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

2010 IWA Water Loss Conference
Sao Paulo, Brazil

Reinhard Sturm, Vice President
Paul Thomas, Program Manager, SCE
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 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 (53.040Mm³) of which 34MAF (41.938Mm³) for agricultural use.
Water Supply In California

State Water Project:

- 700 miles (1,128 km) of canals and pipes
- Lift water nearly 2,000 feet (600m) up and over the Tehachapi Mountains through 10 miles (16km) 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

Recycled Water Treatment

Recycled Water Distribution

Agricultural Commercial Industrial Residential

Wastewater Treatment

Wastewater Collection

End-use

Discharge

Source

Source: Robert Wilkinson, PhD; Dir. of Water Policy Program, UCSB
### Energy Intensity/Embedded Energy Nexus 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.
• 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.
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
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</td>
<td>238</td>
<td>105</td>
<td>451</td>
<td>liter/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>
<th>Mm3/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA - Annual Urban Water Supply</td>
<td>8.7</td>
<td>2,834,907</td>
<td>10.731</td>
</tr>
<tr>
<td>10% Real Losses</td>
<td>0.87</td>
<td>283,491</td>
<td>1.073</td>
</tr>
<tr>
<td>40% of RL Economically Recoverable</td>
<td>0.35</td>
<td>113,396</td>
<td>429</td>
</tr>
</tbody>
</table>

- Enough to provide water for 2 million people with an average daily consumption of 154 gallons (583 liters) per person per day
- 2020 goal is statewide water demand reduction of 1.76 MAF
# Estimating Water Loss on a State-wide Level

<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>Total Energy [kWh/MG]</td>
<td>3,500</td>
<td>11,110</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>KWh/year</th>
<th>KWh/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embedded Energy in total Real Loss Volumes in North CA and South CA</td>
<td>275,615,976</td>
<td>2,274,698,022</td>
</tr>
<tr>
<td>Embedded Energy in recoverable Real Loss Volumes (40%) in North CA and South CA</td>
<td>110,246,390</td>
<td>909,879,209</td>
</tr>
</tbody>
</table>

- 30% of CA urban water demand in Northern CA and 70% in Southern CA
- Estimated energy savings in the range of 1,020,125,599 KWh/year (about 26% of the 2008 California electricity system power generated by coal power plants)
Water Leak Detection Program and Water System Loss Control Study

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>Real Losses [Liters/serv con/day]</td>
<td>174</td>
<td>140</td>
<td>212</td>
</tr>
<tr>
<td>Infrastructure Leakage Index (ILI)</td>
<td>1.8</td>
<td>1.6</td>
<td>2.7</td>
</tr>
<tr>
<td>Apparent Losses [gal/serv con/day]</td>
<td>1</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Apparent Losses [Liters/serv con/day]</td>
<td>4</td>
<td>38</td>
<td>8</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
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

| Percentage of SIV | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q |
|------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25%              |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 20%              |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 15%              |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 10%              |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 5%               |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 0%               |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
Field Leakage Measurements

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

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

![Bar chart showing water losses](chart.png)

- Initial Water Loss Assessment [MG]: 1.73
- Final Water Loss Assessment [MG]: 1.02
More Pressure - More Losses
What Volume of Real Losses is Economic

Where the total cost is at a minimum

Economic Leakage Level

COST OF LEAKAGE CONTROL AND WATER LOST

BACKGROUND LEAKAGE and Reported Breaks

Cost of Water Lost

Cost of Leakage Control

LOSSES (MGD)
### 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>Economic Intervention Frequency</td>
<td>18.8 month</td>
<td>35.2 month</td>
</tr>
<tr>
<td>% of System to be Surveyed Annually</td>
<td>64%</td>
<td>34%</td>
</tr>
<tr>
<td>Annual Budget for Intervention</td>
<td>$51,388</td>
<td>$27,439</td>
</tr>
<tr>
<td>Economic Unreported Real Losses</td>
<td>24.5 MG/Year</td>
<td>45.9 MG/Year</td>
</tr>
<tr>
<td></td>
<td>~93,000m$^3$/Year</td>
<td>~173,000m$^3$/Year</td>
</tr>
<tr>
<td>Potential Recoverable Leakage</td>
<td>137.7 MG/Year</td>
<td>116 MG/Year</td>
</tr>
<tr>
<td></td>
<td>~521,000m$^3$/Year</td>
<td>~439,000m$^3$/Year</td>
</tr>
</tbody>
</table>
Roadmap for SCE Water Loss/Energy Reduction Program

- Review of all BMP 1.2 reports submitted by SCE Edison service territory water utilities.
- First report for FIsA and FinI will be available December 2019.
- Can be carried out by SCE internally.

Import information into a ranking sheet:
- Conduct Component Analysis and Economic Level of Leakage Analysis to design effective intervention strategy for top 20 (or more) water utilities.
- Qualifying Matrix
- Component and PI Analysis
- Intervention Strategies
- Proactive Leak Detection
- Infrastructure Replacement

- For utilities not signatory to the CUA/CES Memorandum of Understanding, that are interested in participating in the program and have reliable meter audit results available. Plus for CUA/CES signatories who want to fast-track their participation in the program.

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- First report for FIsA and FinI will be available December 2019.
- Can be carried out by SCE internally.

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

Questions?

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