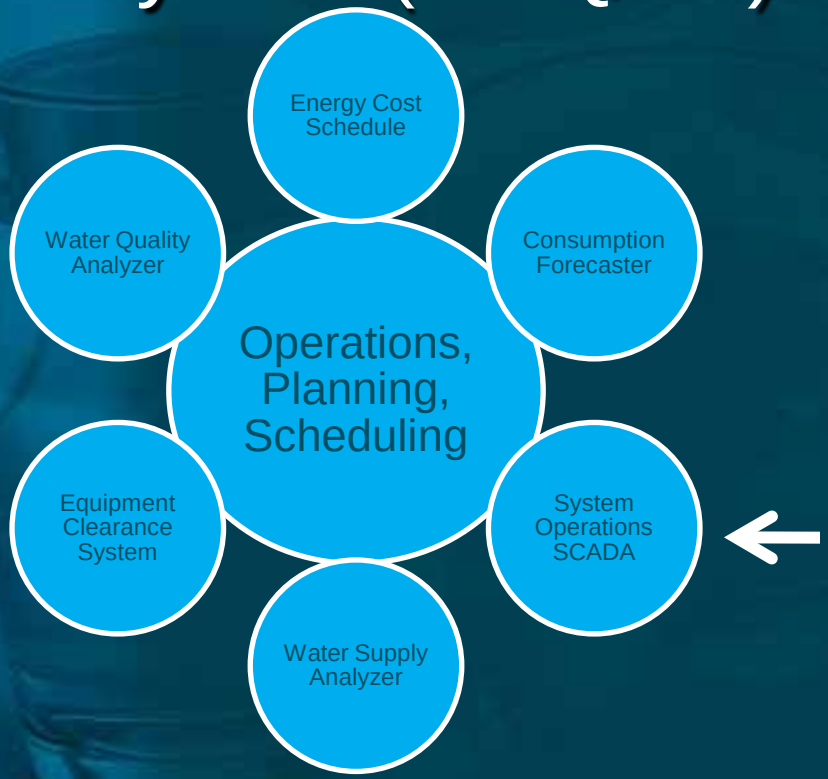
- Market-Based Pricing
- Pricing Rate Structure
- Pricing Incentives

Energy Use

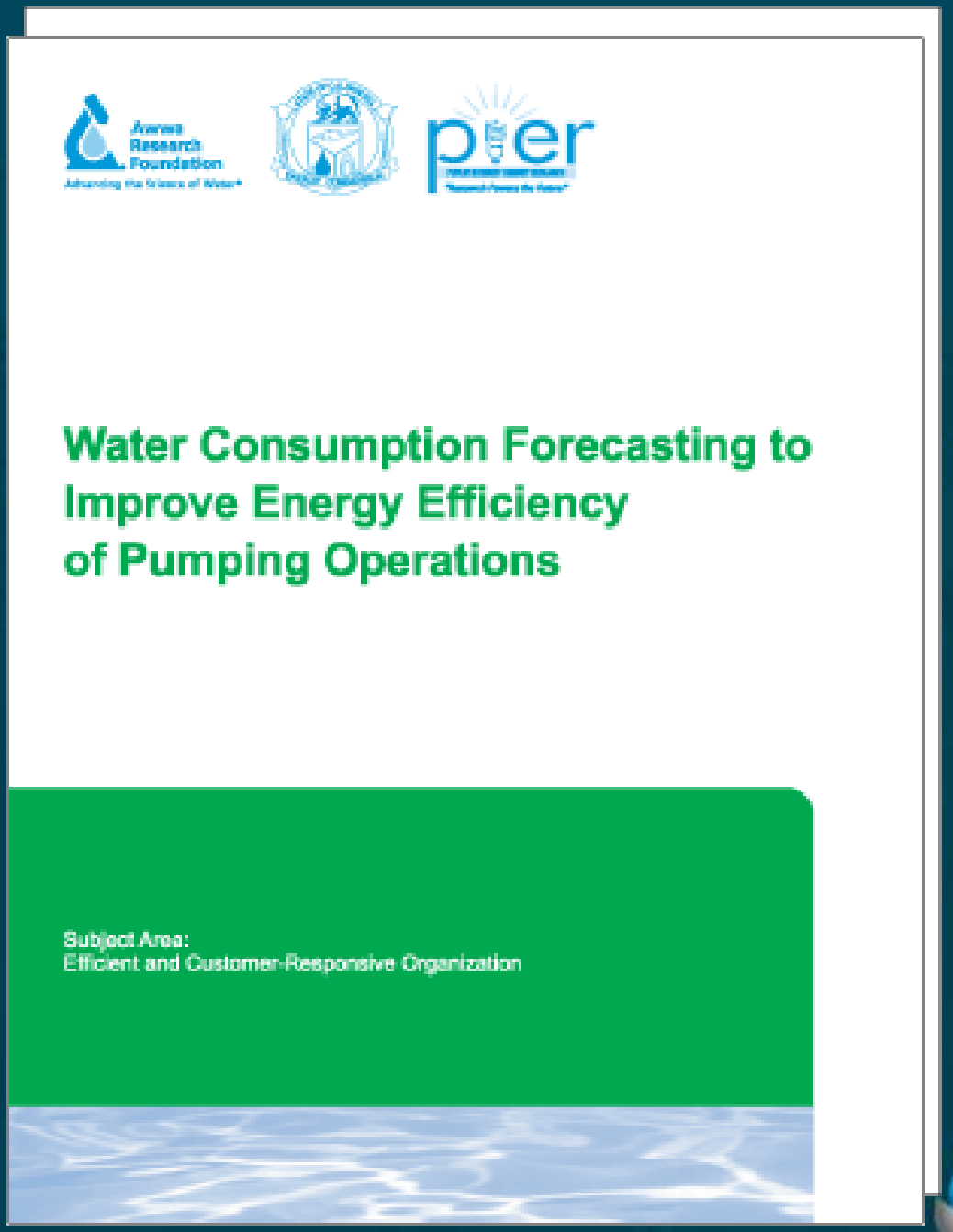
- Lessons from past design and operation
- Energy Audit
- Optimizing pump schedules

