DOCKETED

Docket Number:	25-BSTD-03
Project Title:	2028 Energy Code Pre-Rulemaking.
TN #:	270684
Document Title:	2028 California Energy Code Measure Proposal – Existing Building Performance HVAC Upgrades and Building Commissioning
Description:	Proposed 2028 Energy Code change which would expand requirements for direct digital controls in existing space-conditioning systems and require existing building commissioning when existing space-conditioning system are replaced.
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Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	6/17/2026 1:56:10 PM
Docketed Date:	6/17/2026

2028 California Energy Code

Measure Proposal

Existing Building Performance: HVAC Upgrades and Building Commissioning

MEASURE CATEGORY: Nonresidential HVAC

Prepared by: California Energy Commission with technical support from NORESCO and Glumac

April 2026

CALIFORNIA ENERGY COMMISSION

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ACKNOWLEDGEMENTS

We would like to acknowledge the following staff and leaders:

Leadership – California Energy Commission (CEC) Commissioner Andrew McAllister and his advisor, Bill Pennington, for unwavering leadership throughout the standards development process; Payam Bozorgchami, P.E., senior engineer and technical lead; Michael Shewmaker, supervisor of the Building Standards Development Unit; Gypsy Achong, manager of the Building Standards Branch; Will Vicent, Deputy Director of the Building Standards and Standards Compliance Branches; and Michael Sokol, Director of the Efficiency Division.

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Keywords: Energy Code, Building Energy Efficiency Standards, Statewide Codes and Standards, Title 24, Part 6, 2028, efficiency, direct digital controls (DDC), existing building commissioning (EBCx), pneumatic controls, right sizing, alterations, additions, chillers, boilers, air handling units, terminal units.

Executive Summary

Introduction

The California Energy Commission (CEC) sponsored development of this proposal. NORESCO and Glumac provided technical support as consultants to the CEC, under contract to NORESCO. This proposal describes specific energy efficiency code changes (referred to as “measures”) aimed at reducing wasteful, uneconomic, inefficient, or unnecessary consumption of energy in California. The code change proposal, or “measure”, described in this report is provided for consideration and potential inclusion in the California’s Energy Code (California Code of Regulations, Title 24, Part 6). The Energy Code sets statewide energy efficiency requirements for newly constructed buildings, and additions and alterations to existing buildings. When considering measures to be included in the Energy Code, the CEC evaluates the proposed measures’ cost-effectiveness and technical feasibility.

Code Change Description

The proposed code changes apply to existing nonresidential buildings when space-conditioning system equipment is being replaced. The proposed code changes consist of two measures:

1. Expanded requirements for direct digital controls (DDC) in existing space-conditioning systems. The intent of this proposed measure is to increase the proportion of equipment in existing buildings with DDC as naturally occurring equipment replacement occurs.
2. Require completion of an existing building commissioning (EBCx) study and accompanying report to provide key building and system information that will support future improvements in building efficiency when existing space-conditioning systems are replaced. The intent of this measure is to develop the information necessary for planning future equipment replacements and upgrading energy management control systems (EMCS) to position the building for enhanced current and future efficiency.

The proposed measures include code changes to the following sections of the Restructured 2025 Energy Code[1]:

- Definitions: Section 201

[1] In November, 2025, the CEC published the Restructured 2025 Energy Code. This report uses section numbering from the Restructured 2025 Energy Code, with references to the 2025 Energy Code, where applicable. https://efiling.energy.ca.gov/GetDocument.aspx?tn=267256&DocumentContentId=104435

- For DDC upgrades: Sections 401.2, 401.3 and 401.5, and
- For EBCx requirements: Section 1001.5.

The measures are focused on alterations and additions to nonresidential buildings. The scope of the proposed code changes does not include the following:

- Healthcare Facilities. As specified by Exception 1 to Section 100.4.4 in the Restructured 2025 Energy Code (Exception 1 to Section 141.0 in the 2025 Energy Code), alterations to healthcare facilities are not required to comply with Title 24, Part 6.
- Data Centers. Data Centers are included in the definition of Covered Processes, and are not required to comply with requirements for nonresidential buildings.
- Hotel/Motel Buildings. Assembly Bill 130 suspends updates to the California Building Standards Code (Title 24, all Parts), including the Energy Code, for all residential units until January 1, 2032. Pursuant to the California Building Standards Commission's (CBSC's) memorandums to state agencies regarding Assembly Bill 130 (2025)[2], hotel/motel buildings in their entirety are included in the suspension.

Direct Digital Control

The 2025 Energy Code defines direct digital controls (DDC) as a type of control where controlled and monitored analog or binary data, such as temperature and contact closures, are converted to digital format for manipulation and calculations by a digital computer or microprocessor, then converted back to analog or binary form to control mechanical devices.

The 2025 Energy Code requires DDC to be installed for additions or alterations as follows (see Table 401.2-D of the Restructured 2025 Energy Code, Table 120.2-A in the 2025 Energy Code):

- For zone terminal units such as VAV boxes, when existing zones served by the same air-handling, chilled water, or hot water systems have DDC,
- For air-handling systems or fan coils, when existing air-handling system(s) and fan coil(s) served by the same chilled or hot water plant have DDC,
- For new air-handling systems and all new zones served by that system, when individual system design heating or cooling capacity is 300 kBtu/h

[2] The California Building Standards Commission released to state agencies an initial memorandum regarding AB 130 dated October 29, 2025; with a revised memorandum dated February 9, 2026. The same interpretation of the meaning of "residential units" was published in CBSC Informational Bulletin 25-03 https://www.dgs.ca.gov/BSC/News/Page-Content/Building-Standards-Commission-News-List-Folder/IB-25-03-AB-130

and larger and supplying more than three zones and more than 75 percent of zones are new,

- For new or upgraded chilled water plants, when all chillers are new and plant design cooling capacity is 300 kBtu/h (87.9 kW) and larger,
- For new or upgraded hot water plants, when all boilers are new and plant design heating capacity is 300 kBtu/h (87.9 kW) and larger.

The proposed measures expand when controls upgrades to DDC are required, as described below in more detail. These expanded requirements are expected to increase the number of DDC upgrades compared to the 2025 Energy Code requirements. The reduced AHU capacity thresholds are expected to impact nonresidential buildings greater than 10,000 ft^2. The expansion of terminal unit upgrade requirements is expected to include buildings greater than 7,500 ft^2[3].

The DDC measures expand the conditions when DDC is currently required in Table 401.2-D of the Restructured 2025 Energy Code, Table 120.2-A in the 2025 Energy Code, as follows:

- For terminal units such as VAV boxes:
  - When any new or replacement terminal unit is installed.
- For air-handling systems or fan coils,
  - If the air-handling system has a design cooling capacity of 150 kBtu/h and larger, or
  - For air-handling systems **of any size** where existing air-handling system(s) served by the same chilled water or hot water plant have DDC, or
  - If 50% or more of the existing terminal units served by the same air-handling system are DDC after the addition or alteration, DDC shall also be provided at the air-handling unit.
- For new air-handling systems and all new zones served by that system:
  - Reduces the individual system design heating or cooling capacity threshold from 300 kBtu/h and larger to 150 kBtu/h and larger, or
  - If more than 85% of zones are new, requires DDC for all existing terminal units served by the new air-handling system.
- For new or upgraded chilled water plants, reduces threshold for DDC from requiring all chillers to be new, to requiring more than 50% of plant design cooling capacity to be new, and extends DDC to entire plant (including pumps).
- For new or upgraded hot water plants, reduces threshold for DDC from requiring all boilers to be new, to requiring more than 50% of plant design

[3] Depending on climate zone, building type, quality of building envelope, ventilation and internal loads, a 12.5-ton unit serves approximately 4,000 ft² of higher-load spaces to about 8,000 ft² or more of lighter-load spaces.

heating capacity to be new, and extends DDC to entire plant (including pumps).

Exceptions to these proposed DDC requirements are:

- Chiller plant upgrades for buildings in climate zones 1, 3, 5 or 16, and
- Boiler plant upgrades for buildings in climate zones 6 or 7.

As part of the proposed DDC requirements, new or replacement terminal units in alterations shall be designed to operate at the existing hot water system supply temperature and shall be capable of operation with a supply temperature no greater than 130 °F.

Further, when sizing new or replacement space-conditioning equipment, existing building monitoring data shall be used to support heating and cooling load calculations, if the necessary data is available. The building monitoring data shall be included with the calculations submitted to the enforcement agency.

Existing Building Commissioning

The proposed measure requires completion of an existing building commissioning (EBCx) study and accompanying report of key building and system information when existing space-conditioning systems are replaced. This study will:

a. Determine system sizes to meet the building's load,
b. Evaluate benefits from converting from pneumatic controls to DDC, and
c. Document corrective actions, both completed and recommended.

EBCx studies will be required for alterations to chillers and boilers that have capacities of 300 kBtu/hr (25 tons) and for alterations to AHUs/RTUs that have capacities of 150 kBtu/hr (12.5 tons). These EBCx requirements are new requirements for the Energy Code.

Scope of Work

The proposed measures will modify the following Energy Code sections, reference appendices and supporting documents listed in Table 1. In the "Regulation Type(s)" column, "M" indicates the proposed measures are mandatory requirements, "Ps" indicates prescriptive requirements, and "Pm" indicates requirements in the performance modeling approach.

Table 1: Code Change Scope of Work

Restructured 2025 Energy Code Section(s)	Regulation Type(s): M, Ps, or Pm	Reference Appendices	Modeling Tools	Forms	Other Supporting Documents
Section 401.2.2.10 (previously Section 120.2(j))	Ps	No Change	None	No change	Changes to compliance manuals
Table 401.2-D (previously Table 120.2-A)	Ps	No Change	None	No change	Changes to compliance manuals
Section 401.2.2.12 (previously Section 120.2(k))	Ps	No Change	None	No change	Changes to compliance manuals
Section 401.3.4.1 (previously Section 140.4(b)1)	Ps	No Change	None	No change	Changes to compliance manuals
Section 401.5 (previously Section 141.0)	Ps	No Change	None	No Change	Changes to compliance manuals
Section 1001.5 (new)	M	No Change (may consider JA for EBCx requirements)	None	May require small changes for EBCx	Changes to compliance manuals

An (M) indicates mandatory requirements, (Ps) Prescriptive, (Pm) Performance.

Compliance and Enforcement

Compliance and enforcement would be completed using the same process as for the requirements in Section 401.2.2.2 of the Restructured 2025 Energy Code (Section 120.2(a) of the 2025 Energy Code) that apply to existing buildings when installation or alterations are made to space-conditioning equipment and installation of DDC. Compliance and enforcement for the EBCx studies will use the same process as for the building commissioning requirements in Section 1001 of the Restructured 2025 Energy Code (Section 120.8 of the 2025 Energy Code). This proposal would require the compliance and permit process for commissioning to be expanded to existing buildings within the scope of the proposal.

Market Assessment

The market for DDC upgrades and EBCx is strong and these are routine activities in the building sector. There are numerous suppliers, designers and consultants that can support the required upgrades and reports required by these proposed changes. Based on 2024 Dodge Data and Analytics Group permit data analyzed by NORESCO, the current rate of space conditioning equipment control upgrades to DDC is estimated as 0.4% of buildings per year, which is relatively low. The proposed measures will have modest impact on the rate of upgrades by expanding the requirements currently in place in the 2025 Energy Code.

Without the proposed measures, the expected adoption rate for DDC upgrades for space conditioning systems that either have no controls or use a pneumatic control system is moderate to low. Many building owners would most likely complete like for like replacements and not pursue DDC upgrades or EBCx studies that will allow for right sizing of equipment and provide key information for well-planned future alterations.

Building owners may see modest increases in installation costs but the proposed actions will result in energy savings and maintenance savings from the required improvements.

Cost-effectiveness

Energy savings estimates are based on published findings for DDC upgrades and EBCx. Upgrades to DDC are shown to result in savings between 0.3 and 0.8 kWh per square foot. EBCx is shown to result in savings between 5 and 14 percent of building energy use. A median estimate of 10% reduction in HVAC system energy is used to represent savings for these proposed measures. Staff calculated the LSC savings by climate zone.

Incremental first costs for DDC upgrades were compiled using RS means, and information shared by DDC vendors and SMEs. Using large office buildings as a representative building type, the incremental cost for DDC is $0.41 per square foot. Similarly, the incremental first cost for EBCx studies is $0.366 per square foot.

DDC upgrades provide opportunities for reduced maintenance costs through reduced maintenance activity and improved monitoring. Some studies estimate 10% maintenance cost savings. For buildings with chillers or boilers, DDC upgrades provide savings estimated at 15% for temperature resets and improved monitoring. Annual savings of $0.02 per square foot were determined based on the cost of maintenance contracts. EBCx studies are not expected to result in increased maintenance costs. Potential maintenance savings from EBCx have not been quantified.

Table 2 through Table 5 summarize the estimated benefits, costs and resulting Benefit-Cost Ratios (BCR) by California climate zone for the proposed measures.

Table 2: DDC Upgrade Cost-effectiveness Summary

Climate Zone	Benefit: Total Incremental LSC Savings and Other Savings (PV$)	Cost: Total Incremental First Costs and Maintenance Costs (PV$)	Benefit-Cost Ratio (BCR)
1	$0.844	$0.41	2.06
2	$0.961	$0.41	2.34
3	$0.769	$0.41	1.88
4	$0.872	$0.41	2.13
5	$0.830	$0.41	2.02
6	$0.841	$0.41	2.05
7	$0.867	$0.41	2.11
8	$1.044	$0.41	2.55
9	$0.990	$0.41	2.41
10	$1.086	$0.41	2.65
11	$1.193	$0.41	2.91
12	$1.034	$0.41	2.52
13	$1.132	$0.41	2.76
14	$1.240	$0.41	3.02
15	$1.384	$0.41	3.38
16	$1.332	$0.41	3.25

Table 3: Chiller Plant DDC Upgrade Cost-effectiveness Summary

Climate Zone	Benefit: Total Incremental LSC Savings and Other Savings (PV$) Low Estimate	Benefit: Total Incremental LSC Savings and Other Savings (PV$) High Estimate	Cost: Total Incremental First Costs and Maintenance Costs[1] (PV$)	Benefit-Cost Ratio (BCR) (Low)	Benefit-Cost Ratio (BCR) (High)
1	$0.032	$0.05	$0.256	0.13	0.21
2	$0.315	$0.53	$0.256	1.23	2.06
3	$0.198	$0.33	$0.256	0.77	1.29
4	$0.377	$0.63	$0.256	1.47	2.46
5	$0.244	$0.41	$0.256	0.95	1.59
6	$0.501	$0.84	$0.256	1.96	3.27
7	$0.524	$0.87	$0.256	2.05	3.42
8	$0.690	$1.15	$0.256	2.70	4.51
9	$0.657	$1.10	$0.256	2.57	4.29
10	$0.728	$1.21	$0.256	2.84	4.76
11	$0.659	$1.10	$0.256	2.57	4.31
12	$0.493	$0.82	$0.256	1.93	3.22
13	$0.703	$1.17	$0.256	2.75	4.59
14	$0.644	$1.07	$0.256	2.52	4.21
15	$1.231	$2.05	$0.256	4.81	8.05
16	$0.199	$0.33	$0.256	0.78	1.30

