AWE Cooling Technologies Project Update

December 11, 2019

Alliance for Water Efficiency

U.S. DEPARTMENT OF ENERGY BATTELLE

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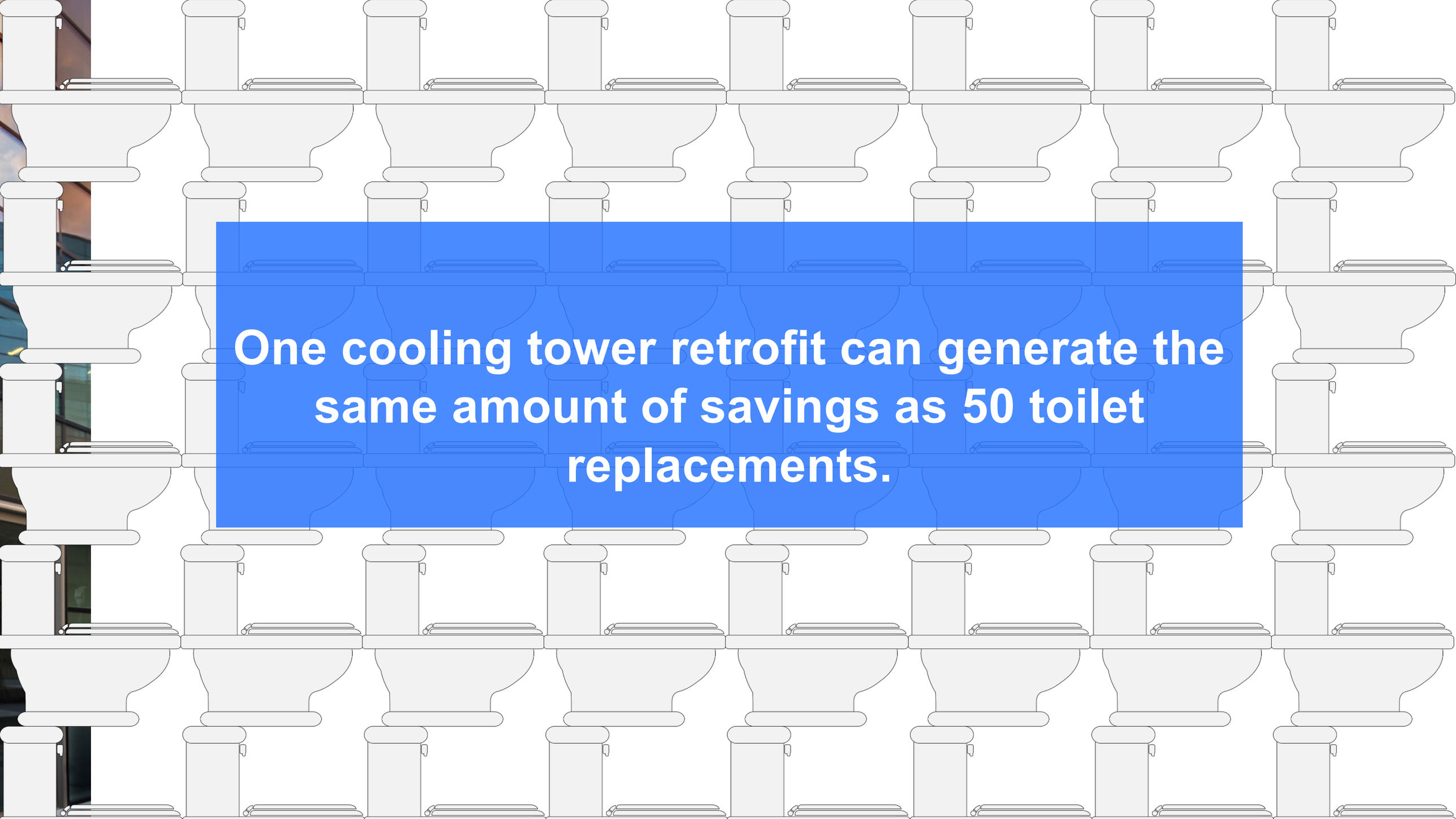
AWE Cooling Technology Study: Origin