Energy Optimization Energy-cost Minimization

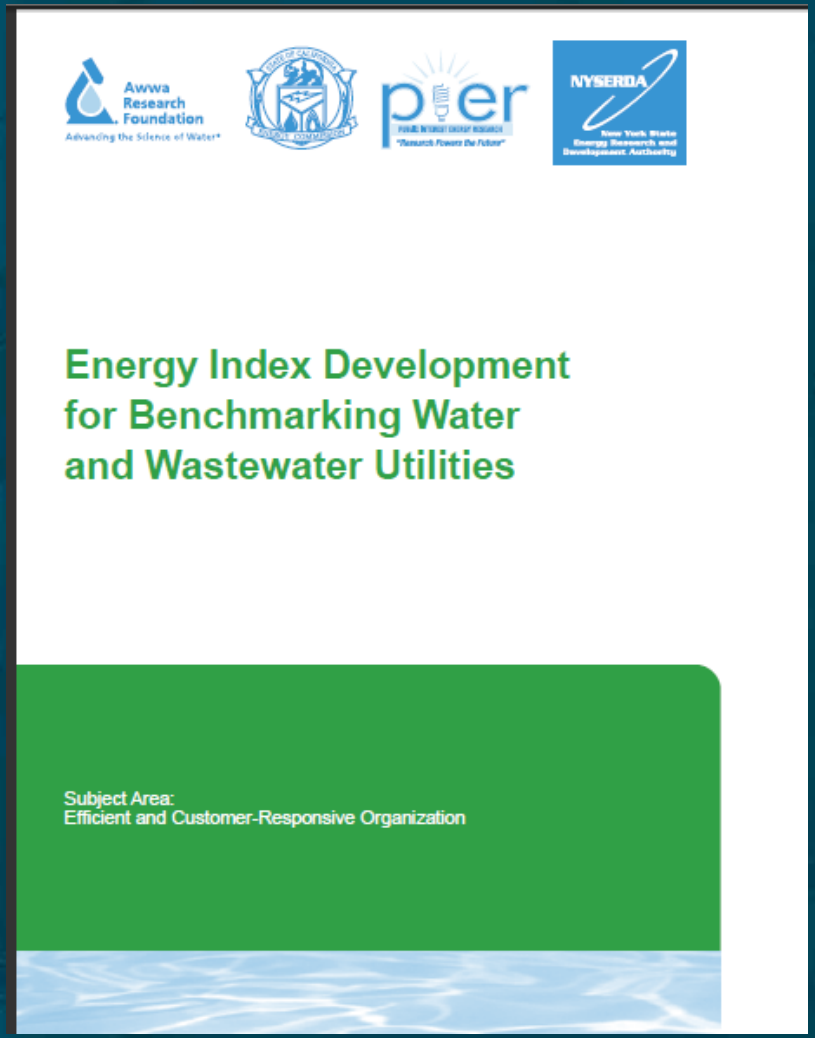
Energy and Water Quality Management System (EWQMS)



- Source Water Supply
- Wells
- Treatment Plants
- Pump Stations
- Reservoirs
- Distribution System Valves



