Advancing Energy Efficiency in Urban Water Systems

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Presented by:
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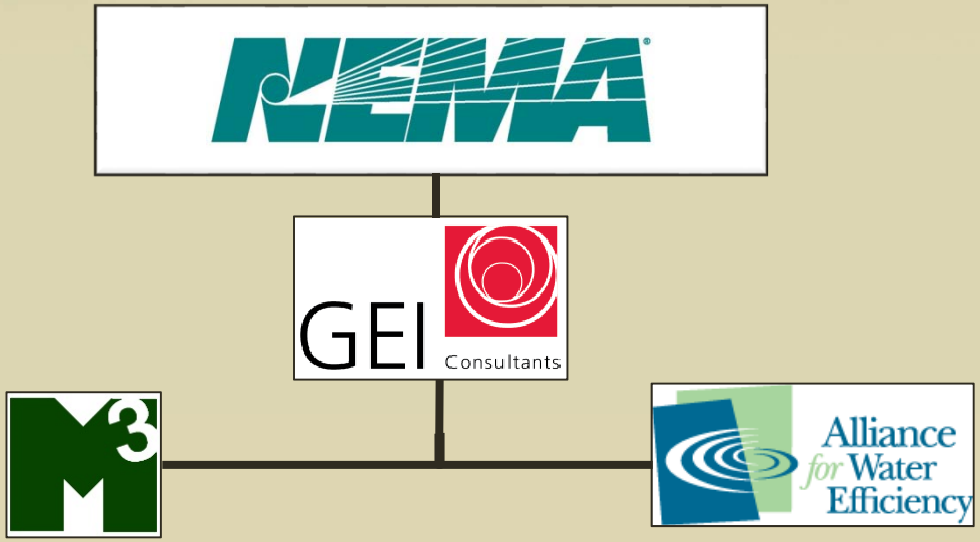
Project Team

Advancing Energy Efficiency in Urban Water Systems Project



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Project Goals

- Quantify the effectiveness and efficiency of equipment in facilities representative of the U.S. urban water supply's delivery and treatment systems;
- Analyze the market potential to improve performance by using NEMA member products; and
- Evaluate the viability of applying energy savings performance contract practices to finance modernization upgrades. This report presents the results of the project team's analysis and conclusions.

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National Electrical Manufacturers Association

- NEMA has nearly 400 Members
  - Motors
  - Lighting Systems
  - Sensors and Controls
  - Security Imaging and Communications Products
  - Switches Boxes, Buses, Power Systems
- Strategic Initiatives - advance knowledge and understanding of technology advances, regulatory matters and industry data.
- Industry Technical Standards and Advocacy
- NEMA frequently partners with the Hydraulic Institute who represent the pump industry

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Project Background

- US urban water systems rely heavily on energy – energy costs are second major expense
- Vast majority of energy consumption is for pumping to extract and move water (55-90%)
- Needed water-related infrastructure investment exceeds $1 trillion (AWWA)
- New and emerging technologies have advanced performance and reliability
- Slow uptake of advanced energy efficient technologies by water sector

