TITLE 24, PART 6 | 2025 CODE CYCLE

ASHRAE Guideline 36

Codes and Standards Enhancement (CASE) Proposal
Nonresidential | HVAC Controls

Rupam Singla, Gwelen Paliaga, Srushti Koli, Eric Martin, Cathy Chappell, *TRC*;

Hwakong Cheng, Taylor Engineers;

Brent Eubanks, *Eubanks Engineering Research*

February 27, 2023

CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

Agenda

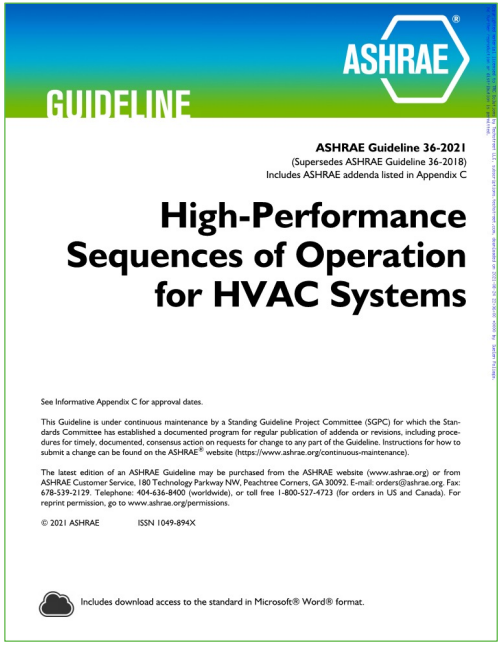
- Background
- Market Overview and Analysis
- Technical Feasibility
- Cost and Energy Methodology
- Compliance and Enforcement
- Proposed Code Changes
- Discussion & Next Steps

Background

- Code Change Proposal
- 2022 Code Requirements
- Context and History

ASHRAE Guideline 36

- **Based on industry best practices**
  - Provides high performance sequences of operation for heating, ventilation, and air conditioning (HVAC) systems
  - American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standing committee with broad representation
  - Consensus process
  - Multiple rounds of public review
- **First published in 2018**; undergoes continuous improvement
- **Recently released 2021 version**



Poll Request

- **Measure Name:** ASHRAE Guideline 36
- **Type of Poll:** Multiple choice (multiple answer)
- **Question:** Please choose the option that best fits your role in the industry.
- **Answers:** Building owner, Building operator, Designer, Controls contractor, Commissioning agent, Manufacturer, Building official (plan checker, inspector, etc.), Other
- **Placement:** After slide ASHRAE Guideline 36 (slide 5)
- **Broadcast results to attendees as they respond: Y**
- **Make poll public during presentation:** Y

Poll Request

- **Measure Name:** ASHRAE Guideline 36
- **Type of Poll:** Multiple choice (multiple answer). Please add 'segmentation' to this poll, based on the previous poll questions. Instructions on how to add segmentation are here.
- **Question:** Please describe your experience with ASHRAE Guideline 36.
- **Answers:**
  - Aside from this CASE measure, I have not heard of Guideline 36
  - I have heard of Guideline 36, but I do not have any experience with it
  - I have some experience with it
  - I have significant experience with it
  - Other (please specify)
- **Placement:** After slide ASHRAE Guideline 36 (slide 5)
- **Broadcast results to attendees as they respond: Y**
- **Make poll public during presentation:** Y

Current Code Requirements

Existing Requirements in Title 24, Part 6

- Key HVAC control measures already required in Title 24 in concept. Guideline 36 provides detail on how to implement them.
  - For example: supply air temperature reset, duct static pressure reset, economizer control, “dual maximum VAV logic”

Existing Model Code Requirements

- Similar requirements in ASHRAE Standard 90.1 and International Energy Conservation Code (IECC)

Proposed Code Change

Prescriptive requirement:

- Existing prescriptive HVAC control requirements would follow Guideline 36
- DDC programming would use control logic from a certified Guideline 36 programming library

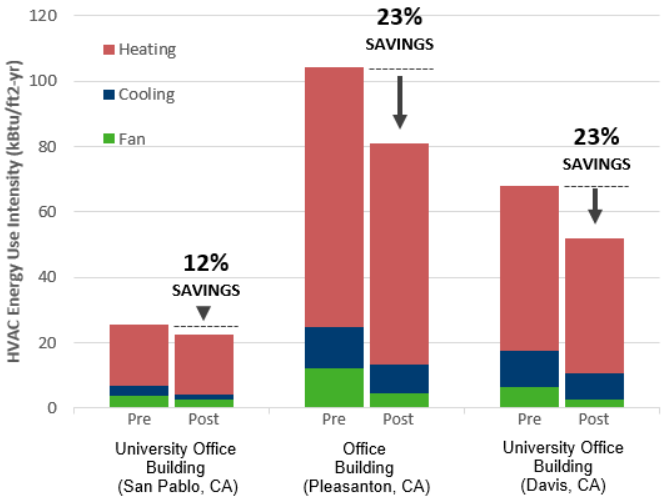
Certified programming library:

- New Joint Appendix would have two paths to certification:
  - Confirm that library contains all elements from a checklist of required logic (does not include testing)
  - Follow a third-party standardized method of test that is approved by the Energy Commission (not yet an available option)
- Companies self-certify that programming library meets all requirements

Draft code language for this measure is available in Handouts.

