The Link between Water Loss and Energy Consumption – Southern California EDISON’s Embedded Energy in Water Pilot

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Reinhard Sturm, Vice President
Paul Thomas, Program Manager, SCE
Presentation Contents

- Background on water supply in California
- What do we know so far about nexus between water supply and energy consumption
- Estimating water loss on a state-wide level
- Components of the Water Loss/Energy Study
- Results of Water Loss/Energy Study
- Roadmap for SCE Water Loss/Energy reduction program
Water-Energy Pilot Evaluation, Measurement & Verification Plan of PG&E, SCE, SDG&P

- Determine if water efficiency programs can create sufficient embedded energy savings to warrant inclusion in energy efficiency program portfolios

- Determine if partnerships of energy utilities and water agencies can increase the opportunities for reducing water use and its embedded energy.
Water Leak Detection Program and Water System Loss Control Study

- Primary Research
  - Three participating water utilities
  - Size ranges between 10,000 and 30,000 service connections
  - Detailed Top-Down Water Audit
  - Bottom-Up DMA measurements
  - Leak detection and repair & pressure management
  - ELL analysis
  - Quantification of savings and conversion into embedded energy
  - Cost benefit analysis
Water Leak Detection Program and Water System Loss Control Study

- Secondary Research
  - Literature review
  - Estimation of state-wide water loss volume
  - Water Loss Control Best Management Practice document
Water Supply In California

- Major sources of water in CA:
  - State Water Project
  - Central Valley Project
  - Colorado River Aqueduct
  - Plus smaller conveyance systems
    - Hetch Hetchy Regional Water System (Bay Area)
    - LA-Aqueduct
    - Mokelumne Aqueduct
    - the All-American Canal and the Coachella Canal
  - Plus ground water

Combined delivery of ~43MAF of which 34MAF for agricultural use.
State Water Project:

- 700 miles of canals and pipes
- Lift water nearly 2,000 feet up and over the Tehachapi Mountains through 10 miles of tunnels
- Net energy consumer
- Single largest energy user in CA (consumes 2-3% of all electricity consumed in CA)
- Consumes ~5,000GWH/year
What Do We Know About Water-Energy Nexus

- ~20% (52,000 GWH) of CA energy demand for water related electrical consumption.

- Steps of Water-use Cycle
  - Water Supply and Conveyance
  - Water Treatment
  - Water Distribution
  - End Use
  - Waste Water Treatment
What Do We Know About Water-Energy Nexus

Typical Water Cycle:

Source

Collection, Extraction & Conveyance

Water Treatment

Water Distribution

End-use
Agricultural
Commercial
Industrial
Residential

Recycled Water Treatment

Recycled Water Distribution

Discharge

Wastewater Treatment

Wastewater Collection

Source

Source: Robert Wilkinson, PhD; Dir. of Water Policy Program, UCSB
## Energy Intensity/Embedded Energy Break Down

<table>
<thead>
<tr>
<th>Total Embedded Energy</th>
<th>52,000 GWH</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Purveyor Energy Use</td>
<td>20,000 GWH</td>
<td>38%</td>
</tr>
<tr>
<td>Water Related Energy Use on Customer Side</td>
<td>32,000 GWH</td>
<td>62%</td>
</tr>
</tbody>
</table>

Energy Intensity: Amount of Energy required to use one unit of water in a specific location.
Estimating Water Loss on a State-wide Level

- Water Audit data set of 32 water utilities (6 audits from WSO and 26 from CUWCC)
- Filter ILI<1.5 (11 utilities report ILI below 1)
- Final data set 17 water utilities

<table>
<thead>
<tr>
<th>Water Loss Characteristics</th>
<th>Average</th>
<th>Min</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure Leakage Index</td>
<td>3.2</td>
<td>1.6</td>
<td>6.6</td>
<td>[ILI]</td>
</tr>
<tr>
<td>Real Losses</td>
<td>63</td>
<td>28</td>
<td>119</td>
<td>gal/service con/day</td>
</tr>
<tr>
<td>Real Losses as % of Volume Supplied</td>
<td>9</td>
<td>4</td>
<td>22</td>
<td>%</td>
</tr>
</tbody>
</table>
# Estimating Water Loss on a State-wide Level

<table>
<thead>
<tr>
<th>Description</th>
<th>MAF/year</th>
<th>Mgall/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA - Annual Urban Water Supply</td>
<td>8.7</td>
<td>2,834,907</td>
</tr>
<tr>
<td>10% Real Losses</td>
<td>0.87</td>
<td>283,491</td>
</tr>
<tr>
<td>40% of RL Economically Recoverable</td>
<td>0.35</td>
<td>113,396</td>
</tr>
</tbody>
</table>

Enough to provide water for 2 million people with an average daily consumption of 154 gallons per person per day.