Table 4: Boiler Plant DDC Upgrade Cost-effectiveness Summary

Climate Zone	Benefit: Total Incremental LSC Savings (Low)	Benefit: Total Incremental LSC Savings (High)	Cost: Total Incremental First Costs and Maintenance Costs[1]	Benefit-Cost Ratio (BCR) (Low)	Benefit-Cost Ratio (BCR) (High)
1	$0.78	$1.30	$0.295	2.66	4.41
2	$0.65	$1.08	$0.295	2.21	3.67
3	$0.50	$0.83	$0.295	1.7	2.82
4	$0.46	$0.77	$0.295	1.56	2.60
5	$0.54	$0.90	$0.295	1.84	3.05
6	$0.28	$0.47	$0.295	0.94	1.58
7	$0.25	$0.42	$0.295	0.84	1.41
8	$0.31	$0.52	$0.295	1.04	1.75
9	$0.34	$0.57	$0.295	1.16	1.92
10	$0.37	$0.62	$0.295	1.25	2.09
11	$0.66	$1.10	$0.295	2.23	3.73
12	$0.60	$1.00	$0.295	2.03	3.39
13	$0.52	$0.87	$0.295	1.77	2.94
14	$0.68	$1.13	$0.295	2.31	3.84
15	$0.29	$0.48	$0.295	1.00	1.64
16	$1.32	$2.20	$0.295	4.49	7.46

Table 5: EBCx Upgrade Cost-effectiveness Summary

Climate Zone	Benefit: Total Incremental LSC Savings and Other Savings (PV$)	Cost: Total Incremental First Costs and Maintenance Costs (PV$)	Benefit-Cost Ratio (BCR)
1	$0.506	$0.366	1.38
2	$0.577	$0.366	1.58
3	$0.461	$0.366	1.26
4	$0.523	$0.366	1.43
5	$0.498	$0.366	1.36
6	$0.505	$0.366	1.38
7	$0.520	$0.366	1.42
8	$0.626	$0.366	1.71
9	$0.594	$0.366	1.62
10	$0.652	$0.366	1.78
11	$0.716	$0.366	1.96
12	$0.620	$0.366	1.70
13	$0.679	$0.366	1.86
14	$0.744	$0.366	2.03
15	$0.830	$0.366	2.27
16	$0.799	$0.366	2.18

Statewide Energy Impacts

Statewide energy impacts are based upon the potential number of buildings that do not have DDC in place. A previous CEC market penetration study (Cheng et al., 2022) identified the number of buildings with energy management systems (EMS) that control space conditioning equipment. NORESCO analyzed 2024 permit data from Dodge Data and Analytics Group to determine the rate of new DDC installations through 2028. Combining the EMS market information and DDC installation rate, NORESCO estimated the number of buildings that would be eligible for DDC upgrade. The data was then used to estimate an annual percentage of retrofits that would meet the criteria for the proposed changes.

Table 6 and Table 7 summarize the estimated statewide energy and greenhouse gas (GHG) emissions savings for the first year that the proposed measure is implemented. GHG emissions savings are a co-benefit of this proposal.

Table 6: Estimated Statewide Energy Savings

	First Year Statewide Electricity Savings (GWh)	First Year Statewide Power Demand Reduction (MW)	First Year Statewide Natural Gas Savings (Million Therms)	First Year Statewide Electricity LSC Savings (PV$)	First Year Statewide Natural Gas LSC Savings (PV$)
Sub-measure 1: DDC Upgrade Requirements	125	0	4	$7,553,646	$3,167,958
Sub-Measure 2: Chiller DDC Upgrade	18	0	0	$1,062,524	$0
Sub-Measure 3: Boiler DDC Upgrade	0	0	4	$0	$257,409
Sub-measure 4: EBCx Requirements	75	0	2	$4,532,187	$1,900,775
TOTAL	**217**	**0**	**11**	**$13,148,357**	**$5,326,142**

Note: Table 6 does not include contributions for climate zones that are excepted from the proposed measure. Specifically, climate zones 1, 3, 5 and 16 are excluded from chiller DDC upgrade savings; and climate zones 6 and 7 are excluded from boiler DDC upgrade savings.

Table 7: Estimated Statewide Greenhouse Gas Emission Savings

	First Year Statewide GHG Emission Savings ($MT\ CO_2e/year$)
Sub-measure 1: DDC Upgrade Requirements	33,590
Sub-Measure 2: Chiller DDC Upgrade	1,587
Sub-Measure 3: Boiler DDC Upgrade	23,055
Sub-measure 4: EBCx Requirements	20,154
TOTAL	**78,386**

Note: Table 7 does not include contributions for climate zones that are excepted from the proposed measure. Specifically, climate zones 1, 3, 5 and 16 are excluded from chiller DDC upgrade savings; and climate zones 6 and 7 are excluded from boiler DDC upgrade savings

ACRONYMS

Acronym	Definition
AB 130	California Assembly Bill 130
ACCA	Air Conditioning Contractors of America
ACM	Alternate Calculation Method
AHU	Air Handling Unit
ANSI	American National Standards Institute
BACnet	Building Automation and Control Network
BCR	Benefit-Cost Ratio
BEM	Building Energy Modeling
BtU	British Thermal Units
CASE	Codes and Standards Enhancement
CBECC	California Building Energy Code Compliance software
CEC	California Energy Commission
CEUS	Commercial Energy-Use Survey
CHW	Chilled water
CPUC	California Public Utilities Commission
CSS	Commercial Saturation Survey
CW	Condenser water
Cx	Commissioning
CZ	California Climate Zone
DDC	Direct Digital Controls
EBCx	Existing Building Commissioning
EMS	Energy Management System

GHG	Greenhouse Gas
GWh	Gigawatt-Hour
HHW	Heating hot water
HVAC	Heating, Ventilation and Air Conditioning
kBtU	Thousands of British Thermal Units
kWh	Kilowatt-Hour
kWh/year	Kilowatt-Hour Per Year
LSC	Long-term System Cost (30-year $)
M&V	Measurement and verification
MW	Megawatt
NLR	National Laboratory of the Rockies
NREL	National Renewable Energy Laboratory
O&M	Operations and maintenance
RCx	Retro-commissioning
RTU	Rooftop unit
TI	Tenant improvement
VAV	Variable air volume
VMT	Vehicle miles traveled

GLOSSARY

Air side refers to equipment for air distribution and conditioning.

Building automation system (BAS) is an energy management control system, usually with additional capabilities, relating to the overall operation of the building in which it is installed, such as equipment monitoring, protection of equipment against power failure, and building security.

Building commissioning is a systematic quality assurance process that spans the entire design and construction process, including verifying and documenting that building systems and components are planned, designed, installed, tested, operated, and maintained to meet the owner's project requirements.

Demand control ventilation (DCV) is a control strategy for ventilation systems to efficiently maintain indoor air quality in intermittently occupied spaces. Spaces do not have processes or operations that generate dusts, fumes, mists, vapors or gasses and are not provided with local exhaust ventilation (such as indoor operation of internal combustion engines or areas designated for unvented food service preparation). This control strategy adjusts the rate of outdoor air based on occupant needs for ventilation.

Direct digital control (DDC) is a type of control where controlled and monitored analog or binary data, such as temperature and contact closures, are converted to digital format for manipulation and calculations by a digital computer or microprocessor, then converted back to analog or binary form to control mechanical devices.

Demand response (DR) is a short-term change in electricity usage by end-use customers from their normal consumption patterns. Demand response may be in response to:

a. changes in the price of electricity; or

b. participation in programs or services designed to modify electricity use:

i. in response to wholesale market prices; or

ii. when system reliability is jeopardized.

Energy management control system (EMCS) or energy management system (EMS) is an automated control system that regulates the energy consumption of a building by controlling the operation of energy consuming systems, and is capable of monitoring loads and adjusting operations in order to optimize energy usage and respond to demand response signals.

Existing building commissioning (EBCx) is a quality-focused process for attaining the current facility requirements of an existing facility and its systems and assemblies being commissioned. The process focuses on planning, investigating, implementing, verifying, and documenting that the facility and/or its systems and assemblies are operated and maintained to meet the current facility requirements, with a recommendation to implement continuous improvement for the remaining life of the facility.

Existing Building Commissioning Provider (EBCxP) is an entity, identified by the owner, or owner's representative, who leads, plans, schedules, and coordinates the necessary personnel required to implement the EBCx process.

Fully burdened labor rate represents the complete cost a company incurs to employ a worker, not just their base salary or hourly wage. It includes direct wages, employer-paid taxes, benefits, paid time off, training, equipment, and a share of overhead costs such as rent and administrative expenses.

Pneumatic control is a type of control that uses compressed air to transmit control signals as analog (variable pressure) or binary (on/off) signals through tubing to actuators, which convert the air pressure into mechanical motion or position control to regulate control devices.

Primary-only hydronic system is a hydronic configuration where all water flow is routed through the water conditioning plant and terminal units in a single loop, with no separate "secondary" loop for distribution.

Primary-secondary hydronic system includes two sets of pumps, distribution system pumps and water conditioning system pumps. The distribution system pumps distribute water to the terminal units and the water conditioning system pumps circulate water through a loop that serves the water conditioning equipment only.

Water side refers to equipment used in hydronic space conditioning systems for handling water distribution and conditioning.

1. INTRODUCTION

This proposal describes specific energy efficiency actions that could result in further reductions of wasteful, uneconomic, inefficient, or unnecessary consumption of energy in California. The code change proposal, or "measure," described in this proposal is provided by the California Energy Commission (CEC) for consideration and potential inclusion in the California Energy Code (Title 24, Part 6). The Energy Code sets statewide energy efficiency requirements for newly constructed buildings, and additions and alterations to existing buildings. This measure will be considered and may be modified as part of a comprehensive regulatory package proposed and adopted by the CEC. The Energy Code must be found to be technically feasible and cost-effective as a whole.

Consistent with Public Resources Code 25402(b)(3) an energy standard is cost-effective if the life-cycle value of the energy savings (benefits) exceed the life-cycle costs, when amortized over the economic life of the structure. This corresponds to a Benefit-Cost Ratio (BCR) of 1.0 or greater,. BCR is calculated by dividing the total dollar benefit of the measure by the total dollar cost of the measure, over a period of analysis of 30 years.

To calculate benefit, Long-term System Cost (LSC) is used to determine the dollar value of energy measures in the Energy Code. LSC hourly factors help the state account for long-term benefits associated with policies needed to meet the statewide climate actions goals – such as 100% renewable generation, proliferation of electric transportation, and drastic reductions in fossil fuel combustion occurring in buildings. Today's energy costs do not adequately account for these long-term values to California's energy system. LSC hourly factors weigh the long-term value of each hour differently, where times of peak demand are more valuable, and times of off-peak demand are less valuable. LSC hourly factors are not utility rates or energy rate forecasts. LSC is not a predicted utility bill.

LSC hourly conversion factors are developed and published by the CEC for each code cycle. These LSC hourly factors are used to convert predicted site energy use – an output common to building energy modeling (BEM) software – to 30-year present value to California's energy system.

In addition to LSC, the CEC also considers the Source Energy impact of proposed measures. Source energy is defined as the long run hourly marginal source energy of fossil fuels that are combusted as a result of building energy consumption either directly at the building site or caused to be consumed to meet the electrical demand of the building considering the long-term effects of Commission-projected energy resource procurement. For a given hour, the value in that hour for each forecasted year is averaged to establish a lifetime average source energy.

The CEC develops and publishes conversion factors for LSC, Source Energy, and for GHG Emissions for each code cycle. The GHG emissions factors are used to estimate any GHG emissions reduction co-benefits associated with measure proposals. These three sets of hourly factors are published on CEC's website and formatted to be accessible and usable in combination with broadly available BEM tools.

Energy savings for the proposed measures are estimated from existing studies on direct digital controls (DDC) and existing building commissioning. Many of these studies were completed to support previous Energy Code measures and remain applicable to the existing building stock and the measures proposed in this report.

To calculate cost, first costs and ongoing maintenance costs must be assessed for proposed measures and accounted for over a period of analysis of 30 years. In the BCR, both the benefits and the costs are assessed incrementally, meaning in comparison to the latest adopted version of the Energy Code.

Existing buildings represent a significant portion of California's energy use. The California Electricity[4] and Natural Gas[5] Consumption Dashboards indicates that approximately 60% of State energy use is attributable to the building sector. Within the building sector, commercial buildings represent 24% of the energy use. Figure 1 shows the California average annual state energy use (combined electricity and natural gas) from 1990 through 2024 as presented in the California Electricity and Natural Gas Consumption Dashboards. The average annual state energy use is approximately 618,895 GWh. Please note that "Streetlighting" makes up 0.24% of the total and is not visible in the chart.

[4] California Electricity Consumption Dashboard

[5] California Natural Gas Consumption Dashboard

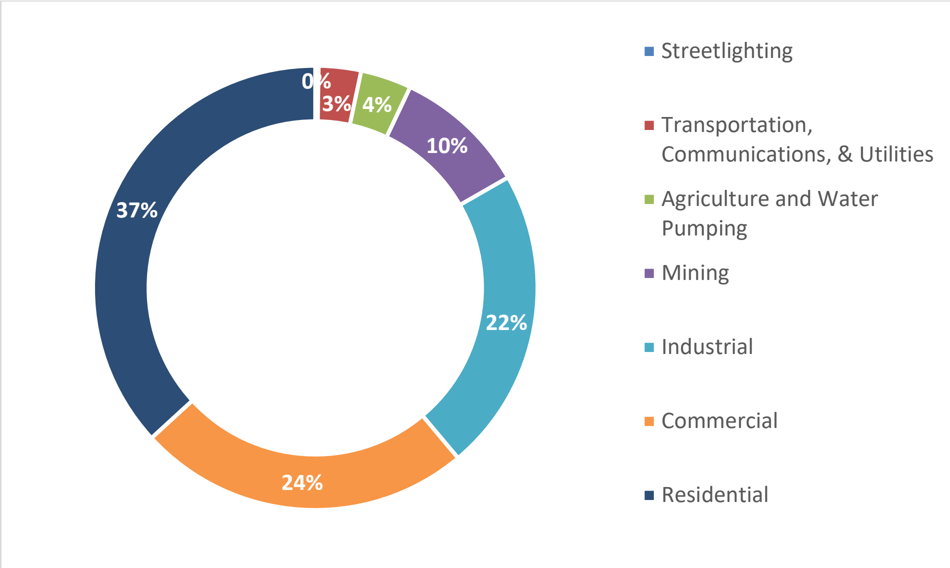

Figure 1: California Energy Use by Sector

Source: California Electricity and Natural Gas Consumption Dashboards

The ComStock[6] database from the National Laboratory of the Rockies (NLR) represents energy use by vintage. ComStock estimates building sector energy use with calibrated building energy models representative of the building stock. Using the 2025 AMY2018_Release 3 dataset, staff subtracted the healthcare and lodging building energy use for California to arrive at an estimate of annual energy use for the commercial buildings in the scope of the proposed measures, which was 1,209 GWh. Based on the ComStock data, up to 80% of California's commercial building energy use is from buildings built prior to 2000, shown in Figure 2.