Context and History

- Control measures in Guideline 36 proven to provide significant and cost-effective HVAC energy savings
  (EPIC Best in Class field demonstrations)
- Measures already required in Title 24 in concept. Guideline 36 provides details of how to implement
- Low compliance rates observed for existing Title 24 requirements in current practice



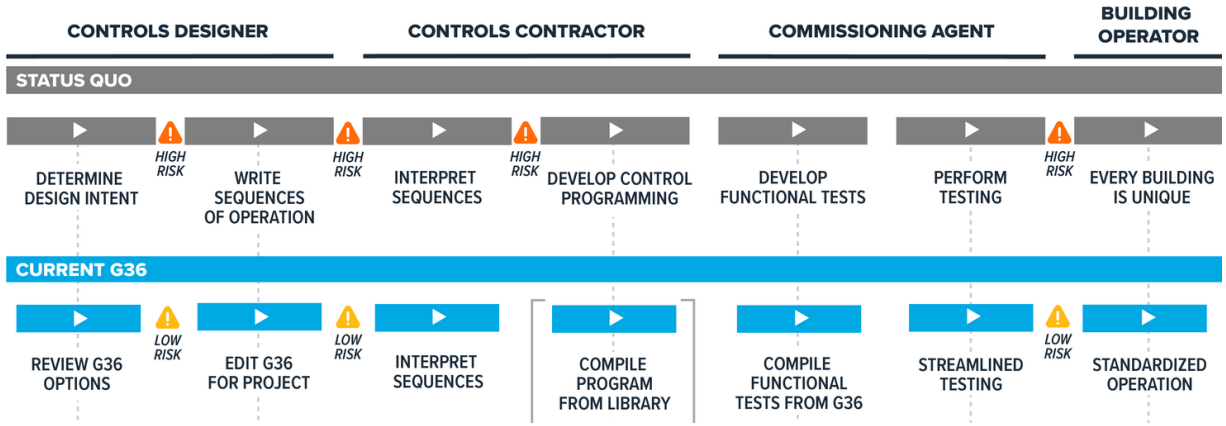
Demonstrating Scalable Operational Efficiency Through Optimized Controls Sequences and Plug-and-Play Solutions. 2022. https://www.energy.ca.gov/publications/2022/demonstrating-scalable-operational-efficiency-through-optimized-controls

Rosenberg et al. 2017. Implementation of Energy Code Controls Requirements in New Commercial Buildings. Pacific Northwest National Laboratory. https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-26348.pdf

