Evaluating CII Cooling Tower Water Use and Potential

Dave Bracciano, Tampa Bay Water
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Presentation Outline

- Background
- A Little CII Profiling
- Estimating Market Potential and Water Savings Rates
  - Cooling Towers
- Results / Conclusions
  - Water Savings Potential
  - Cost Effectiveness
• Regional water supply authority serving over 2.3 million customers

• Six member governments, across three counties

• Members historically implemented programs

• Member demands:
  – 2010: 222 MGD
  – 2035: 270 MGD
  (variability expected)
CII Profiling
Good Data Sources = Good Information

- Member Water Use / Conservation Data / Single-Family Survey
- Property Appraiser / FDOR Property Use Designations
- Florida State Government Datasets Seating/Rooms/Students

Characteristics known to influence water use.

Customer class disaggregation.

Database for water use characterization
## Initial Assessment

### Key Non-residential Sectors

<table>
<thead>
<tr>
<th>Hotels/Motels</th>
<th>Office Buildings</th>
<th>Restaurants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 use more than national benchmarks</td>
<td>1/3 use more than national benchmarks</td>
<td>1/2 use more than national benchmarks</td>
</tr>
<tr>
<td>9% of accounts use 50% of total water use</td>
<td>5% accounts use 60% of total water use</td>
<td>8% of accounts use 32% of total water use</td>
</tr>
<tr>
<td>Seasonal factors: Irrigation, Cooling, Spring Break</td>
<td>Seasonal factors: Cooling</td>
<td>Fast food restaurants may have most efficiency potential</td>
</tr>
</tbody>
</table>
Retirement Sector Weather-Sensitive and Weather-Insensitive Demands

- Oct: 6.2% Weather Sensitive
- Nov: 3.3% Weather Sensitive
- Dec: 3.4% Weather Sensitive
- Jan: 5.5% Weather Sensitive
- Feb: 6.4% Weather Sensitive
- Mar: 5.7% Weather Sensitive
- Apr: 11.6% Weather Sensitive
- May: 14.7% Weather Sensitive
- Jun: 14.7% Weather Sensitive
- Jul: 12.9% Weather Sensitive
- Aug: 37.6% Weather Sensitive
- Sep: 0.0% Weather Sensitive
Hospital Sector Type Weather-Sensitive and Weather-Insensitive Demands

% Weather Sensitive Use

Month

- Oct: 96.1%
- Nov: 72.9%
- Dec: 78.5%
- Jan: 73.0%
- Feb: 79.1%
- Mar: 98.0%
- Apr: 99.1%
- May: 123.9%
- Jun: 113.6%
- Jul: 117.7%
- Aug: 155.4%
- Sep: 110.1%

- Oct: 61.1%
- Nov: 58.9%
- Dec: 55.9%
- Jan: 50.5%
- Feb: 63.7%
- Mar: 68.9%
- Apr: 80.6%
- May: 76.2%
- Jun: 88.6%
- Jul: 78.1%
- Aug: 90.7%
- Sep: 78.7%
Nursing Home Sector Type Weather-Sensitive and Weather-Insensitive Demands

![Bar chart showing % Weather Sensitive Use by Month from Oct to Sep.]

- October: 30.4%
- November: 25.7%
- December: 24.0%
- January: 28.9%
- February: 23.9%
- March: 31.3%
- April: 32.9%
- May: 28.1%
- June: 40.2%
- July: 35.8%
- August: 36.8%
- September: 30.2%
Office Building Sector Weather-Sensitive and Weather-Insensitive Demands

![Bar Chart](chart.png)
Cooling Tower Potential
Where: larger commercial and industrial facilities
What: Heat removal
How: By a central refrigeration system and compressor, and water cooled. Water cooled systems are connected with a circulating loop to a cooling tower—exchange occurs with atmosphere through evaporative cooling.
How to assess cooling tower technology and programs?