- 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

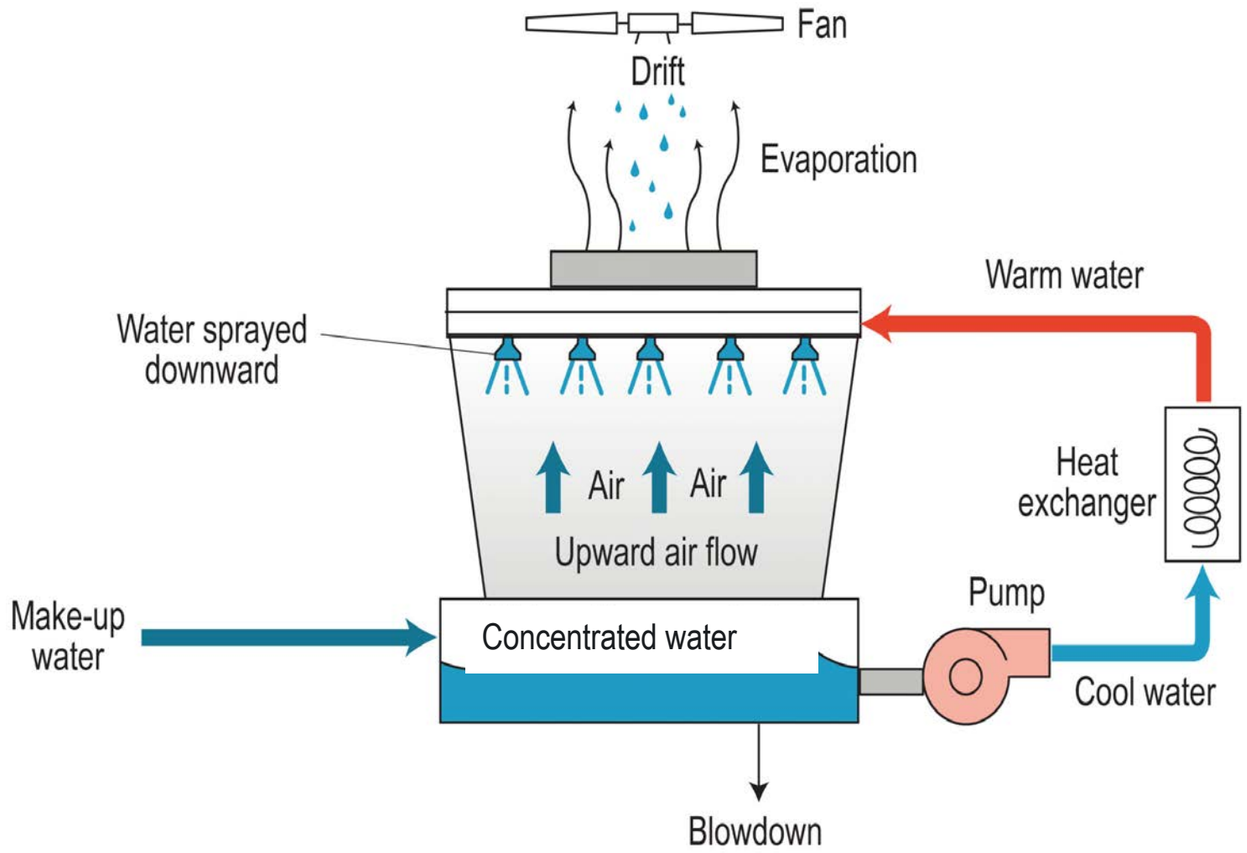
Project Managers and Advisors

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

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?



