CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

Second Stakeholder Meeting for Nonresidential HVAC

Proposals Based on ASHRAE 90.1-2016 Revisions to Waterside Economizer

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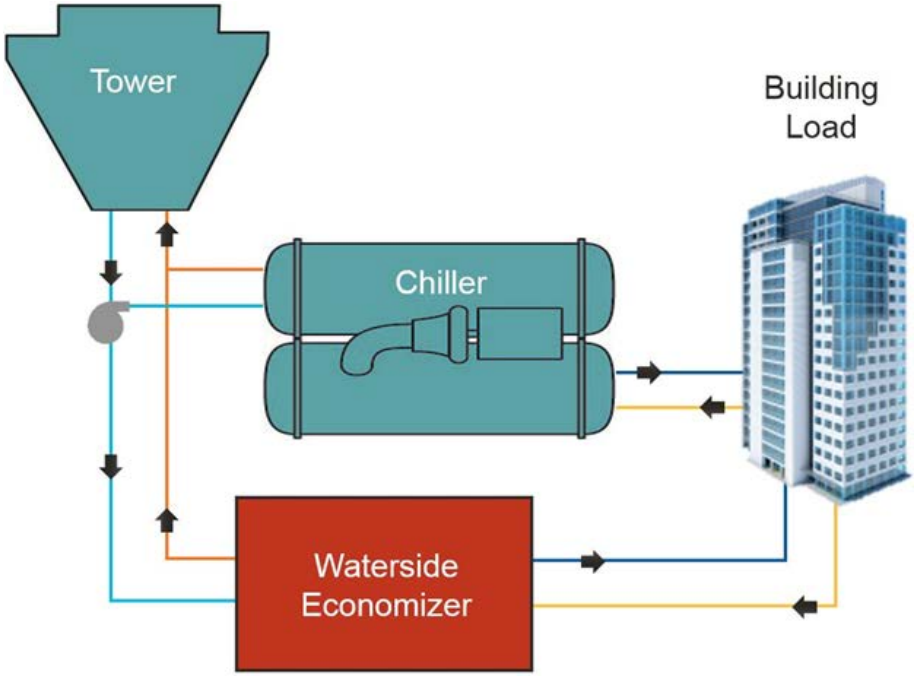
CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

Los Angeles Department of Water & Power | SMUD | SDGE A Sempra Energy utility | SoCalGas A Sempra Energy utility | Southern California Edison An EDISON INTERNATIONAL Company | Pacific Gas and Electric Company

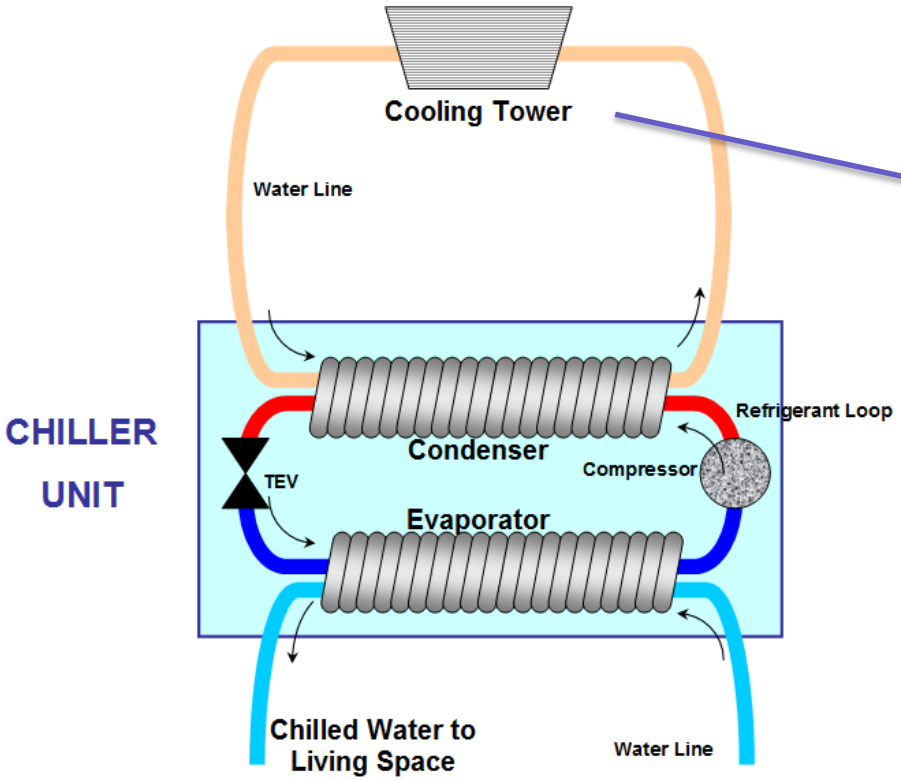
Agenda

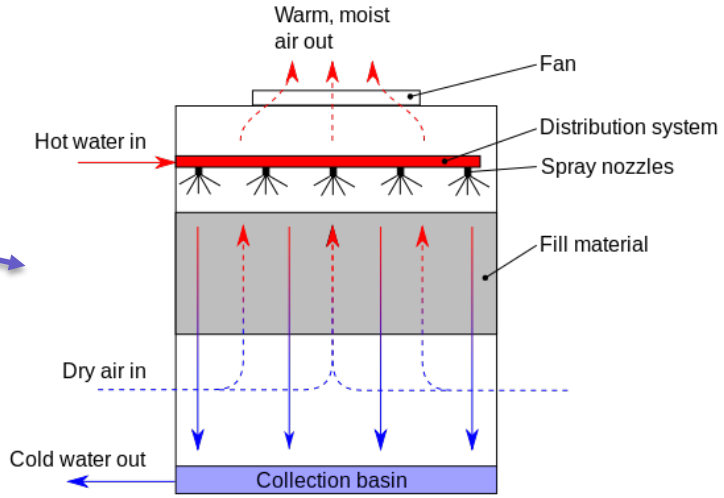
1. Background
2. Proposed Code Changes
3. Technical and Market Barriers
4. Compliance and Enforcement
5. Cost-Effectiveness and Energy Impacts
6. Next Steps

1. Background



Introduction to Technology / Building System

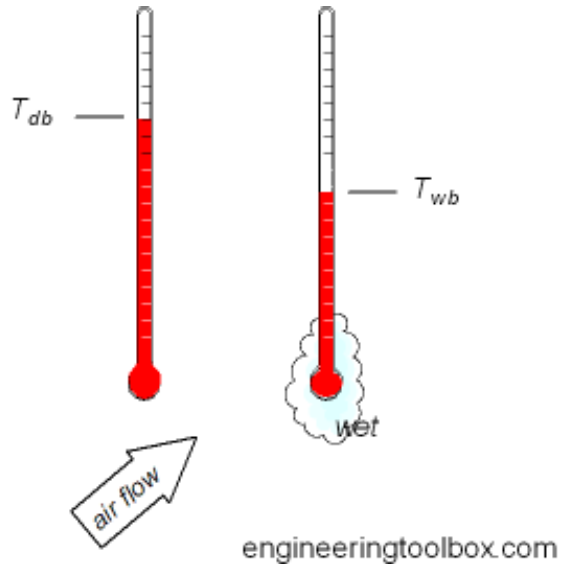




How much can a cooling tower cool the air?

Introduction to Technology / Building System

- Wet-bulb temperature represents minimum temperature possible by evaporative cooling
- Wet-bulb varies with humidity



An infinitely large tower could cool water all the way to a wet-bulb, however this is not practical for buildings.

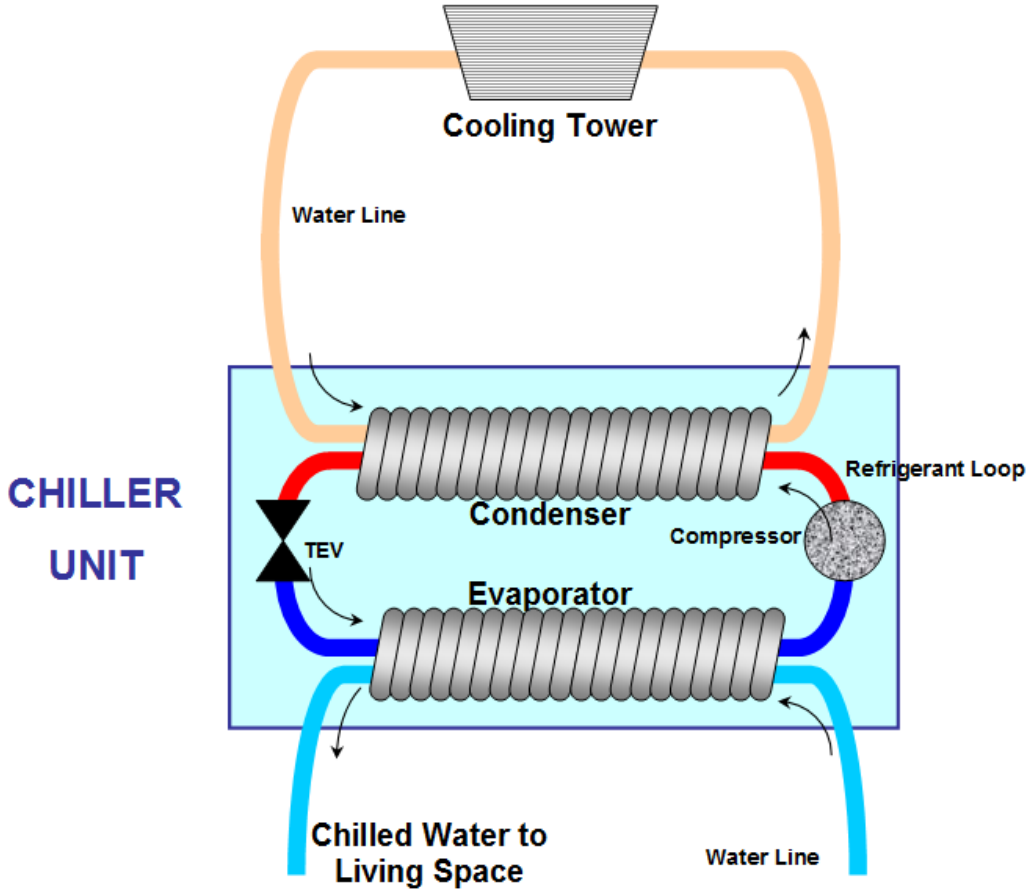
We can get close…

How close we get is called the **approach:**

$$\text{Approach} = T_{\text{CoolingTowerOutlet}} - T_{\text{wet-bulb}}$$

Introduction to Technology / Building System

When wet-bulb is low enough…



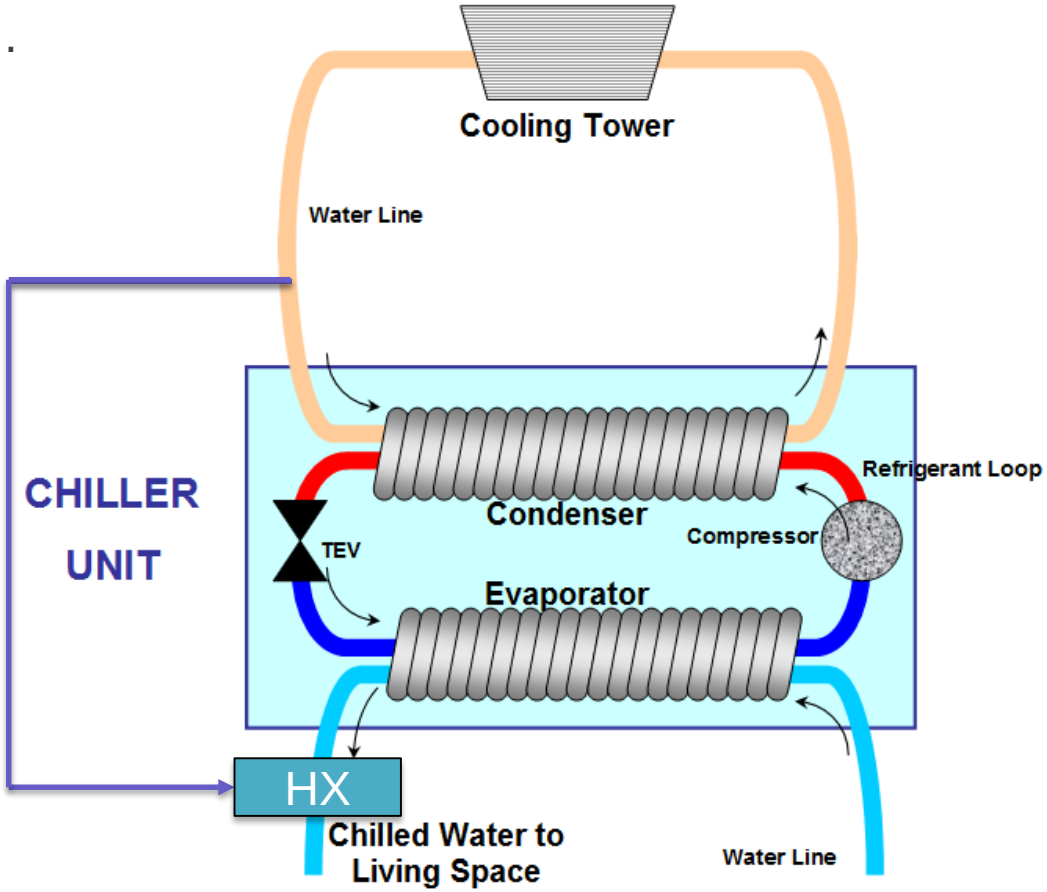
Introduction to Technology / Building System

When wet-bulb is low enough…

Bypass Chiller

Non-Integrated
Waterside Economizer

- Cooling towers with lower approaches can run in this mode for more hours



Introduction to Technology / Building System

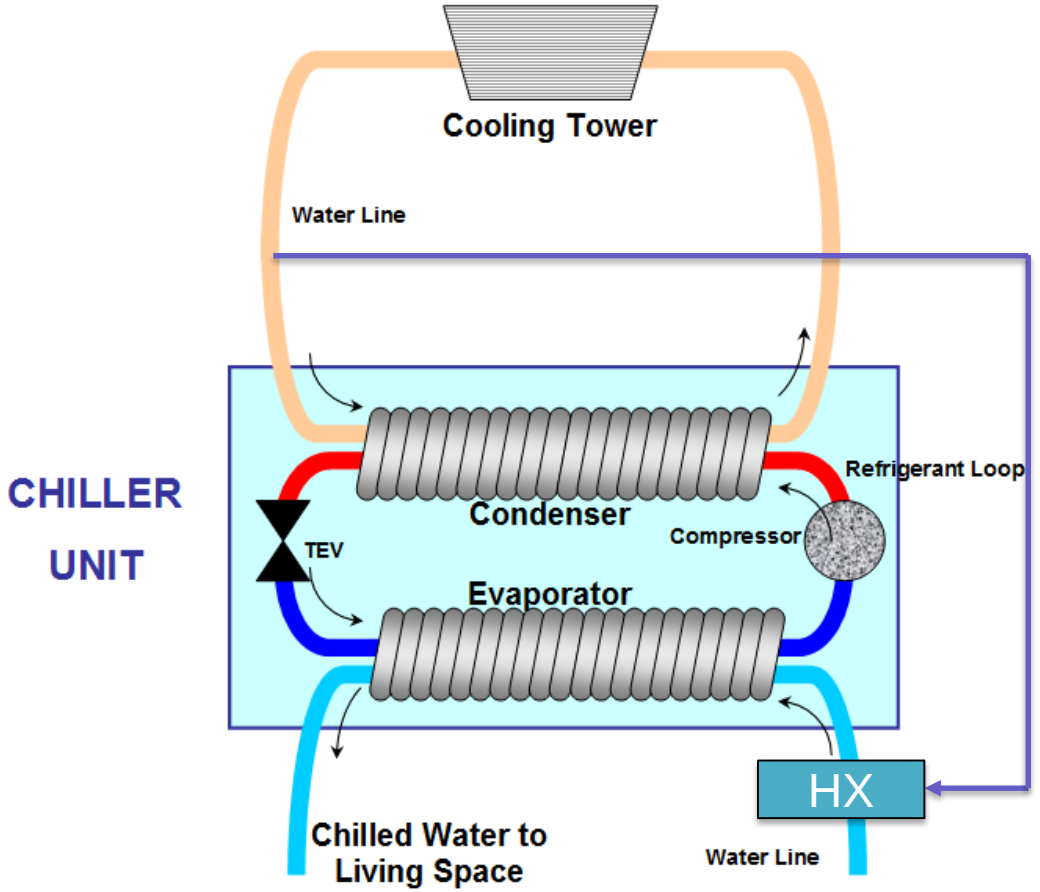
When wet-bulb is low enough…

Or…

- Pre-cool chilled water with cooling tower water
- Allows chiller to use less energy

Integrated Waterside Economizer

- Cooling towers with lower approaches can run in this mode for more hours



Relevant Code History

- There are requirements in Title 24, Part 6, based on ASHRAE 90.1
  - Cooling Air Handler's over 54,000 Btu/hr shall include either an air or water economizer
    - Water economizer must meet full cooling load at 45° F wet-bulb and 50° F dry-bulb
- Other Relevant Code Requirements
  - ASHRAE 90.1 2016 updated waterside economizer requirements to be more stringent
    - Require water economizers on passive "without fan" systems as well
    - Limit pressure drop of Heat exchangers
    - Require cooling towers to operate efficiently when not economizing
    - Require system to use **Integrated** Waterside Economizer for pre-cooling

2. Proposed Code Changes

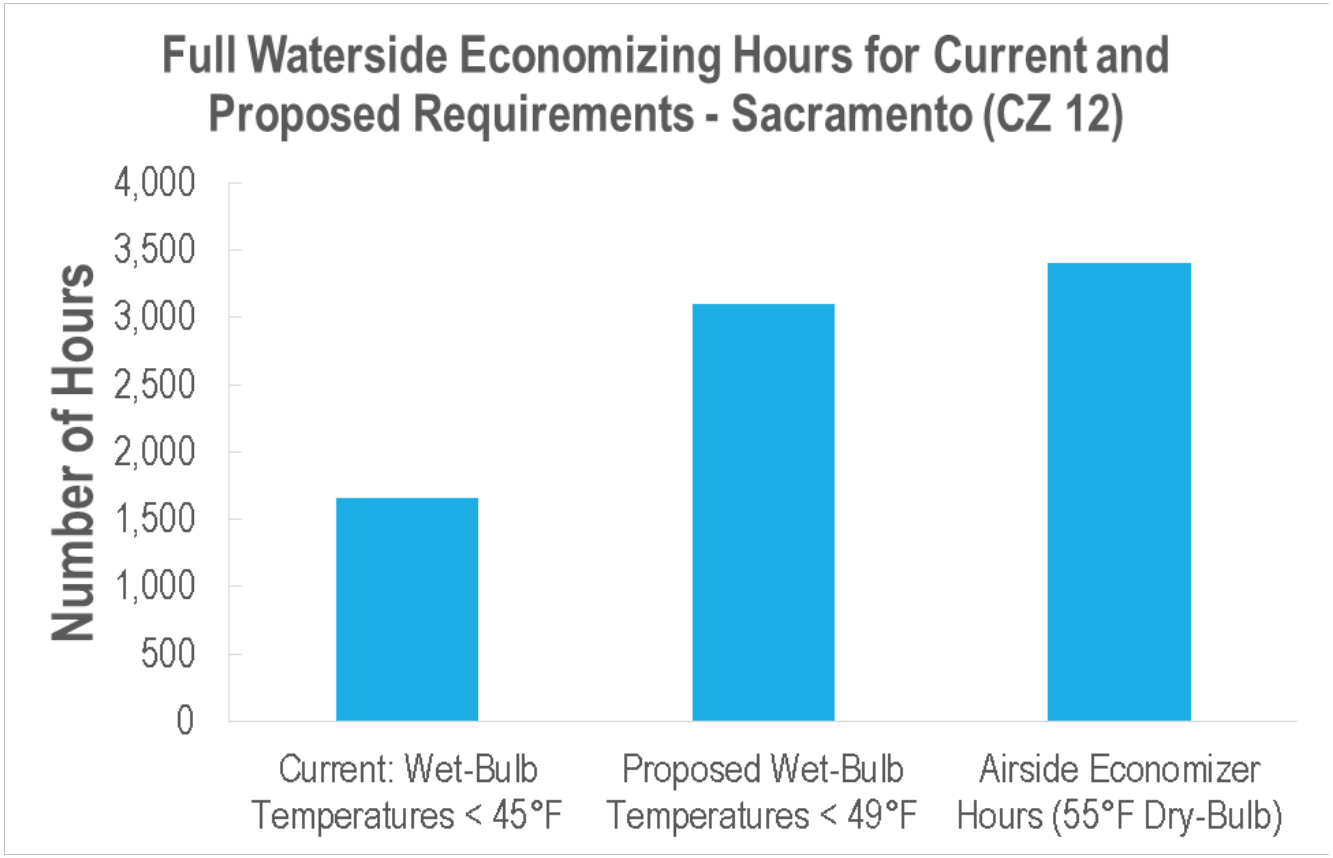
Proposed Code Change

- Prescriptive requirement for waterside economizers
  - Require water economizers on passive “without fan” systems
  - Limit pressure drop of Heat exchangers
  - Require cooling towers to operate efficiently when not economizing
  - Require system to use **Integrated** Waterside Economizer for pre-cooling
  - Limits **Approach** by requiring water economizers to provide full cooling at 49˚ F wet-bulb, compared to the current 45˚ F requirement
- Revision to existing requirement
- Applies to Nonresidential buildings (not data centers) which use waterside economizer and undergo prescriptive compliance
- Does **not** apply to additions and alterations
- Aligns Title 24, Part 6 with 2016 ASHRAE 90.1-2016

Why Are We Proposing This Code Change?

- Support ZNE goals
- Achieve significant energy savings
  - Significant water savings associated with heat rejection devices
- Align with ASHRAE 90.1-2016
- Benefit from California's relatively dry climate with numerous economizer opportunity
  - Pushes number of economizer hours closer to air-side economizer
- Support market trends toward high-efficiency, low-approach, high temperature chilled water distribution systems

Why Are We Proposing This Code Change?



What do you think?

- Do you understand the proposed code change?
- Does it seem reasonable to you?

3. Technical and Market Barriers

Technical and Market Barriers

- Increased Cooling Tower/Heat Exchanger Space/Weight Requirements
  - Lower approach cooling towers/heat exchangers are larger in size
  - Projects with space constraints can use performance compliance and use smaller, less efficient equipment
    - Most large buildings use performance compliance
    - Alterations are exempted
  - Structural engineers indicated negligible affect on design for new construction

What do you think?

- What's your opinion of structural engineers' assessment that there will be negligible affect on design for new construction?
- Are you aware of additional technical or market barriers that we haven't identified?

4. Compliance and Enforcement

Compliance Process

Design Phase

- What happens during design phase
  - Coordination of equipment selection and placement
  - Lower approach towers/heat exchangers are larger and heavier, important for the design team to know and coordinate early in design process to ensure sufficient space exists
  - Piping layout and controls for non-integrated (current requirement) and integrated (proposed requirement) are different
    - Engineers need to learn new sequences and layouts
  - Must specify chillers which perform well at low-lift conditions

Compliance Process

Permit Application Phase

- What happens in permit application phase?
  - Mechanical equipment design approaches, pressure drops, and system capabilities checked against requirements
    - More requirements for waterside economizers create additional items which need to be checked for permit

Compliance Process

Construction Phase

- What happens in construction phase?
  - Equipment efficiency is certified by manufacturer
    - Cooling towers less than 5° F approach cannot be certified by the Cooling Tower Institute (CTI)
    - How can we ensure we are getting the required approach?
  - Equipment is shipped to site and installed
    - Process unchanged by proposal
  - Equipment undergoes acceptance test by Mechanical Acceptance Test Technician to ensure rated efficiency
    - Acceptance test must now show new compliant approaches

Compliance Process

Inspection Phase

- What happens in permitting phase?
  - Acceptance test documentation checked against prescriptive requirement and specified design
    - Test must meet prescriptive requirements and/or specified design

Compliance and Enforcement Barriers

- The Cooling Tower Institute (CTI) certification of Low-Approach cooling towers
  - CTI only certifies towers to a minimum of 5˚ F approach
    - Manufacturers can design cooling towers to meet lower approaches, but these will not be CTI certified
  - Gathered data for several low-approach cooling towers in operation, and analyzing to compare design approach to real-world performance
    - Compliance issues since these towers will not be CTI certified – how can we be sure that these towers actually operate as designed?
- Suggestions?