[6] ComStock Datasets

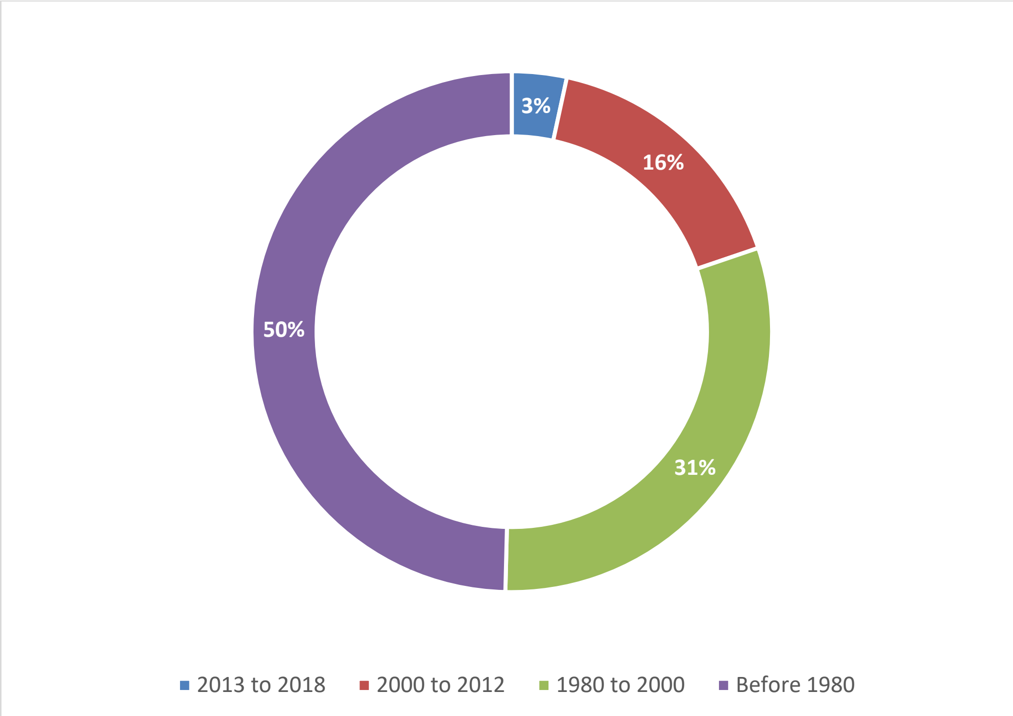

Figure 2: California Commercial Building Energy Use by Vintage

Source: ComStock

Combining these data suggests that energy use of existing commercial buildings that were built prior to 2000 makes up almost 20% of the State's annual energy use. This makes older existing commercial buildings a worthy target for efficiency improvement while also helping the State achieve its climate goals.

To this end, existing building energy use and efficiency are addressed by the Energy Code when alterations are made to specific equipment. A renewed focus on existing building energy use has led to a state requirement for building energy benchmarking in accordance with Assembly Bill 802 (2015). Staff are proposing measures that will both increase energy efficiency and set a strong foundation for future building upgrades. The proposed changes will enable existing buildings to better track and manage their future energy performance. The intent is to also provide the information necessary for planning future equipment replacements and upgrading energy management control systems (EMCS) to enhance space conditioning efficiency.

In response to this proposal, the CEC is requesting general input, as well as specific input on questions one through six below. Please provide relevant building characteristics when answering, including:

- Building use/occupancy type
- Building size (ft^2)
- Building vintage

Questions for response:

1. What percentage of buildings with HVAC controls rely on pneumatic controls for all, or part, of the system?
2. When upgrading terminal units (such as VAV boxes), would it be advantageous to upgrade all terminal units to DDC or to make DDC upgrades by zones as replacement warrants?
3. What percentage of buildings with DDC have enabled trend data collection and storage?
4. For those buildings with trend data collection and storage, how many hours/days' worth of trend data are typically stored?
5. What percentage of buildings have already completed EBCx?
6. What operational improvements do you expect a Cx Agent to make during the EBCx study? Some examples include:
   - Restoring overridden schedules or setpoints
   - Repairing disconnected actuators
   - Repairing damaged fan belts
   - Stroking/adjusting dampers
7. Are there any EBCx-specific testing requirements that should accompany the proposed changes to Section 1001.5 in the Reference Appendices?

Please post comments and suggestions to the [2028 Energy Code Pre-Rulemaking Docket No. 25-BSTD-03](https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=25-BSTD-03) with "Existing Building Performance Foundation" in the subject (https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=25-BSTD-03).

2. MEASURE DESCRIPTION

This proposal consists of a modification and addition to existing regulations. The measure extends the scope of common controls upgrades when HVAC equipment replacements are made. The measure also requires existing buildings to conduct existing building commissioning that provides information necessary for enhancing building efficiency during current and future equipment upgrades. The measure will achieve energy savings by implementation of energy saving strategies for HVAC system operation and facilitation of future right sizing of HVAC equipment at replacement.

2.1 Measure Modifications to Energy Code Documents

This section provides descriptions of how the proposed measure will affect each Energy Code document. See *Section 6.*

2.1.1 Energy Code Change Summary

The proposed measure includes changes to two main sections of the Restructured 2025 Energy Code to include:

- Section 401.2.2.10 and 401.2.2.12 - DDC installation at space-conditioning system equipment replacement
- Section 1001.5 – Existing building commissioning (EBCx) study and report completed at space-conditioning system equipment replacement

The proposed measure adds new definitions for EBCx to Section 200. These definitions are based upon ASHRAE Standard 230, 2022.

Section 401.2.2.10 consists of changes to Table 401.2-D for alterations and additions. Scope of DDC installation/upgrades has been expanded.

Section 401.2.2.12 expands requirements for HVAC hot water temperature to alterations of terminal units.

Section 1001.5 was previously a reserved section. Requirements are added for alterations to perform EBCx with specific scopes, dependent upon HVAC alteration type. These changes are included as mandatory requirements. The requirements:

- Outline the EBCx process, based on ASHRAE Standard 230, 2022,
- Include general provisions for EBCx, and
- Add a table listing EBCx scope details specific to different HVAC system types.

2.1.2 Reference Appendices Change Summary

The proposed measure does not currently include any proposed changes to the Reference Appendices. The CEC will seek feedback on if EBCx-specific testing requirements should accompany the proposed changes to Section 1001.5.

2.1.3 Compliance Manuals Change Summary

Updates are recommended for the Nonresidential Compliance Manual. These updates focus on the two primary changes to the code: DDC upgrades and EBCx requirements. Recommended Nonresidential Compliance Manual updates include:

- Language updates stressing changes for Additions and Alterations
- Updates to existing DDC flowcharts
- Examples for each DDC application
- New section added for the EBCx process and requirements

2.1.4 ACM Reference Manuals Change Summary

There are no recommended changes for the ACM Reference Manuals.

2.1.5 Compliance Forms Change Summary

There are no recommended changes for Compliance Forms for the proposed expansion of DDC installation / upgrade scope in Section 401.2.2. Changes to Compliance Forms for the added EBCx requirements in Section 1001.5 may be required. Recommended changes will be outlined in the Rulemaking measure report. All efforts will be made to leverage existing Cx forms and processes to minimize the impact to the building community.

2.2 Measure Context

2.2.1 Comparable Model Code or Standard

The proposed measure to adjust requirements for upgrades of HVAC controls to DDC, or other existing building commissioning requirements, is not included in other energy codes or model codes. There are, however, related ASHRAE Standards that cover the use of DDC controls and the EBCx process.

There are four relevant specifications regarding DDC controls:

- ASHRAE Guideline 13-2024, Specifying Building Automation Systems, identifies how DDC controls work with the building automation system (BAS) infrastructure. DDC controls provide for robust control options, including but not limited to proportional-integral-derivative control, monitoring, and scheduling.
- ANSI/ASHRAE/ACCA Standard 180-2018 defines inspection and maintenance requirements for DDC systems.

- ASHRAE Standard 135 defines communication protocols, just as BACnet, for building automation and control networks.
- ASHRAE Guideline 36 defines best practice control requirements for building HVAC systems, and has been incorporated into 2025 Energy Code requirements for newly constructed buildings in Reference Appendices, Joint Appendix JA-18.

The existing building commissioning process is defined in ASHRAE 230-2022. The commissioning process includes developing a commissioning plan and a measurement and verification (M&V) plan that documents data collection procedures before and after any changes to equipment operating procedures of functional adjustments. Additionally, ASHRAE Standard 211, Standard for Commercial Building Energy Audits, identifies procedures for data collection required to establish an initial benchmark at the start of the EBCx investigation phase.

In addition to the EBCx process definitions from ASHRAE, there are a number of enforcement agencies in California that have passed ordinances which include requirements for regular energy audits and/or RCx. Table 8 summarizes the requirements for these enforcement agencies.

Table 8: California Enforcement Agency Energy Audit/RCx Ordinance Summary

Jurisdiction	Threshold	Audit Required	Energy Audits	RCx	Prescribed Measures	Performance	Trigger Conditions	Frequency
Berkeley	≥25,000 ft^2	Yes	Energy Audit	N/A	Yes (RCx or audit + measures)	N/A	Recurring	5 years
Brisbane	≥10,000 ft^2	Have option to meet performance thresholds	10,000 ft^2 < Bldgs < 40,000 ft^2 = Energy Audit 40,000 ft^2 ≤ Bldgs = ASHRAE Level 2	RCx as optional outcome from audit	Improvement measures as optional outcome from audit	Meet specified performance thresholds	One Time (date)	N/A
Chula Vista	≥20,000 ft^2	Yes	ASHRAE Level 2	≥ 50,000 ft^2 = RCx performed	Multifamily (ONE TIME) = complete measures from list based on vintage and CZ	Meet ENERGY STAR or EUI improvement target	Recurring	5 years
Los Angeles	≥20,000 ft^2	Yes	Energy and Water Audit	RCx included in energy audit	N/A	N/A	Recurring	5 years
San Francisco	≥10,000 ft^2	Yes (≥50,000 ft^2)	10,000 ft^2 < Bldgs ≤ 50,000 ft^2 = ASHRAE Level 1 50,000 ft^2 > Bldgs = ASHRAE Level 2	N/A	Yes (RCx or audit + measures)	N/A	Recurring	5 years
San José	≥20,000 ft^2	If not meeting performance	ASHRAE Level 2 OR Utility provided energy audit Water audit	RCx performed + implemented	Complete 2 measures from list	N/A	Do not meet one of specified performance metrics	Annually

Source: NORESCO analysis

2.2.2 Conflicts with Other Regulations or Certifications

This measure introduces no conflicts with other building regulations.

The proposed DDC requirements for alterations of existing buildings for specific HVAC systems expand the scope of current requirements. Expanding these requirements does not introduce conflicts with other Regulations.

The proposed EBCx requirements rely on processes and strategies that are current industry practice.

2.3 Compliance and Enforcement

The proposed measure will result in minimal increase to the demands on enforcement agencies. The primary incremental work will be in reviewing permit applications to verify installed equipment for the expanded scope of alterations to existing buildings. The compliance/enforcement for the DDC upgrades will be the same as the current Table 401.2-D requirements.

The EBCx process includes the development of a commissioning report, with systems tested and key findings. Documentation required to demonstrate compliance is still under development, and will be detailed in the final Rulemaking measure report. For permitting, the compliance process could include a simple form, or added section to a compliance form, that indicates that the existing building commissioning process has been completed, with the signature of a qualified commissioning agent who performed or oversaw the testing. An EBCx report shall be submitted as a reference, in case the enforcement agency wishes to review the EBCx scope.

3. MARKET AND ECONOMIC ANALYSIS

For the proposed measure, this section provides the CEC's assessment of product availability, incremental cost, potential market size, and potential economic and fiscal impacts to the state – including potential impacts on the creation or elimination of jobs in the state.

3.1 Market Structure and Availability

Buildings considered for this proposed measure are nonresidential buildings as described in the Section 401.2.2, excluding data centers, health care and hotel/motel buildings.

Data centers, health care and hotel/motel buildings are excluded from this proposal:

- As specified by Exception 1 to Section 100.4.4, alterations to healthcare facilities are not required to comply with Title 24, Part 6.
- Data Centers are included in the definition of Covered Process and therefore are subject to Section 910 and are not included in the scope of these proposed measures.
- Assembly Bill 130 suspends updates to the California Building Standards Code (Title 24, all Parts), including the Energy Code, for all residential units until January 1, 2032. Pursuant to the California Building Standards Commission's (CBSC's) memorandums to state agencies regarding Assembly Bill 130 (2025)[7], hotel/motel buildings in their entirety are included in the suspension.

The 2022 Commercial End-Use Survey (CEUS) (ADM Associates 2024) provides a breakdown of 12 types of nonresidential buildings, shown in Figure 3. The health care and lodging buildings excluded from the proposed measure comprise 14% of the floor area of nonresidential buildings.

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[7] The California Building Standards Commission released to state agencies an initial memorandum regarding AB 130 dated October 29, 2025; with revised memorandum dated February 9, 2026.

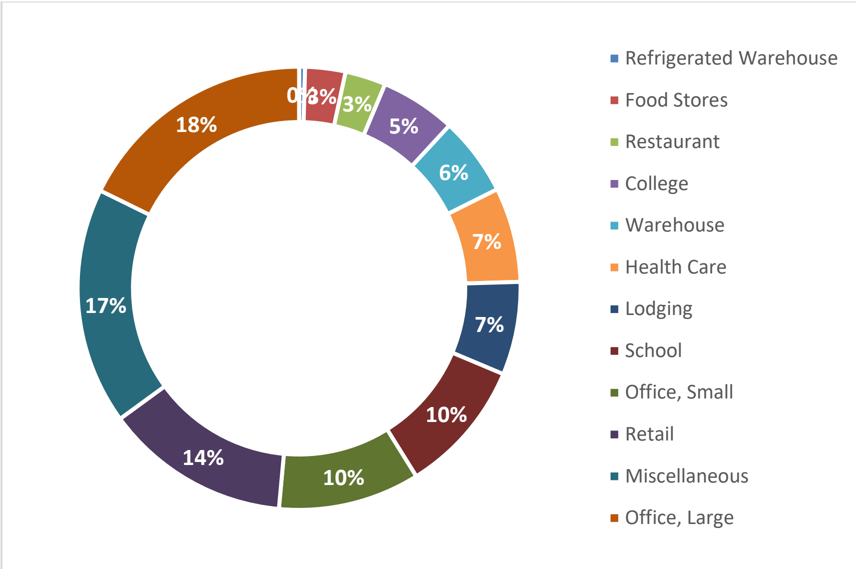

Figure 3: Conditioned Floor Area by Commercial Building Type

Source: 2022 Commercial End-Use Survey (ADM Associates, 2024)

Because the measures are triggered by alterations and additions to existing buildings, the population of affected buildings will most likely include buildings constructed prior to 2000. The proposed measures also do not impact the healthcare and lodging building types, so they were removed from this dataset. 2022 CEUS data (ADM Associates 2024) indicates that more than 70% of nonresidential buildings were constructed prior to 2000. This is seen in Figure 4, where 71% of nonresidential buildings were constructed 1997 or earlier and 15% after 1997. This reveals that more than 70% would have been constructed prior to 2000.

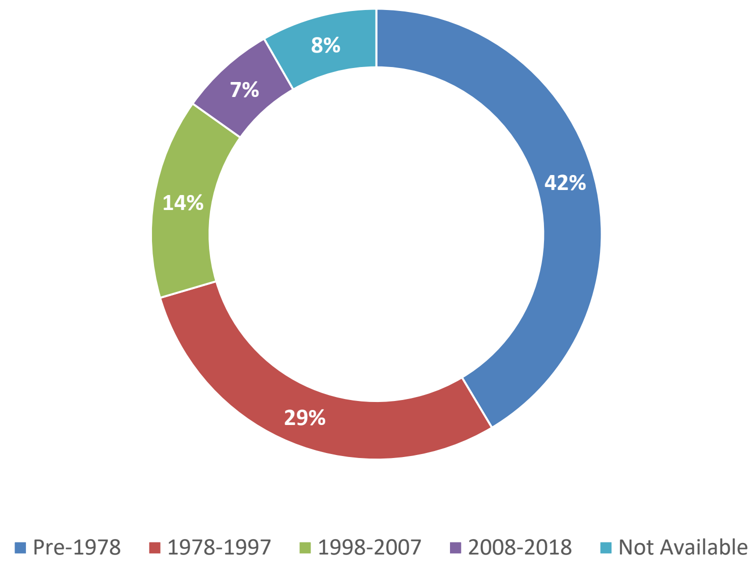

Figure 4: Commercial Building Conditioned Floor Area Breakdown by Vintage

Source: 2022 Commercial End-Use Survey (ADM Associates, 2024)

Not all buildings constructed prior to 2000 continue to operate with their original controls systems. HVAC controls are commonly upgraded when HVAC alterations take place. Figure 5 shows the timing of the last HVAC controls upgrade for buildings constructed prior to 2021 based on 2022 CEUS data. As shown in the figure, the majority of survey respondents had made HVAC controls upgrades but were unable to identify the year in which the upgrade was made. Not visible in the figure are the upgrades in the year bins since 2000; all of these are sufficiently small to represent less than 0.1% of HVAC controls upgrades.