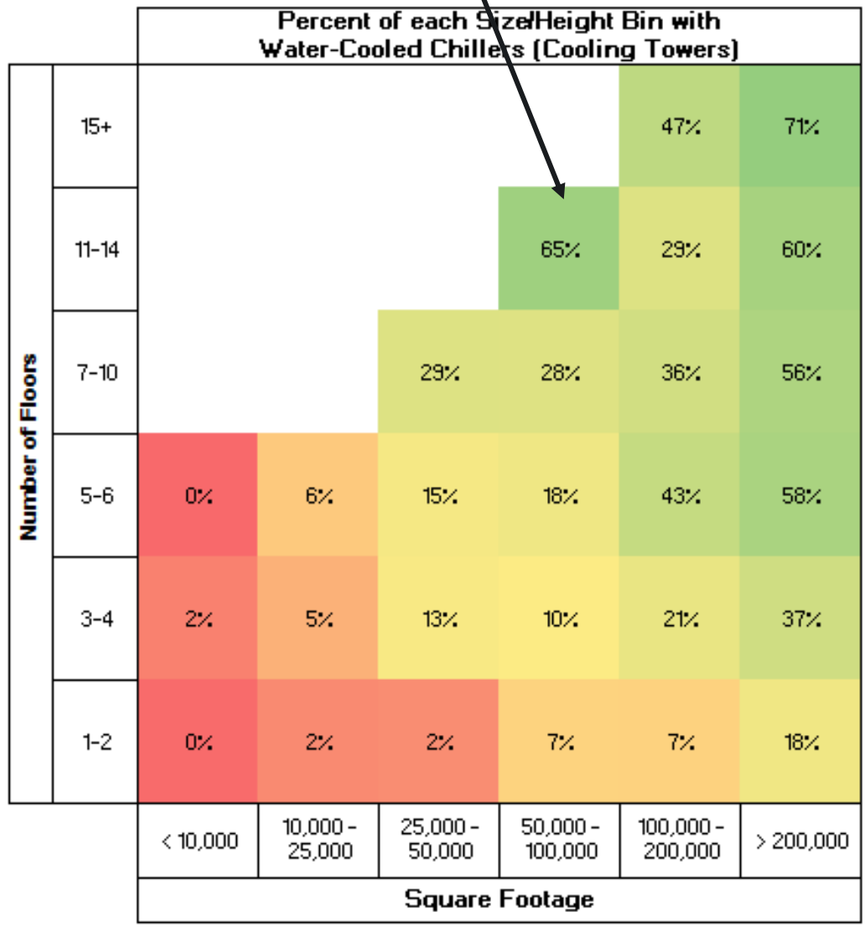
Important Terms:

- **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