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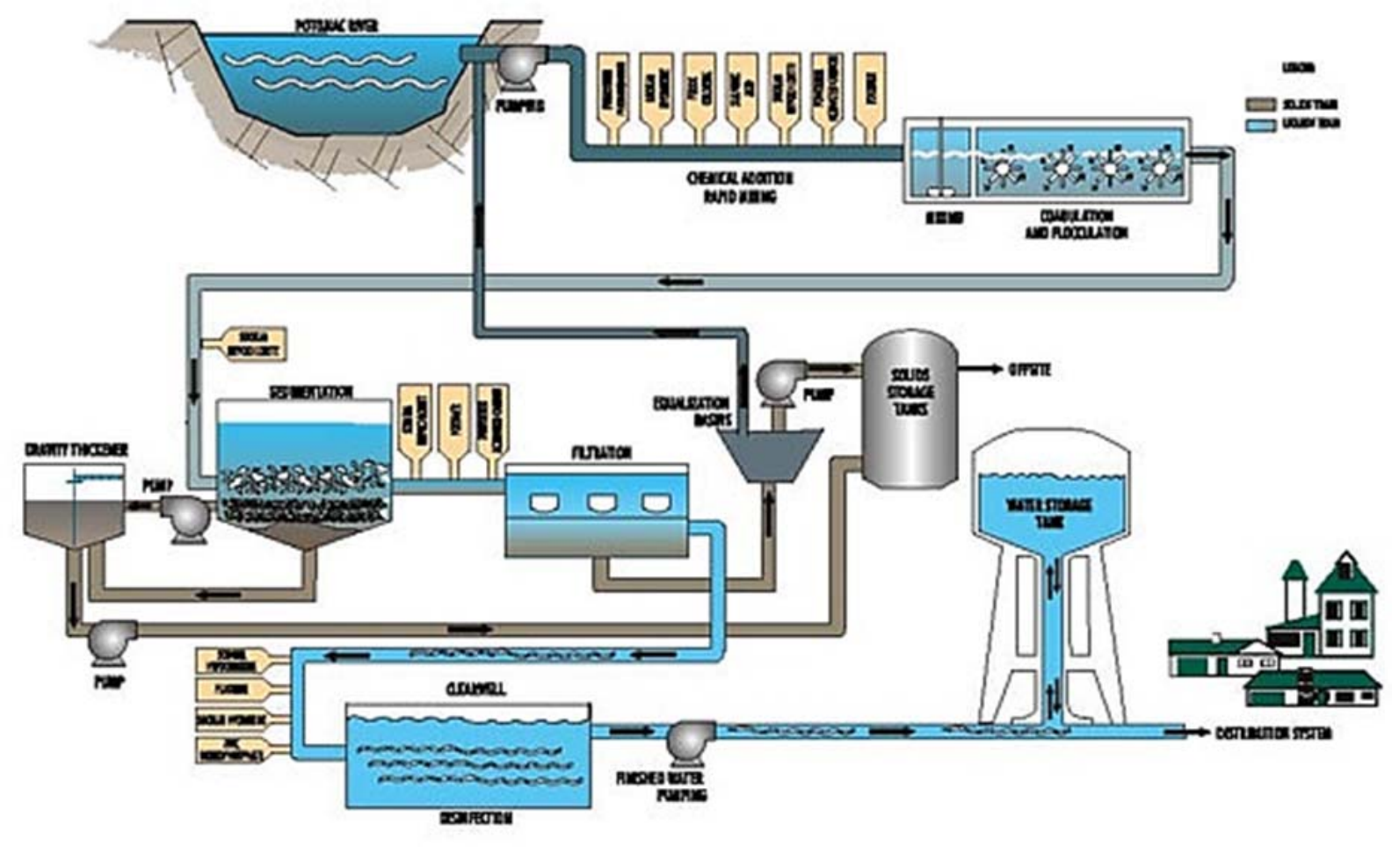
Water Treatment Plant



Kenneth B Rollins WTP – Leesburg Virginia

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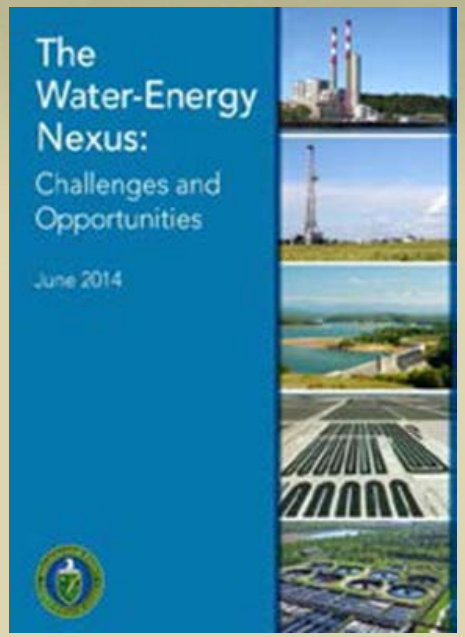
US DOE W-E Climate Nexus