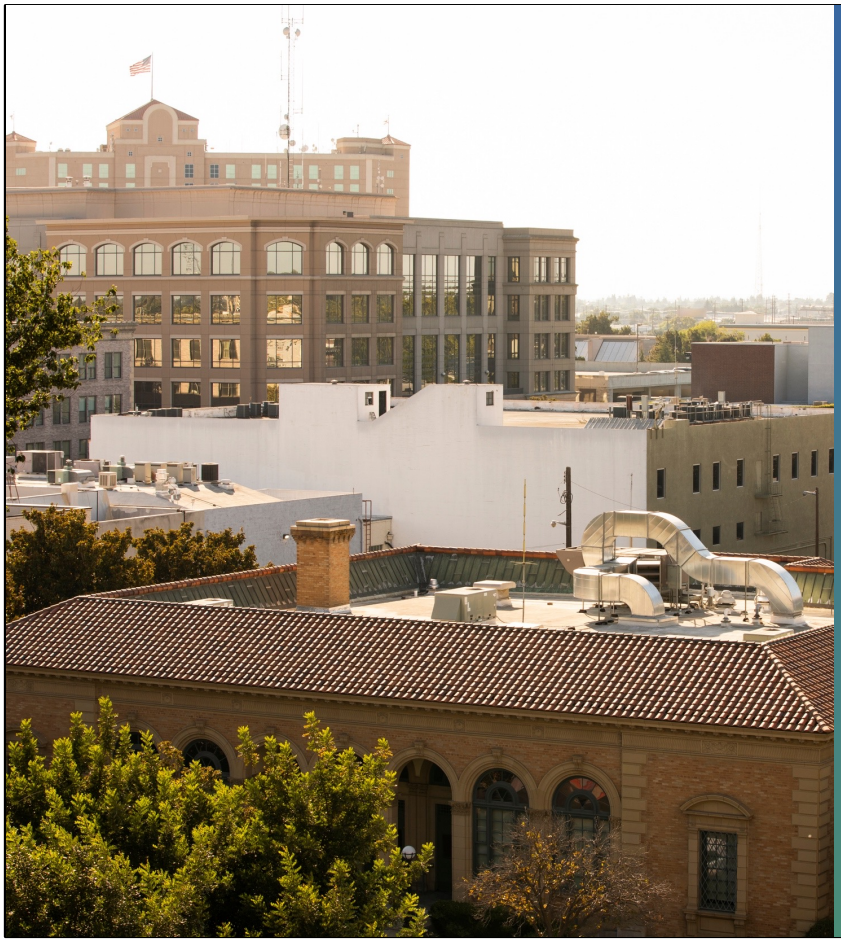
Context and History

Streamlining implementation and compliance through standardization around Guideline 36 and use of certified programming libraries

- **Existing practice:** manual process, high effort and risk-prone steps, vulnerable to low awareness/understanding and lack of attention to detail
- **With Guideline 36 certified programming libraries:** simplifies design and programming, reduces cost, and improves quality



Demonstrating Scalable Operational Efficiency Through Optimized Controls Sequences and Plug-and-Play Solutions. 2022. https://www.energy.ca.gov/publications/2022/demonstrating-scalable-operational-efficiency-through-optimized-controls



Market Overview

- Current Market Conditions
- Market Trends
- Potential Market Barriers and Solutions

Market Overview and Analysis

Market Trends

- Spring 2021 controls contractor survey, 488 responses:
  - 68% have heard of G36
  - Of which, 43% have implemented at least one G36 project
- 8 major BAS manufacturers have G36 libraries released or in development
- G36 industry educational resources
  - Presentations/trainings: ASHRAE Learning Institute, ASHRAE local chapter meetings, PG&E Energy Centers, DOE Better Buildings Council, and many other workforce trainings by BAS manufacturers and other organizations
  - Industry articles: ASHRAE Journal, Facility Executive, CIBSE Journal, and LinkedIn

Market Overview and Analysis

Market Barriers & Solutions

- Value proposition across market actors is not clear
  - Solutions underway: Recent field demonstrations and simulation studies show clear energy and cost savings
- Lack of awareness among designers and contractors
  - Solutions underway: ASHRAE, other industry organizations, some BAS manufacturers, and research projects are spreading awareness

Do you agree with this description? What else should we know?