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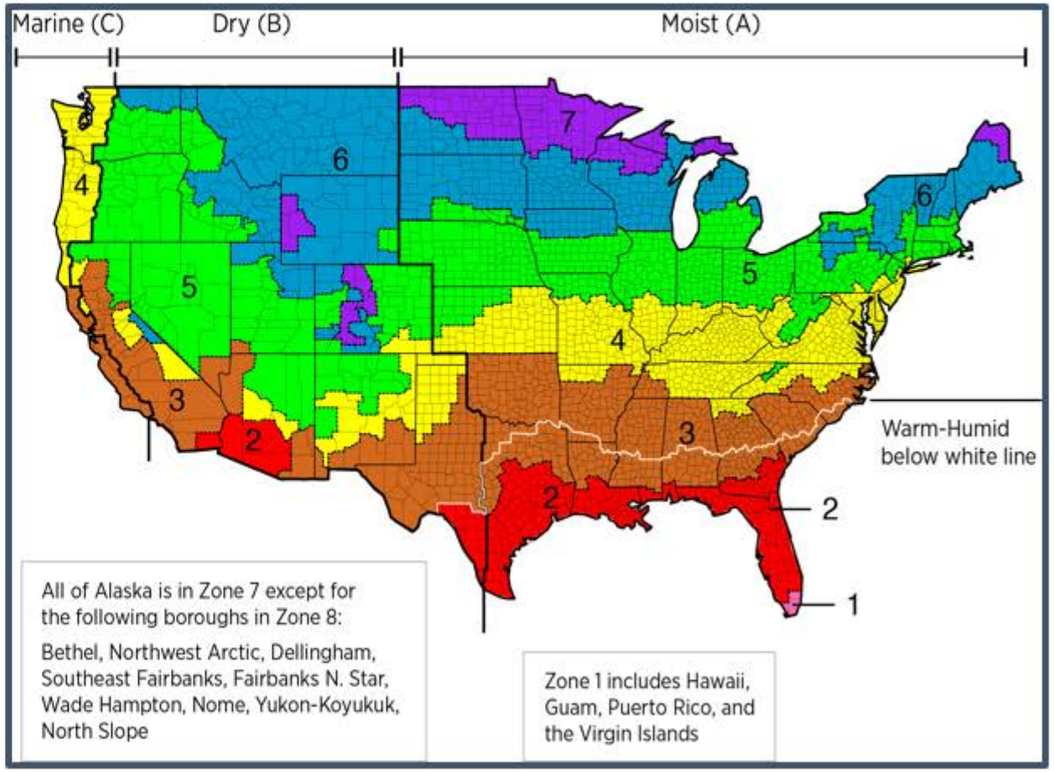
Cooling Tower Estimating Model