- Optimize freshwater efficiency of energy production, electricity generation, and end use systems
- Optimize the energy efficiency of water management, treatment, distribution, and end use systems
- Enhance the reliability and resilience of energy and water systems
- Increase safe and productive use of nontraditional water sources
- Promote responsible energy operations with respect to water quality, ecosystem, and seismic impacts
- Exploit productive synergies among water and energy systems

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Approach

- Extensive investigation of available information and literature:
  - Status of energy efficiency efforts and best practices by urban water suppliers in the US
  - Available and needed funding
  - Barriers and challenges to system upgrades and optimization
- Surveys and interviews
  - NEMA Working Group Members
  - Water supply utilities (SurveyMonkey®)
  - Industry Organizations and Agencies
- Determined potential energy savings and assessed how ESCOs are or can be used by water utilities.

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Findings

- Numerous studies and reports exist documenting the various applications and benefits of energy efficient technologies in water systems.
- Several entities (EPA, NYSERDA, EPRI, etc…) have defined effective energy-related BMPs for water managers.
- Although the survey was submitted to thousands of water utility representatives, few responded – few are interested in energy efficiency.
- There is significant energy efficiency potential in US water systems.
- ESCO's are a viable business model to obtain advances.

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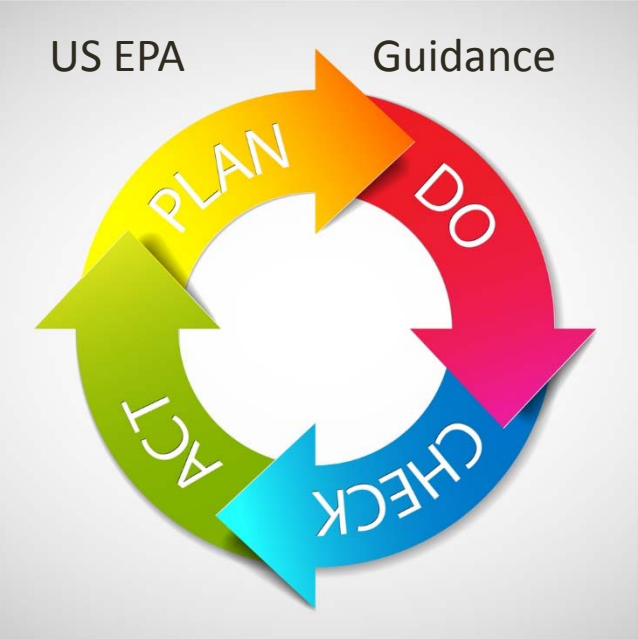
Best Management Practices

1. Benchmarking and tracking monthly and annual energy use;
2. Identifying and prioritizing energy operations and issues that can increase efficiency;
3. Identifying energy efficiency objectives and targets;
4. Defining the performance indicator(s) to use to measure progress towards your energy targets;
5. Establishing energy management programs (i.e., action plans to meet your goals);
6. Monitoring and measuring the performance of your established target(s);
7. Documenting and communicating success; and
8. Reviewing your progress periodically and making adjustments as necessary.



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Energy Management Opportunities

Energy Efficiency and Demand Response	Emerging Technologies and Processes	Energy Recovery and Generation
• Strategic Energy Management • Data Monitoring and Process Control • Water Conservation • High-Efficiency Pumps and Motors • Adjustable Speed Drives • Pipeline Optimization • Advanced Aeration • Demand Response	• Odor Control • Membrane Bioreactors • Deammonification Sidestream Process • Water Reuse • Residuals Processing • Microbial Fuel Cells • LED UV Lamps	• Cogeneration Using Digester Biogas • Use of Renewable Energy to Pump Water • Recovery of Excess Line Pressure to Produce Electricity