DDC prescriptive requirements (Table 401.2-D of the Restructured 2025 Energy Code, Table 120.2-A in the 2025 Energy Code) were added to the Energy Code in 2016. These requirements apply to nonresidential buildings and require the installation of DDC for newly constructed buildings and additions and alterations of specified HVAC equipment, such as chillers, boilers, AHUs and VAV boxes. HVAC controls upgrades made prior to 2016 may have used pneumatic controls. To quantify the potential population of buildings with pneumatic controls, staff assumed that 50% of the HVAC controls upgrades designated as "Year Unknown" in the 2022 CEUS study were made prior to 2016. Although DDC was not required until 2016 in California, industry practice was already shifting to DDC. Staff estimated that 30% of the HVAC controls upgrades made prior to

2016 were made with pneumatic controls[8]. Thus, approximately 15% of the "Year Unknown" HVAC controls upgrades would be pneumatic.

Combined with the 10% of buildings where data is "Not Available" (meaning no data was available on any upgrades) and the 22% of buildings with "No Upgrades", approximately 45% of nonresidential buildings are likely candidates for upgrades to DDC.

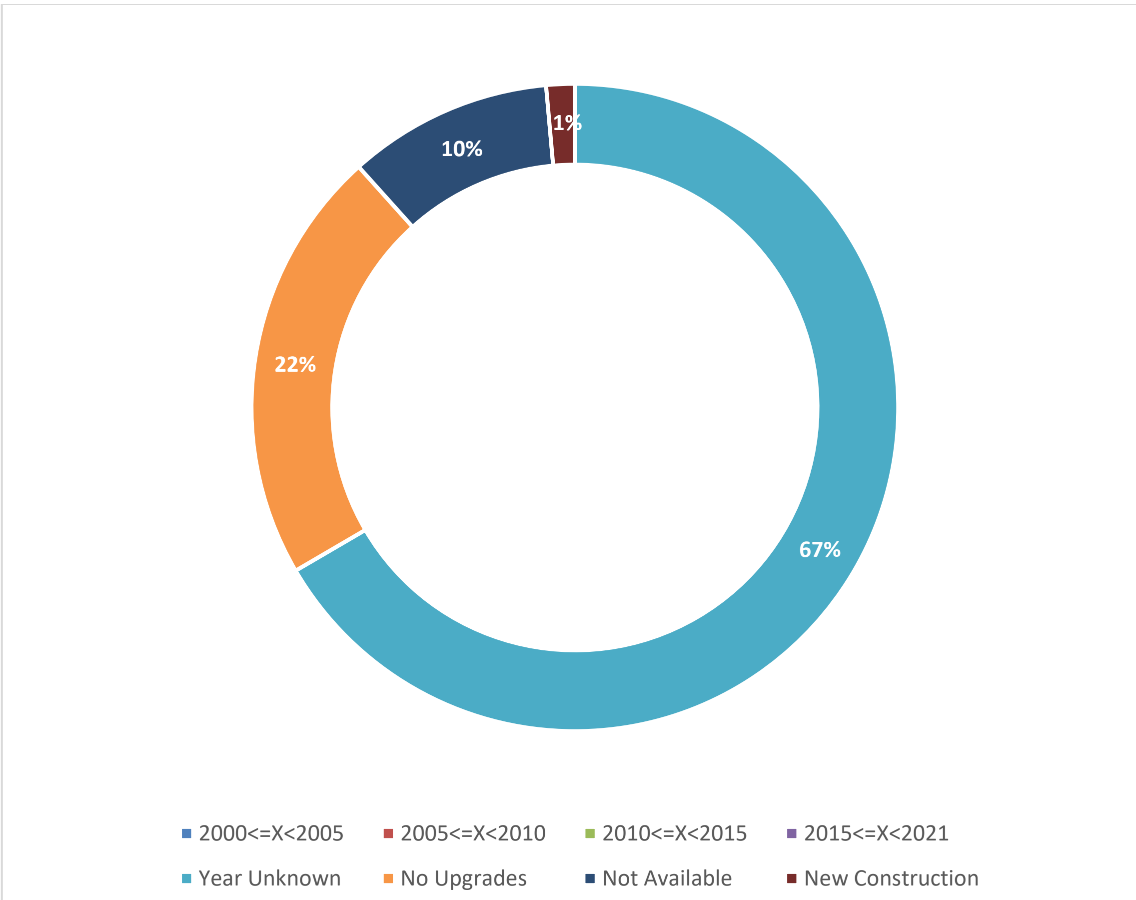

Figure 5: Timing of Last HVAC Controls Upgrade (2000-2021)

Source: 2022 Commercial End-Use Survey (ADM Associates, 2024)

[8] Typical useful life of AHUs and terminal units is 15-20 years, which means that roughly 5-6% of equipment is replaced each year. If all equipment replaced after 2016 includes DDC, 50-60% of equipment would have DDC.

The market for DDC upgrades is strong. DDC controllers are widely available for both new construction and retrofit markets[9]. Many manufacturers offer products designed for upgrades from pneumatic controls. Upgrades can be partial – replacing controllers with DDC while retaining pneumatic tubing and actuators – or a complete upgrade, with new sensors and actuators, A partial upgrade would require electric-to-pneumatic transducers. Since a complete upgrade to DDC, including upgrades of existing terminal units (VAV boxes), carries a high project cost, this analysis assumes a partial upgrade to DDC, with upgrades to replaced air handling units and upgrades to new VAV boxes. This allows for improvements in monitoring and control sequences in a cost-effective manner, and makes for an easier transition for future upgrades.

There are several suppliers for DDC that are available for installation. Many of these systems have the capability to be implemented for individual pieces of equipment, systems or for the entire floor of a building without interrupting other base building (existing and operational) controls, such as, pneumatic systems. Additionally, ASHRAE and other Sequence of Operation (SOO) and control logic are considered industry-standard and are prevalent across consultants and contractors. There is also a strong network of HVAC controls contractors for installation.

Similarly, there is a strong network of consultants who regularly provide EBCx and energy auditing services in California[10]. Staff anticipate that the teams that complete commissioning for newly constructed nonresidential buildings in compliance with Section 1001 of the Restructured 2025 Energy Code (Section 120.8 of the 2025 Energy Code) will be able to provide the EBCx and energy auditing services required by this proposal. The CEC will continue to evaluate workforce availability and work with workforce training partners as needed.

Without the proposed measures, the expected adoption rate for DDC upgrades for space conditioning systems that either have no controls or use a pneumatic control system is moderate to low. The adoption rate is likely highest for packaged airside equipment and for waterside equipment because these equipment types are more likely to come equipped with DDC. Use of DDC in built-up or custom airside systems would be expected to be lower than in off-the-shelf packaged equipment because these systems can be designed to

[9] Over 40% of total commercial floorspace nationwide included building automation systems (BAS) for heating/cooling. US Energy Information Administration, Commercial Buildings Energy Consumption Survey, 2018. https://www.eia.gov/consumption/commercial/data/2018/pdf/CBECS_2018_Building_Characteristics_Flipbook.pdf

[10] For example, the cities of Los Angeles, San Francisco and San Jose already require periodic audits and retrocommissioning of some commercial buildings.

include new equipment with DDC and older equipment without DDC. The adoption rate is expected to be low for DDC at the zone level with terminal unit replacements when the existing systems either have no controls or use a pneumatic control system.

Without this measure, the adoption rate of the EBCx study and report would be expected to be very low. The majority of building owners will simply complete like-for-like replacements of space-conditioning systems equipment and not invest the time and money to right-size the replacement equipment, nor will they collect the data and information ahead of time to make planned equipment replacements near end of useful life with a goal of significantly increasing building efficiency. A large majority of HVAC equipment in the existing building stock was sized to accommodate internal loads that have decreased significantly over time. For example, incandescent lights have largely been replaced with LED lights.

3.2 Design and Construction Practices

There should not be negative impacts to current design and construction practices. DDC is very common and upgrades to obsolete (or no-longer-existent) building controls are relatively common as a part of a tenant improvement or system replacement project. Upgrades to DDC controls often start with upgrades to the air handling units, which are easier to upgrade. A full upgrade to DDC controls requires replacing pneumatic thermostats, actuators, and VAV boxes. Even converting from pneumatic controls to DDC is a common enough retrofit that are typical industry-standard practice.

The local governments that have regular energy audit/RCx requirements have based the frequency of action on best practice for EBCx (such as, every 5 years) for their covered buildings (City of Los Angeles, City of San Francsico, etc.). Beyond these local government requirements, most building owners do not pursue any regular energy audit or RCx activities; EBCx represents a best practice for the industry statewide.

There should not be any negative impacts to health and safety, structural and seismic design, or indoor air qualityfrom these measures. Moreover, typically DDC controls have the capability to use other digital/analog inputs/outputs to track air quality and movement. If the EBCx report leads to right sizing of equipment and planned replacements that are more energy efficient and reduce building emissions, there would be a positive impact on community and environmental health.

3.3 Impacts on Market Actors

The proposed measure could potentially impact building owners with increased cost beyond the cost for a like-for-like replacement. The increased cost stems from two factors:

- Increased cost for installing DDC along with equipment replacement if if DDC was otherwise not going to be installed, and
- Added cost of hiring a consultant to complete the EBCx study.

In contrast, the EBCx study could indicate that a smaller capacity system (airflow, heating/cooling capacity) could be incorporated into the design, and this study/requirement could provide a reduced total project cost due to smaller capacity equipment or distribution systems.

Chapter 4 details the cost of the proposed measure. The increased cost for DDC upgrades is approximately $0.81/ft^2 compared to a replacement unit that does not include DDC. This cost is offset by an expected annual maintenance savings, with a net present cost of $0.41/ft^2.

The added cost for the EBCx study and report is approximately $0.366/ft^2.

The proposed measure will likely increase business for building designers and consultants as they will be asked to provide designs with DDC included as well as to complete EBCx studies. It should be noted that small and local businesses would likely see a larger percentage of the benefit due to the relatively small size and scale of these studies and projects. Similarly, the manufacturers, suppliers and install contractors for DDC will see an increase in business.

3.4 Impacts on Jobs and Businesses

The proposed measure will likely increase business for building mechanical, electrical, plumbing firms and consultants as they will be asked to provide designs with DDC included as well as to complete EBCx studies. Similarly, the manufacturers, suppliers and install contractors for DDC will see an increase in business. This would translate to either a neutral impact or a slight increase in new jobs in the state; the demand could be met by the existing base of consultants, designers, vendors, suppliers, and installers and could potentially produce a market response of increased firms and consultants in this industry space.

3.5 Economic and Fiscal Impacts

The primary economic impacts of this measure are documented in Section 5 of this report. There will also be indirect benefits to the state: operational benefits will include a positive impact on worker comfort and productivity; upgrades to building infrastructure will increase building valuation for commercial real estate managers. As mentioned, local suppliers and distributors of equipment may experience increased sales of DDC controls and hardware.

3.6 Cost of Compliance and Enforcement

The DDC measure is an extension of existing DDC requirements for building alterations, so there should not be a significant increase in the compliance review process. The existing building commissioning requirement may require an additional form or form section to be completed by the commissioning agent. The commissioning agent would deliver to the building owner or agent for the building owner a commissioning report, which details the systems tested, documentation of existing conditions, and any recommended measures. Since this report is a separate standalone report, and the commissioning agent bears responsibility for the services performed, the enforcement agency should only have to verify that the commissioning took place.

On the enforcement side, an enforcement agency may have to review additional documentation verifying that the required DDC controls upgrade took place, as needed. The enforcement agency would also be required to verify that existing building commissioning (EBCx) took place as part of the building additions and alterations process. Note that the primary responsibility lies with the commissioning agent: while the enforcement agency would verify that EBCx occurred, they would not be expected to review a commissioning report in detail. If the enforcement agency requests a copy of the commissioning report, it should be made available. The enforcement activities should not add significant review time for alterations projects that trigger this measure.

As discussed earlier, documentation required to demonstrate compliance is still under development, and will be detailed in the final Rulemaking measure report.

4. COST-EFFECTIVENESS

This section provides a summary of energy savings estimates, costs, and overall cost-effectiveness analysis for the proposed measure. Energy savings, costs, and cost effectiveness of proposed measures are assessed incrementally, in comparison to the latest adopted version of the Energy Code. Best available data is used and references to those data sources are provided to clearly substantiate energy savings, costs, and cost effectiveness.

4.1 Energy Savings Methodology

Consistent with Public Resources Code 25402(b)(3), an energy standard is cost-effective if the life-cycle value of the energy savings (benefits) exceed the life-cycle costs, when amortized over the economic life of the structure. This corresponds to a Benefit-Cost Ratio (BCR) that is 1.0 or greater. BCR is calculated by dividing the total dollar benefit of the measure by the total dollar cost of the measure, over a period of analysis of 30 years.

To calculate benefit, Long-term System Cost (LSC) is used to determine the dollar value of energy efficiency measures in the Energy Code. LSC hourly factors help the state account for long-term benefits associated with policies needed to meet the statewide energy and climate goals – such as 100% renewable generation, proliferation of electric transportation, and reductions in fossil fuel combustion occurring in buildings. Today's energy costs do not adequately account for these long-term values to California's energy system. LSC hourly factors weigh the long-term value of each hour differently, where times of peak demand are more valuable, and times off-peak demand are less valuable. LSC hourly factors are not utility rates or energy rate forecasts. LSC is not a predicted utility bill.

LSC hourly conversion factors are developed and published by the CEC for each code cycle. These LSC hourly factors are used to convert predicted site energy use – an output common to building energy modeling (BEM) software – to 30-year present value to California's energy system.

Energy savings for proposed measures are estimated using both LSC hourly factors and CEC-established model prototypes. Large sets of survey data are used to create prototypes that act as typical representations of common building types in California. These prototypes are created for use in BEM software to provide accuracy and consistency amongst energy models that are used to determine energy savings for the state. CEC-developed prototypes and LSC hourly factors are published by the CEC ahead of each code cycle integral to research versions of CEC's reference Energy Code compliance software (CBECC-Res and CBECC). For this reason, CBECC-Res and CBECC are the CEC-recommended BEM software tools when assessing energy savings of proposed measures.

To calculate cost, first costs and ongoing maintenance costs must be assessed for proposed measures and accounted for over a period of analysis of 30 years. In the BCR, both the benefits and the costs are assessed incrementally, meaning in comparison to the latest adopted version of the Energy Code.

Like LSC hourly factors, the CEC develops and publishes conversion factors for Source Energy, and for GHG Emissions for each code cycle. These three sets of hourly factors are published on CEC's website and formatted to be accessible and usable in combination with broadly available BEM tools.