Technical Considerations

- Technical Considerations
- Potential Barriers and Solutions

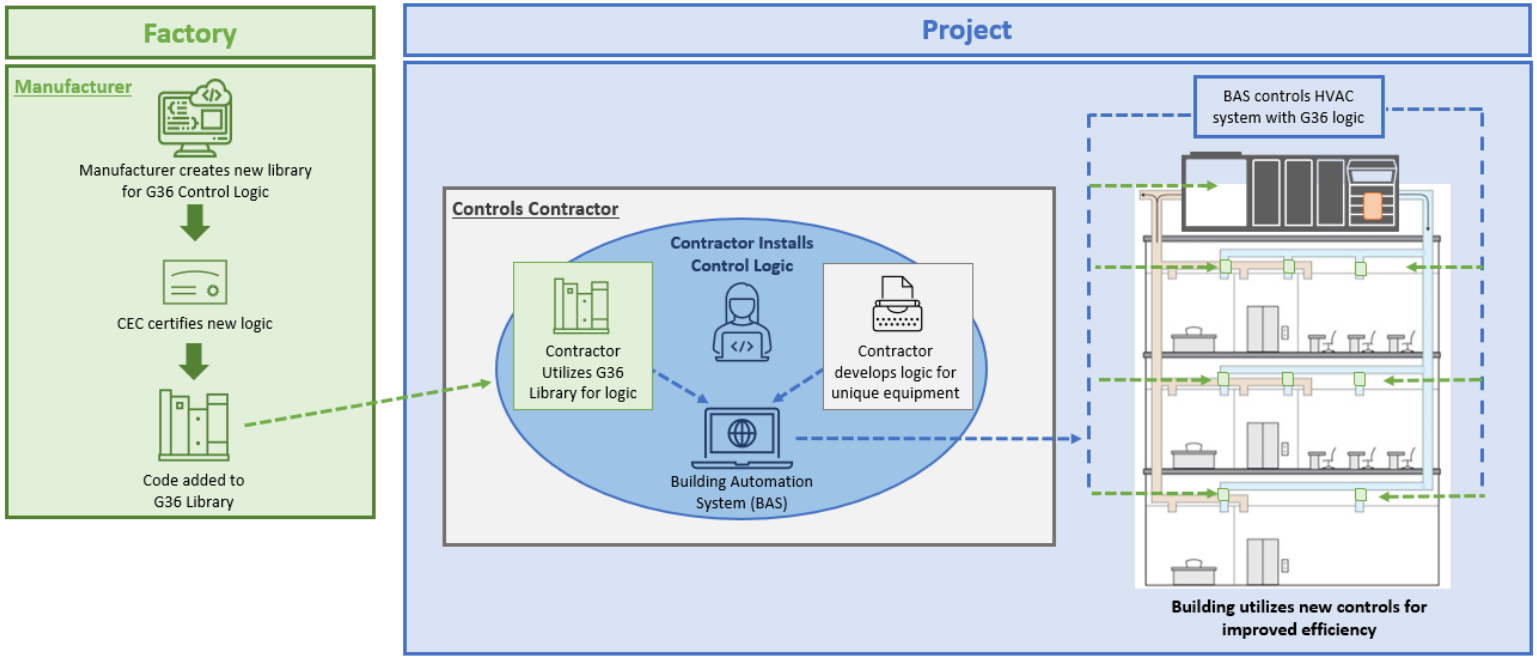
Technical Considerations

In current practice: Designers and controls contractors tend to start new jobs with in-house standards or from work on previous jobs

With the proposed code change:

- Designers specify G36 where applicable.
- Controls contractors start programming with certified manufacturer G36 libraries.
- Improved compliance with energy efficiency requirements

Technical Considerations



Technical Considerations

Technical Barriers

- Complexity, unfamiliarity

Existing and In Progress Solutions

- Trainings/classes by ASHRAE, other continuing education, and manufacturers
- Advanced Building Automation Systems Best Practices Guide
- Software tool to help designers
- Manufacturer libraries

Advanced Building Automation Systems Best Practices Guide, June 2022. https://tayloreng.egnyte.com/dl/phXTDfFQb8/2022-06-13_BAS_Best_Practices_Guide_v1.0.pdf

Poll Request

- Measure Name: ASHRAE Guideline 36
- Type of Poll: Free response
- Question: Do you think standardization would improve compliance with current controls requirements in the code and why?
- Placement: After last Technical Considerations slide
- Broadcast results to attendees as they respond: Y
- Make poll public during presentation: Y

Poll Request

- Measure Name: ASHRAE Guideline 36
- Type of Poll: Free response
- Question: For controls contractors: If you do not currently use manufacturer libraries, what changes would be needed for this process flow to work?
- Placement: After last Technical Considerations slide
- Broadcast results to attendees as they respond: Y
- Make poll public during presentation: Y

Poll Request

- Measure Name: ASHRAE Guideline 36
- Type of Poll: Free response
- Question: Are there barriers to using G36 that we haven't described?
- Placement: After last Technical Considerations slide
- Broadcast results to attendees as they respond: Y
- Make poll public during presentation: Y

Poll Request

- Measure Name: ASHRAE Guideline 36
- Type of Poll: Free response
- Question: Is there anything else you would like us to know about the market?
- Placement: After last Technical Considerations slide
- Broadcast results to attendees as they respond: Y
- Make poll public during presentation: Y

Energy and Cost Impacts Per Sq ft

Methodology and Assumptions

- Energy Savings Methodology and Results
- Cost Impacts Methodology and Results
  - Incremental costs
  - Energy cost savings

Methodology for Energy Impacts Analysis

Per-sq ft energy and demand impacts:

- Base case based on current practice, determined through literature review and input from SMEs
- 2022 prototypes: Buildings with PVAV or VAVS systems: OfficeLarge and OfficeMedium

Energy analysis: CBECC-2025

Climate zones modeled: All climate zones

Assumptions for Standard and Proposed Designs

	Base Case: Current Practice	Proposed Design: ASHRAE G36
Terminal unit logic	Single max VAV logic; Zone min airflow = 30%	Zone min airflow = ventilation; Separate heating max airflow setpoint
Duct static pressure reset	“Good” DSP reset fan curve; Min fan speed 0.3	“Perfect” DSP reset fan curve; Min fan speed 0.1
Supply air temperature reset	Reset based on load with a narrower range to mimic less effective reset	Reset based on load
Zone groups	1 floor has one hour longer schedule than remaining floors. HVAC system runs to serve whole building on extended schedule.	1 floor has one hour longer schedule than remaining floors. HVAC system only serves active floor.