Source: EPRI/WRF 2010

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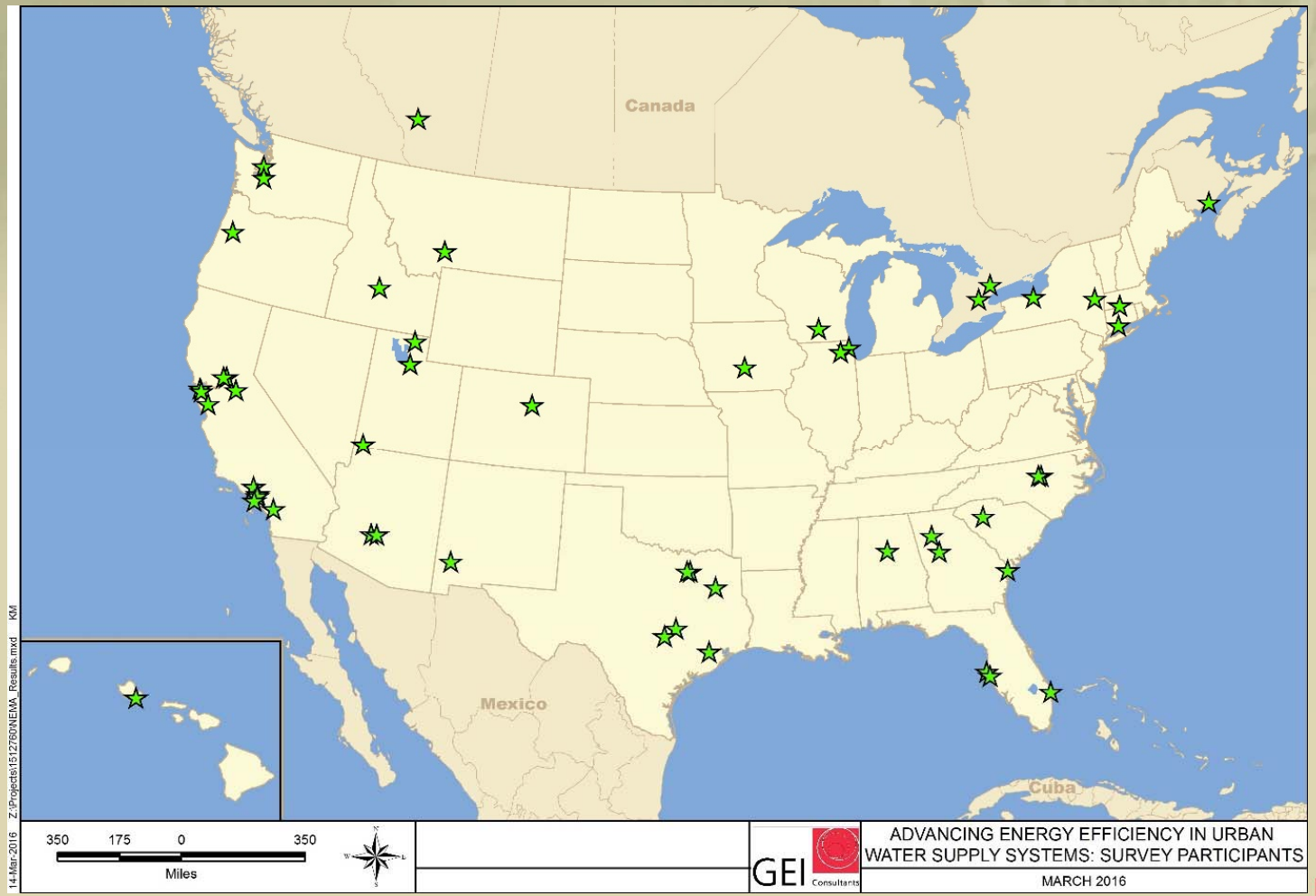
Survey Major Participants



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Survey Results

- Informal Responses
  - Information requested was detailed and answers had to be provided by several departments.
  - Data was not easily accessible or readily available within the time allotted.
  - Data is perceived to be sensitive and thus is not willingly shared.
  - Survey was too long, short response window, and timing was too close to the holidays.

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Survey Results (cont.)