4.1.1 Measure Savings Approach.

The proposed measures include code changes to Section 401.2.2 for DDC upgrades and to Section 1001.5 for EBCx requirements. The measures are focused on alterations and additions to existing nonresidential buildings. Section 401.2.2 applies to "Nonresidential and hotel/motel buildings". Staff have narrowed this further as follows:

- As specified by Exception 1 to Section 100.4.4, alterations to healthcare facilities are not required to comply with Title 24, Part 6.
- Data Centers are included in the definition of Covered Process and therefore are subject to Section 910 and are not included in the scope of these proposed measures.
- Pursuant to the California Building Standards Commission's (CBSC's) memorandums to state agencies regarding Assembly Bill 130 (2025)[11], these proposed changes do not apply to hotel/motel buildings in their entirety.

Based on this narrowed group of nonresidential buildings, the proposed measures are triggered by alterations or additions of specific HVAC equipment, listed in Table 401.2-D. These are chillers, boilers, AHUs/RTUs, and terminal units such as VAV boxes. Figure 6 and Figure 7, compiled from the 2022 Commercial End Use Survey (ADM Associates 2024) data illustrate the HVAC system types for the types of nonresidential buildings considered, demonstrating that chillers, boilers and packaged systems make up over half of the HVAC systems found in the buildings for the proposed measures. As expected, chiller/boiler systems are

[11] Governor Gavin Newsom signed Assembly Bill 130 (AB130), which pauses new updates to the California Building Standards Code, including the Energy Code, that affect residential units until January 1, 2032. The California Building Standards Commission released to state agencies an initial memorandum regarding AB 130 dated October 29, 2025; with revised memorandum dated February 9, 2026.

concentrated in the largest buildings (colleges and large offices) and packaged systems are common in all building types.

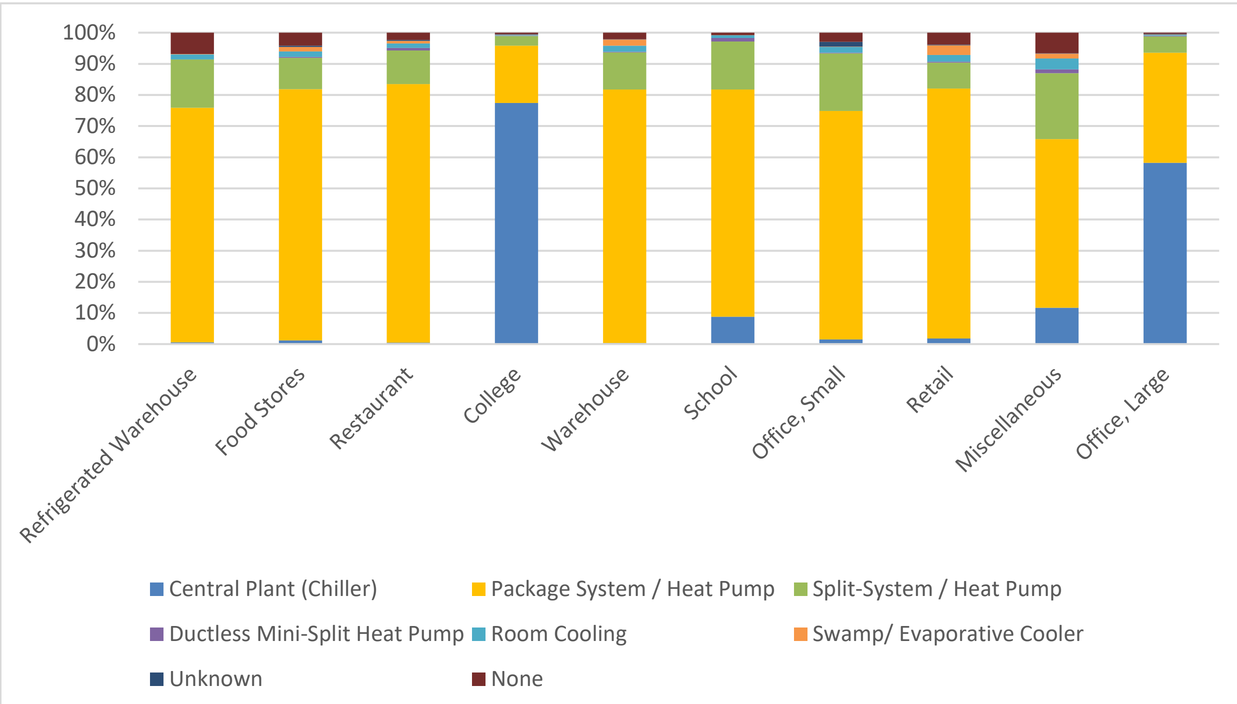

Figure 6: Cooling System by Building Type

Source: 2022 Commercial End-Use Survey (ADM Associates, 2024)

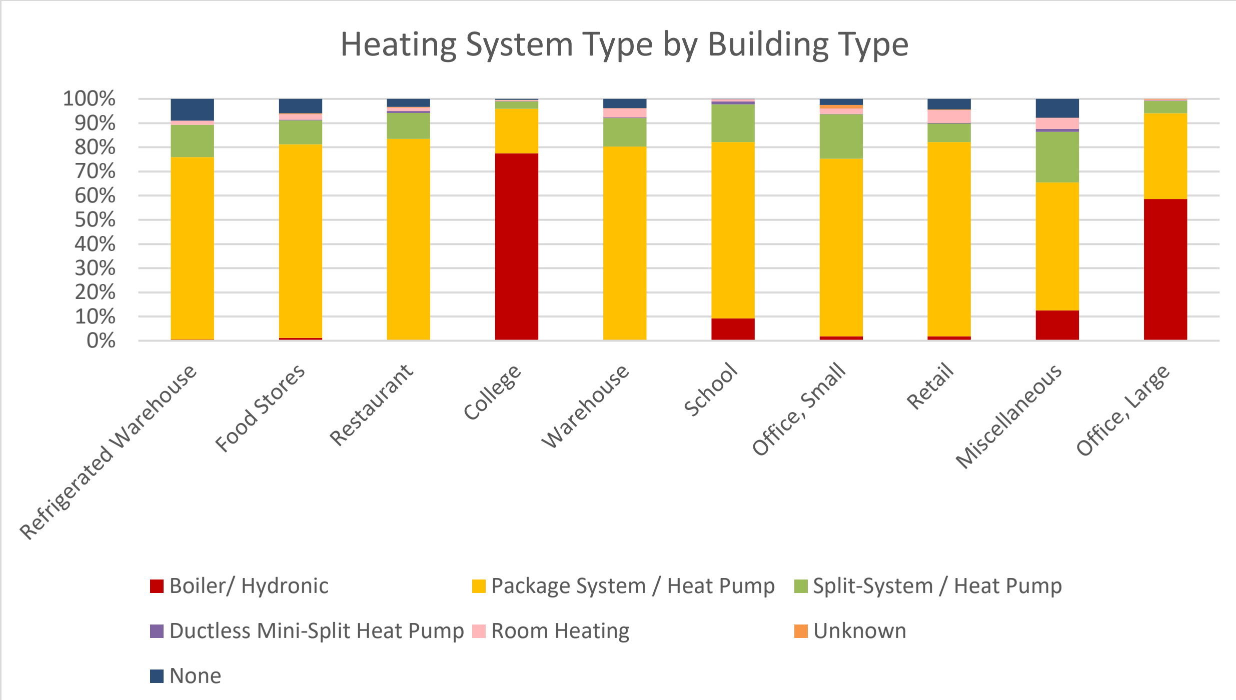

Figure 7: Heating System by Building Type

Source: 2022 Commercial End-Use Survey (ADM Associates, 2024)

The energy savings results for the DDC control upgrade and EBCx measures apply a conservative savings estimate of 10% to all HVAC energy use based on the sources described in Section 4.2. The Long-term System Cost (LSC) for energy consumption for the standard design is determined from CBECC 2025 models of a large office building. Similar energy saving results are expected for other building types.

4.2 Energy Savings Results

Energy savings estimates are based on published findings on the energy savings of DDC controls and existing building commissioning.

A previous study as part of the 2016 Energy Code update (Bailey 2015) estimated savings measures from extending the requirements for DDC controls to a broader set of buildings in California. The study modeled energy savings resulting from the added ability to incorporate demand control ventilation, demand-based temperature and pressure resets, and demand-response measures. Due to additional DDC measures in this code change proposal, the energy savings for upgrades to DDC would likely be higher than those estimated in 2016. The 2016 study estimated energy savings of 0.3 to 0.8 kWh/ft^2, depending on climate zone.

A meta-study that reviewed energy savings from existing building commissioning projects across 1,299 buildings (Crowe 2020) revealed a median energy savings of 5 to 14 percent. The study also found that 87% of all measures implemented were HVAC-related, with 3% concerning lighting and 10% designated as "other." The study's average savings from office building EBCx projects of 6% was applied to the HVAC energy use from the large office building energy model prototype, to estimate savings for the code change proposal. With an average project cost of $0.366/ft^2$, the EBCx projects were highly cost effective (Crowe 2020).

For the cost effectiveness analysis, HVAC energy savings are estimated as a percentage of the total HVAC energy use for the 2025 CBECC large office building prototype model. The proposed changes apply to all nonresidential buildings, with exceptions noted in Section 4.1 above. Given the exceptions for alterations and the targeted HVAC capacities of the proposed changes, code change proposals are mostly likely to apply to medium to large nonresidential buildings.

Table 9: Prototype(s) Used for Energy, Cost, and Environmental Analysis

Prototype ID	Occupancy Type (Residential, Retail, Office, etc.)	Floor Area (ft^2)	Number of Stories	Statewide Floor Area (Million ft^2)
Large Office	Office	498,589	13	1,046

The LSC savings estimate is based on a 10% reduction in HVAC system energy use, in alignment with previous studies.

Table 10: DDC Upgrade LSC Savings Over 30-Year Period of Analysis

Climate Zone	30-Year Electricity LSC Savings (PV$)	30-Year Natural Gas LSC Savings (PV$)	30-Year Total Energy LSC Savings (PV$)
1	$0.402	$0.442	$0.844
2	$0.617	$0.344	$0.961
3	$0.503	$0.266	$0.769
4	$0.647	$0.225	$0.872
5	$0.547	$0.283	$0.830
6	$0.739	$0.102	$0.841
7	$0.766	$0.101	$0.867
8	$0.894	$0.150	$1.044
9	$0.851	$0.139	$0.990
10	$0.933	$0.153	$1.086
11	$0.870	$0.323	$1.193
12	$0.736	$0.298	$1.034
13	$0.890	$0.242	$1.132
14	$0.903	$0.337	$1.240
15	$1.286	$0.980	$1.384
16	$0.605	$0.727	$1.332

Energy savings estimates for chiller plant and boiler plant upgrades are derived by applying a 15% savings level for cooling and heating energy use for modest upgrades to control sequences. For older buildings that have no resets of either chilled water supply temperature or at the air handlers, a more aggressive energy savings estimate of 25% is applied. Energy savings from DDC upgrades to chiller plants and boiler plants are shown in Table 16 and Table 17 in the cost effectiveness summary section.

Table 11: EBCx LSC Savings Over 30-Year Period of Analysis

Climate Zone	30-Year Electricity LSC Savings (PV$)	30-Year Natural Gas LSC Savings (PV$)	30-Year Total Energy LSC Savings (PV$)
1	$0.241	$0.265	$0.506
2	$0.370	$0.206	$0.577
3	$0.302	$0.160	$0.461
4	$0.388	$0.135	$0.523
5	$0.328	$0.170	$0.498
6	$0.443	$0.061	$0.505
7	$0.460	$0.061	$0.520
8	$0.536	$0.090	$0.626
9	$0.511	$0.083	$0.594
10	$0.560	$0.092	$0.652
11	$0.522	$0.194	$0.716
12	$0.442	$0.179	$0.620
13	$0.534	$0.145	$0.679
14	$0.542	$0.202	$0.744
15	$0.772	$0.588	$0.830
16	$0.363	$0.436	$0.799

4.3 Economic and Fiscal Impacts

Economic and fiscal impacts of this proposal are anticipated to be limited. The proposed measure is triggered when existing equipment is replaced, and is limited to low cost actions intended to both increase energy efficiency and set a strong foundation for future building upgrades. The intent is to also provide the information necessary for planning future equipment replacements and upgrading energy management control systems (EMCS) to enhance space conditioning efficiency.

This measure will create minimal cost burden for state and local governments.

4.4 Incremental First Cost

Incremental costs for a DDC upgrade include costs for a DDC controller, sensors, electric-to-pneumatic transducers, and commissioning.

Table 12: Cost for DDC Upgrade in an AHU

Component	Equipment	Labor	Subtotal	Source	Notes
Sensors	$592	$1916	$2508	RSMeansOnline, Non-union labor rates	Supply air temp, mixed air temp, outside air temp, airflow measurement station
Electric-to-pneumatic transducers	$3000	$750	$3750	AC Direct (HVAC equipment wholesale distributor), labor costs from Schneider Electric installation estimate and $200/hr loaded rate	Five electric-to-pneumatic transducers, 45 min labor each to install
DDC Controller and Controls Installation	n/a	n/a	$12000	Estimated $1200/point at 10 points (partial DDC install)	Cost to install for industry average, wiring, device mounting, pneumatic tie-ins
Commissioning	n/a	$3000	$2000	Subject matter expert estimate	Point checkout, sequence validation, Test Adjust Balance testing coordination
Total			$20,258		

A second, independent estimate from a controls engineer estimated that an upgrade of an AHU to DDC controls would cost between $10,000 and $20,000, covering the cost of the controller, its integration with an existing BACnet system, and an allocation of $1,000 per control point. This estimate is consistent with the estimate above.

The AHU in the large office prototype serves an area of 38,353 ft^2, resulting in a cost of $0.56 /ft^2. Since air handling unit size can vary, this cost effectiveness study conservatively assumes the same incremental cost for an AHU serving 25,000 ft^2, or $0.81/ft^2.

Existing building commissioning costs are derived from the median costs for ~1,299 moderately large buildings identified in a metadata review (Crowe 2020). The study reported median EBCx costs of $3.94/m^2$, or $0.366/ft^2$. The same study reported average energy savings from office building EBCx studies of 6%. The study also found that 87% of all measures implemented were HVAC-related, with 3% concerning lighting and 10% designated as "other." Staff applied the 6% average only to the HVAC portion of annual energy costs to estimate cost effectiveness for the EBCx measure. This is a conservative estimate since 87% of the whole building savings are likely due to HVAC. Instead, savings in this report is based on only 6% of HVAC energy use, which typically represents approximately 30-50% of whole building energy use[12].

Chiller and boiler plant upgrades to DDC consist of adding control points and sensors and updating control sequences. While costs depend on the number of boilers and chillers, and whether the building has a primary-only or primary-secondary distribution system[13], an estimate of cost to upgrade central plant equipment for a large office building aligned with the building energy model prototype is shown in the table below.

[12] U.S. Energy Information Administration, 2018 Commercial Buildings Energy Consumption Survey, December 2022 - https://www.eia.gov/energyexplained/use-of-energy/commercial-buildings.php

[13] A primary-only hydronic system is a hydronic configuration where all water flow is routed through the water conditioning plant and terminal units in a single loop, with no separate "secondary" loop for distribution. In contrast, a primary-secondary hydronic system includes two sets of pumps, distribution system pumps and water conditioning system pumps. The distribution system pumps distribute water to the terminal units and the water conditioning system pumps circulate water through a loop that serves the water conditioning equipment only.