2020 goal is statewide water demand reduction of 1.76 MAF.
<table>
<thead>
<tr>
<th>Water Energy Proxies for Indoor Use</th>
<th>Northern CA</th>
<th>Southern CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Supply and Conveyance [kWh/MG]</td>
<td>2,117</td>
<td>9,727</td>
</tr>
<tr>
<td>Water Treatment [kWh/MG]</td>
<td>111</td>
<td>111</td>
</tr>
<tr>
<td>Water Distribution [kWh/MG]</td>
<td>1,272</td>
<td>1,272</td>
</tr>
<tr>
<td><strong>Total Energy [kWh/MG]</strong></td>
<td><strong>3,500</strong></td>
<td><strong>11,110</strong></td>
</tr>
</tbody>
</table>

### Embedded Energy in total Real Loss Volumes in North CA and South CA
- 275,615,976 KWh/year in North CA
- 2,274,698,022 KWh/year in South CA

### Embedded Energy in recoverable Real Loss Volumes (40%) in North CA and South CA
- 110,246,390 KWh/year in North CA
- 909,879,209 KWh/year in South CA

- 30% of CA urban water demand in Northern CA and 70% in Southern CA
- Estimated energy savings in the range of 1.02 Billion KWh/year
  (about 26% of the 2008 California electricity system power generated by coal power plants)
Primary Research
Primary Research – Water Audit Results

<table>
<thead>
<tr>
<th>Utility</th>
<th>LVMWD</th>
<th>AVRWC</th>
<th>LACSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>21,000</td>
<td>26,000</td>
<td>8,000</td>
</tr>
<tr>
<td>Real Losses [%SIV]</td>
<td>4</td>
<td>6</td>
<td>22</td>
</tr>
<tr>
<td>Real Losses [gal/serv con/day]</td>
<td>46</td>
<td>37</td>
<td>56</td>
</tr>
<tr>
<td>Infrastructure Leakage Index (ILI)</td>
<td>1.8</td>
<td>1.6</td>
<td>2.7</td>
</tr>
</tbody>
</table>
Water Leak Detection Program and Water System Loss Control Study

Performance Indicator—Infrastructure Leakage Index

ILI Ranges

Infrastructure Leakage Index [ILI]

A B C D E F G H I J K L M N O P Q
Water Leak Detection Program and Water System Loss Control Study

Performance Indicator – Real Losses/Serv/Day

Real Losses per Service Connection per Day

Real Losses [gall/servcon/day]
Water Leak Detection Program and Water System Loss Control Study

Performance Indicator - Percentage Real Losses

Real Losses as Percentage of System Input Volume

Real Losses [% of SIV]
Field Leakage Measurements

- DMAs: Seminole–Latigo-Three Springs and Twin Lakes
Field Leakage Measurements

- Seminole–Latigo-Three Springs System
  Final Water Loss Assessment

<table>
<thead>
<tr>
<th>Initial Water Loss Assessment [MG]</th>
<th>Final Water Loss Assessment [MG]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.73</td>
<td>1.02</td>
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Water Losses
More Pressure - More Losses
What Volume of Real Losses is Economic

COST OF LEAKAGE CONTROL AND WATER LOST

Background Leakage and Reported Breaks

LosSES (MGD)

Where the total cost is at a minimum
Economic Leakage Level

Cost of Water Lost

Cost of Leakage Control
Management Tools for Real Loss Reduction

- Potentially Recoverable Real Losses
- Real Losses
- Unavoidable Annual Real Losses
- Economic Level of Real Losses

- Speed and Quality of Repairs
- Active Leakage Control

- Pipeline and Asset Management: Selection, Installation, Maintenance, Renewal, Replacement

Current Annual Real Losses
## Economic Frequency of Intervention (Rate of Rise Method) - Proactive Leak Detection

- **Retail Cost vs. Avoided Cost**

<table>
<thead>
<tr>
<th></th>
<th>Retail Cost Valuation of Real Losses</th>
<th>Avoided Cost Valuation of Real Losses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Economic Intervention Frequency</strong></td>
<td>18.8 month</td>
<td>35.2 month</td>
</tr>
<tr>
<td><strong>% of System to be Surveyed Annually</strong></td>
<td>64%</td>
<td>34%</td>
</tr>
<tr>
<td><strong>Annual Budget for Intervention</strong></td>
<td>$51,388</td>
<td>$27,439</td>
</tr>
<tr>
<td><strong>Economic Unreported Real Losses</strong></td>
<td>24.5 MG/Year</td>
<td>45.9 MG/Year</td>
</tr>
<tr>
<td><strong>Potential Recoverable Leakage</strong></td>
<td>137.7 MG/Year</td>
<td>116 MG/Year</td>
</tr>
</tbody>
</table>
Roadmap for SCE Water Loss/Energy Reduction Program

Voluntary Application Process

- For utilities not signatory to the CUWCC Memorandum of Understanding that are interested in participating in the program and have reliable water audit results available. Plans for CUWCC signatories who want to fast-track their participation in the program.

BMP 1.2 Reports

- Review of all BMP 1.2 reports submitted by SCE Edison service territory water utilities.
- First reports for Pr9 and Pr10 will be available December 2010.
- Can be carried out by SCE intensively.

Qualifying Matrix

- Import information into a ranking sheet.
- Ranking = B x C x D

Component and ELL Analyses

- Conduct Component Analysis and Economic Level of Leakage Analysis to design adequate intervention strategy for top 10 (or more) water utilities of ranking sheet.
- The final number of utilities selected for component analysis and ELL depends on results of initial ranking sheet.
- This step will guarantee that only cost-effective water loss intervention strategies will be pursued.

Intervention Strategies

- Pursue individual intervention strategies:
  - Pressure Management - Has results on all three Real loss components. Rule of thumb is 10% reduction in pressure results in 10% reduction in Real Losses. ELL will determine by how much pressure can economically and technically be reduced.
  - Proactive Leak Detection - Reduces backlog of leaks and keeps losses from unexpected leaks at economic optimum. ELL will determine the economically optimum leak detection frequency.
  - Infrastructure Replacement

Pressure Management

Proactive Leak Detection

Infrastructure Replacement

Savings MG/KWH

Offer incentive for infrastructure replacement based on assessment of direct and embedded energy savings.
Thank You!

Questions?

reinhard.sturm@wso.us