- Formal Responses
  - Most respondents can provide water production data in annual, monthly and daily intervals but less than half can provide hourly.
  - Peak monthly production can be 2x the annual average requiring most water utilities to maintain significant excess capacity in their systems.
  - Few respondents identified their energy utility and less than half new what they spent on electricity.
  - Median energy costs reported - $57/AF or $174/MG.
  - If a water utility has made energy efficiency improvements it is mostly to pumps and motors.

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Challenges to Advancement

- Decision making processes
- Risk averse
- Competing priorities
- Minimal direct interaction between water utility representatives and manufacturers
- Lack of familiarity, experience, knowledge and understanding of new and emerging technologies

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Water Utility Procurement

- Operating revenues are declining; investments must focus on short payback periods.
- Most elected decision-makers reluctant to raise rates limiting available funds for upgrade investments.
- Limited operating budget for competing projects.
- Available financial incentives can “tip the scale” and make energy efficiency a more attractive investment.
- Decision-makers and system operators do not always have the same priorities.
- Limits on the availability of debt-financed funding can discourage efficiency purchases if up front costs are large.
- Comprehensive Asset Management Programs may not be supported in all utilities.

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Process Can Take Years

PLAN

- Identify needs and requirements
- Define approach and analyze potential solutions
- Define specifications

SOURCE

- Identify possible vendors
- Solicit bids
- Negotiate and select vendor
- award contract

INTEGRATE/ MANAGE

- Initiate project
- Prepare design
- Define success criteria
- **SELECT EQUIPMENT**
- Install
- Operate

TIME

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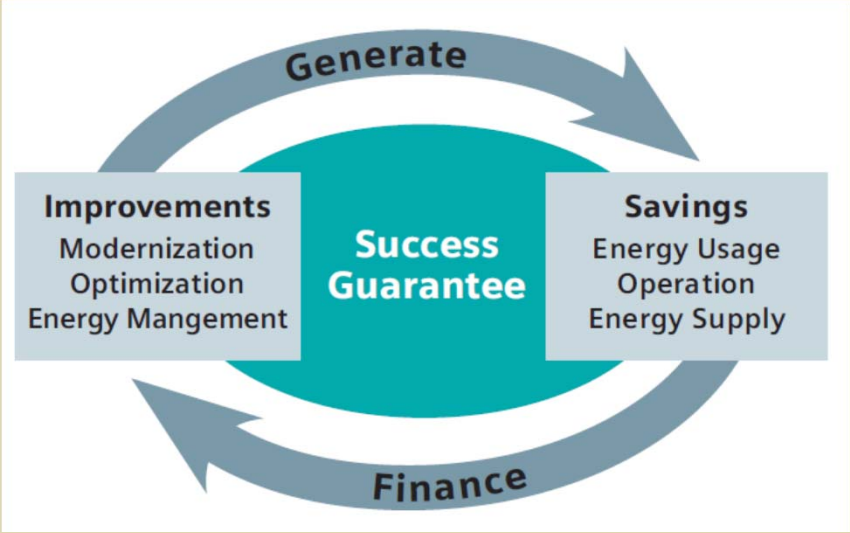
Performance Contracting

- Value-based procurement process
- Dollars not spent on energy pay for facility improvements
- Shared risk and mutual accountability
- Tend to be more expensive than traditional “low-bid” solutions
- Utility and operational savings are guaranteed



Images Courtesy of Siemens

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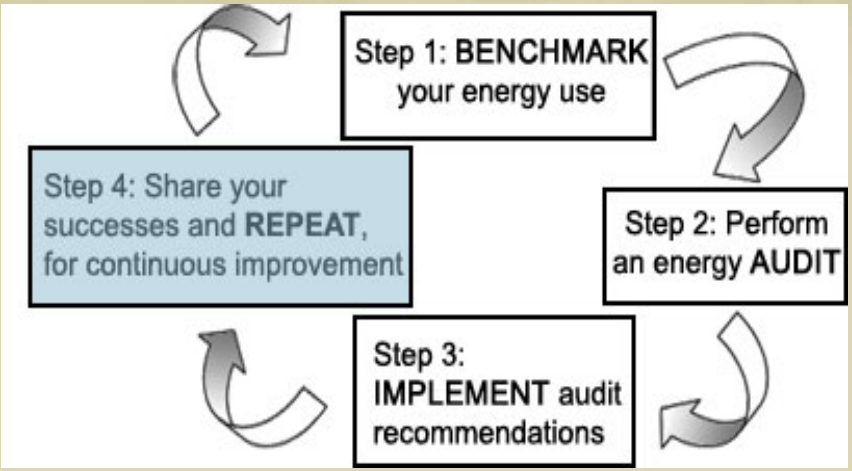
Estimated Savings Potential