Zone groups: Schedules are the default Office Occupancy schedules from ACM Appendix 5.4B. The base case operation schedules are extended by 1 hour to represent extended occupancy.

If anyone has any data on current practice that supports these assumptions or is different, please tell us.

Poll Request

- **Measure Name:** ASHRAE Guideline 36
- **Type of Poll:** Free response
- **Question:** Do you agree with the assumptions for the base case? Why/why not?
- **Options:** Allow respondents to provide multiple responses
- **Placement:** After slide Assumptions for Standard and Proposed Designs
- **Broadcast results to attendees as they respond: Y**
- **Make poll public during presentation:** Y

Preliminary Energy Savings Estimates Per Sqft – Office Large

Savings represent combination of:

- Dual max VAV logic
- DSP reset
- SAT reset
- Zone Groups

Energy and Energy Cost Impacts - New Construction & Additions							
Climate Zone	First-Year Electricity Savings (kWh)	First-Year Electricity Savings (%)	First-Year Peak Electrical Demand Reduction (W)	First-Year Natural Gas Savings (therms)	First-Year Natural Gas Savings (%)	First-Year Source Energy Savings (kBtu)	30-Year Present Valued Energy Cost Savings (2026 PV$)
CZ01	0.34	5.1%	0.00	0.013	10.0%	0.39	2.82
CZ02	0.65	0.9%	0.01	0.014	15.4%	0.58	4.15
CZ03	0.49	7.1%	0.00	0.014	15.8%	0.47	3.54
CZ04	0.87	1.2%	0.01	0.015	18.8%	0.74	5.49
CZ05	0.59	8.2%	0.01	0.016	19.3%	0.54	4.17
CZ06	0.82	1.1%	0.01	0.012	26.5%	0.67	4.85
CZ07	0.73	9.6%	0.01	0.009	25.7%	0.63	4.42
CZ08	1.03	1.3%	0.01	0.012	28.4%	0.80	5.86
CZ09	0.98	11.8%	0.01	0.011	23.1%	0.77	5.56
CZ10	1.14	1.4%	0.01	0.012	24.5%	0.84	6.35
CZ11	0.99	11.6%	0.01	0.012	15.9%	0.82	5.75
CZ12	0.79	1.1%	0.01	0.013	16.8%	0.68	4.88
CZ13	1.10	12.7%	0.01	0.012	18.7%	0.85	6.41
CZ14	1.11	1.4%	0.01	0.012	18.9%	0.79	6.28
CZ15	1.64	15.6%	0.02	0.011	34.7%	0.98	8.63
CZ16	0.65	0.9%	0.01	0.010	12.6%	0.61	3.95

Preliminary Energy Savings Estimates Per Sqft – Office Medium

Savings represent combination of:

- Dual max VAV logic
- DSP reset
- SAT reset
- Zone Groups

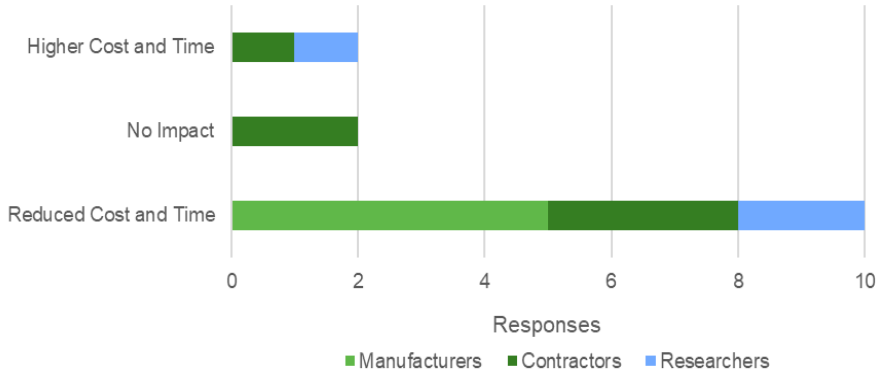
Energy and Energy Cost Impacts - New Construction & Additions							
Climate Zone	First-Year Electricity Savings (kWh)	First-Year Electricity Savings (%)	First-Year Peak Electrical Demand Reduction (W)	First-Year Natural Gas Savings (therms)	First-Year Natural Gas Savings (%)	First-Year Source Energy Savings (kBtu)	30-Year Present Valued Energy Cost Savings (2026 PV$)
CZ01	0.20	2.9%	0.02	0.004	6.2%	0.23	1.35
CZ02	0.26	3.3%	0.02	0.008	15.1%	0.30	1.94
CZ03	0.19	2.6%	0.02	0.006	13.8%	0.21	1.42
CZ04	0.33	3.7%	0.03	0.010	20.9%	0.31	2.52
CZ05	0.22	2.9%	0.02	0.008	19.1%	0.26	1.81
CZ06	0.35	4.1%	0.03	0.006	34.9%	0.33	2.21
CZ07	0.30	3.5%	0.02	0.004	31.2%	0.28	1.69
CZ08	0.39	4.2%	0.03	0.008	39.9%	0.33	2.50
CZ09	0.39	4.2%	0.03	0.008	36.7%	0.31	2.44
CZ10	0.43	4.4%	0.03	0.009	38.3%	0.31	2.62
CZ11	0.31	3.2%	0.02	0.009	16.1%	0.24	1.96
CZ12	0.28	3.2%	0.02	0.007	14.5%	0.30	1.94
CZ13	0.31	3.2%	0.03	0.007	19.0%	0.21	2.01
CZ14	0.48	4.9%	0.04	0.013	25.3%	0.39	3.43
CZ15	0.38	3.0%	0.03	0.012	56.9%	0.19	2.56
CZ16	0.39	4.9%	0.03	0.010	15.3%	0.39	2.74