What about compliance issues?

5. Cost-Effectiveness and Energy Impacts

Definition of Baseline and Proposed Conditions

- **Baseline Conditions**
  - Minimally compliant with 2016 Standards or industry standard practice
  - 500,000 square foot office
  - Non-integrated economizer operation
  - 5 degree approach cooling tower
  - 4 degree approach heat exchanger

- **Proposed Conditions**
  - Compliant with proposed code change (which prescriptive option did you analyze?)
  - 500,000 square foot office
  - Integrated economizer operation
  - 3 degree approach cooling tower
  - 2 degree approach heat exchanger

Cost Effectiveness Analysis

Incremental Costs

- Incremental First Cost
  - Heat Exchanger Lower Approach ($82/ton)
  - Cooling Tower Lower Approach ($18/ton)
  - **Total Incremental First Cost ($100/ton)**
- Incremental Maintenance Costs over 15-year period of analysis
  - Maintenance Cost (negligible)
  - **Total Incremental Maintenance Cost ($0)**
- **Total Incremental Cost over 15-year period of analysis = $100/ton**

Cost Effectiveness Analysis

Incremental Cost Savings (Benefits)

- Energy Cost Savings over 15-year period of analysis
  - **Total Energy Cost Savings = range of $0.24 to $1.07/sf depending on climate zone**
  - *Energy cost savings explained in more detail in following slides.*

Benefit-to-Cost Ratio

Climate Zone	Benefit to Cost
1	3.0
2	2.2
3	2.6
4	2.4
5	6.5
6	1.3
7	1.2
8	1.4
9	2.1
10	2.2
11	1.1
12	2.1
13	1.6
14	4.7
15	2.4
16	1.7

Cost Effective in All Climate Zones

If Benefit-to-Cost Ration is over 1, measure is cost effective.

Annual Energy Savings per Square Foot

Climate Zone	TDV Energy Savings (TDV kBtu/yr)	15-Year TDV Energy Cost Savings ($2020)
1	5.02	$0.15
2	5.02	$0.20
3	5.38	$0.18
4	5.83	$0.22
5	11.99	$0.16
6	3.18	$0.22
7	2.95	$0.22
8	3.32	$0.21
9	5.39	$0.23
10	6.56	$0.27
11	2.69	$0.22
12	4.94	$0.21
13	3.79	$0.21
14	10.39	$0.20
15	7.67	$0.28
16	3.82	$0.20

Annual Energy Savings per Square Foot

Climate Zone	Annual Electricity Savings (kWh/yr)	Peak Electric Demand Reduction (kW)	Annual Natural Gas Savings (therms/yr)
1	0.200	-	-
2	0.204	-	-
3	0.208	-	-
4	0.240	-	-
5	0.246	-	-
6	0.131	-	-
7	0.141	-	-
8	0.163	-	-
9	0.211	-	-
10	0.259	-	-
11	0.176	-	-
12	0.197	-	-
13	0.226	-	-
14	0.279	-	-
15	0.321	-	-
16	0.130	-	-

What about the incremental costs & savings?

This is the polling session that was set up in the meeting room and we played with a bit. (Julian now is comfy with how they work, so you needn't worry about that.)

6. Next Steps

Next Steps

- Please send any additional feedback within 2 weeks to:
  - CASE Author (see contact info at end of this presentation)
  - Info@title24stakeholders.com
- Keep an eye on Title24Stakeholders.com for:
  - Presentations from today's meeting
  - Draft Code Change Language
  - Notes from today's meeting
  - Draft CASE Report (will be posted in April)

Let's move on to…

Prescriptive Efficiency Requirements for Cooling Towers

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