DOCKETED	
Docket Number:	22-BSTD-01
Project Title:	2025 Energy Code Pre-Rulemaking
TN #:	252023
Document Title:	August 24, 2023, 2025 Energy Code Pre-Rulemaking Workshop Presentation
Description:	Slides from August 24, 2023, 2025 Energy Code staff pre-rulemaking workshop on prescriptive heat pump baselines, and solar photovoltaic and energy storage system requirements.
Filer:	Javier Perez
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	8/29/2023 5:11:07 PM
Docketed Date:	8/30/2023

Good morning and thank you for joining us.

The workshop will begin shortly.

Housekeeping Rules

Public Comments

Zoom App/Online

- Click “raise hand”

Telephone

- Press *9 to raise hand
- Press *6 to Mute/Unmute

When called upon

- CEC will open your line
- Unmute on your end
- Spell name and state affiliation, if any
- 2 minutes or less per speaker, 1 speaker per entity

Today's Agenda

	Topics	Presenter
1	Introduction	Javier Perez
2	Single-Family Heat Pump Baselines	Bach Tsan
3	Multifamily Heat Pump Baselines	Danny Tam
4	Nonresidential Heat Pump Baselines	Bach Tsan
5	Solar Photovoltaic and Energy Storage	Muhammad Saeed
6	Adjourn	

July 27th Workshop Recording

To watch the recording of the July 27th, 2023, heat pump baseline and PV and energy storage systems workshop, visit: https://www.energy.ca.gov/event/workshop/2023-07/staff-workshop-2025-energy-code-heat-pump-baselines-and-solar-photovoltaic

2025 Energy Code – Pre-Rulemaking

Energy Code Authority, Drivers and Themes, Metrics, and Timeline

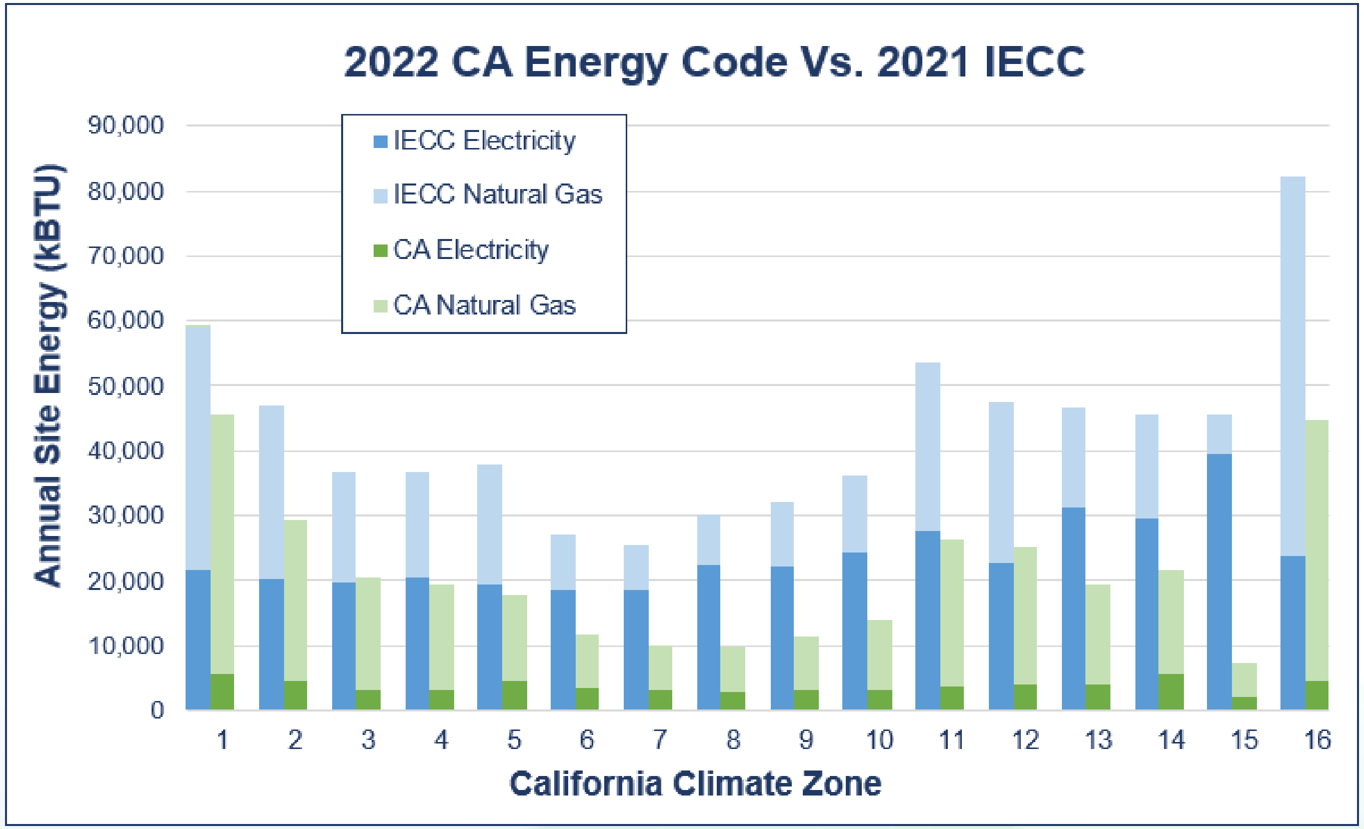
Javier Perez, Project Manager – 2025 Energy Code

August 24, 2023

California Energy Commission's Authority and Process

California's Warren Alquist Act Signed into law in 1974

- Reduction of wasteful, uneconomic, inefficient, or unnecessary consumption of energy as it relates to buildings
- Residential Chart Details:
  - Blue bars: Site energy of a single-family building built to 2021 International Energy Conservation Code (IECC)
  - Green bars: Site energy of a single-family building built to 2022 California Energy Code
- For more on how the 2022 Energy Code compares to federal standards, see our 2022 Impact Analysis at: https://www.energy.ca.gov/publications/2023/impact-analysis-2022-update-california-energy-code



2025 Energy Code Drivers and Themes

State Goals

- Increase building energy efficiency cost-effectively
- Contribute to the state's GHG reduction goals

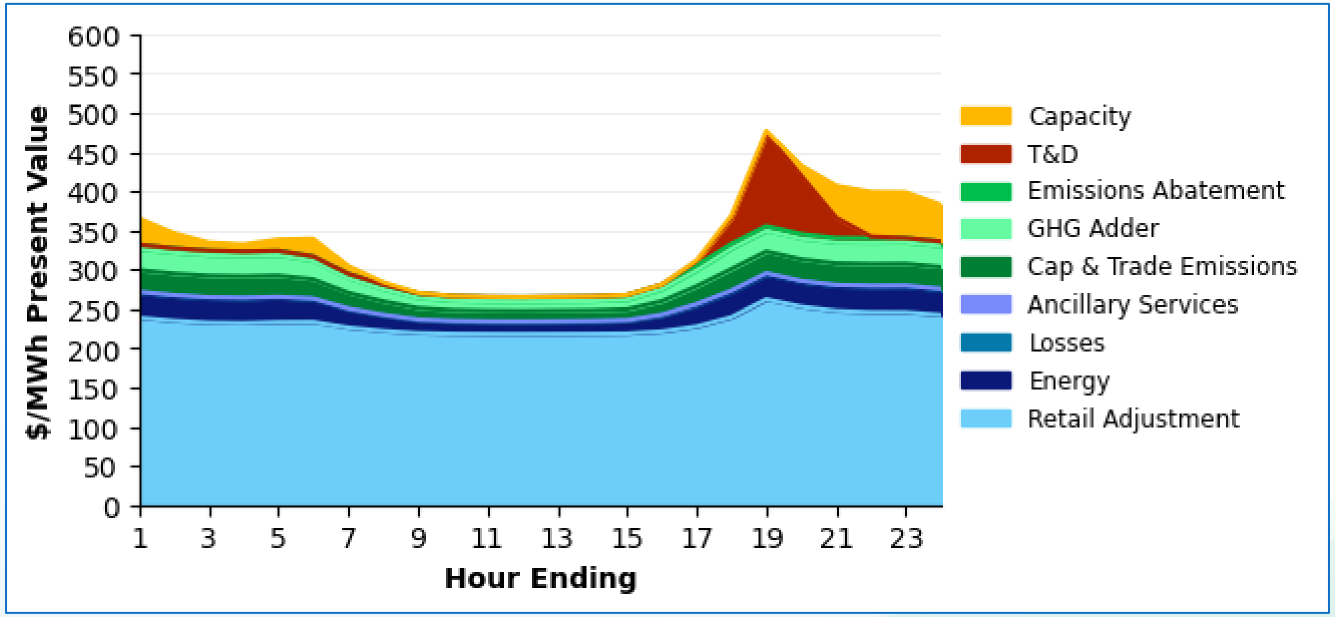
2025 Energy Code Strategies

- Heat pump baselines
- Promote demand flexibility, Solar PV generation and energy storage
- Covered process loads
- Equity & affordable new housing program integration
- Additions, alterations, and smaller homes (e.g., ADUs)
- Electric vehicle readiness support
- Interagency coordination

Long-Term System Cost

Long-term System Cost (LSC) Hourly factors are used to convert predicted site energy use to long-term dollar costs to CA's energy system.

Since the *time* that energy is used is as important as the *amount* of energy used, these factors are generated on an hourly basis for a representative year and created for each of CA's diverse climate zones.



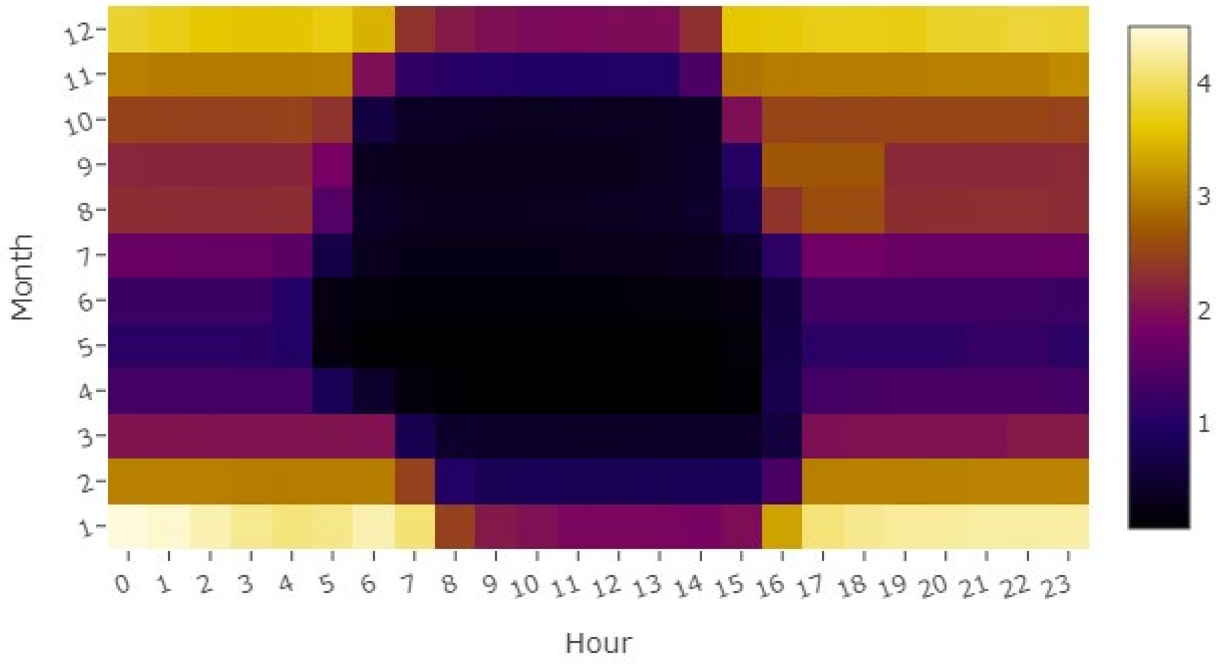
Sample LSC shape by component, average day, levelized 30-year residential, climate zone 12

Source Energy Metric

Long run marginal source energy is defined as the source energy of fossil fuels following the long-term effects of any associated changes in resource procurement.

Source Energy focuses specifically on the amount of fossil fuels that are combusted in association with demand-side energy consumption and assists in aligning our standards with the CA's environmental goals.

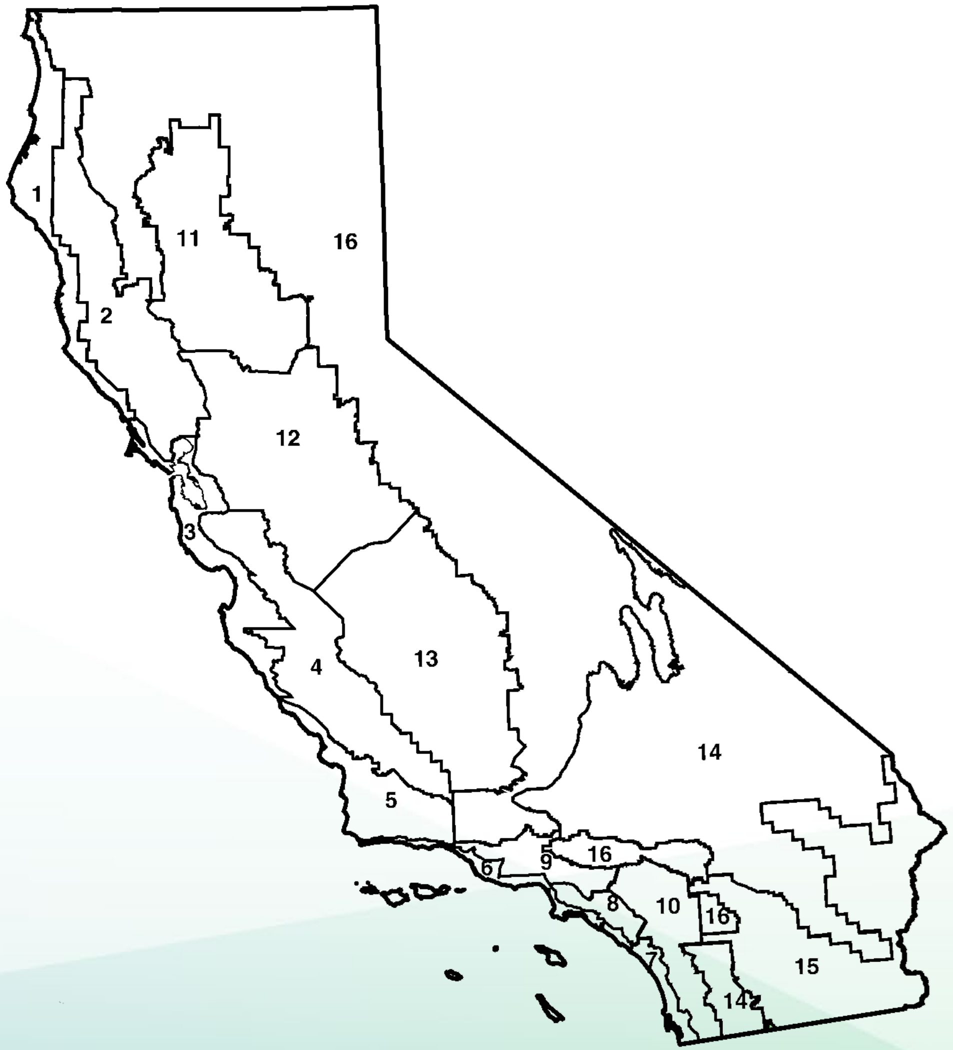
5-Month Average of electricity long run marginal source energy for 2025 Energy Code



California Climate Zones

California has 16 climate zones

- Climate Zones allow software to more accurately simulate variances weather, and as a result, energy consumption of buildings
- A measure's cost effectiveness can vary as a result of weather differences
- Energy Code requirements vary by climate zone as a result



More on 2025 Energy Accounting Metrics

For more on the 2025 Energy Code metrics:

- July 18th, 2022, workshop page, including slides and recording
  - https://www.energy.ca.gov/event/workshop/2022-07/staff-workshop-energy-accounting-2025-building-energy-efficiency-standards
- November 10th, 2022, workshop page, including slides and recording
  - https://www.energy.ca.gov/event/workshop/2022-11/final-staff-workshop-energy-accounting-2025-building-energy-efficiency

2025 Energy Code Work To Date

Milestones	Timelines
Codes & Standards Enhancement (CASE) Team Requested & Received 2025 Measure Proposal Ideas	June 2021 – May 2022
CEC Updated Weather Data, LSC, and Source Energy Metrics	March - November 2022
CASE Team Held Welcome Webinars on 2025 Measures & Work To Come	October 2022
CASE Team Held Stakeholder Workshops on 2025 Proposals	January – May 2023
Energy Commission Worked Feverishly on 2025 Heat Pump and PV System Measures	November 2022 - Now
CASE Team Published Draft Measure Proposal Reports* + Comment Period	May – July 2023

*To view CASE team draft measure proposal reports, and upcoming final reports, visit https://title24stakeholders.com/2025-cycle-case-reports/

2025 Energy Code Work To Come

Milestones	Timelines
CASE Team Publishes Final Measure Proposal Reports	July – August 2023
CEC 2025 Prerulemaking Workshops	July – August 2023
CEC Publishes 2025 Energy Code Draft Updates (Draft Express Terms)	October 2023
CEC Rulemaking for 2025 Energy Code	January 2023 – June 2024
2025 Energy Code Business Meeting Adoption	June 2024
Building Standards Commission Approval of 2025 Energy Code	December 2024
2025 Energy Code Effective Date	January 2026

2025 Energy Code Senior Staff Contacts

- **Javier Perez** – Project Manager
- **Payam Bozorgchami** – Technical Lead, Envelope, Additions and Alterations, ADUs
- **Haile Bucaneg** – Covered Process, Demand Response, Nonresidential and Residential ACM
- **Muhammad Saeed** – Solar Photovoltaic and Energy Storage Systems
- **Bach Tsan** – HVAC Systems, Refrigeration
- **Email Convention at the Energy Commission:** firstname.lastname@energy.ca.gov

2025 Energy Code – Pre-Rulemaking

Single Family Heat Pump Baselines – Workshop 2

Bach Tsan P.E., Senior Mechanical Engineer, Building Standards Branch

August 24, 2023

Agenda

- Recap of 2025 Single Family HP Baseline Proposals – Part 6
- 2025 Proposal Updates
  - Part 11 - Voluntary
    - Single Family Alterations Cost Analysis Update