Version 0.1 (Beta)

Pacific Northwest NATIONAL LABORATORY

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 (ppm)
(TDS of Conductivity)	
Enter Water Quality:	631



CTEM Base Feature Results

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Cooling Tower Estimating Model

Version 0.1 (Beta)

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Final Results

CTEM Results

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

Cycles of Concentration	Baseline	2.4
	Potential	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 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 refiners
- Petrochemical plants
- Thermoelectric power plants

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Cooling Tower Estimating Model

Version 0.1 (Beta)

Confirm for each building:

Export Inventory

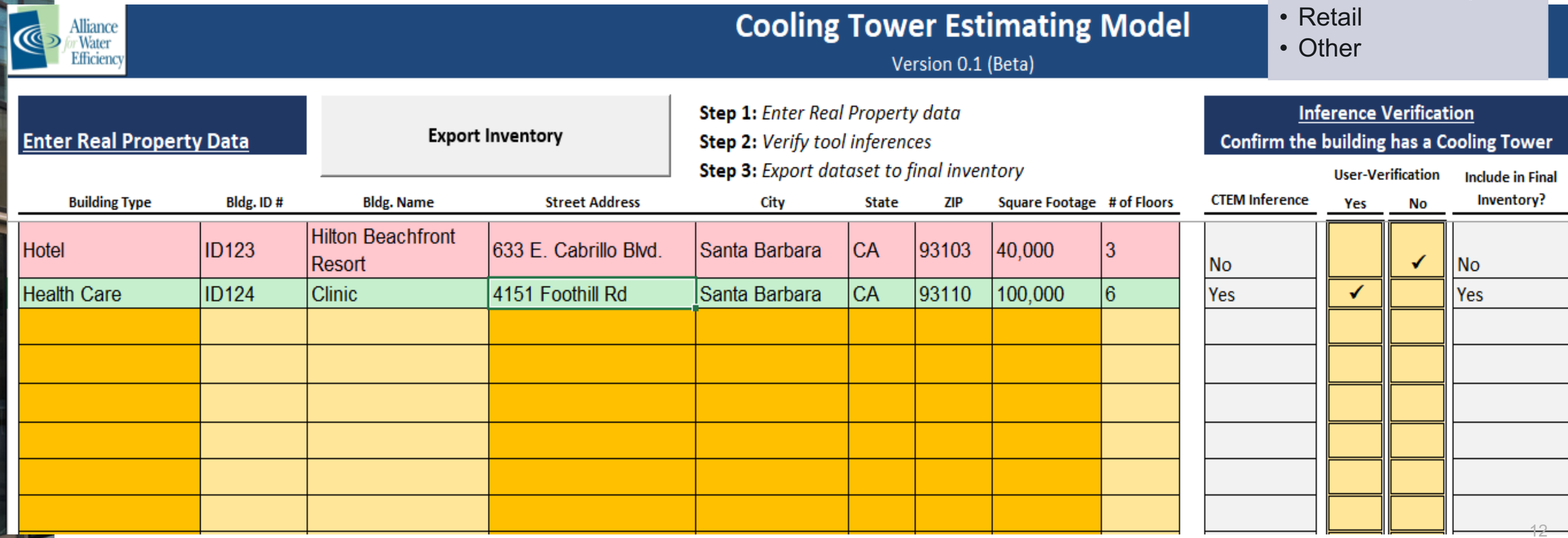
Located in Service Territory?		Has a cooling tower?		Facility Type	Facility Name	Address	City	State	Zip Code	County
Yes	No	Yes	No							
				Airport	Santa Barbara Municipal Airport	500 James Fowler Rd	Santa Barbara	CA	93117	Santa Barbara
				College/University	Fielding Graduate University		Santa Barbara	CA		Santa Barbara
				College/University	Santa Barbara City College		Santa Barbara	CA		Santa Barbara
				College/University	University of California-Santa Barbara		Santa Barbara	CA		Santa Barbara
				College/University	Allan Hancock College		Santa Maria	CA		Santa Barbara
				Data Center	Telecom	5383 Hollister Ave	Santa Barbara	CA	93111	Santa Barbara
				Data Center	Level 3 Communications	122 Helena Ave	Santa Barbara	CA	92101	Santa Barbara
				Data Center	Impulse Advanced Communications	104 West Anapamu Street	Santa Barbara	CA	93101	Santa Barbara
				Hospital	Goleta Valley Cottage Hospital	351 South Patterson Avenue	Santa Barbara	CA	93160	Santa Barbara
	✓			Hospital	Lompoc Valley Medical Center	1515 East Ocean Avenue	Lompoc	CA	93436	Santa Barbara
	✓			Hospital	Marian Medical Center	1400 E. Church Street	Santa Maria	CA	93456	Santa Barbara

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

Commercial Buildings

- Education (K-12)
- Health care outpatient
- Hotel
- Laboratory
- Multi-family residential
- Nursing homes
- Office
- Public assembly
- Retail
- Other



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Cooling Tower Estimating Model

Version 0.1 (Beta)

Enter Real Property Data | **Export Inventory**

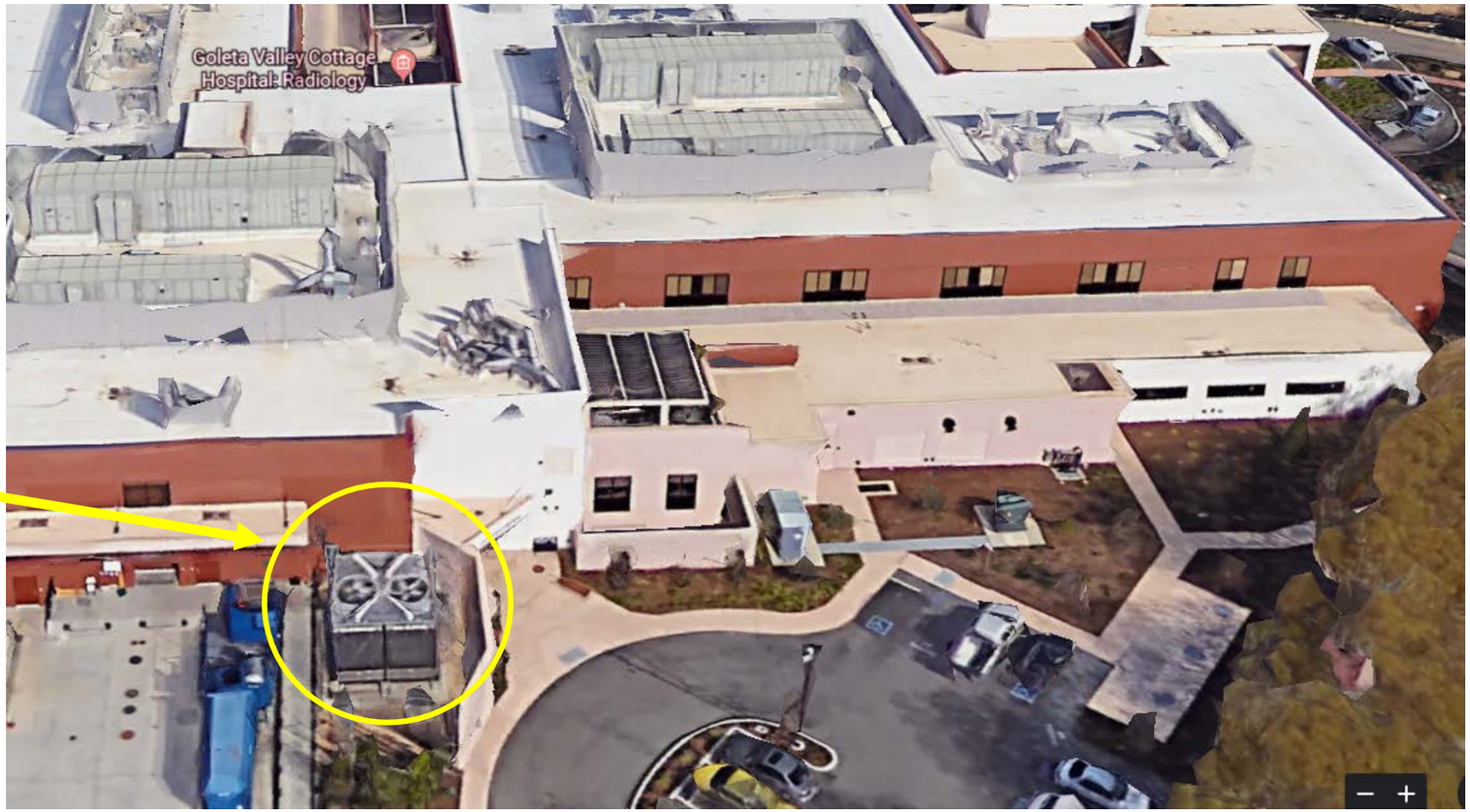
Step 1: *Enter Real Property data*
Step 2: *Verify tool inferences*
Step 3: *Export dataset to final inventory*

Inference Verification
Confirm the building has a Cooling Tower

Building Type	Bldg. ID #	Bldg. Name	Street Address	City	State	ZIP	Square Footage	# of Floors	CTEM Inference	User-Verification Yes	User-Verification No	Include in Final Inventory?
Hotel	ID123	Hilton Beachfront Resort	633 E. Cabrillo Blvd.	Santa Barbara	CA	93103	40,000	3	No		✓	No
Health Care	ID124	Clinic	4151 Foothill Rd	Santa Barbara	CA	93110	100,000	6	Yes	✓		Yes