Table 13: Cost for DDC Upgrade to Chiller and Boiler

Component Upgrade	Unit Cost	Quantity	Total Cost	Reference
Chiller DDC upgrade	$32,500	3	$97,500	R&R 2025
Chiller Front End Programming	$30,000	1	$30,000	R&R 2025
Chiller Subtotal			$127,500	
Boiler Control Points	$1000	140	$140,000	Point Breakdown: Boilers-40 Pumps-30 Sensors-20 Valves-30 Plant Logic-20
Boiler Plant Optimization	$7,243	1	$7,243	RSMeans 230923108200
Boiler Subtotal			$147,243	

The DDC project upgrade costs are $127,500 for the chiller plant and $147,243 for the boiler plant. Applying the large office model prototype conditioned floor area of 498,589 ft^2 (see Table 9), these costs are $0.256/$ft^2$ and $0.295/$ft^2$ for the chiller and boiler plant, respectively.

Fan coil unit replacements are available with pneumatic or DDC controls. In most cases, the upgrade would require a smart thermostat. DDC upgrades of fan coil units do carry significant costs: an actuator for the control value, the smart thermostat, programming and mapping of points for room temperature, discharge air temperature, and fan status. These upgrades cost approximately $2,400.

Additional benefits can be realized by fitting an electronically commutated motor (ECM) onto a fan coil unit. A one-half power motor costs $450 and costs $450 to install, with a fully burdened labor rate of $150/hr[14]. Adding an ECM motor would increase the cost but unlock additional benefits due to fan

[14] The fully burdened labor rate represents the complete cost a company incurs to employ a worker, not just their base salary or hourly wage. It includes direct wages, employer-paid taxes, benefits, paid time off, training, equipment, and a share of overhead costs such as rent and administrative expenses.

operation at multiple speeds. Including an ECM motor was not included in the cost effectiveness analysis.

The energy savings for the fan coil upgrade depends upon control capabilities of the upstream components and of the other terminal units. Improved control of scheduling, monitoring for faults, and the added ability to adjust fan speeds if a variable speed drive is installed will contribute towards energy savings. It is far more cost effective to add DDC capability when installing a new unit, rather than working to retrofit an upgrade to an existing unit. Including a variable speed drive in the fan coil upgrade was not included in the cost effectiveness analysis.

4.5 Incremental Maintenance Costs

An upgrade to DDC controls typically reduces maintenance costs, by reducing the maintenance staff required to respond to occupant complaints about space temperatures being too hot or too cold calls (Trane 2026). Maintenance costs are decreased by reduced manual intervention to calibrate pneumatic controls, and through more robust monitoring and reporting, enabling maintenance staff to more rapidly find the root cause of problems. Annual maintenance cost savings depend on the scope of the upgrade. Staff used a median estimate of 10% annual maintenance cost savings consistent with case studies (Hydeman et al., 2006; Rowan et al., 2014)[15].

A maintenance contract for an office building in California can cost $0.25/ft^2 (Shyft 2026); therefore, annual savings of $0.02/ft^2 can be expected with a DDC upgrade.

Existing building commissioning is not expected to result in increased maintenance costs and could reduce O&M costs; this effect has not been quantified.

4.6 Cost Effectiveness

Cost-effectiveness analysis is required to determine the economic impact of proposed measures over a 30-year period of analysis. This analysis must consider and include incremental energy savings for all impacted energy sources (electricity and natural gas), incremental first costs, and incremental maintenance costs over a 30-year period of analysis. Design costs and

[15] Hydeman et al., 2006 found maintenance cost savings of 20-40%. Rowan et al., 2014 found maintenance cost savings of 2%. Staff anticipate savings to be relatively higher due to increased information at the zone level and improved ability to identify the roof cause of faults and issues.

incremental costs associated with code compliance are not included in this analysis.

For purposes of the California Energy Code, a standard is cost-effective if the life-cycle value of the energy savings (benefits) exceed the life-cycle costs, when amortized over the economic life of the structure. This corresponds to a Benefit-Cost Ratio (BCR) that is equal to or greater than 1.0. BCR is calculated by dividing the total present value cost benefits by the total present value costs.Table 15 provides savings and costs for the DDC upgrades, based on a large office building. Combining incremental first costs ($0.81/ft^2) for the project and the present value of annual recurring maintenance savings ($0.40/ft^2), the measure is cost effective in all climate zones.

Table 14: DDC Upgrade Cost-effectiveness Summary

Climate Zone	Benefit: Total Incremental LSC Savings and Other Savings (PV$)	Cost: Total Incremental First Costs and Maintenance Costs[1] (PV$)	Benefit-Cost Ratio (BCR)
1	$0.844	$0.41	2.06
2	$0.961	$0.41	2.34
3	$0.769	$0.41	1.88
4	$0.872	$0.41	2.13
5	$0.830	$0.41	2.02
6	$0.841	$0.41	2.05
7	$0.867	$0.41	2.11
8	$1.044	$0.41	2.55
9	$0.990	$0.41	2.41
10	$1.086	$0.41	2.65
11	$1.193	$0.41	2.91
12	$1.034	$0.41	2.52
13	$1.132	$0.41	2.76
14	$1.240	$0.41	3.02
15	$1.384	$0.41	3.38
16	$1.332	$0.41	3.25

1 – Note that the present value of net incremental cost includes incremental first costs and an annual maintenance cost savings of $0.02/ft2

With conservative savings estimates of 15% of cooling energy and chiller plant pumping energy, the chiller DDC upgrade submeasure is cost effective in all climate zones except 1, 3, 5, and 16. With 15% estimated energy savings for the boiler DDC upgrade, from temperature resets and improved monitoring, the boiler DDC upgrade is cost effective in all climate zones except 6 and 7, where heating loads are low.

Table 15: Chiller Plant DDC Upgrade Cost-effectiveness Summary

Climate Zone	Benefit: Total Incremental LSC Savings and Other Savings (PV$) Low Estimate	Benefit: Total Incremental LSC Savings and Other Savings (PV$) High Estimate	Cost: Total Incremental First Costs and Maintenance Costs[1] (PV$)	Benefit-Cost Ratio (BCR) (Low)	Benefit-Cost Ratio (BCR) (High)
1	$0.032	$0.05	$0.256	0.13	0.21
2	$0.315	$0.53	$0.256	1.23	2.06
3	$0.198	$0.33	$0.256	0.77	1.29
4	$0.377	$0.63	$0.256	1.47	2.46
5	$0.244	$0.41	$0.256	0.95	1.59
6	$0.501	$0.84	$0.256	1.96	3.27
7	$0.524	$0.87	$0.256	2.05	3.42
8	$0.690	$1.15	$0.256	2.70	4.51
9	$0.657	$1.10	$0.256	2.57	4.29
10	$0.728	$1.21	$0.256	2.84	4.76
11	$0.659	$1.10	$0.256	2.57	4.31
12	$0.493	$0.82	$0.256	1.93	3.22
13	$0.703	$1.17	$0.256	2.75	4.59
14	$0.644	$1.07	$0.256	2.52	4.21
15	$1.231	$2.05	$0.256	4.81	8.05
16	$0.199	$0.33	$0.256	0.78	1.30

Table 16: Boiler Plant DDC Upgrade Cost-effectiveness Summary

Climate Zone	Benefit: Total Incremental LSC Savings (Low)	Benefit: Total Incremental LSC Savings (High)	Cost: Total Incremental First Costs and Maintenance Costs[1]	Benefit-Cost Ratio (BCR) (Low)	Benefit-Cost Ratio (BCR) (High)
1	$0.78	$1.30	$0.295	2.66	4.41
2	$0.65	$1.08	$0.295	2.21	3.67
3	$0.50	$0.83	$0.295	1.7	2.82
4	$0.46	$0.77	$0.295	1.56	2.60
5	$0.54	$0.90	$0.295	1.84	3.05
6	$0.28	$0.47	$0.295	0.94	1.58
7	$0.25	$0.42	$0.295	0.84	1.41
8	$0.31	$0.52	$0.295	1.04	1.75
9	$0.34	$0.57	$0.295	1.16	1.92
10	$0.37	$0.62	$0.295	1.25	2.09
11	$0.66	$1.10	$0.295	2.23	3.73
12	$0.60	$1.00	$0.295	2.03	3.39
13	$0.52	$0.87	$0.295	1.77	2.94
14	$0.68	$1.13	$0.295	2.31	3.84
15	$0.29	$0.48	$0.295	1.00	1.64
16	$1.32	$2.20	$0.295	4.49	7.46

Low estimate results in a 15% energy cost savings of the heating plant; a high estimate assumes fewer controls for the existing building , which results in a 25% energy cost savings of the heating plant.

Table 18 provides savings and costs for the EBCx, based on the documented results from previous studies. The measure is cost effective in all climate zones.

Table 17: EBCx Cost-effectiveness Summary

Climate Zone	Benefit: Total Incremental LSC Savings and Other Savings (PV$)	Cost: Total Incremental First Costs and Maintenance Costs[1] (PV$)	Benefit-Cost Ratio (BCR)
1	$0.506	$0.366	1.38
2	$0.577	$0.366	1.58
3	$0.461	$0.366	1.26
4	$0.523	$0.366	1.43
5	$0.498	$0.366	1.36
6	$0.505	$0.366	1.38
7	$0.520	$0.366	1.42
8	$0.626	$0.366	1.71
9	$0.594	$0.366	1.62
10	$0.652	$0.366	1.78
11	$0.716	$0.366	1.96
12	$0.620	$0.366	1.70
13	$0.679	$0.366	1.86
14	$0.744	$0.366	2.03
15	$0.830	$0.366	2.27
16	$0.799	$0.366	2.18

5. Statewide Impacts

This section provides the first-year statewide savings of the proposed measure. This analysis estimates the overall value of the proposed measure to the State of California and is not used to determine cost effectiveness of the proposed measure. To assist with this analysis a statewide new construction forecast was developed by the CEC for 2029, which is presented in more detail in *Appendix A: Statewide Savings Methodology*. The first-year energy impacts represent the first year annual savings from all buildings forecasted to be renovated in 2029. This section also provides statewide greenhouse gas emissions savings, water use impacts, materials impacts and environmental impacts.

Determining the statewide impact for the proposed code measure begins with understanding the potential number of buildings that would benefit from upgrades to/installation of DDC. These can be buildings that either do not have existing control systems or may have pneumatic controls. The CEC investigated the penetration of DDC in the California building stock in preparation for some previous code measures proposed for the 2025 Title 25, Part 6. The 2022 report, Demonstrating Scalable Operational Efficiency Through Optimized Controls Sequences and Plug-and-Play Solutions (Cheng, Singla and Paliaga 2022), Appendix F, includes market data on building HVAC controls. These data are taken from the 2014 California Commercial Saturation Survey (CSS) (CPUC 2014).

A more recent report from the National Renewable Energy Laboratory (NREL), now the National Laboratory of the Rockies (NLR), studied barriers, drivers and costs for implementing HVAC controls systems. According to the report, over 75% of nonresidential buildings have not implemented HVAC controls (Trenbath et al. 2022). Breaking this down, the report states that nearly 60% of buildings over 50,000 ft^2 have HVAC controls whereas only 13% of buildings less than 50,000 ft^2 have them. These results align with the CSS results shown in Table 20, with about 60% of large buildings having an EMS and about 12% of the Medium and Small buildings having an EMS.

Comparing to the CEUS data for HVAC Controls upgrades in Figure 5, reinforces the results. While approximately 67% of nonresidential buildings have upgraded their HVAC controls since 2000, the vast majority did not identify the year of the upgrade. As discussed in Section 3.1, a portion of these upgrades may not have been DDC. It is also not clear if the CEUS definition for HVAC controls refers only to an EMS or if it may include stand alone controls like smart or programmable thermostats.

The CSS categorized buildings as large, medium, small, or very small but did not define them as specific floor areas. Based on a review of the CSS data, staff developed general floor area ranges represented by these categories as follows:

Table 18: CSS Building Type Estimated Size

	Size Range (ft^2)
Large	100,000 +
Medium	10,000 – 100,000
Small	5,000 – 10,000
Very Small	< 5,000

The market study (Cheng, Singla and Paliaga 2022) provides data on the market penetration of energy management systems (EMS) for nonresidential buildings. The study indicated the share of buildings with EMS, and the share of those EMS buildings that control HVAC. The study also looked at age of EMS and indicated those buildings with systems less than 5 years old. Our proposed changes are concerned with older EMS that may use pneumatic systems. Staff used the market study data to determine the number of buildings that would have EMS more than 5 years old, and made an assumption that 30 percent of these systems would use pneumatic systems. In addition to these pneumatic systems, staff are interested in buildings with no EMS that would benefit from the installation of DDC. Staff calculated the total number of nonresidential buildings that would meet the criteria of having no DDC installed, whether no EMS or an EMS using pneumatic controls.

Table 20 below summarizes the market data and number of buildings that form the population subject to the proposed changes. Staff have excluded healthcare and lodging (hotel/motel) buildings as representing a total of 14% of nonresidential buildings per Figure 3. Staff also used the more recent CEUS data to scale up the number of buildings with HVAC controls. Staff scaled the large buildings up to 67%, in line with the CEUS data. Staff scaled the other building size groups up proportionally with the increase in number of large buildings.

Table 19: DDC Market Penetration

	Building Quantity				
Original CSS Dataset	**Large**	**Medium**	**Small**	**Very Small**	**Total**
Total No. Buildings	117,660	262,473	334,880	190,067	905,080
CSS Determined Share with EMS	59.6%	21.7%	2.5%	0.2%	15%
No. Buildings	70,126	56,957	8,372	381	135,836
Exclude Healthcare + Lodging (14% of NonRes Bldgs)	60,308	48,983	7,200	328	116,819
Share of EMS that control HVAC	78.2%	78.2%	78.2%	78.2%	78.2%
No. Buildings with EMS that control HVAC	47,162	38,305	5,631	257	91,355

Adjust for HVAC Controls Upgrades per 2022 CEUS					
Total No. Buildings	117,660	262,473	334,880	190,067	905,080
CEUS Adjusted Share with EMS	67.0%	30.0%	10.0%	0.2%	21%
Adjusted No. Buildings	78,833	78,742	33,488	381	191,444
Exclude Healthcare + Lodging (14% of NonRes Bldgs)	67,796	67,718	28,800	328	164,642
Share of EMS that control HVAC	78.2%	78.2%	78.2%	78.2%	78.2%
Adjusted No. Buildings with EMS that control HVAC	53,017	52,956	22,522	257	128,752
Estimate Type of EMS (DDC vs. Pneumatic)					
EMS newer than 5 years	47.5%	47.5%	47.5%	47.5%	66.9%
No. Buildings	25,184	25,155	10,698	123	61,160
EMS older than 5 years	52.5%	52.5%	52.5%	52.5%	74.0%
No. Buildings	27,833	27,801	11,824	134	67,592
Estimate 30% of "old" EMS are pneumatic	30.0%	30.0%	30.0%	30.0%	30.0%
No. Buildings with pneumatics	8,350	8,341	3,548	41	20,280
No. Buildings with no EMS	33,391	158,009	259,197	163,130	613,727
No. Buildings for DDC Upgrades	41,741	166,350	262,745	163,171	634,007

Source: NORESCO analysis; 2014 California Commercial Saturation Survey (CSS) (CPUC 2014), 2022 Commercial End-Use Survey (ADM Associates, 2024)

Table 21 summarizes the data in terms of building energy consumption (MWh) to estimate energy consumption.