2025 Proposed Single Family Newly Constructed Buildings Baseline - Recap

Part 6 – CA Energy Code

- **BOLD** indicates change from 2022 prescriptive requirements
- HPSH and HPWH in all climate zones except for climate zone 15
- Current analysis shows HPSH cost-effectiveness challenges in climate zone 15

Climate Zone	HVAC System	Domestic Hot Water System
1	**HPSH**	HPWH
2	**HPSH**	HPWH
3	HPSH	**HPWH**
4	HPSH	**HPWH**
5	**HPSH**	HPWH
6	**HPSH**	HPWH
7	**HPSH**	HPWH
8	**HPSH**	HPWH
9	**HPSH**	HPWH
10	**HPSH**	HPWH
11	**HPSH**	HPWH
12	**HPSH**	HPWH
13	HPSH	**HPWH**
14	HPSH	**HPWH**
15	**TBD**	HPWH
16	**HPSH**	HPWH

Single Family Alterations – Cost Analysis

Part 11 - Voluntary

Cost Variability

- Incentive availability – contractors entering the HP market and taking advantage of incentives with higher prices
- Contractor Service/Experience
- Electrical Cost Considerations
  - Run 220V electrical to air handler (HP AHUs need 220V, even without strip heat)

AC Replacement Scenario

Part 11 - Voluntary

- Scenario: AC fails
- Base case:
  - Install air conditioner outdoor unit and indoor coil. Leave existing furnace/air handler.
  - Meet prescriptive requirements for duct sealing (10%), refrigerant charge & 300 cfm/ton airflow (CZs 2, 8-15)
- Proposed
  - New heat pump outdoor unit and indoor coil. Leave existing furnace/air handler.
  - Add controls to operate furnace as backup heat.
  - Meet prescriptive requirements for duct sealing (10%), refrigerant charge & 300 cfm/ton airflow (all CZs per 2025 proposal)

HP vs. AC Replacement Costs

Part 11 - Voluntary

- 2 contractors provided system costs
  - Other surveyed contractors do not install HPs aside existing furnaces.
- Incremental first costs ranged from $1,800 to $2,600 for a 3-ton HP vs. AC
- System lifetimes based on DEER.
  - 15 years for HP
  - 15 years for AC
- No change to costs assumed at time of replacement.

Average Incremental First Cost

Measure	3-Ton	4-Ton
Air Conditioner	$9,829	$11,293
Heat Pump	$12,041	$13,101
Incremental Cost	**$2,213**	**$1,809**

Total Lifetime Costs

Measure	Year Replaced	Replacement Cost (2023 PV$) 3-Ton	Replacement Cost (2023 PV$) 4-Ton
Air Conditioner	15	$6,309	$7,248
Heat Pump	15	$7,729	$8,409
	Incremental Cost (Replacement Only)	**$1,420**	**$1,161**
	Incremental Cost (30-year)	**$3,633**	**$2,969**

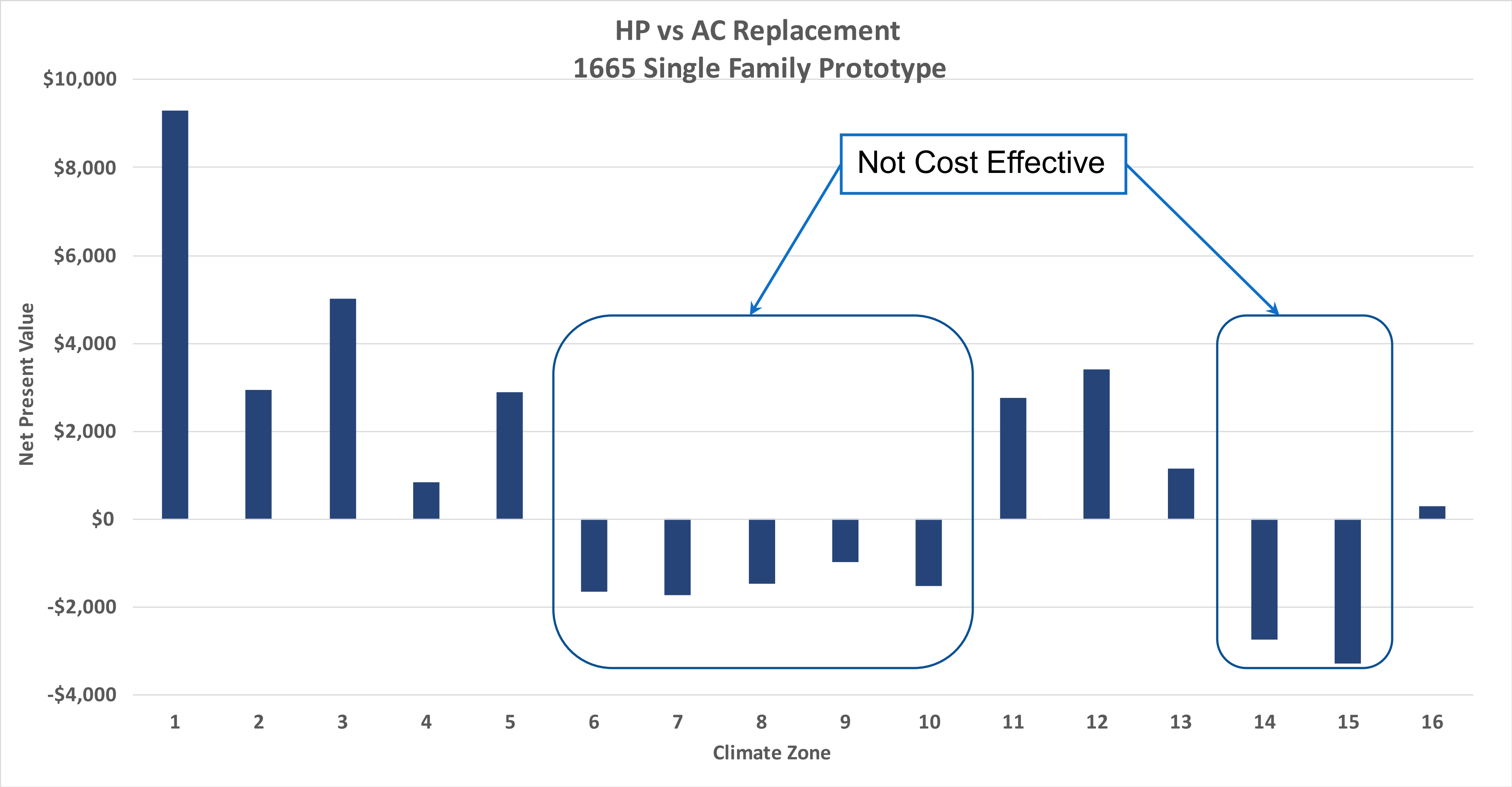
Cost-Effectiveness - Update

AC Only Replacement

Part 11 - Voluntary

- Based on 3-ton costs (worst case)

Climate Zone	LSC Savings	Incremental Cost	Benefit-to-Cost Ratio
CZ01	$12,937	$3,633	3.6
CZ02	$6,577	$3,633	1.8
CZ03	$8,658	$3,633	2.4
CZ04	$4,479	$3,633	1.2
CZ05	$6,510	$3,633	1.8
CZ06	$1,965	$3,633	(0.5)
CZ07	$1,898	$3,633	(0.5)
CZ08	$2,148	$3,633	(0.6)
CZ09	$2,647	$3,633	(0.7)
CZ10	$2,115	$3,633	(0.6)
CZ11	$6,377	$3,633	1.8
CZ12	$7,043	$3,633	1.9
CZ13	$4,779	$3,633	1.3
CZ14	$882	$3,633	(0.2)
CZ15	$333	$3,633	(0.1)
CZ16	$3,929	$3,633	1.1



HP vs. Furnace/AC Replacement Costs

Part 11 - Voluntary

- 5 contractors provided system costs
- Incremental first costs ranged from $600 to $2,800 for a 3-ton HP vs. AC/Furnace
  - Above costs are before adding $600 to the furnace case to meet ultra low NOx standards.
- System lifetimes based on DEER.
  - 15 years for HP
  - Average of 15 years for AC and 20 years for furnace
- No change to costs assumed at time of replacement.