Incremental Cost Information

The incremental cost impact of implementing G36 recommended controls vs. current code compliant controls was compiled through:

- Interviews with BAS manufacturers and Contractors
- Manufacturer websites and marketing material
- Industry presentations, seminars, and trainings

Findings show G36 libraries will reduce engineering, programming and commissioning time.



- **$0 incremental first costs** for implementing Guideline 36 controls in new buildings
- Standardization → Less training, More streamlined operation → Reduced building operator time → **$0 incremental maintenance costs**

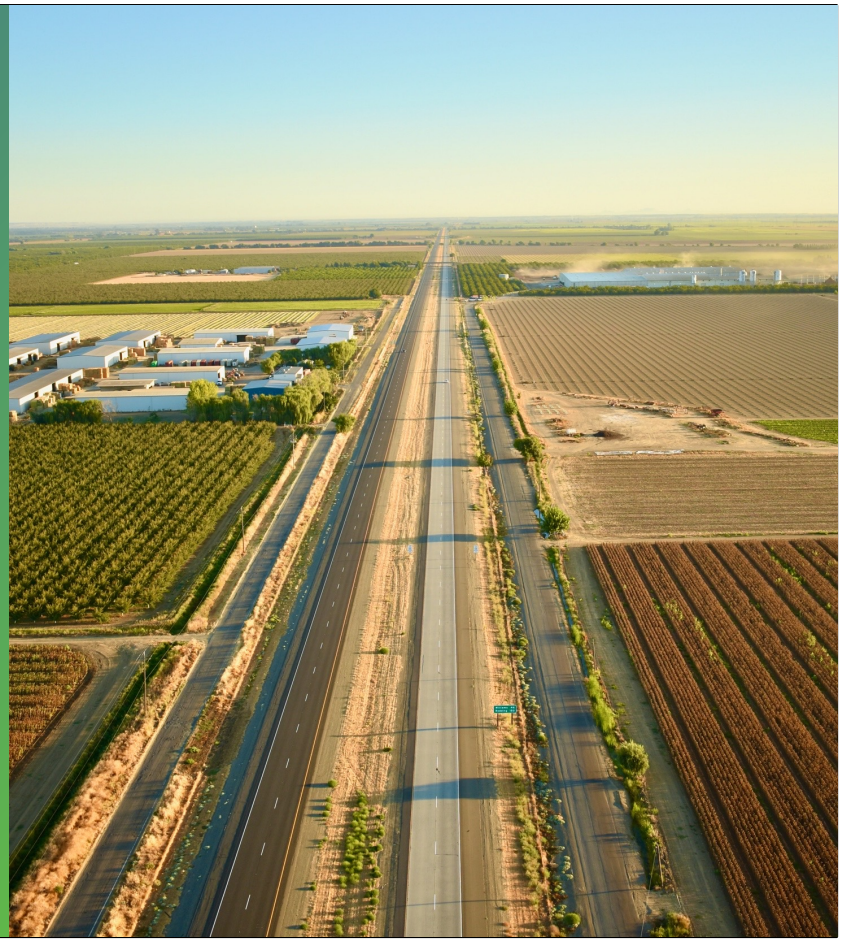
Poll Request

- **Measure Name:** ASHRAE Guideline 36
- **Type of Poll:** Slider scale
- **Question:** How will project costs be impacted? Assume existing comprehensive and robust application libraries developed around Guideline 36 sequences of operation.
  - Design
  - Programming
  - Commissioning
  - Building operation labor
- **Answers. Slider bar from 1 to 3 labels for Low, Mid, and High values:**
  - 1: Decreased cost
  - 2: No change
  - 3: Increased cost
- **Check option to 'allow participants to skip single statements'**
- **Placement: After Incremental Cost Information slide**
- **Broadcast results to attendees as they respond:** Y
- **Make poll public during presentation:** Y