Table 20: DDC Market Penetration (Energy Use)

	Building Energy Use				
CSS Original Dataset	**Large**	**Medium**	**Small**	**Very Small**	**Total**
Total MWh	16,251,506	24,052,229	18,201,686	6,500,602	65,006,023
CSS Share with EMS	63.8%	23.8%	4.2%	0.4%	26%
MWh	10,368,461	5,724,431	764,471	26,003	16,883,366
Exclude Healthcare + Lodging (14% of NonRes Bldgs)	8,916,876	4,923,011	657,445	22,363	14,519,695
Share of EMS that control HVAC	78.2%	78.2%	78.2%	78.2%	67.3%
MWh	6,972,998	3,849,795	514,123	17,488	11,354,404
Adjust for HVAC Controls Upgrades per 2022 CEUS					
Total MWh	16,251,506	24,052,229	18,201,686	6,500,602	65,006,023
CEUS Adjusted Share with EMS	67.0%	30.0%	10.0%	0.2%	31%
Adjusted No. Buildings / MWh	10,888,510	7,215,669	1,820,169	13,002	19,937,350
Exclude Healthcare + Lodging (14% of NonRes Bldgs)	9,364,119	6,205,475	1,565,345	11,182	17,146,121
Share of EMS that control HVAC	78.2%	78.2%	78.2%	78.2%	78.2%
Adjusted MWh with EMS that control HVAC	7,322,741	4,852,682	1,224,101	8,745	13,408,269
Estimate Type of EMS (DDC vs. Pneumatic)					
EMS newer than 5 years	47.5%	47.5%	47.5%	47.5%	56.1%
MWh	3,478,302	2,305,024	581,448	4,154	6,368,928

EMS older than 5 years	52.5%	52.5%	52.5%	52.5%	62.0%
MWh	3,844,439	2,547,658	642,653	4,591	7,039,341
Estimate 30% of "old" EMS are pneumatic	30.0%	30.0%	30.0%	30.0%	30.0%
MWh with pneumatics	1,153,332	764,298	192,796	1,378	2,111,804
MWh with no EMS	4,612,177	14,479,442	14,088,105	5,579,336	38,759,059
MWh for DDC Upgrades	5,765,509	15,243,740	14,280,901	5,580,714	40,870,863

Source: NORESCO analysis; 2014 California Commercial Saturation Survey (CSS) (CPUC 2014), 2022 Commercial End-Use Survey (ADM Associates, 2024)

The proposed changes will take effect in 2029, so staff adjusted for the number of buildings that will have made DDC upgrades since the 2022 CEUS report, with data coming from 2021.

First, staff assumed all new buildings since 2021 included DDC and would not be impacted by proposed measure. This is based on results from a market survey documented in a 2006 Workshop Report. Stakeholders indicated that 90%-95% of the new construction market was DDC to the zone level (Hydeman, Stein & Zhou 2006, 8-10).

Next, DDC prescriptive requirements (Table 120.2-A) were added to the Energy Code in 2016. These requirements apply to nonresidential buildings and require the installation of DDC for newly constructed buildings and upon alterations of specified HVAC equipment, such as chillers, boilers, AHUs and VAV boxes.

To account for DDC upgrades made during alterations staff calculated an average HVAC alteration rate using permit records in DODGE data[16]. The DODGE data did not specify which type of permit, so staff made an assumption that 2/3 (67%) of permits were upgrades that would include DDC upgrades, whether HVAC alterations or tenant improvement (TI) updates. On average, 0.6% of buildings issued permits for alterations related to DDC upgrades and this estimate was used to represent the annual average DDC upgrades in the market.

Table 21: Annual Estimated DDC Upgrades

Climate Zone	Total No. Buildings	Total No. Bldg. Alteration Permits	Percentage of Bldgs with ALT Permits	Estimated ALT Permits Impacting DDC	Bldgs with DDC related ALT Permits
1	4,994	24	0.5%	67.0%	0.32%
2	23,455	114	0.5%	67.0%	0.33%
3	78,179	574	0.7%	67.0%	0.49%

[16] Dodge Construction Network Data

4	38,364	489	1.3%	67.0%	0.85%
5	11,363	76	0.7%	67.0%	0.45%
6	37,959	435	1.1%	67.0%	0.77%
7	28,965	443	1.5%	67.0%	1.02%
8	57,856	801	1.4%	67.0%	0.93%
9	77,103	456	0.6%	67.0%	0.40%
10	55,993	589	1.1%	67.0%	0.71%
11	29,066	186	0.6%	67.0%	0.43%
12	109,058	585	0.5%	67.0%	0.36%
13	43,151	327	0.8%	67.0%	0.51%
14	10,371	86	0.8%	67.0%	0.56%
15	9,978	87	0.9%	67.0%	0.58%
16	15,130	73	0.5%	67.0%	0.32%

Source: NORESCO analysis; DODGE data

We multiplied this average annual alteration rate by 8 years (2021-2029) to account for DDC upgrade alterations made since the CEUS. Table 23 shows the application of these adjustments to the number of buildings that met the criteria in Table 20.

Table 22: Number of Buildings Available for DDC Upgrades in 2029

	Building Quantity				
	Large	**Medium**	**Small**	**Very Small**	**Total**
Annual Upgrades to DDC	0.6%	0.6%	0.6%	0.6%	2%
Annual No. Buildings Upgraded to DDC	235	938	1,481	920	14,299
Estimated No. Buildings with DDC Upgrades 2021-2029	1,883	7,504	11,852	7,360	28,598
Remaining No. Buildings for Upgrade to DDC	39,858	158,846	250,893	155,811	605,409

Source: NORESCO analysis

5.1 Statewide Energy and Energy Cost Savings

We used the average HVAC alteration rate to estimate the number of buildings that would upgrade to DDC in the first year compared to the 2025 Energy Code.

The 2025 Energy Code requires DDC upgrades for alterations to chillers, boilers and AHUs/RTUs that have capacities of 300 kBtu/hr (25 tons) or larger. DDC upgrades are required for terminal units when all other terminal units served by an AHU are DDC. Based on these requirements, staff estimate that DDC upgrades will take place in HVAC alterations for buildings greater than 50,000 ft^2. Table 24 represents the population for the 2025 Energy Code requirements; all large buildings and half of medium buildings were included in this estimate as representing buildings greater than 50,000 ft^2.

Table 23: Estimated Number of Buildings Requiring DDC Upgrade in 2029 per 2025 Energy Code

	Building Quantity				
	Large	Medium	Small	Very Small	Total
Buildings meeting criteria for 2025 code	39,858	79,423	0	0	119,281
Percent annual DDC upgrades from DODGE data	0.6%	0.6%	0.0%	0.0%	1%
Estimated No. Buildings Upgrade to DDC in 2029	225	448	0	0	673

Source: NORESCO analysis

The proposed measures adjust the HVAC capacity thresholds and requirements for terminal unit upgrades. EBCx studies will be required for alterations to chillers, boilers that have capacities of 300 kBtu/hr (25 tons) and for alterations to AHUs/RTUs that have capacities of 150 kBtu/hr (12.5 tons). DDC upgrades will be required for the alterations to these same equipment types and capacities, as well as for any terminal unit replacements. In addition, if the alteration includes 50% or more of terminal units served by the same AHU, DDC upgrades will be required at the AHU also. These expanded requirements increase the number of expected upgrades compared to the 2025 Energy Code requirements. The reduced AHU capacity thresholds are expected to impact buildings greater than 10,000 ft^2, which is represented by all large and medium buildings. The expansion of terminal unit upgrade requirements are expected to include buildings down to approximately 7,500 ft^2, which staff represented as up to half of the small buildings. Table 25 provides the number of buildings expected to upgrade to DDC in the first year under the proposed measures.

Table 24: Estimated Number of Buildings Impacted in 2029 per Proposal

	Building Quantity				
	Large	Medium	Small	Very Small	Total
Buildings meeting criteria for proposed changes	39,858	158,846	125,447	0	324,151
Percent annual DDC upgrades from DODGE data	0.6%	0.6%	0.6%	0.0%	2%
Estimated No. Buildings Upgrade to DDC in 2029	225	896	707	0	1,828

We multiplied these quantities by the estimated savings for an individual building (Section 4.2) to calculate the statewide impact. The savings for an individual building were represented as the average across climate zones, weighted by the percentage distribution of buildings in each climate zone. The statewide savings account for excluding the chiller DDC upgrade measure for climate zone 1, 3, 5 and 16, and for excluding the boiler DDC upgrade measure for climate zones 6 and 7.

Table 25: Estimated Statewide Energy Savings

	First Year Statewide Electricity Savings (GWh)	First Year Statewide Power Demand Reduction (MW)	First Year Statewide Natural Gas Savings (Million Therms)	First Year Statewide Electricity LSC Savings (PV$)	First Year Statewide Natural Gas LSC Savings (PV$)
Sub-measure 1: DDC Upgrade Requirements	125	0	4	$7,553,646	$3,167,958
Sub-Measure 2: Chiller DDC Upgrade	18	0	0	$1,062,524	$0
Sub-Measure 3: Boiler DDC Upgrade	0	0	4	$0	$257,409
Sub-measure 4: EBCx Requirements	75	0	2	$4,532,187	$1,900,775
TOTAL	**217**	**0**	**11**	**$13,148,357**	**$5,326,142**

5.2 Statewide Greenhouse Gas Emissions Savings

GHG emissions reductions are a co-benefit of this proposal. Staff calculated the first year statewide GHG emissions savings using the appropriate hourly GHG Emissions factors published by the CEC. These GHG emissions savings are summarized in Table 27.

Table 26: Estimated Statewide Greenhouse Gas Emissions Savings

	First Year Statewide GHG Emission Savings (MT CO_2e/year)
Sub-measure 1	33,590
Sub-measure 2	1,587
Sub-measure 3	23,055
Sub-measure 4	20,154
TOTAL	**78,386**

5.3 Statewide Water Savings

The proposed changes will not have a significant impact on water consumption. There may be a small amount of water savings if the EBCx results in the implementation of chilled water/condenser water reset strategies. However, for the purposes of this code measure proposal staff assumed that there are no appreciable water savings generated from the proposed changes.

5.4 Statewide Material Impacts

The implementation of the proposed changes to the Energy Code may cause increases in material uses. Such material uses include additional electronic equipment and wiring. Staff evaluated the proposed changes to the Energy Code for the potential increases in material uses for those listed in Table 11. Staff estimate that the contribution of each proposed change to the potential increases in material use is a small fraction of the material use in the current market.

The proposed change will result in pneumatic controls being replaced with DDC, or with new DDC installed where no controls previously operated, which are typical upgrades within the building market. Where pneumatic controls are replaced with DDC during an HVAC replacement, it is very likely these controls would be upgraded as normal market progression so the materials increase is considered negligible. Where no controls previously existed, there will be an increase in materials due to the installation of DDC, including materials like copper, plastic and silicon. When compared to the HVAC equipment replacements triggering these DDC upgrades, they are a minimal increase.

Because these proposed changes are focused on alterations to existing buildings, they do not affect whether building projects are sited in one location versus another, eliminating conflicts with transit, roadway, bicycle, or pedestrian facilities. They also do not increase or decrease the potential vehicle miles travelled (VMTs) that might be associated with the construction or occupancy of new buildings.

5.5 Environmental Impacts

The implementation of the proposed changes to the Energy Code may cause increases in material uses. Such material uses include additional electronic equipment and wiring. Staff evaluated the proposed changes to the Energy Code for their potential for environmental impacts. For the proposed measures, the existing regulations governing the production, processing, handling, transportation, storage, use, recycling, and disposal of mercury, lead, copper, steel, plastic, silicon, lithium, aluminum, fiberglass, glass, and wood are adequate to protect the public health and to restrict the potential environmental impacts such that they are less than significant.

Because these proposed changes are focused on alterations to existing buildings, they do not affect whether building projects are sited in one location versus another, eliminating conflicts with transit, roadway, bicycle, or pedestrian facilities. They also do not increase or decrease the potential vehicle miles travelled (VMTs) that might be associated with the construction or occupancy of new buildings.

5.6 Other Impacts

A key benefit of the proposed changes is to prepare California's existing building stock for the potential of future performance requirements. Installing DDC in place of pneumatic controls, or where no controls existed, and completing the EBCx studies will provide building owners and building design professionals with critical information and the means to trend and collect building performance data that will enable better design decisions to improve building energy and emissions performance.

6. Proposed Code Language

6.1 Restructured 2025 Energy Code (California Code of Regulations, Title 24, Part 6)

SECTION 201 *[Section 100.1]* **DEFINITIONS**

ASHRAE Standard 230 is the American Society of Heating, Refrigerating, Air-Conditioning Engineers document titled "Commissioning Process for Existing Buildings and System". 2022 (ANSI/ASHRAE 230-2022)

Existing Building Commissioning (EBCx) is a quality-focused process for attaining the current facility requirements of an existing facility and its systems and assemblies being commissioned. The process focuses on planning, investigating, implementing, verifying, and documenting that the facility and/or its systems and assemblies are operated and maintained to meet the current facility requirements, with a recommendation to implement continuous improvement for the remaining life of the facility.

Existing Building Commissioning Provider (EBCxP) is an entity, identified by the owner, or owner's representative, who leads, plans, schedules, and coordinates the necessary personnel required to implement the EBCx process.

SUBCHAPTER 4 SPACE-CONDITIONING AND VENTILATION

SECTION 401 NONRESIDENTIAL AND HOTEL/MOTEL OCCUPANCIES

401.2 Mandatory Requirements (Newly Constructed, Additions, Alterations)

401.2.2.10 *[Section 120.2(j)]* **Direct Digital Controls (DDC)**

Direct Digital Controls to the zone shall be provided as specified by Table 401.2-D *[Table 120.2-A]*. The provided *DDC* system shall meet the control logic requirements of Section 401.2.1.2 and Section 400.6 *[Sections 120.1(d), 110.12(a) and 110.12(b)]*, and be capable of the following:

…

Exception 1 to Section 401.2.2.10: Chiller plant upgrades for buildings in climate zones 1, 3, 5 and 16.

Exception 2 to Section 401.2.2.10: Boiler plant upgrades for buildings in climate zones 6 and 7.

Table 401.2-D [TABLE 120.2-A] DDC Applications and Qualifications

Building Status	Applications	Qualifications
Newly Constructed Buildings	Air-handling system and all zones served by the system	Individual systems supplying more than three zones and with design heating or cooling capacity of 300 kBtu/h and larger
Newly Constructed Buildings	Chilled water plant and all coils and terminal units served by the system	Individual plants supplying more than three zones and with design cooling capacity of 300 kBtu/h (87.9 kW) and larger
Newly Constructed Buildings	Hot water plant and all coils and terminal units served by the system	Individual plants supplying more than three zones and with design heating capacity of 300 kBtu/h (87.9 kW) and larger
Additions or Alterations	Zone terminal unit such as VAV Box	Healthcare facilities and hotel/motel buildings: Where existing zones served by the same air-handling, chilled water, or hot water systems have *DDC*. All other buildings: Any new or replacement terminal unit, or If 50% or more of the terminal units are served by the same air-handling system are *DDC* after the addition or alteration, *DDC* shall also be provided at the air-handling unit.
Additions or Alterations	Air-handling system or fan coil	Healthcare facilities and hotel/motel buildings: Where existing air-handling system(s) and fan coil(s) served by the same chilled or hot water plant have *DDC* All other buildings: Air-handling system(s) with design cooling capacity of 150 kBtu/h and larger, or Air-handling system(s) or fan coil(s) of any size where existing air-handling system(s) and fan coil(s) served by the same chilled or hot water plant have *DDC*, or

Building Status	**Applications**	**Qualifications**
		Air-handling system(s) of any size where greater than 50% of the existing downstream terminal units have DDC.
Additions or Alterations	New air-handling system and all new zones served by the system	Healthcare facilities and hotel/motel buildings: Individual systems with design heating or cooling capacity of 300 kBtu/h and larger and supplying more than three zones and more than 75 percent of zones are new. All other buildings: Individual systems with design heating or cooling capacity of 150 kBtu/h ~~300kBtu/h~~ and larger and supplying more than three zones and more than 75 percent of zones are new, or If more than 85% of zones are new, all existing terminal units served by the new air-handling system shall be upgraded to DDC.
Additions or Alterations	New or upgraded chilled water plant	Healthcare facilities and hotel/motel buildings: Where all chillers are new and plant design cooling capacity is 300 kBtu/h (87.9 kW) and larger All other buildings: If more than 50% of plant design cooling capacity is new and total plant design cooling capacity is 300 kBtu/h (87.9 kW) and larger, the entire plant shall be *DDC*, including pumps.
Additions or Alterations	New or upgraded hot water plant	Healthcare facilities and hotel/motel buildings: Where all boilers are new and plant design cooling capacity is 300 kBtu/h (87.9 kW) and larger All other buildings:

Building Status	Applications	Qualifications
		Where more than 50% of plant design heating capacity is new and total plant design heating capacity is 300 kBtu/h and larger, the entire plant shall be *DDC,* including pumps.