Average Incremental First Cost

Measure	3-Ton	4-Ton
Air Conditioner	$15,555	$17,041
Heat Pump	$16,571	$18,207
Incremental Cost	**$1,016**	**$1,167**

Total Lifetime Costs

Measure	Year Replaced	Replacement Cost (2023 PV$) 3-Ton	Replacement Cost (2023 PV$) 4-Ton
Air Conditioner	17.5	$7,442	$8,153
Heat Pump	15	$10,636	$11,687
	Incremental Cost (Replacement Only)	**$3,195**	**$3,534**
	Incremental Cost (30-year)	**$4,211**	**$4,701**

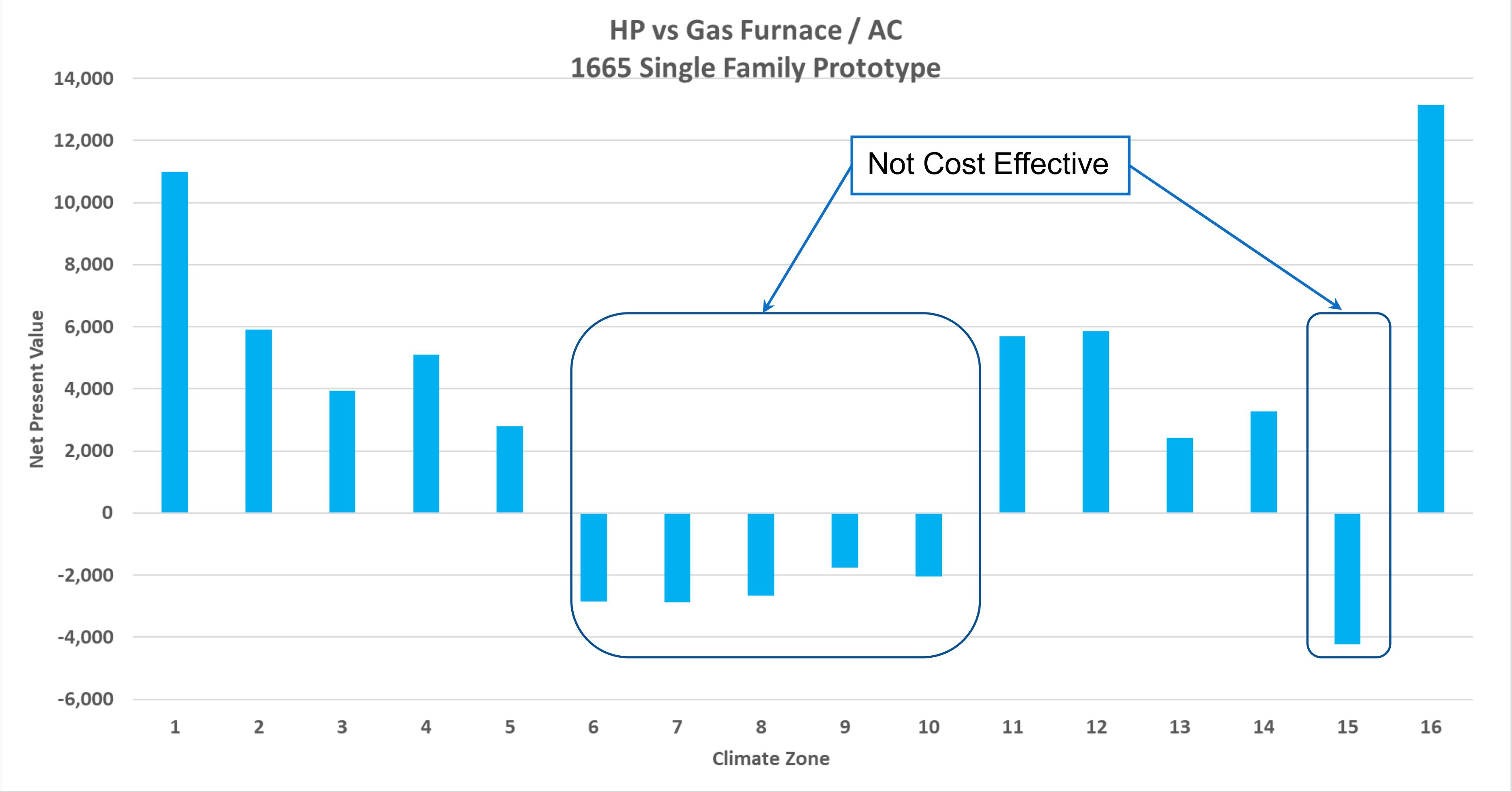
Cost-Effectiveness

Furnace + AC Replacement

Part 11 - Voluntary

- Based on 4-ton costs (worst case)

Climate Zone	LSC Savings	Incremental Cost	Benefit-to-Cost Ratio
CZ01	$15,684	$4,701	3.3
CZ02	$10,606	$4,701	2.3
CZ03	$8,641	$4,701	1.8
CZ04	$9,790	$4,701	2.1
CZ05	$7,493	$4,701	1.6
CZ06	$1,848	$4,701	(0.4)
CZ07	$1,832	$4,701	(0.4)
CZ08	$2,031	$4,701	(0.4)
CZ09	$2,947	$4,701	(0.6)
CZ10	$2,664	$4,701	(0.6)
CZ11	$10,390	$4,701	2.2
CZ12	$10,556	$4,701	2.2
CZ13	$7,126	$4,701	1.5
CZ14	$7,975	$4,701	1.7
CZ15	$466	$4,701	(0.1)
CZ16	$17,849	$4,701	3.8



Comparison to Costs from the July Workshop

Part 11 - Voluntary

- Heat pumps versus furnace/AC replacement scenario
  - AC replacement only not presented in July workshop
- July workshop costs from 2021 reach code report 2019 Cost-Effectiveness Study: Existing Single Family Residential Building Upgrades.[1]
- Today's costs from 2023 contractor surveys.

Incremental Cost Comparison

Measure	July Workshop	Today
First Cost	-($237)	$1,016
Replacement Cost (2023 PV$)	$1,252	$3,195
30-year Lifetime Incremental Cost	**$1,015**	**$4,211**

1https://localenergycodes.com/download/875/file_path/fieldList/2019%20V2-Residential%20Retrofit%20Cost-eff%20Report-2021-08-27.pdf

Next Steps

- Development of Code Language
  - Edits to Residential Section 150.1(c)6 and (c)8
- Modeling Specifications
  - Residential Modeling Guide / Software Wrap
- Continued docketed comment review
- Analyzing prescriptive options
- Incremental cost analysis on flexible performance approach
- Evaluate Emergency Replacement Scenario

Comments

Comments on today's workshop due

September 7, 2023, by 5:00 PM

Submit comments to CEC Docket 22-BSTD-01

https://efiling.energy.ca.gov/Ecomment/Ecomment.aspx?docketnumber=22-BSTD-01

Contact: Bach.Tsan@energy.ca.gov

Thank You!

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2025 Energy Code – Pre-Rulemaking

Heat Pump Water Heater Baseline For Multifamily Buildings – Workshop 2

Danny Tam, Mechanical Engineer, Building Standards Branch

August 24, 2023

Existing 2022 Code Requirements

- **Section: 170.2(d)– Water-heating systems**

- **Different requirements for system serving individual dwelling unit and central system**
- **Different requirements for gas and electric systems.**
  - For system serving single dwelling, if electric, the system shall be a heat pump water heater (HPWH)
  - If gas, the system shall be an instantaneous water heater
- **Performance baseline follows the prescriptive requirements in Section 170.2(d)**

2025 Proposed Requirements

- **Criteria to address in establishing heat pump baselines**
  - Show LSC savings when compared to buildings built to 2022 Standards
  - Show source energy savings when compared to buildings built to 2022 Standards
  - Prove measures to be cost effective
  - Ensuring options exist to allow for buildings flexibility with mixed fuel systems

2025 Proposed Requirements

Section: 170.2(d)1– Water-heating systems

- **Applicable to systems serving individual units only**
  - No changes to central systems
- **NEW – Applicable to low-rise multifamily buildings only**
- **HPWH prescriptive baseline**
  - Remove gas instantaneous prescriptive option
  - Other system types can comply using performance

2025 Proposed Requirements

- **Update the single dwelling system water heating baseline for performance compliance for low-rise multifamily building**
  - Set the LSC target for water heating as HPWH
  - Maintain the source energy target the same as 2022 Standard Design (HP space heating only)

Key Assumptions

- The HPWH is a federal minimum efficiency generic heat pump water heater (UEF 2.0)
- The instantaneous gas water heater is a federal minimum efficiency instantaneous gas (UEF 0.81)
- NEW – HPWH is located in an outdoor closet

Comments

Comments on today's workshop due

September 7, 2023, by 5:00 PM

Submit comments to CEC Docket 22-BSTD-01

https://efiling.energy.ca.gov/Ecomment/Ecomment.aspx?docketnumber=22-BSTD-01

Contact: danny.tam@energy.ca.gov

Thank You!

15-minute Break

We will resume at 10:35

2025 Energy Code – Pre-Rulemaking

Nonresidential Heat Pump Baselines Workshop 2

Bach Tsan P.E., Senior Mechanical Engineer, Building Standards Branch

August 24, 2023

Agenda

- Recap of 2025 HP Baseline Proposals
- 2025 Proposal Updates
  - Part 6
    - Nonresidential Performance Approach Cost Analysis
    - Nonresidential Heat Pump Requirements for Single Zone Rooftop Air-Conditioning Alterations
    - Medium Office Baseline – Refrigerants
    - Next Steps
  - Part 11 - Voluntary
    - Nonresidential Update

2025 Proposed Nonresidential Baseline Systems

Building Prototype	System Description
Medium Office	Variable Refrigerant Flow with heat recovery Dedicated Outside Air System Heat Recovery Ventilation
Large Office	Air to Water Heat Pump Four Pipe Fan Coil Dedicated Outside Air System Heat Recovery Ventilation with bypass; performs economizer function
Large School	Air to Water Heat Pump Four Pipe Fan Coil Dedicated Outside Air System Heat Recovery Ventilation with bypass; performs economizer function

Nonresidential Performance Approach Incremental Cost Analysis

Medium Office Gas Pathway	CZ1	CZ2	CZ3	CZ4	CZ5	CZ6	CZ7	CZ8
VRF/DOAS Project Total	$1,469,516	$1,516,500	$1,514,364	$1,525,042	$1,501,550	$1,520,771	$1,525,042	$1,534,335
DX Splt HW Coil/AdvDOAS/DCV	$1,544,577	$1,552,131	$1,550,197	$1,559,867	$1,538,592	$1,555,999	$1,559,867	$1,568,355
Mixed Fuel Alternative Incremental Cost	$75,061	$35,631	$35,832	$34,825	$37,041	$35,228	$34,825	$34,019
Mixed Fuel Alt Incremental Cost per SF	$1.40	$0.66	$0.67	$0.65	$0.69	$0.66	$0.65	$0.63
Incremental Cost %	5.1%	2.3%	2.4%	2.3%	2.5%	2.3%	2.3%	2.2%

Medium Office Gas Pathway	CZ9	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16
VRF/DOAS Project Total	$1,532,200	$1,542,878	$1,540,742	$1,516,500	$1,529,314	$1,555,692	$1,559,963	$1,585,591
DX Splt HW Coil/AdvDOAS/DCV	$1,566,421	$1,576,091	$1,574,157	$1,552,131	$1,563,736	$1,587,697	$1,591,565	$1,614,775
Mixed Fuel Alternative Incremental Cost	$34,221	$33,213	$33,415	$35,631	$34,422	$32,005	$31,602	$29,184
Mixed Fuel Alt Incremental Cost per SF	$0.64	$0.62	$0.62	$0.66	$0.64	$0.60	$0.59	$0.54
Incremental Cost %	2.2%	2.2%	2.2%	2.3%	2.3%	2.1%	2.0%	1.8%

Assumptions: (1) DOAS unit cost proportional to Capacity; (2) Larger ductwork from Advanced DOAS adds 15% to ductwork cost; (3) DCV sensors at $300 each installed in all zones, (4) Incremental Cost added for reduced window U-factor in CZ1

Medium Office Baseline – Refrigerants

California Air Resources Board Timeline for 750 GWP limit:

January 1, 2025 - For new AC equipment
January 1, 2026 - For new Variable Refrigerant Flow Systems*

January 1, 2025 : A2Ls have been allowed in the California Building Code

*Aligns with implementation date of the 2025 Energy Code

Heat Pump Requirements for Single Zone Rooftop Air-Conditioning Alterations - Update

2025 Proposed Requirements

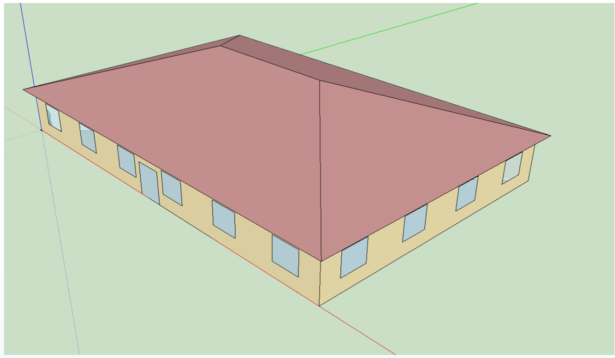
Nonresidential Building Space Conditioning Alterations to rooftop package units below 65,000 Btu/h.

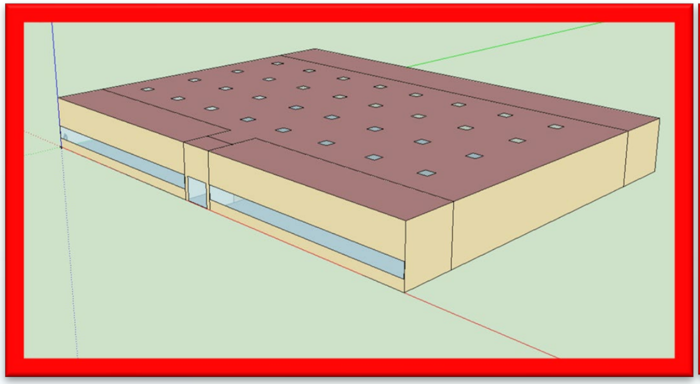
- Prescriptively require gas-fired single zone rooftop unit replacements to be heat pump-based in Alterations

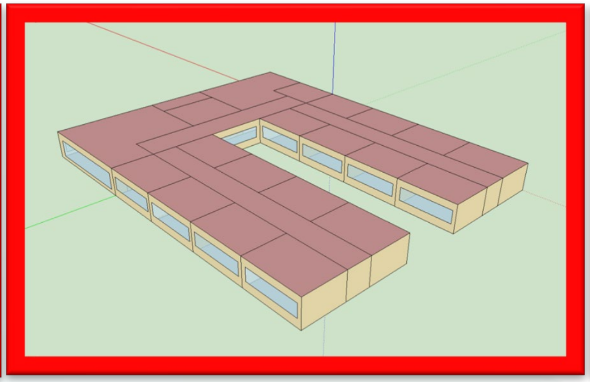
Climate Zone	Medium Retail	Small Office	Small School	Library
1	N/A	HP RTU	HP RTU	HP RTU
2	HP RTU	HP RTU	HP RTU	HP RTU
3	HP RTU	HP RTU	HP RTU	HP RTU
4	HP RTU	HP RTU	HP RTU	HP RTU
5	HP RTU	HP RTU	HP RTU	HP RTU
6	HP RTU	HP RTU	HP RTU	HP RTU
7	HP RTU	HP RTU	HP RTU	HP RTU
8	HP RTU	HP RTU	HP RTU	HP RTU
9	HP RTU	HP RTU	HP RTU	HP RTU
10	HP RTU	HP RTU	HP RTU	HP RTU
11	HP RTU	HP RTU	HP RTU	HP RTU
12	HP RTU	HP RTU	HP RTU	HP RTU
13	HP RTU	HP RTU	HP RTU	HP RTU
14	HP RTU	HP RTU	HP RTU	HP RTU
15	HP RTU	HP RTU	HP RTU	HP RTU
16	N/A	N/A	N/A	N/A

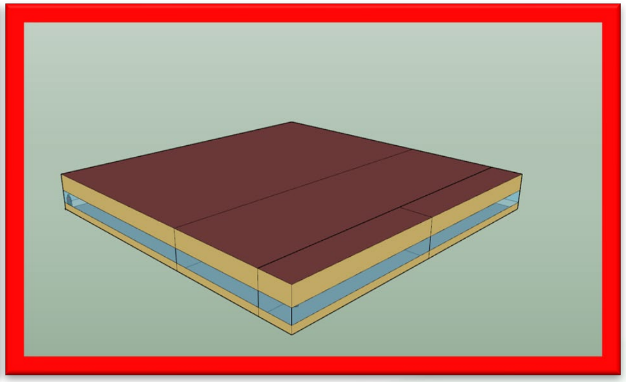
Software Used & Prototypes

- CBECC 2025 & EnergyPlus 9.4
- Medium Retail, Small Schools, Library Prototypes
  - Existing building of vintage year 2000s


Small Office


Medium Retail


Small School


Library

2025 Nonresidential Load Analysis

- Existing prototypes are all commercial buildings that are internal load dominated.
- Small office is the only exception with its small footprint and more envelope exposure.
  - One RTU in the small office shows its heating coil sizing being 120% of its cooling coil size in CZ1. But the increase is small enough to worry about triggering up to the next system size.

Key Assumptions

Prototype	Medium Retail	Small School	Library (Assembly)
Lighting	Existing per T24 2016 Prescriptive Area Category - Retail: 1.2W/SF - Entry: 0.95W/SF - Back Space: 0.6W/SF w/ daylighting control	Existing per T24 2016 Prescriptive Area Category • Cafeteria: 1.0W/SF • Classroom: 1.2W/SF • Lobby: 0.95W/SF • Office: 0.75W/SF • Corridor / Restrooms: 0.6W/SF • Mech/Elec Rooms: 0.55W/SF w/ daylighting control	Existing per T24 2016 Prescriptive Area Category • Lobby: 0.95W/SF • Conference: 1.2W/SF • Library Reading:1.1W/SF • Library Stack:1.5W/SF w/ daylighting control
Envelope	Existing per T24 2005 Table 143-A	Existing per T24 2005 Table 143-A	Existing per T24 2005 Table 143-A
HVAC	New: SZAC RTU Size <**65kBtuh** **HP: SEER 14 HSPF 8.2** • CZ-1-15 electric resistance heater for supplemental heating • CZ-16 furnace for supplemental heating **DX/Gas: SEER 13, Burner Efficiency 81%** Units <65kBtuh & >=54kBtuh have economizer	New: SZAC RTU Size <**65kBtuh** **HP: SEER 14 HSPF 8.2** • CZ-1-15 electric resistance heater for supplemental heating • CZ-16 furnace for supplemental heating **DX/Gas: SEER 13, Burner Efficiency 81%** Units <65kBtuh & >=54kBtuh have economizer	New: SZAC RTU Size <**65kBtuh** **HP: SEER 14 HSPF 8.2** • CZ-1-15 electric resistance heater for supplemental heating • CZ-16 furnace for supplemental heating **DX/Gas: SEER 13, Burner Efficiency 81%** Units <65kBtuh & >=54kBtuh have economizer
Ventilation	CBECC default T24 2022 120.1(c)3	CBECC default T24 2022 120.1(c)3	CBECC default T24 2022 120.1(c)3

Measure Description

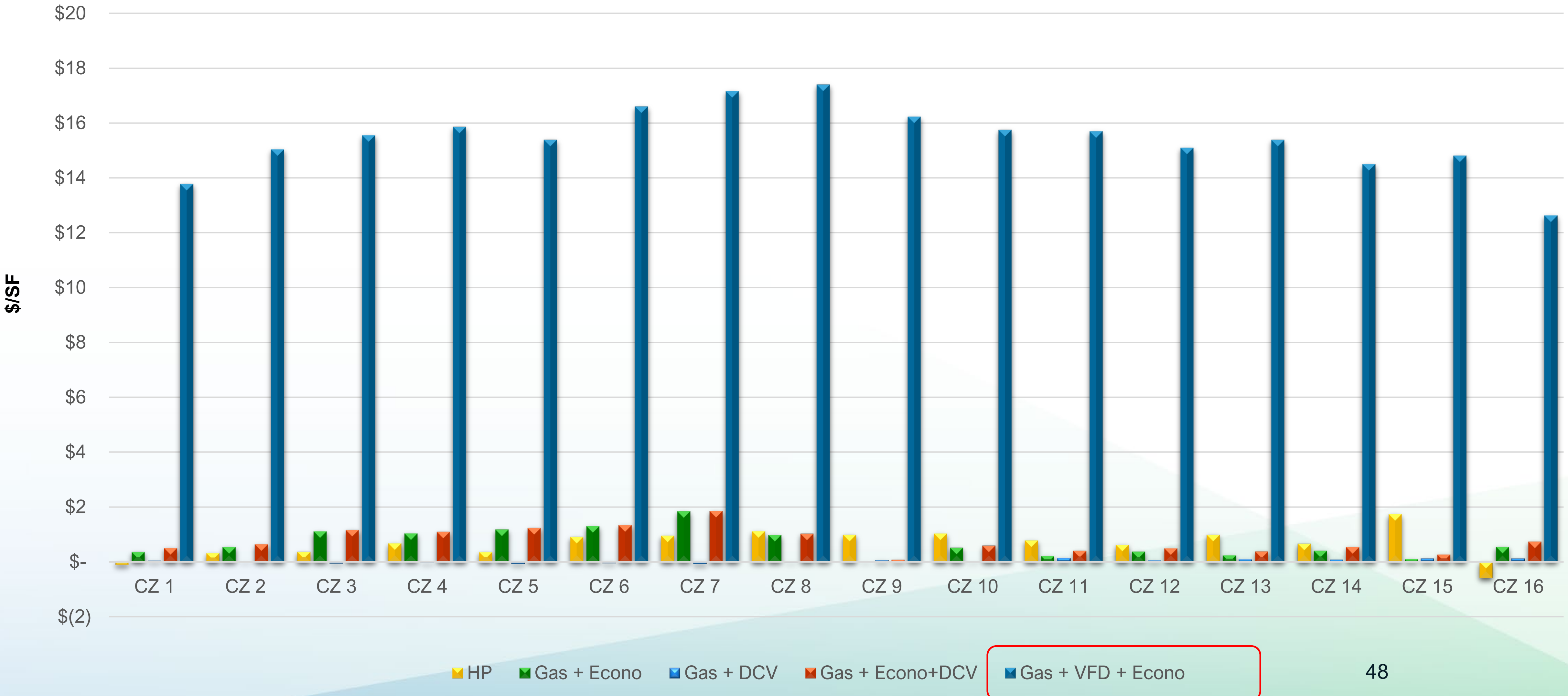
Economizer Ctrl	Differential Drybulb	Differential Drybulb	Differential Drybulb
DCV	T24 2022 120.1(c)3 & 120.1(d)4	T24 2022 120.1(c)3 & 120.1(d)4	T24 2022 120.1(c)3 & 120.1(d)4
Supply Fan variable speed control	Variable volume fan: down to 50% air flow	Variable volume fan: down to 50% air flow	Variable volume fan: down to 50% air flow

Energy Impact – MEDIUM RETAIL

Climate Zone	Annual Electricity Savings (kWh)	Annual Natural Gas Savings (therms)	LSC Energy Savings ($/SF)	Annual Source Energy Savings (kBtu/ft2)
1	(10,793)	1,184	($0.1)	3.2
2	(2,834)	608	$0.3	1.6
3	(2,307)	534	$0.4	1.5
4	(252)	428	$0.7	1.2
5	(1,845)	472	$0.3	1.3
6	3,190	174	$0.9	0.6
7	3,328	118	$1.0	0.5
8	4,323	166	$1.1	0.6
9	3,054	239	$1.0	0.8
10	2,844	271	$1.0	0.9
11	(2,723)	796	$0.8	2.1
12	(1,742)	613	$0.6	1.6
13	1,186	465	$1.0	1.3
14	(2,855)	752	$0.7	1.9
15	7,828	105	$1.7	0.6
16	(16,926)	1,681	($0.6)	4.3

30-Year Long-Term System Cost (LSC) Savings – MEDIUM RETAIL

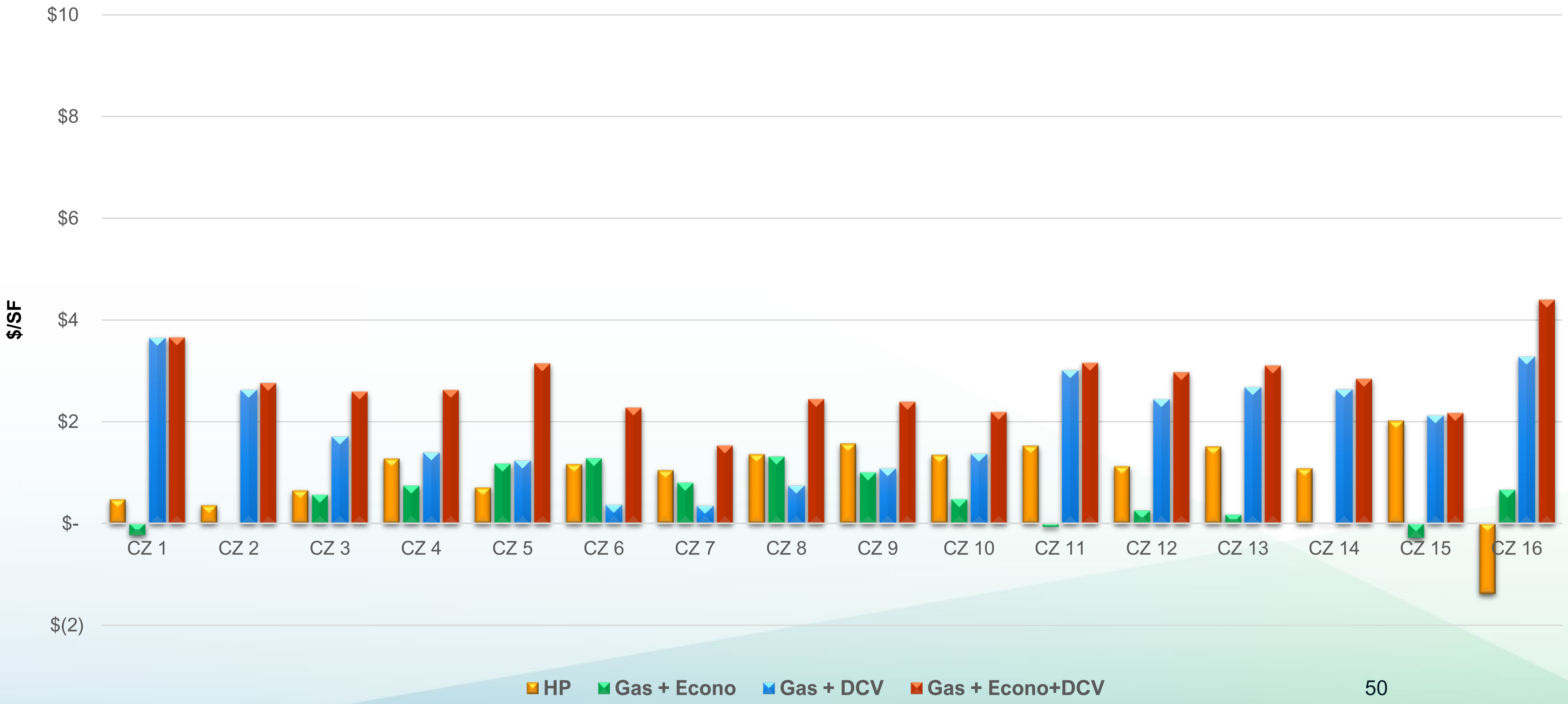
30-Year Long-Term System Cost (LSC) Savings – MEDIUM RETAIL



Energy Impact – SMALL SCHOOL

Climate Zone	Annual Electricity Savings (kWh)	Annual Natural Gas Savings (therms)	LSC Energy Savings ($/SF)	Annual Source Energy Savings (kBtu/ft2)
1	(36,735)	4,335	$0.5	12.7
2	(21,661)	2,723	$0.4	7.5
3	(14,641)	2,128	$0.6	6.1
4	(11,127)	1,790	$1.3	5.1
5	(13,751)	1,942	$0.7	5.5
6	(2,087)	813	$1.2	2.4
7	(1,198)	609	$1.0	1.8
8	(347)	750	$1.4	2.2
9	(1,940)	998	$1.6	2.9
10	(3,872)	1,060	$1.3	3.0
11	(18,342)	2,669	$1.5	7.3
12	(17,689)	2,457	$1.1	6.7
13	(12,348)	2,050	$1.5	5.7
14	(16,382)	2,271	$1.1	5.9
15	6,199	402	$2.0	1.3
16	(50,310)	4,849	($1.4)	13.0