Total estimated annual cost savings of $217 million across US (0.2-3.8%).

- We derived conservative estimates for potential savings using multiple data sources and studies.
- Savings depend on electricity rates paid, location, sources of supply and processes.

- Benchmarking and auditing can be used to prove actual savings.



Source: US EPA

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Funding Opportunities

Tradition Sources

- Grants and Cost Share Funding
  - Drinking and Clean Water State Revolving Funds
  - WaterSMART
- Water Infrastructure Bonds
- Customer Rates
- Tax Revenues
- Incentive Programs

New and Emerging Sources

- Water Resources Reform and Development Act Program Low Interest Loans (2014)
- Green Infrastructure Bonds
- Expanded Energy Utility Efficiency Project Eligibility
  - Leak detection

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Recommendations

- Support activities that expand the analytic capacity and capabilities of water utilities
  - Develop tools to facilitate site audits
  - Provide training to perform testing of pumps, motors and other equipment
  - Training and educate staff on the performance and integration requirements of new and emerging equipment
- Engage water sector more directly
  - Water Utility Focused Group
  - Partnerships on research or project implementation
  - Continue to support and fund technology demonstrations
- Identify and organize funding portfolios that leverage ESCOs, public and private dollars, and energy utility incentives.

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To continue the dialogue, contact:

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EXTRA SLIDES

Important Concepts and Terms

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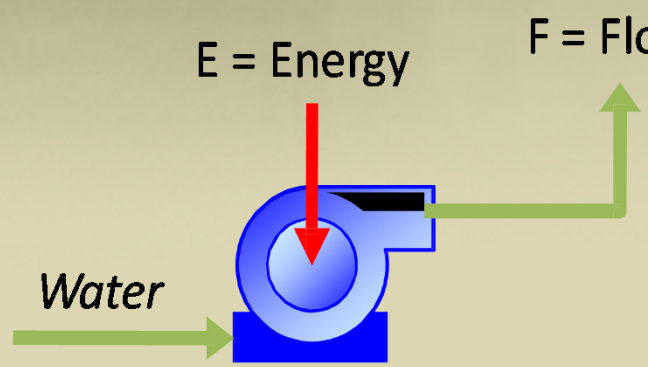
Energy Intensity

Illustrative Energy Intensity Calculation for a Pump



$$EI = \frac{E}{F}$$

ENERGY INTENSITY OF WATER

The amount of energy (electricity, natural gas or oil) required to produce a unit of water for a particular use. For the purposes of this study, energy intensity is expressed as kilowatt-hours per million gallons, or kWh/MG.

To determine energy intensity it is important to match system component to component function to associated energy demand.