Statewide Energy Impacts

Methodology and Assumptions

- Statewide Energy Impacts Methodology



Statewide Energy Impacts Methodology

The Statewide CASE Team estimates annual statewide impacts by multiplying **A x B x C**:

A. per-Sqft energy impacts (discussed in previous section)

B. number of Sqft of new construction/additions/alterations of each applicable building type

C. portion of affected Sqft in each climate zone

Example:

Per Unit Impacts

Savings type	**Savings** per sq ft
Electricity	[X] kWh
Peak demand	[X] Watts
Natural gas	[X] Therms
GHG emissions	[X] Tons CO_2e

×

Affected New Construction

Climate Zone	**Large Office** sq ft	**Assembly** sq ft
1	100	20
2	1,000	1,500
…		
16	5,000	3,000

=

Statewide Energy Impacts

Climate Zone	**Elec Savings** (GWh)	**…**	**GHG savings** (MT CO_2e)
1	20		1,500
2	50		3,000
…			
16	100		2,000

2026 Construction Forecast

Construction Forecast Building Type	Newly Constructed Floorspace Impacted (%)	Existing Floorspace Impacted (%)
Large Office	50%	3.33%
Medium Office	50%	3.33%
Small Office	0%	0%
Large Retail	0%	0%
Medium Retail	0%	0%
Strip Mall	0%	0%
Mixed-use Retail	0%	0%
Large School	0%	0%
Small School	0%	0%
Non-refrigerated Warehouse	0%	0%
Hotel	0%	0%
Assembly	0%	0%
Hospital	0%	0%
Laboratory	0%	0%
Restaurant	0%	0%
Enclosed Parking Garage	0%	0%
Open Parking Garage	0%	0%
Grocery	0%	0%
Refrigerated Warehouse	0%	0%
Controlled-environment Horticulture	0%	0%
Vehicle Service	0%	0%
Manufacturing	0%	0%
Unassigned	0%	0%

Preliminary Savings – Statewide Energy and Energy Cost Impacts Estimates

Energy and Energy Cost Impacts - New Construction & Additions						
Climate Zone	Statewide Impacted by Proposed Change in 2026 (square feet)	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (million therms)	First-Year Source Energy Savings (million kBtu)	30-Year Present Valued Energy Cost Savings (million 2026 PV$)
CZ01	130,200	0.05	0.00	0.00	0.05	0.35
CZ02	476,100	0.26	0.02	0.01	0.24	1.91
CZ03	4,606,000	2.21	0.07	0.13	2.46	22.12
CZ04	2,322,200	1.68	0.05	0.05	1.81	13.40
CZ05	370,500	0.20	0.02	0.01	0.17	1.61
CZ06	2,623,000	1.76	0.07	0.05	1.75	12.67
CZ07	1,629,600	1.05	0.05	0.02	1.03	7.58
CZ08	3,934,000	3.15	0.12	0.07	2.98	21.47
CZ09	7,336,000	5.45	0.22	0.12	5.33	38.00
CZ10	1,565,600	1.28	0.08	0.03	1.13	8.45
CZ11	377,300	0.26	0.01	0.01	0.26	1.92
CZ12	3,373,700	2.03	0.14	0.06	2.01	15.14
CZ13	585,900	0.36	0.03	0.01	0.31	2.42
CZ14	548,400	0.43	0.02	0.01	0.41	3.07
CZ15	275,930	0.20	0.02	0.01	0.18	1.41
CZ16	151,950	0.10	0.01	0.00	0.10	0.69
Total	**30,306,380**	**20.44**	**0.94**	**0.59**	**20.22**	**152.17**