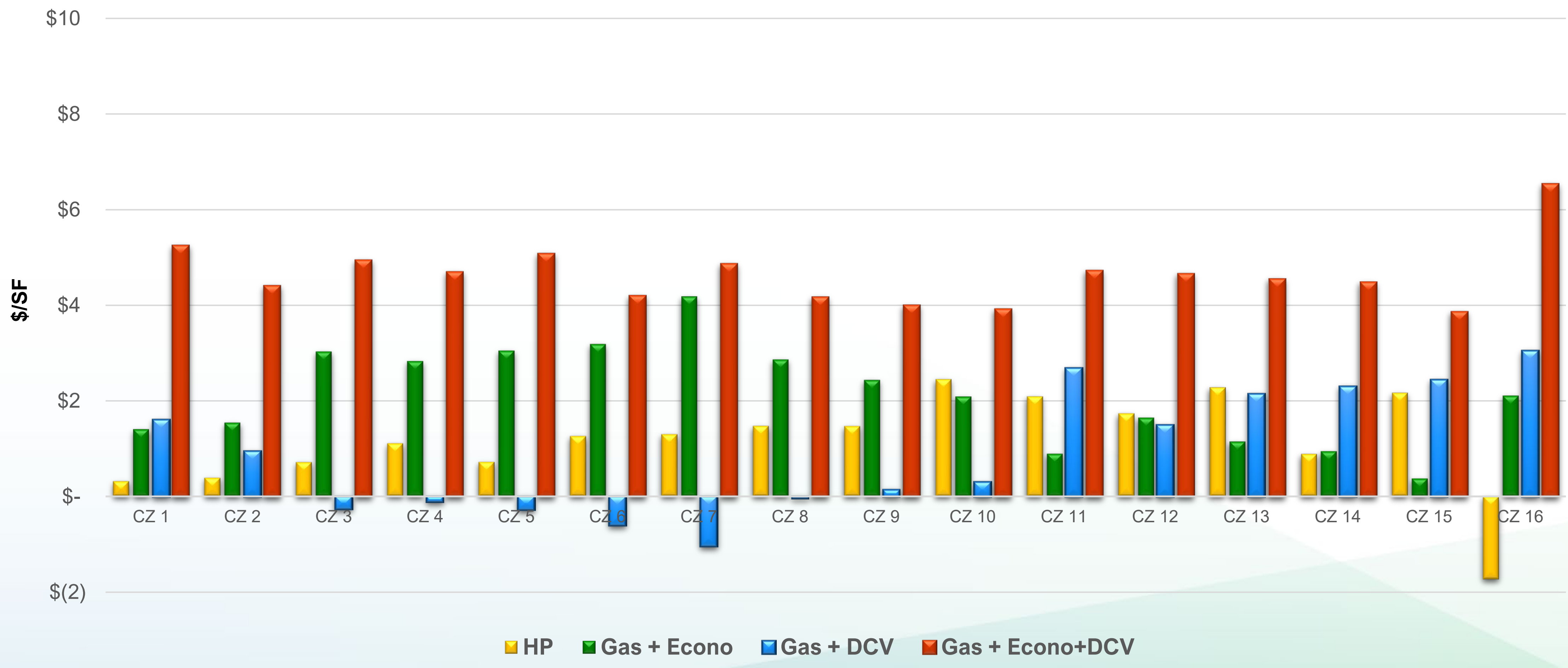
30-Year Long-Term System Cost (LSC) Savings – SMALL SCHOOL



Energy Impact – LIBRARY

Climate Zone	Annual Electricity Savings (kWh)	Annual Natural Gas Savings (therms)	LSC Energy Savings ($/SF)	Annual Source Energy Savings (kBtu/ft2)
1	(9,030)	1,188	$0.3	6.16
2	(5,067)	798	$0.4	3.91
3	(2,374)	569	$0.7	2.96
4	(1,361)	490	$1.1	2.56
5	(2,822)	584	$0.7	2.97
6	1,315	227	$1.3	1.34
7	1,771	156	$1.3	0.99
8	1,920	227	$1.5	1.35
9	1,211	300	$1.5	1.70
10	3,785	293	$2.5	1.83
11	(1,150)	768	$2.1	3.90
12	(1,041)	691	$1.7	3.50
13	1,272	560	$2.3	2.99
14	(3,917)	746	$0.9	3.48
15	4,649	111	$2.2	0.90
16	(16,959)	1,609	($1.7)	7.30

30-Year Long-Term System Cost (LSC) Savings – LIBRARY



LSC Results Discussion

Overview

- Heat Pump shows LSC savings against gas baseline on:
  - Small Office in CZ1-15
  - Medium Retail in CZ2-15
  - Small School in CZ1-15
  - Library in CZ1-15
- Gas pathway with design specified or field installed options are being considered
  - *Economizer for unit sizes <54,000Btuh and/or Demand Controlled Ventilation*
  - *Plus Variable speed fan operation if required*
- Gas pathway can also be considered with building level Performance Path

Cost Effectiveness: Benefit-to-Cost Ratio (BCR)

Measure is cost-effective if BCR > 1

Where incremental cost is < 0 and LSC savings > 0, then BCR = infinite

If LSC savings <0, BCR is N/A

Climate Zone	SMALL OFFICE	MEDIUM RETAIL	SMALL SCHOOL	LIBRARY
1	6.8	N/A	Infinite	Infinite
2	Infinite	Infinite	Infinite	Infinite
3	Infinite	Infinite	Infinite	Infinite
4	Infinite	Infinite	Infinite	Infinite
5	Infinite	Infinite	Infinite	Infinite
6	Infinite	Infinite	Infinite	Infinite
7	Infinite	Infinite	Infinite	Infinite
8	Infinite	Infinite	Infinite	Infinite
9	Infinite	Infinite	Infinite	Infinite
10	Infinite	Infinite	Infinite	Infinite
11	Infinite	Infinite	Infinite	Infinite
12	Infinite	Infinite	Infinite	Infinite
13	Infinite	Infinite	Infinite	Infinite
14	Infinite	Infinite	Infinite	Infinite
15	Infinite	Infinite	Infinite	Infinite
16	N/A	N/A	N/A	N/A

Next Steps for Part 6

Development of Code Language

- Nonresidential
  - New Section 140.4(a)3
    - Office, financial institution, and library ≤ 5 floors that use a central heating system shall use VRF + DOAS or alternatives (TBD)
    - Office, financial institution, and library > 5 floors that use a central heating system shall use AWHP + FPFC + DOAS or alternatives (TBD)
    - Schools that use a central heating system shall use the AWHP + DOAS or alternatives (TBD)
- Modeling Specifications
  - Nonresidential Modeling Guide
- Continued docketed comment review
- Prescriptive options for Medium Office/Large Office/Large Schools
- Continued cost analysis on flexible performance approach
- Evaluate Emergency Replacement Scenarios

2025 CALGreen Title 24 Part 11 Voluntary - Nonresidential

- California Energy Commission evaluated the feasibility of rooftop unit replacement systems greater than 65,000 Btu/h

- Decision to not pursue for this code cycle

- Challenges:
    - Cost Effectiveness
    - Technological Barriers
    - Design Flexibility

Comments

Comments on today's workshop due

September 7, 2023, by 5:00 PM

Submit comments to CEC Docket 22-BSTD-01

https://efiling.energy.ca.gov/Ecomment/Ecomment.aspx?docketnumber=22-BSTD-01

Contact: Bach.Tsan@energy.ca.gov

2025 Energy Code – Pre-Rulemaking

Photovoltaic (PV) and Energy Storage Systems – Workshop 2

Muhammad Saeed, P.E., Senior Electrical Engineer

August 24, 2023

2025 Photovoltaic (PV) and Energy Storage Systems

Topics to be discussed:

- **Modifications to proposals from July 27th workshop**
- **Single-Family and Low-Rise Multifamily Requirements**
  - 2022 Existing PV system size requirements
  - 2025 Single-Family Proposed PV System Size Requirements
  - 2022 Energy Storage Existing JA12 Requirements
  - 2025 Proposed Single and Multifamily Energy Storage JA12 Requirements
- **Nonresidential and High-Rise Residential Requirements**
  - 2022 Existing PV system size requirements
  - 2025 Nonresidential and Multifamily Proposed PV System Size Requirements
  - 2022 Existing Energy Storage system size requirements
  - 2025 Nonresidential and Multifamily Proposed Energy Storage System Size Requirements
- **Other Requirements**
  - Community Solar
  - Energy Storage Ready
  - 10-109(k)
- **Cost Effectiveness**

Modifications From July 27th Workshop

Nonresidential PV System Size Requirements:

- Original strategy was to determine system size by space type, including multipliers that tracked with lighting power categories
  - Found challenges with this strategy
    - Determining uniform requirements across different building types
    - Enforceability concerns
- Proposal will move forward with 2022 Energy Code strategy by building type
  - Build on current 2022 strategy
  - Increase building types covered

Non-VNEM exception for Low-Rise Multifamily:

- Analysis for this ongoing

Questions about Modifications From July 27th Workshop?