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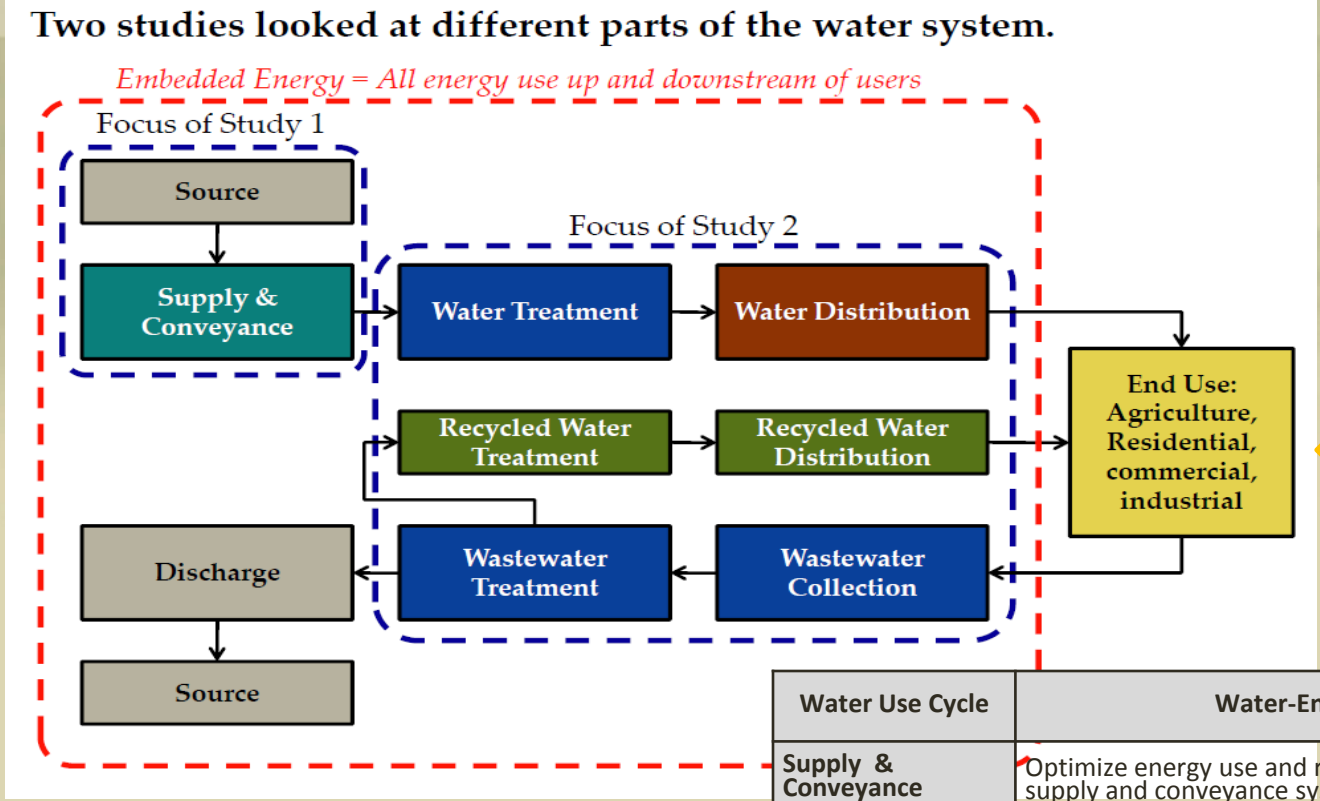
Water Use Cycle



Vast majority of energy is needed for end uses

7.7 % of CA Electricity Demand is 4,620 MW at Peak!

Water Use Cycle	Water-Energy Initiative Objectives
Supply & Conveyance	Optimize energy use and reduce peak demand of wholesale water supply and conveyance systems
Treatment	Reduce energy intensity of water and wastewater treatment systems and processes
Distribution	Reduce energy intensity and peak demand of distribution systems
End Use	Develop technologies, tools and techniques that maximize savings of energy embedded in water
Renewable Energy	Advance technologies that increase renewable energy production by water and wastewater systems