Ranking Your Performance



- **Project #3009**

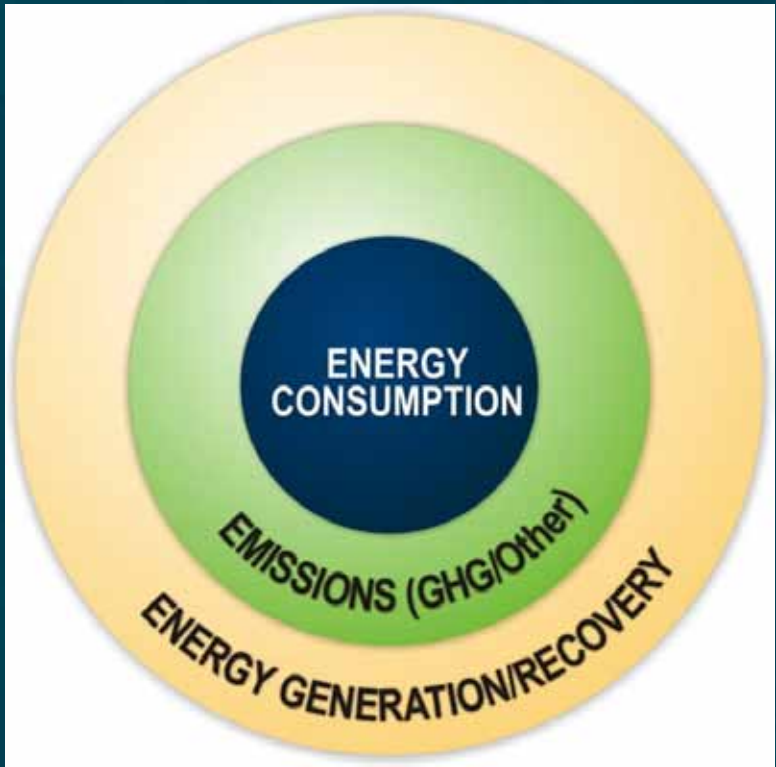
Created metrics for comparing utility energy use among peers

On-going Research

Decision Support System for Sustainable Energy Management #4090

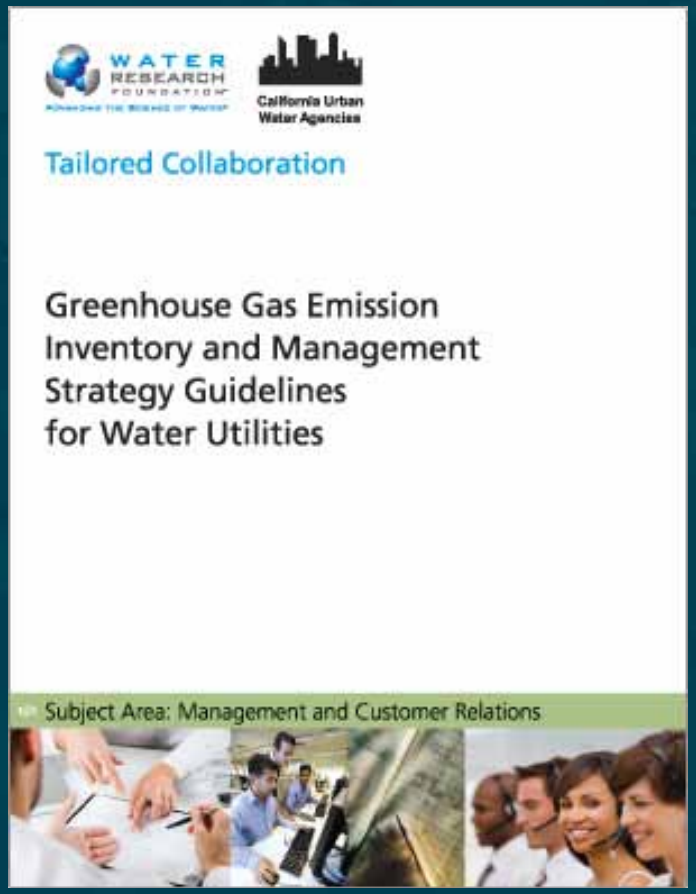
On-going Research

Energy Efficiency in the North American Water Supply Industry: A Compendium of Best Practices and Case Studies #4223



Greenhouse Gas Emissions

Greenhouse Gas Emission Inventory and Management Strategy Guidelines for Water Utilities (#4156)



CH2MHILL

California Urban Water Agencies

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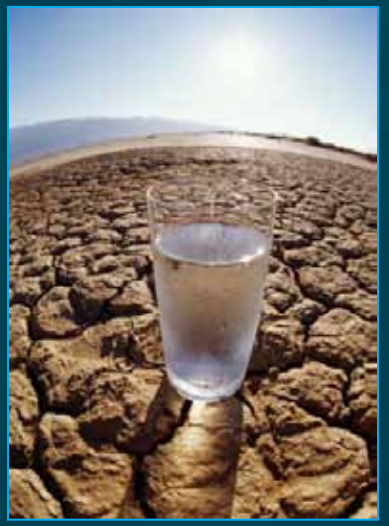
Greenhouse Gas Emissions

Toolbox for Water Utility Energy and Greenhouse Gas Emission Management: An International Review #4224

Local Projects

Lowering Chemical and Energy Usage for Inland Desalination Concentrate Volume Reduction (4283)

- Tailored Collaboration with City of Phoenix
- Carollo Engineers



Future Research

- Carbon footprinting if the capital improvement process
- Green certification program for water and wastewater utilities
- Carbon trading and the carbon market: opportunities for utilities
- Advancing process optimization: energy efficiency and control of GHG emissions
- Guidance for integrated water, energy, and environmental resource planning

Partners

- Electric Power Research Institute
- Global Water Research Coalition
- California Energy Commission
- Water Environment Research Foundation
- New York State Energy Research and Development Authority

Resources

- California Energy Commission http://www.energy.ca.gov/process/water/index.html
- National Renewable Energy Laboratory (NREL) http://www.nrel.gov/analysis/workshops/water_connect_workshop.html

Thank You

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