Single Family and Low-Rise Multifamily PV Requirements

Single-Family and Low-Rise Multifamily PV System Sizing – Existing Requirements

2022 Energy Code Existing Requirements:

- **Prescriptive Approach:**
  - PV system size based on equation:
    - PV Size = (CFA x **A**)/1000 + (Dwelling units x **B**)
    - Where A and B are multipliers that vary depending on climate zone
- **Performance Approach:**
  - PV system standard design size based on annual load of mixed fuel building as determined by software simulations.
- **PV Size because of Reduced SARA:**

If the solar access roof area is limited, the PV size depends on the maximum PV system that can be installed on the roof's Solar Access Roof Area (SARA).

Single-Family PV System Sizing – 2025 Proposed Requirements

- **Prescriptive Approach:**
  - Equation and multipliers updated
  - Min PV Size = $\frac{CFA}{1000} \times (A - B * F_{EER}) + C$
    - ***C*** = Dwelling unit adjustment factor
      - Where building is not dwelling unit, C = 0
    - $(\boldsymbol{B * F_{EER}})$**:** This represents a reduction in PV system size where EER_2 rating of HVAC system is higher than 7, and up to 11.7
    - $\boldsymbol{F_{EER}}$ = Smaller of (EER_2 – 7), or 4.7
- **Performance Approach:**
  - Standard design determined according to calculation above
- **For Solar Access Roof Area (SARA) Limitations:**
  - Roof pitch < 2:12: Min PV required = SARA x 14 w/ft^2
  - Roof pitch ≥ 2:12: Min PV required = SARA x 18 w/ft^2

CZ	A	B	C
1	0.849	0	1.4603
2	0.7091	0.0001	1.2595
3	0.6583	0	1.1974
4	0.7163	0.0123	1.2106
5	0.6267	0	1.1488
6	0.6054	0.0012	1.1872
7	0.6584	0.0051	1.3072
8	0.779	0.0108	1.3494
9	0.7834	0.0166	1.2689
10	0.9323	0.0321	1.3028
11	1.423	0.0864	1.4276
12	0.812	0.0177	1.3127
13	1.5646	0.107	1.4301
14	1.0602	0.0493	1.1775
15	2.5975	0.2271	1.5697
16	0.6919	0	1.1829

Questions about 2025 Single-Family Proposed PV System Size Requirements?

Single-Family and Low-Rise Multifamily Energy Storage JA12– 2022 Existing Requirements

Safety Requirements:

- UL 1973, UL 9540. UL 1741, UL 1741 Supplement A

Minimum Energy Storage System capacity:

- Usable capacity could not be < 5kWh

Control Requirements for

Control Requirements for Self-Utilization Credit:

- Same requirement for all energy storage types
- Discharge override control reset, twice annually
- Load shifting capacity not clearly defined

Single-Family and Low-Rise Multifamily Energy Storage JA12– 2025 Proposed Requirements

Safety Requirements:

- UL 1973, UL 9540. UL 1741, UL 1741 Supplement B

Minimum Energy Storage System capacity:

- Minimum usable capacity will recognize combinations of units when total capacity is => 5kWh.
  - Intent is to clarify that smaller energy storage units can be used

Control Requirements for Self-Utilization Credit:

- 72 hour reset if cycling capacity is reduced
- Contractor to set cycling capacity in the energy storage that will match the Certificate of compliance form (CF1R)
- Battery could include a sticker/label indicating JA12 capacity on the enclosure
- Load shifting capacity will be derated by x% for calculating self-utilization credit to account for reserve capacity for emergency situations
- An operation manual should include a description of this JA12 control strategy

Questions about 2025 Single-Family and Low-Rise Multifamily Energy Storage JA12– Proposed Requirements?

Non-Residential and High-Rise Multifamily PV System Sizing – Existing Requirements

2022 Energy Code Existing Requirements:

- **Prescriptive Approach:**
  - PV system size based on equation:
    - PV Size = (CFA x **A**)/1000
    - Where A multiplier that vary depending on climate zone
- **Performance Approach:**
  - PV system standard design size based on the equation above.
- **PV Size because of Reduced SARA:**

  If the solar access roof area is limited, the PV size depends on the SARA multiplied by 14w/ft2 value

- **The following building categories require PV + battery:**
  - Grocery
  - High Rise Multifamily
  - Office, Financial Institutions, Unleased Tenant Space
  - Retail
  - School
  - Warehouse
  - Auditorium, Convention Center, Hotel/Motel, Library, Medical Office Building/Clinic, Restaurant, Theater

Non-Residential and High-Rise Multifamily PV System Sizing – Proposed Requirements

2025 Energy Code Proposed Requirements:

- **Prescriptive Approach:**
  - PV system size based on equation:
    - PV Size = (CFA x **A**)/1000
    - Where A is the multiplier that vary depending on climate zone and LSCs
- **Performance Approach:**
  - PV system standard design size based on the equation above.
- **For Solar Access Roof Area (SARA) Limitations:**
  - Roof pitch < 2:12: Min PV required = SARA x 14 w/ft^2
  - Roof pitch ≥ 2:12: Min PV required = SARA x 18 w/ft^2

Non-Residential and High-Rise Multifamily PV System Sizing – Proposed Requirements

The following building categories require PV+ energy storage:

- Exhibits and Events
- Library
- Religious Worship
- Sports & Recreation
- Hotel/Motel
- Laboratory
- Office
- Schools
- Retail
- Warehouse
- Restaurant
- Parking Garage
- High-rise residential

Questions about 2025 Non-Residential and High-Rise Multifamily PV System Sizing – Proposed Requirements?

Non-Residential and High-Rise Multifamily Battery System Sizing – Existing Requirements

2022 Energy Code Existing Requirements:

- **Prescriptive Approach:**
  - Battery system size based on equation:
    - Battery kWh Size = kWhbatt = kWPVdc x B / D0.5
    - kWbatt = kWPVdc x C
- **Performance Approach:**
  - PV system standard design size based on the equation above.

Non-Residential and High-Rise Multifamily Battery System Sizing – Proposed Requirements

2025 Energy Code Proposed Requirements:

- **Prescriptive Approach:**
  - Battery system size based on equation:
    - Battery kWh Size = kWhbatt = kWPVdc x B / D0.5
    - kWbatt = kWPVdc x C
  - B, C, and D to be updated to allow “x % derating”
- **Performance Approach:**
  - PV system standard design size based on the equation above.

Questions about 2025 Non-Residential and High-Rise Multifamily Battery System Sizing – Proposed Requirements?

2025 Energy Storage Ready Requirements

Existing 2022 Standards	2025 Proposed Standards
Energy storage requirements for newly constructed single- family buildings including ADUs	Consider adding new exceptions to the energy storage ready requirement if: • No PV is required for the building. • Multiple exceptions exist to PV requirements • We are analyzing modifications to the 225 A busbar requirement.

Questions about Energy Storage Ready Requirements?

2025 Community Solar Requirements

Existing 2022 Standards	2025 Proposed Standards
Building Opt-out. No provision for opt-outs of individual dwelling units that are owner-occupied in multifamily buildings.	For multifamily buildings, an owner of a multifamily dwelling unit can opt-out from a community solar program without requiring the whole building to opt-out (e.g., condominium in multifamily complex).
Location. located on a distribution system of the load serving entity. providing service to the participating buildings.	Clarify that a distribution system will be defined as having the interconnection voltage≤ 100 kV.
Executive Director Approval of Revised Applications: No public comment period is mentioned.	**Executive Director Approval of Revised Applications:** Clarify that a public comment period will be required.

Questions about Community Solar?

2025 Determinations (10-109(k))

10-109(k): Allows CEC to determine that PV system requirements do not apply where cost effectiveness thresholds where public agency rules cause cost effectiveness analysis to not hold for that project.

Existing 2022 Standards	Proposed Standards
• New application requires CEC business meeting for approval • Revised applications that were previously approved require CEC business meeting for approval	• Revised applications will only require Executive Director approval, following similar strategy for community solar revised applications.

2022 PV Requirements Cost Effectiveness Update - All Buildings

	2019/2022 Cost Effectiveness Assumptions	2025 Cost Effectiveness Assumptions
Accounting Method	2019, 2022 TDVs	2025 LSCs
Export Compensation	NEM2.0 (Retail – NSCs)	Net Billing Tariff (aka NEM3.0) Avoided Cost determined based on LSCs
Income Tax Credit	0% (2019) 10% (2022)	30% Info on direct pay: https://www.whitehouse.gov/cleanenergy/directpay/#local
Costs Data Source	2016 NREL Data	2022 NREL Data

Questions about Cost-Effectiveness Assumptions?

Comments

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September 7, 2023, by 5:00 PM

Submit comments to CEC Docket 22-BSTD-01

https://efiling.energy.ca.gov/Ecomment/Ecomment.aspx?docketnumber=22-BSTD-01

Contact: Muhammad.Saeed@energy.ca.gov

Comments

- **Comments on Todays Workshop**
- **Due Date: September 7, 2023, by 5:00 PM**

- **Comments to be submitted to:**
  https://efiling.energy.ca.gov/Ecomment/Ecomment.aspx?docketnumber=22-BSTD-01

- Thank you for participating!

Next Workshops

Upcoming 2025 Energy Code Pre-Rulemaking Workshops:

- Tuesday, August 29, from 9am to 3pm, topics covered will include:
  - Field Verification & Diagnostic Testing
  - Nonresidential HVAC Efficiency
- Wednesday, August 30, from 9am to 3pm, topics covered will include:
  - Commercial Kitchens
  - Laboratories
  - Nonresidential Envelope
  - Lighting Requirements

Thank you for participating in today’s workshop!