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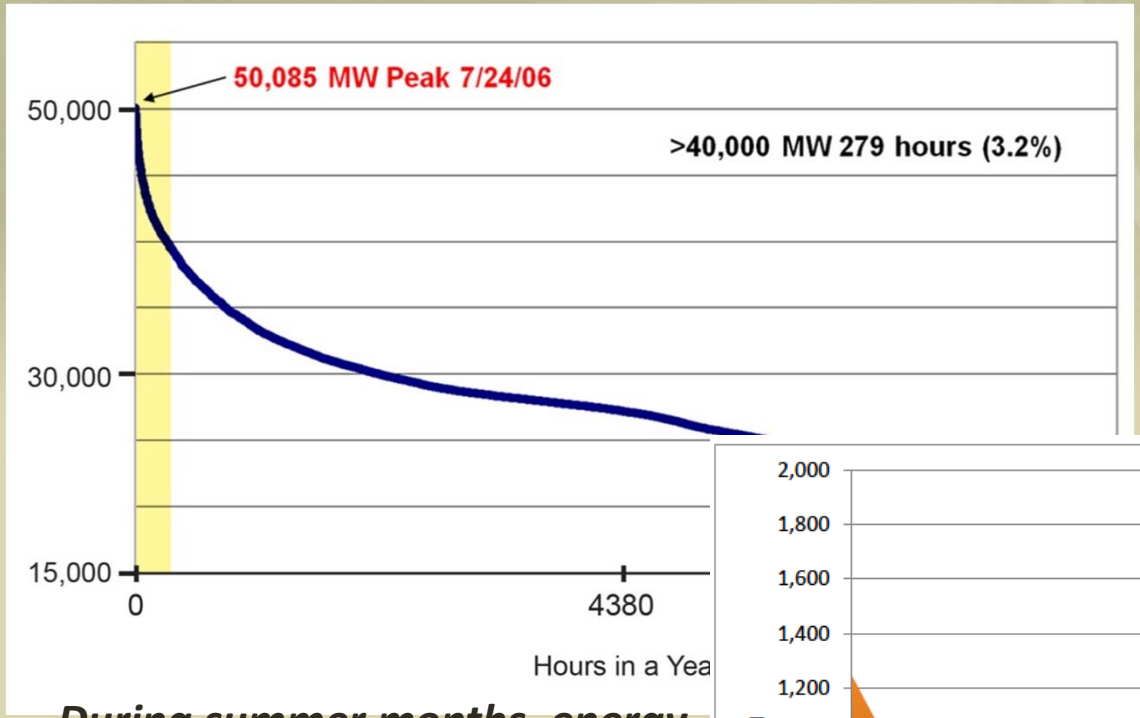
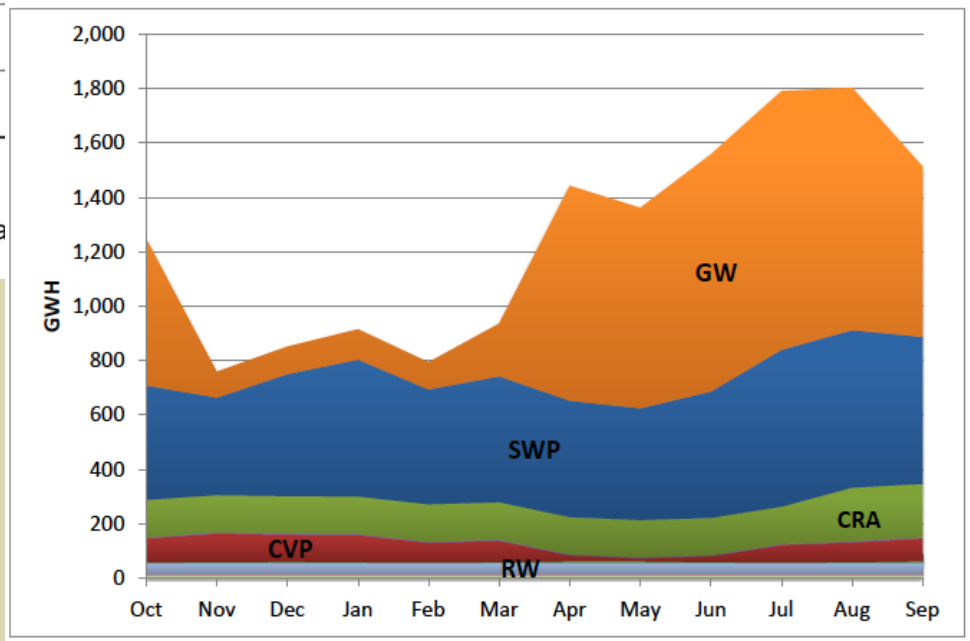
Peak Challenges





During summer months, energy used for groundwater pumping exceeds that used by the state's 3 largest conveyance systems, combined

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