– Identify tools necessary to determine if they are in your system/sectors
– Calculate average cooling hour loads
– Determine average cycles of concentration of water use
– How long do programs last
– What is the average savings rate
Cooling Tower Screening and Water Use Determination

• Screening: ASHRAE - buildings square footage > 25,000 ft.² or 4 stories of heated area in database

• Conducted visual evaluation of all sites to estimate cooling towers (coop student)
  – 569 in 2008 (conservative number based on discussions with cooling tower contracting firm)

• Increase at same rate as residential accounts - 801 in 2035

• City of Tampa - reclaimed master plan provided numbers and estimated COC’s
Cooling Tower Screening and Water Use Determination

- All cooling towers considered eligible
  - 25% program penetration by 2035 (~10/year)
  - Savings rate based on median (2.5 to 6 COC’s)
  - Program costs and savings consistent nationally (conservative for Florida)
  - Program costs- submetering, financial incentive for treatment technology
  - Govt. cost/retrofit- $1000
    - Submetering
    - Treatment technology
    - Agreements to implement and track
## Ex: Estimating Cooling Load

### Ex: Schools
- **AAAAA School size 250,000 ft.$^2$**

<table>
<thead>
<tr>
<th>ASHRAE EFLH Table</th>
<th>Occupancy Assumptions</th>
<th>Sectors</th>
<th>Equivalent Full Load Hours</th>
<th>Capacity (Ft$^2$/ Ton)</th>
<th>Unit Load (Tons/Ft$^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>MIN</td>
<td>MAX</td>
<td>Average</td>
</tr>
<tr>
<td>Table 17. EFLH for Typical School</td>
<td>9 months, 8 am-4 pm</td>
<td>Education</td>
<td>1050</td>
<td>1100</td>
<td>1075</td>
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<td></td>
<td></td>
<td>Miscellaneous Seasonal</td>
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<td>Table 18. EFLH for Typical Office</td>
<td>year-round, weekdays, 8 am-5 pm</td>
<td>Office &lt;10 stories</td>
<td>1800</td>
<td>2000</td>
<td>1900</td>
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<td></td>
<td></td>
<td>Government</td>
<td></td>
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<td></td>
<td></td>
<td>Medical Services</td>
<td></td>
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</tr>
<tr>
<td>Table 19. EFLH Office Extended Retail Type Occupancy</td>
<td>year-round, weekdays, 8 am-10 pm</td>
<td>Office &gt;10 stories</td>
<td>2170</td>
<td>2580</td>
<td>2375</td>
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</tbody>
</table>
Ex: Calculate Cooling Tons and Ton-hours Cooling for School

**COOLING TONS**

\[ CT = L_f \times A \times (0.0032 \times 250,000) \]

- \( CT = 800 \) Tons

**Where**

- \( CT \) = Cooling Tons
- \( L_f \) = Unit Load (tons/ ft²) by facility type
- \( A \) = Building Area

**Ton-Hours of Cooling**

\[ H = CT \times E_f \times (800 \times 1075) \]

- \( H = 860,000 \)

**Where**

- \( H \) = Ton-Hours of Cooling (annual)
- \( CT \) = Cooling Tons
- \( E_f \) = Equivalent Full Load Hours per Year by Facility Type
Existing Water Use at 2.5 COC

\[ Q = H \times WU_c \ (860,000 \times 3.15) \]

- \( Q_1 = 2,709,000 \) gallons/year

Where

- \( Q \) = Total Cooling Water Use (gpy)
- \( H \) = Ton-Hours of Cooling (annual)
- \( WU_c \) = Water Use per TON at specified COC

Existing Water Use at 6 COC

\[ Q = 860,000 \times 2.17 \]

- \( Q_2 = 1,866,200 \) gallons/year

Water Saved \( 842,800 \) gallons/year or \( 2309 \) gallons/day
### Percent Reduction in Water Use vs. COC Change

<table>
<thead>
<tr>
<th>COC's Before Increasing Cycles</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>12</th>
<th>15</th>
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<td>1.5</td>
<td>33%</td>
<td>50%</td>
<td>56%</td>
<td>58%</td>
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<td>2</td>
<td>25%</td>
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<td>38%</td>
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<td>42%</td>
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<td>46%</td>
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<td>3</td>
<td>11%</td>
<td>17%</td>
<td>20%</td>
<td>22%</td>
<td>24%</td>
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<td>6%</td>
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<td>1%</td>
<td>3%</td>
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<td>6%</td>
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</tbody>
</table>
Overall Results and Conclusions
### Cooling Tower Intervention Market Potential

<table>
<thead>
<tr>
<th>Variable</th>
<th>2015</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eligible Measures</td>
<td>610</td>
<td>638</td>
<td>676</td>
<td>730</td>
<td>801</td>
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<tr>
<td>Cumulative Planned Interventions</td>
<td>10</td>
<td>57</td>
<td>105</td>
<td>153</td>
<td>200</td>
</tr>
<tr>
<td>Eligible Measures After Planned Interventions</td>
<td>600</td>
<td>580</td>
<td>571</td>
<td>577</td>
<td>601</td>
</tr>
</tbody>
</table>

### Cooling Tower Rebate Estimated Savings Potential

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total GPD</th>
<th>Median GPY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Use @ 2.5 COC</td>
<td>10,386,840</td>
<td>4,449,743</td>
</tr>
<tr>
<td>Water Use @ 6.0 COC</td>
<td>7,152,752</td>
<td>3,063,214</td>
</tr>
<tr>
<td>Savings Potential</td>
<td>3,234,089</td>
<td>1,386,530</td>
</tr>
</tbody>
</table>
Anticipated Low Penetration Rate

- Alternative Irrigation Sources, SF: 3.72 MGD
- Residential HETs, SF: 2.64 MGD
- ET/SMS Irrigation Controllers, SF: 2.05 MGD
- HEUs (1/2 Gallon), NR: 1.36 MGD
- Residential HETs, MF: 1.13 MGD
- ULFTs (Valve-Type), NR: 0.63 MGD
- Cooling Towers, NR: 0.36 MGD
- HETs (Tank-Type), NR: 0.30 MGD
- PRSVs, NR: 0.06 MGD
- Dishwashers (Conveyor), NR: 0.04 MGD
## Most Cost Effective - Top Ten Potential Programs

<table>
<thead>
<tr>
<th>Activity Name</th>
<th>Class</th>
<th>$ per 1000 gal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling Tower</td>
<td>Non-Residential</td>
<td>$ 0.07</td>
</tr>
<tr>
<td>Pre-Rinse Spray Valve</td>
<td>Non-Residential</td>
<td>$ 0.11</td>
</tr>
<tr>
<td>Valve-Type ULFT Rebate</td>
<td>Non-Residential</td>
<td>$ 0.22</td>
</tr>
<tr>
<td>1/2 Gallon Urinal</td>
<td>Non-Residential</td>
<td>$ 0.23</td>
</tr>
<tr>
<td>Alternative Irrigation Source</td>
<td>Single-Family</td>
<td>$ 0.32</td>
</tr>
<tr>
<td>Tank-Type HE Toilet</td>
<td>Non-Residential</td>
<td>$ 0.32</td>
</tr>
<tr>
<td>Residential HE Toilets</td>
<td>Multi-Family</td>
<td>$ 0.35</td>
</tr>
<tr>
<td>ET Irrigation Controller</td>
<td>Single-Family</td>
<td>$ 0.35</td>
</tr>
<tr>
<td>Residential HE Toilets</td>
<td>Single-Family</td>
<td>$ 0.36</td>
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<tr>
<td>Dishwasher Conveyor</td>
<td>Non-Residential</td>
<td>$ 0.42</td>
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<tr>
<td>Irrigation Evaluations</td>
<td>Single-Family</td>
<td>$ 1.35</td>
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<tr>
<td>Landscape/Irrigation Modifications</td>
<td>Single-Family</td>
<td>$ 1.50</td>
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<tr>
<td>Residential HE Washer</td>
<td>Single-Family</td>
<td>$ 2.03</td>
</tr>
<tr>
<td>Residential HE Washer</td>
<td>Multi-Family</td>
<td>$ 2.26</td>
</tr>
</tbody>
</table>
Conclusions

- Cooling tower programs need to be developed and canned for use by conservation coordinators.
- Potential savings rates are high but low penetration rates/lack of data nationally preclude high expectations.
- Sub-metering (with AMI) of cooling tower water use should be in utility purview or credits given for reduced wastewater or stormwater flows.
- Reclaimed water programs provide additional potential.
Thank you!

Questions?

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