401.2.2.12 *[Section 120.2(l)]* **HVAC Hot Water Temperature.**

Zones that use hot water for space heating shall be designed for a hot water supply temperature of no greater than 130 °F. New or replacement terminal units in alterations shall be designed to operate at the existing hot water system supply temperature and shall be capable of operation with a supply temperature no greater than 130 °F.

401.3 *[Section 140.4]* **Prescriptive Requirements (Newly Constructed)**

401.3.4.1 *[Section 140.4(b)1]* **Heating and cooling loads.**

Heating and cooling system design loads shall be determined in accordance with the procedures described below:

1. For systems serving *hotel/motel buildings* and *nonresidential buildings* other than *healthcare facilities*, the method in the 2017 ASHRAE Handbook, Fundamentals shall be used or as specified in a method approved by the *Commission*. When sizing new or replacement space-conditioning equipment in a nonresidential building alteration, other than in healthcare facilities and hotel/motel buildings, existing submetered HVAC energy use data or energy use trend data from the building automation system shall be used to support heating and cooling load calculations, if the necessary data is available.
2. For systems serving *healthcare facilities*, the method in the California Mechanical Code shall be used.

401.5 *[Section 141.0]* **Additions and alterations to existing buildings**

401.5.1 *[Section 141.0]* **Additions**

Exception to Section 401.5.1: When heating or cooling to an *addition* are provided by expanding existing systems, the existing systems and *equipment* need ~~not~~ only comply with ~~this Section.~~ the *DDC* requirements in Section 401.2.2.10, if applicable.

401.5.2 *[Section 141.0(b)]* **Alterations**

Exception 2 to Section 401.5.2: When heating or cooling for an *alteration* are provided by expanding existing systems, the existing systems and *equipment* need ~~not~~ only comply with ~~this section.~~ the *DDC* requirements in Section 401.2.2.10, if applicable.

401.5.2.2.1 *[Section 141.0(b)2C]* **New or Replacement Space-Conditioning Systems or Components.**

New or Replacement *Space-Conditioning Systems* or Components other than new or replacement *space-conditioning system* ducts shall meet the requirements of Section 401.3 *[Section 140.4]* applicable to the systems or components being altered and meet the requirements of Sections 401.5.2.2.1.1, ~~and~~ 401.5.2.2.1.2, and 401.5.2.2.1.3.

401.5.2.2.1.3 Existing Building Commissioning.

Existing building commissioning (EBCx) shall be performed in accordance with Section 1001.5.2.1.1, as applicable, based on the scope of the new or replacement *space-conditioning systems* or components.

Exception to 401.5.2.2.1.3: *Hotel/motel buildings*

401.5.2.2.2 *[Section 141.0(b)2E]* **Altered Space-Conditioning Systems.**

401.5.2.2.2.3 Existing Building Commissioning

Existing building commissioning (EBCx) shall be performed in accordance with Section 1001.5.2.1.1, as applicable, based on the scope of the altered space-conditioning systems.

Exception to 401.5.2.2.2.3: *Hotel/motel buildings*

SUBCHAPTER 10 DESIGN REVIEW AND COMMISSIONING

SECTION 1001 NONRESIDENTIAL OCCUPANCIES (NEWLY CONSTRUCTED, ADDITIONS, ALTERATIONS)

1001.1 *[Section 120.8]* **General. (Newly Constructed).**

1001.5 Additions and alterations to existing buildings.

1001.5.1 Additions

RESERVED

1001.5.2 Alterations

Alterations to components of existing nonresidential buildings, including alterations made in conjunction with a change in building occupancy to a nonresidential occupancy, shall comply with the applicable requirements of Section 1001.5.2 in the building design and construction processes.

Exception 1 to Section 1001.5.2: Alterations to *healthcare facilities* and *hotel/motel buildings* are not required to comply with this Section.

1001.5.2.1 Mandatory Requirements (Alterations)

1001.5.2.1.1 Existing Building Commissioning

When required by Sections 401.5.2.2.1.3 or 401.5.2.2.2.3 for altered, new, or replacement space-conditioning systems and equipment, existing building commissioning (EBCx) shall be performed as specified by this section. Table 1001.5-A in Section 1001.5.2.1.1.3 specifies when EBCx is required and what systems are to be included.

1001.5.2.1.1.1 Existing Building Commissioning Process

EBCx shall be performed in accordance with ASHRAE Standard 230. The results of the EBCx study shall be documented in an EBCx report, with content as specified in ASHRAE Standard 230, and shall be delivered to the owner or owner's representative prior to final inspection by the enforcement agency.

1001.5.2.1.1.2 General Provisions

This section specifies the general provisions that shall apply to the required EBCx process. During the EBCx process, the existing building commissioning provider (EBCxP) shall:

1. Identify the expected remaining years of useful life of major space-conditioning equipment. This equipment includes chillers, boilers, air handlers with design heating or cooling capacity greater than 150 kBtu/h, and packaged rooftop units. The EBCx report shall include a recommended replacement schedule for existing equipment.

   Exception to 1001.5.2.1.1.2.1: When the EBCx scope only includes zone terminal units (ex. VAV boxes).

2. Where existing pneumatic control devices remain for some space-conditioning system equipment, the EBCxP shall include in the EBCx report a summary of the possible benefits, if any, to the installation of interface devices between the existing pneumatic controls and new DDC (for example, electric-to-pneumatic transducers).
3. Assess compatibility with applicable ASHRAE Guideline 36 sections as specified in Reference Appendices, Joint Appendix JA18, Table JA18.4-1. This includes an assessment of the necessary input and output control points that are available, sensor technology, as well as the ability to implement the recommended sequence of operations.
4. The EBCx report shall include a list of identified issues and corrective actions taken by the EBCxP. At a minimum, the EBCxP should attempt to take corrective actions which align the building with its originally intended operating parameters. Corrective actions that could not be performed during times when the building is unoccupied, or that require the owner to hire additional building professionals to

implement, shall be listed as future recommendations. Future recommended corrective actions listed in the EBCxP report shall include both the corrective process and the type of building professional(s) that would be required.

1001.5.2.1.1.3 System-specific provisions

The EBCx process shall include, at a minimum, the following scope for each of the applicable systems and equipment listed in Table 1001.5-A.

Table 1001.5-A EBCx Scope for Space-Conditioning System Replacements and Alterations

Scope of New, Replaced, or Altered Space-Conditioning System or Equipment	**Capacity Threshold of New, Replaced, or Altered Space Conditioning System or Equipment**	**Existing Building Commissioning Scope**
Zone terminal unit(s), such as VAV Box	All	For existing zone terminal units served by the same air-handling system: 1. Evaluate any zone heating/cooling overlap of perimeter and central systems and implement deadband control to avoid simultaneous heating/cooling 2. Evaluate implementation of energy saving control strategies a. Occupancy based schedules b. Occupancy based temperature setpoint resets
Air-handling system	Design heating or cooling capacity of 150 kBtu/h and larger	For all existing air-handling systems with a design heating or cooling capacity of 150 kBtu/h and larger: 1. Evaluate system outdoor air ventilation rates specified by section 401.2.1.2 of the Restructured 2025 Energy Code (120.1(d) of the 2025 Energy Code) 2. Visually inspect outdoor air and economizer dampers and linkages for signs of movement restrictions. 3. Evaluate implementation of energy saving control strategies a. Occupancy based schedules

		b. Occupancy based temperature setpoint resets c. Supply air temperature reset d. Static pressure reset
New or upgraded chiller	Plant with design cooling capacity 300 kBtu/h and larger	For the chilled water plant: 1. Evaluate implementation of energy saving control strategies (chilled water and condenser water supply temperature and differential pressure resets) For all existing air-handling systems served by the chilled water system: 1. Evaluate system outdoor air ventilation rates specified in section 401.2.1.2 of the Restructured 2025 Energy Code (120.1(d) of the 2025 Energy Code) 2. Visually inspect outdoor air and economizer dampers and linkages for signs of movement restrictions.
New or upgraded boiler	Plant with design heating capacity 300 kBtu/h and larger	For the heating hot water plant: 1. Evaluate heating plant capability to meet zone heating loads at the lowest possible HHW supply temperature (down to 130 °F as specified by section 401.2.2.12 of the Restructured 2025 Energy Code (120.2(l) of the 2025 Energy Code) 2. Evaluate implementation of energy saving control strategies: a. Supply temperature reset b. Pump differential pressure reset For all existing air-handling systems served by the heating hot water plant: 1. Evaluate system outdoor air ventilation rates specified by section 401.2.1.2 of the Restructured 2025 Energy Code (120.1(d) of the 2025 Energy Code) 2. Visually inspect outdoor air and economizer dampers and linkages for signs of movement restrictions.

6.2 Reference Appendices

There are no proposed changes to the Reference Appendices.

6.3 Compliance Manuals

The Nonresidential Compliance Manual should be updated as follows:

- The Additions and Alterations section should be updated to reflect the significant change that there are now some scenarios in the Energy Code that will require controls upgrades for existing systems or equipment.
- Examples for each "application" for DDC controls in Table 401.2-D should be provided to ensure compliance with each scenario. Existing DDC flow charts in the manual should be updated.
- Provide an example of how a replacement zone terminal VAV box can be selected to operate at the design conditions (ex. 180°F) and low-temperature conditions (ex. 130°F)
- A section should be added to outline the process for conducting the heating hot water supply temperature evaluation required for the EBCx in Table 1001.5-A
- A section should be added to the Compliance Manual dedicated to the EBCx process and requirements.
- Clarify that hospitals are excepted from these requirements.
- Clarify that pursuant to the California Building Standards Commission's (CBSC's) memorandums to state agencies regarding AB 130 (2025), hotel/motel buildings in their entirety are excepted from these requirements — these buildings will be addressed in subsequent code iterations.

6.4 ACM Reference Manuals

There are no proposed changes to the ACM Reference Manuals. The ACM Reference Manual includes a simplified means of accounting for the benefits of DDC controls. Essentially, the presence of DDC controls "unlocks" best practice control strategies for demand-based resets of chilled water temperatures, supply air temperatures, and variable flow control strategies. This functionality shall remain.

6.5 Compliance Forms

Recommended changes to compliance forms will be outlined in the Rulemaking measure report. At a high level, existing compliance forms involving DDC controls will be amended to add a signatory section indicating the equipment modified to comply with the DDC alterations requirements and EBCx control requirements of this measure. The EBCx provider would sign the form and provide an indication that the commissioning process has been completed, and a report has been delivered to the building owner.

7. REFERENCES

ADM Associates, Inc. 2024. "2022 California Commercial End-Use Survey (CEUS): Final Report" California Energy Commission Final Project Report. CEC-200-2023-017. February 2024.

Bailey, Scott, John Baffa, Dennis Rowan, Jeff Stein. 2015. "Results Report – Proposals Based on ASHRAE 90.1-2013". Codes and Standards Enhancement Initiative (CASE). September 2015.

[BCA] Building Commissioning Association. 2008. "Best Practices in Commissioning Existing Buildings". Building Commissioning Association. August 2008. https://cdn2.hubspot.net/hubfs/416421/pdf/bca-ebcx-best-practices.pdf

[CEC] California Energy Commission. 2026. "California Energy Consumption Dashboards" https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/california-energy-consumption-dashboardshttps://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/california-energy-consumption-dashboards. Accessed April 16, 2026.

[CPUC] California Public Utilities Commission. 2014. "California Commercial Saturation Survey" Prepared by Itron, Inc. https://www.calmac.org/publications/California_Commercial_Saturation_Study_Report_Finalv2.pdf

Cheng, Hwakong, Rupam Singla, and Gwelen Paliaga. 2022. "Demonstrating Scalable Operational Efficiency Through Optimized Controls Sequences and Plug-and-Play Solutions." California Energy Commission Final Project Report. CEC-500-2022-017. October 2022.

Crowe, E., E. Mills, T. Poeling, C. Curtin, C., D. Bjørnskov, L. Fischer, J. Granderson. 2020. Building Commissioning Costs and Savings Across Three Decades and 1,500 North American Buildings. Energy & Buildings 227(110408). Lawrence Berkeley National Laboratory. November 2020.

Crowe, E., E. Mills, T. Poeling, C. Curtin, C., D. Bjørnskov, L. Fischer, J. Granderson. 2020. Building Commissioning Costs and Savings Across Three Decades and 1,500 North American Buildings. Energy & Buildings 227(110408). Doi.org/10.1016/j.enbuild.2020.110408

Dodge Data and Analytics Group, "Construction Starts Data 1967-2024," 2024.

Hydeman, Mark, Jeff Stein, Anna Zhou. 2006. "July 13th, 2006 Workshop Report. DDC to the Zone Level Measure 5: Supply Air Temperature Reset." Codes and Standards Enhancement Initiative (CASE). July 2006.

[NLR] National Laboratory of the Rockies. 2026. "ComStock_amy2018_release_3" https://comstock.nlr.gov/page/datasets. Accessed April 13, 2026.

Rowan, Dennis, Scott Bailey, John Baffa, Jeff Stein. 2014. "Proposals based on ASHRAE 90.1-2013". Codes and Standards Enhancement Initiative (CASE). September 2014.

Shyft 2026. San Francisco HVAC Maintenance Cost Guide: Optimize Facility Operations, Accessed March 2026. https://www.myshyft.com/blog/commercial-hvac-preventative-maintenance-cost-san-francisco-california

Trane 2026. Geisinger Hughes, Project Highlights, Danville, Pennssylvania. Accessed March 2026. https://www.trane.com/commercial/north-america/canada/en/about-us/newsroom/case-studies/commercial-real-estate/geisinger-hughes.html?utm_source=chatgpt.com

Trenbath, Kim, Ryan Myer, Korbaga Woldekidan, Kristi Maisha, Morgan Harris. 2022. "Commercial Building Sensors and Controls Systems: Barriers, Drivers, and Costs." National Renewable Energy Laboratory. NREL/BR-6A50-82750. May 2022.

[U.S. DOE] United States Department of Energy, Better Buildings Solution Center. 2020. "The Value of Building Commissioning." https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Value%20of%20Building%20Commissioning_Final_0.pdf. Accessed March 24, 2026.

[U.S. EPA] United States Environmental Protection Agency. 2011. "Emission Factors for Greenhouse Gas Inventories." http://www.epa.gov/climateleadership/documents/emission-factors.pdf. Accessed December 2, 2013.