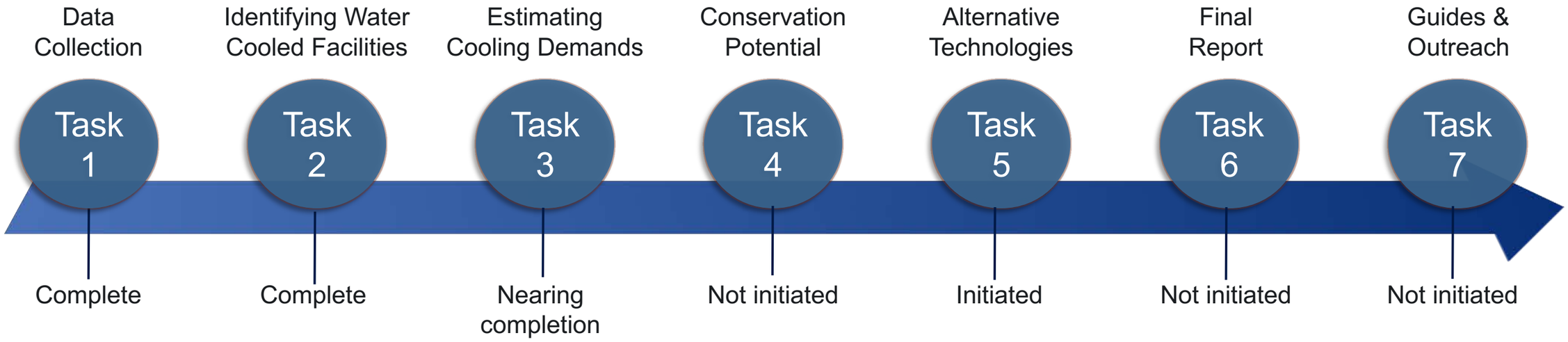
Verify the Existence of Cooling Towers

- 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

Real Property Building Data Entry Module

This module handles the data processing for individual buildings located within the modeled service territory. Large-scale facilities are automatically generated in other modules via location-based lookups (see the *Building and Facility Types* tab for details).

The user performs a copy/paste (in bulk form) of their planning-office-supplied Real Property data into these fields. (Note: the user must perform some adjustment of their Real Property data to match these fields.) After all of the data has been entered, the user clicks the "Run" macro button. The model will automatically select buildings that meet the various statistical filtering criteria for likely having cooling towers (e.g., office buildings of >200,000 square feet and >3 floors). Buildings that are likely to have cooling towers are then highlighted blue. These highlighted results form the high-probability list of addresses that the user can use to initiate a Cooling Tower Registry program (e.g., for *Legionella*-detection purposes).

The highlighted buildings are also forwarded to the Load Calculation modules within the model for caclulations related to cooling load and cooling tower water use. The model's inferences for buildings with cooling towers can be used as is, or can be modified by the user. (For example, the model might select a large office building as likely to have a cooling tower. If the user knows that the building actually uses air-cooled chillers, the user can manually check a "No" box for that building (thereby preventing that building from being forwarded to the Load Calculation module).

	Optional Input
	Required Input

Bldg ID #	Bldg Name	Street Address	City	State	ZIP	Building Type	Square Footage	# of Floors	Year Built
User-Defined	User-Defined					Select from drop-down list			
User-Defined	User-Defined					Select from drop-down list			
User-Defined	User-Defined					Select from drop-down list			
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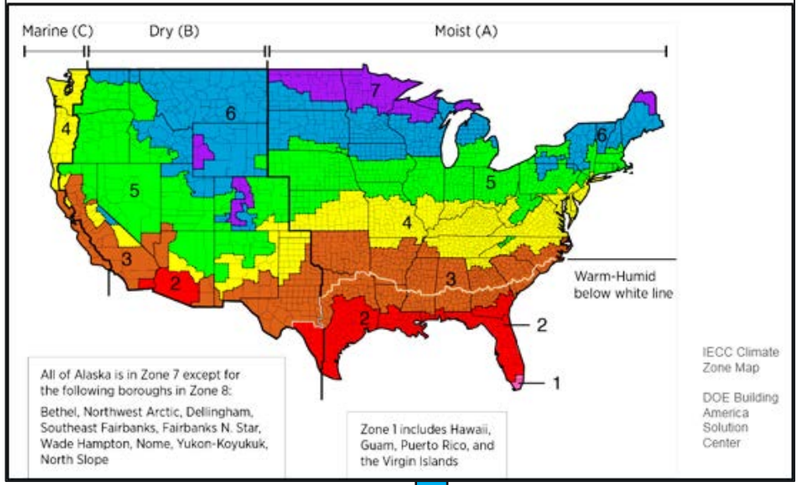
Building Energy Models

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

Climate Data



Cooling Load and Cooling Tower Usage Calculations