AWE Cooling Technologies Project Update

December 11, 2019

PNNL is operated by Battelle for the U.S. Department of Energy
AWE Cooling Technology Study: Origin

• AWE Water Efficiency Research Committee
• Members identified needs:
  ▪ Cooling towers poorly understood
  ▪ Difficult to design effective water utility efficiency programs
  ▪ Hard to connect with the right people
  ▪ Number of cooling towers, locations, and water use often unknown
  ▪ Identify water savings potential – savings potential may be large, but difficult to quantify
One cooling tower retrofit can generate the same amount of savings as 50 toilet replacements.
Project Goals and Team

1. Develop best practices for identifying water-cooled facilities in urban areas.
2. Develop best practices for estimating water demands for cooling.
3. Determine the conservation potential for various improvements to traditional cooling technologies such as cooling towers.
4. Determine the conservation potential of alternative cooling technologies.
5. Develop practical guides, incorporating study results, to increase the effectiveness of cooling WUE incentive and outreach programs.

Research Team
- Pacific Northwest National Laboratory

Project Managers and Advisors
- Bill Christiansen - Alliance for Water Efficiency
- Maureen Erbeznik & Associates
- Project Advisory Committee
  ✓ Funders
  ✓ H.W. Hoffman & Associates

Funders
- H.W. Hoffman & Associates
Project Partners

1. Metropolitan Water District of Southern California, United States
2. Southern Nevada Water Authority, United States
3. San Antonio Water System, United States
4. California Water Service, United States
5. City of Guelph, Canada
6. Denver Water, United States
7. City of Tucson, United States
8. City of Santa Fe, United States
9. Santa Clara Valley Water District, United States
10. City of Calgary, Canada
11. East Bay Municipal Utility District
12. City of Dallas
13. Austin Water
What is a Cooling Tower?

Important Terms:

• **Consumptive Water Use**: Water evaporated through cooling tower, which is water is “lost” to the atmosphere.

• **Non-consumptive Water Use**: Briny water sent down the drain, called blowdown water, is considered water that is “not consumed” by the atmosphere and is returned to the environment in liquid state near where it was collected.

• **Cycles of Concentration**: Ratio of the concentration of dissolved solids in the blowdown water compared to the make-up water.
Initial Data Collection and Analysis

- **Commercial Buildings Energy Consumption Survey (CBECS) 2012**
  - Provides data on energy-related building characteristics and energy use data for the stock of U.S. commercial buildings
  - Developed correlations regarding building use types and physical characteristics that are statistically likely to use cooling towers

- **New York State Department of Health**
  - Detailed listing of cooling towers registered in the State of New York
  - Provided correlations between population density and cooling tower installations (including data on cooling tower numbers and overall cooling tower capacity)

- **U.S. Census Bureau**
  - Provided county-level information on various commercial and industrial activities
  - Used to correlate occurrence of cooling towers and cooling water use with various databases

Large and tall buildings tend to have water-cooled chillers
Resources and Tools

Best Practices for Identifying Cooling Towers in Urban Areas

- Guidebook: Steps and methods for building a cooling tower inventory
- Excel-Based Tool – Cooling Tower Estimating Model (CTEM)

Best Practices Guide and CTEM are designed to help water utilities and other interested entities identify cooling towers in urban areas and estimate cooling loads and water use.
CTEM Base Feature Inputs

Enter Location and Water Quality Inputs

- Select Country: United States
- Select State: California
- Select County: Santa Barbara

Population in County (2018): 446,527

Enter Population Served: 93,000
(This input will scale the results to the service population)

IECC Climate Zone: 3C

Select Water Quality Measurement Type: TDS
(TDS of Conductivity)

Enter Water Quality: 631
# CTEM Base Feature Results

## Cooling Tower Estimating Model

**Version 0.1 (Beta)**

### Final Results

#### CTEM Results

<table>
<thead>
<tr>
<th></th>
<th>Large-Scale Facilities</th>
<th>Commercial Facilities</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Facilities</td>
<td>11</td>
<td>31</td>
<td>42</td>
</tr>
<tr>
<td># of Cooling Towers</td>
<td>95</td>
<td>75</td>
<td>170</td>
</tr>
<tr>
<td>Cooling Capacity, tons</td>
<td>29,053</td>
<td>24,469</td>
<td>53,522</td>
</tr>
<tr>
<td>Annual Cooling Load, tons/year</td>
<td>42,677,550</td>
<td>35,943,404</td>
<td>78,620,954</td>
</tr>
<tr>
<td>Consumptive Water Use, kgal/year</td>
<td>73,491</td>
<td>61,895</td>
<td>135,386</td>
</tr>
<tr>
<td>Non-Consumptive Water Use, kgal/year</td>
<td>53,363</td>
<td>44,943</td>
<td>98,306</td>
</tr>
</tbody>
</table>

### Cycles of Concentration

- **Baseline Potential**
  - 2.4
  - 3.4

### Non-Consumptive Water Use

- **kgal/year (baseline)**
  - 98,306
- **kgal/year (potential)**
  - 56,952

### Savings Potential

- **kgal/year**
  - 41,354
- **% Savings**
  - 42%
CTEM Base Feature Inventory

- Output: Large-scale facilities that are likely to have cooling towers, located within the county of the service territory
- Tool allows to finetune results to eliminate or confirm facilities

### Large-Scale Facilities

- Airports
- College/Universities
- Data centers
- District chilled water plants
- Hospitals
- Microchip fabrication
- US research labs
- Oil refineries
- Petrochemical plants
- Thermoelectric power plants

### Cooling Tower Estimating Model

<table>
<thead>
<tr>
<th>Facility Name</th>
<th>Address</th>
<th>City</th>
<th>State</th>
<th>Zip Code</th>
<th>County</th>
</tr>
</thead>
<tbody>
<tr>
<td>Santa Barbara Municipal Airport</td>
<td>500 James Fowler Rd</td>
<td>Santa Barbara</td>
<td>CA</td>
<td>93101</td>
<td>Santa Barbara</td>
</tr>
<tr>
<td>Fielding Graduate University</td>
<td>1000 West Valley Blvd</td>
<td>Santa Barbara</td>
<td>CA</td>
<td>93101</td>
<td>Santa Barbara</td>
</tr>
<tr>
<td>Santa Barbara City College</td>
<td>1200 East Valley Blvd</td>
<td>Santa Barbara</td>
<td>CA</td>
<td>93101</td>
<td>Santa Barbara</td>
</tr>
<tr>
<td>University of California-Santa Barbara</td>
<td>351 South Pitzer Ave</td>
<td>Santa Barbara</td>
<td>CA</td>
<td>93101</td>
<td>Santa Barbara</td>
</tr>
<tr>
<td>Allan Hancock College</td>
<td>2333 Highland Ave</td>
<td>Santa Barbara</td>
<td>CA</td>
<td>93101</td>
<td>Santa Barbara</td>
</tr>
<tr>
<td>Telecom</td>
<td>2225 E Valley Blvd</td>
<td>Santa Barbara</td>
<td>CA</td>
<td>93101</td>
<td>Santa Barbara</td>
</tr>
<tr>
<td>Level 3 Communications</td>
<td>1221 S Main St</td>
<td>Santa Barbara</td>
<td>CA</td>
<td>93201</td>
<td>Santa Barbara</td>
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<tr>
<td>Impulse Advanced Communications</td>
<td>2221 E Valley Blvd</td>
<td>Santa Barbara</td>
<td>CA</td>
<td>93101</td>
<td>Santa Barbara</td>
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<tr>
<td>Goleta Valley Cottage Hospital</td>
<td>1515 East Ocean Avenue</td>
<td>Lompoc</td>
<td>CA</td>
<td>93436</td>
<td>Santa Barbara</td>
</tr>
<tr>
<td>Lompoc Valley Medical Center</td>
<td>1600 E Church Street</td>
<td>Santa Barbara</td>
<td>CA</td>
<td>93456</td>
<td>Santa Barbara</td>
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<tr>
<td>Marian Medical Center</td>
<td>1515 East Ocean Avenue</td>
<td>Lompoc</td>
<td>CA</td>
<td>93436</td>
<td>Santa Barbara</td>
</tr>
</tbody>
</table>

### Confirm for each building:

- Located in Service Territory? Yes
- Has a cooling tower? Yes

- Airport
- College/University
- Data Center
- Hospital
CTEM Full Detail Inventory Feature

- **Input**: Commercial building data (real property data from construction permits, city planning documents/databases)
- **Output**: Predicted locations that have water-cooled chillers in commercial building types
- Tool allows to finetune results
Verify the Existence of Cooling Towers

- Satellite imagery (e.g., Google Earth) can be used as a starting place to locate cooling towers identified by CTEM
- Cooling towers may not be on the roof
- Cooling towers can be behind buildings or even inside buildings
Progress and Timeline

- Currently completing Task 3
- Project completion targeted for the second half of 2020
- Funders and PAC members gain early access to tools and resources
Thank you
• Back up slides
Cooling Load Determination

Real Property Results

Hourly load data of prototype buildings that use cooling towers, simulated in various climate zones around the country

Building Energy Models

Climate Data

Cooling Load and Cooling Tower Usage Calculations