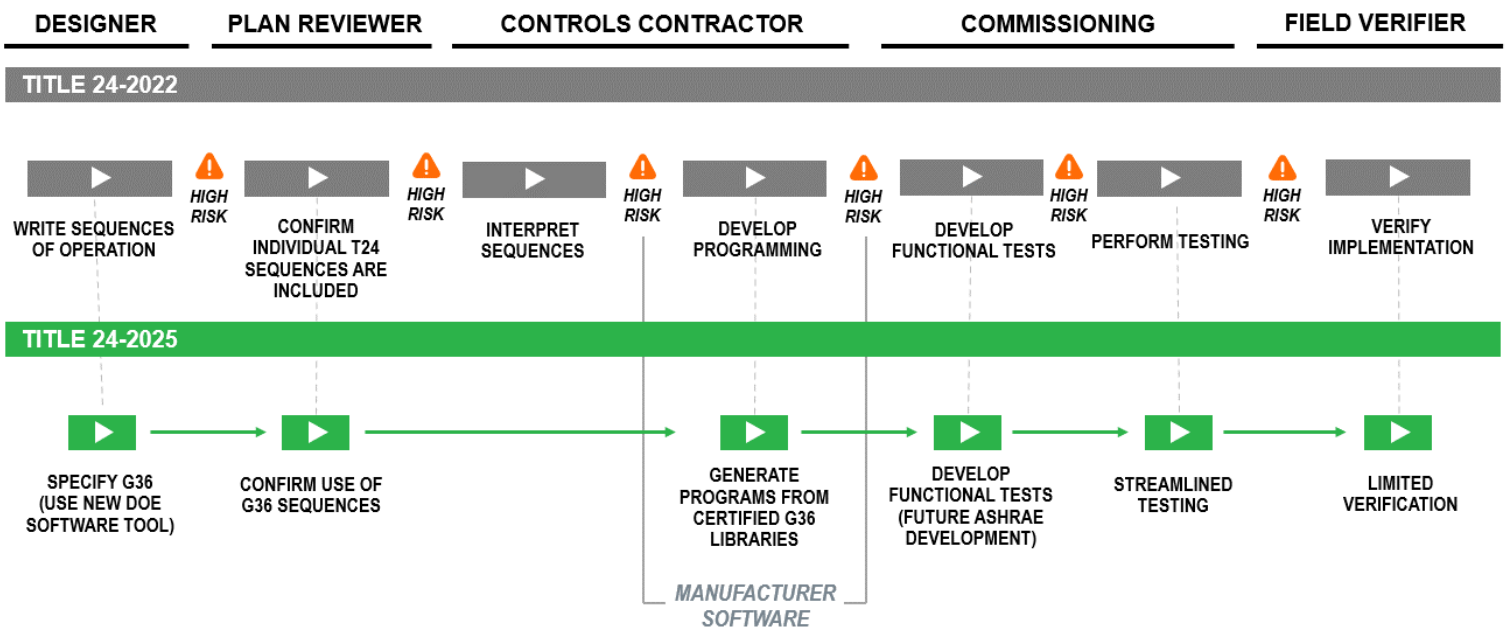
Compliance and Enforcement

- Design
- Permit Application
- Construction
- Inspection

Compliance and Verification

Phase	Current Practice	Proposed	Impact: Effort Level	Impact: Enforceability
Design	Designer develops control sequences of operation	Designer uses sequences from G36 (leverages new DOE software)	Reduced	N/A
Permit	Compliance form shows individual control requirements	Compliance form also shows use of G36	No impact	No impact
	Plans examiner reviews compliance forms	Plans examiner reviews compliance forms	No impact	No impact
	(Plans examiner reviews plan/specs to confirm specific control reqs)	(Plans examiner reviews plans/specs to confirm use of G36)	Reduced	Improved
Construction	Manufacturer provides software to controls contractor	Manufacturer provides software… with certified G36 programming libraries	Increased	N/A
	Contractor develops/adapts control programming	Contractor draws from certified G36 programming library	Reduced	N/A
	CxA reviews/tests installation	Streamlined review/testing for CxA	Reduced	Improved
Inspection	ATT verifies individual control measures	ATT verifies use of G36	Reduced	Improved
	Inspector checks compliance form	Inspector checks compliance form	No impact	No impact

Compliance and Verification



Review of Code Language Markup

- Draft Code Change Language

Draft Code Change Language

Summary:

- Where there are existing, prescriptive HVAC control requirements for airside systems, add references to Guideline 36. Applies to:
  - Dual maximum VAV logic (limitation on simultaneous heating and cooling) – 140.4(d)2.A
  - Duct static pressure reset – 140.4(c)2.B
  - Supply air temperature reset – 140.4(f)
  - Economizer control – 140.4(e)2
- Prescriptively require that DDC control of applicable airside systems use control logic originating from a Guideline 36 programming library that is certified by the CEC, as a new section 140.4(r)

Draft code language available for review in the resources tab and downloadable.
Please provide feedback to CASE Author by **March 13, 2023**.

Discussion and Next Steps

We want to hear from you!

- Provide **any last comments or feedback** on this presentation now verbally or over the chat
- More information on pre-rulemaking for the 2025 Energy Code at https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2025-building-energy-efficiency

Comments on this measure are due by March 13. Please send comments to info@title24stakeholders.com and copy CASE Authors (see contact info on following slide).

Thank You

Rupam Singla
G36 Measure Lead
510-469-0810
rsingla@trccompanies.com

Hwakong Cheng
G36 Measure Technical Lead

CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM