2022 Denver Energy Code
Commercial Prescriptive Path Compliance

Community Planning and Development /
Office of Climate Action, Sustainability and Resiliency

May 31, 2023

Questions?

- Time is reserved at the end of the presentation for Q&A
- Please use the Q&A feature to submit your questions

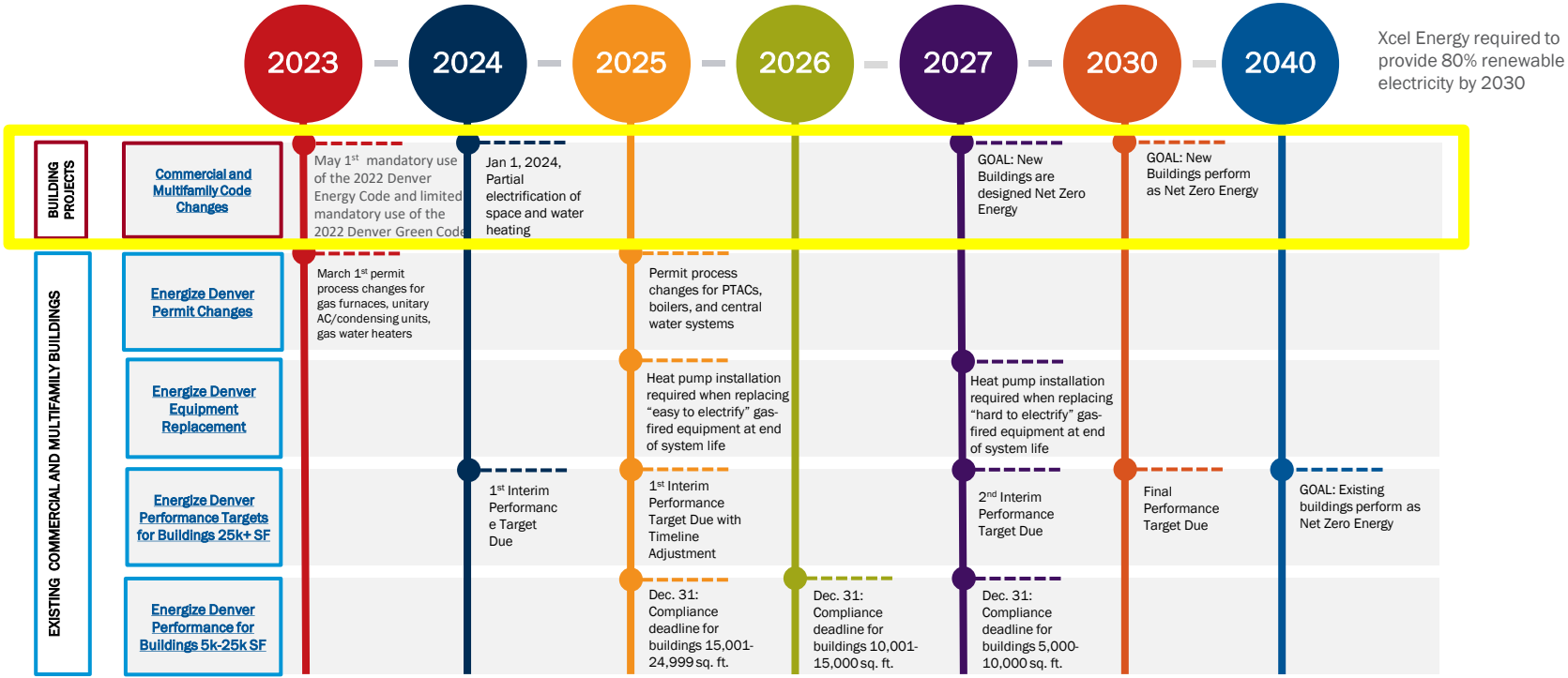
- Responses to all questions not addressed today will be sent out by email to registered participants
- Additional questions may be sent to: energy.review@denvergov.org

Training Series

SCAN ME

	Commercial/Multifamily (Wednesdays at 12 pm)	Residential (Thursdays at 1 pm)
	Electrification May 24	Compliance Overview May 25
Prescriptive Path	May 31	June 1
Performance Paths	June 7	June 8
Contractor/Inspector Part 1	June 14	June 22
Contractor/Inspector Part 2	June 21	June 29

Timeline - Commercial Electrification and Performance Requirements



2022 Denver Energy Code Prescriptive Path

- This is a high-level summary of the **commercial prescriptive path** of the 2022 Denver Energy Code
- Does not include all changes to the 2022 Denver Energy Code. Please refer to the 2022 Denver Energy Code for specific code language. Denvergov.org/BuildingCode
- Denver-specific COMcheck and REScheck are anticipated fall 2023

 = Prescriptive provision

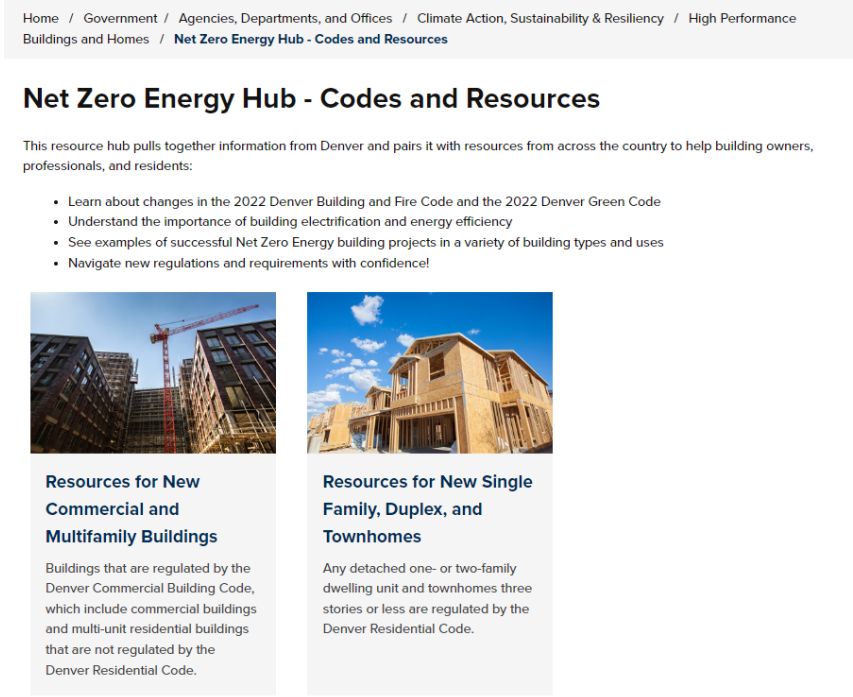
 = Required for all paths

Net Zero Energy Hub – Codes and Resources

www.denvergov.org/EnergyCode

Resources for:

- New provisions in the 2022 Denver Energy Code
- The Denver Energy Code compliance pathways
- Specifics to each phase of a new building project, from design and construction to alterations and additions
- Training videos to walk you through specific provisions that have been updated since the 2019 Denver Building Code



Home / Government / Agencies, Departments, and Offices / Climate Action, Sustainability & Resiliency / High Performance Buildings and Homes / **Net Zero Energy Hub - Codes and Resources**

Net Zero Energy Hub - Codes and Resources

This resource hub pulls together information from Denver and pairs it with resources from across the country to help building owners, professionals, and residents:

- Learn about changes in the 2022 Denver Building and Fire Code and the 2022 Denver Green Code
- Understand the importance of building electrification and energy efficiency
- See examples of successful Net Zero Energy building projects in a variety of building types and uses
- Navigate new regulations and requirements with confidence!

Resources for New Commercial and Multifamily Buildings

Buildings that are regulated by the Denver Commercial Building Code, which include commercial buildings and multi-unit residential buildings that are not regulated by the Denver Residential Code.

Resources for New Single Family, Duplex, and Townhomes

Any detached one- or two-family dwelling unit and townhomes three stories or less are regulated by the Denver Residential Code.

New Building Electrification Pilots

Design Support: partial funding for drawing sets and as-built drawings that can be reviewed by Denver builders to help inform how electrification can work for their projects

Pilot Projects: partial funding for builders or property owners interested in leveraging city funds to help a new building project be built all-electric

www.denvergov.org/NetZero

Equity and Local Focus: 50% of the pilot project funds will be prioritized for affordable housing or otherwise serve or benefit under-resourced communities in Denver. Denver-based and/or MWBE firms and organizations are especially encouraged to apply for incentives.

Tips for referencing code

2022 Denver Amendments

+

2021 International Energy Conservation Code (IECC)

=

2022 Denver Energy Code (DEC)

Agenda

- Submittal Overview
- Building Envelope
- Mechanical
- Service Hot Water
- Power and Lighting
- Additional Efficiency Credits
- Commissioning
- When to Consider Performance Paths

Purpose: This presentation provides an overview of the prescriptive path for commercial building projects.

Other presentations cover electrification, performance path, and contractor / inspector focus.

2022 DEC Submittal Overview

Definition: Commercial Building

Residential buildings are detached one- and two-family dwellings and multiple single-family dwellings (townhouses) and Group R-3 and R-4 buildings three stories or less in height above grade plane.

Commercial buildings are all other buildings

Definition: All-Electric Property

All-Electric Property is one that contains no permanently installed equipment or appliances that utilize *combustion*, plumbing for fuel gas or fuel oil or *fuel gas* utility connection, installed within the *building(s)* or site, except for *emergency power systems* and *standby power systems*.

Commercial Compliance Process

- Choose a Compliance Pathway (C401.2.1): Prescriptive or Performance
- Meet requirements for all paths - partial list:
  - HVAC/DHW/Lighting Commissioning
  - Building Envelope Verification and Air Leakage Testing
  - Complete 2022 DEC Checklist for Requirements
    - *Includes reporting Energize Denver Ordinance 2030 EUI Target*
- Related
  - Denver Green Buildings Ordinance - denvergov.org/Greenroofs
  - Denver Green Code - denvergov.org/Greencode

Prescriptive vs Performance

Prescriptive

- Easy to see what is needed for compliance
- No energy modeling required
- Can be completed quickly
- 2022 DEC requirements
- Submit compliance documentation, i.e., COMcheck

Performance

- Allows for more flexibility and holistic design process
- Modeling can help inform Energize Denver Ordinance compliance. Can also provide utility incentives, tax deductions
- 2022 DEC Mandatory Requirements + ASHRAE 90.1-2019 Mandatory Provisions
- Submit energy model

Instructions for CPD Plans Reviewers

Action for Reviewer

To facilitate inspections, record in Permit Scope of Work text box on permit:

1. One compliance path from four options:
   - Prescriptive Compliance Path
   - C407 Energy Cost
   - Appendix SE Site Energy
   - Appendix PT Performance Target
2. Record if All-Electric Property:
   - All-Electric Property

Note: dedicated Accela fields for this information are in development

All Pathways – Report the Energize Denver Ordinance Target EUI

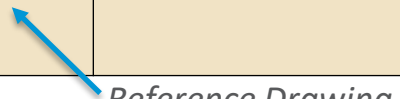
- Energy Use Intensity (EUI)
- Buildings 25,000 SF and larger have 2030 EUI targets
- Include 2030 EUI Target in permit documents (reported in IECC Checklist)

Building Type	2030 Target EUI (kBtu/sf)
Office	48.3
Medical Office	69.0
Multifamily	44.2
Hotel	61.1
Restaurant	194.1

Energize Denver Ordinance - Performance Requirements

Prescriptive Checklist Documentation

Code Section	Focus Area	Code Description	Drawing or Specification Number to demonstrate compliance (N/A if not applicable)	Submitter Notes (e.g. If "N/A" Please explain why requirement does not apply or is not demonstrated on drawings/specs)	Submittal Requirements and Clarifications
ALL COMPLIANCE PATHS					
C402.1.5	Minimum insulation	Roofs, walls, and floors shall meet applicable maximum U-factor requirements of Table C402.1.5			Indicate location of: - Supplemental calculations if applicable



Reference Drawing from CD set

C406 Planning Tool

Planning Tool for C406.1 2022 Denver Energy Code Additional Energy Efficiency Credit Requirements

Instructions: Enter values in to applicable cells. Floor areas in Tables C406.1(1) and C406.1(2) must match.

Project Background

1: Property is all-electric (Y/N):	N	3: C403.2.4 Space Heating is required (Y/N):	N
2. Project is non-previously-occupied tenant space (Y/N):	N	4: C404.10 Water Heating is required (Y/N):	N

Credit Requirements Table C406.1(2)

	Floor Area by Building Type (sf)	Denver Credit Requirements		Use Group for Table C406.1(1)
		All-Electric Properties[a]	All Other Buildings	
Multifamily	24,000	10	40	Group R
Healthcare/Hospital		10	40	Group I
Hotel/Motel		10	36	Group R
Office		10	31	Group B
Retail	8,000	10	35	Group M
School		10	24	Group E
Warehouse		10	48	Other Occupancies (Group S)
All Other		10	40	Other Occupancies
Total	**32,000**			
Area Weighted Denver Credit Requirements		10	39	
Building Credit Requirement	**39**			

Credit Requirement by Occupancy Type

C406 Planning Tool

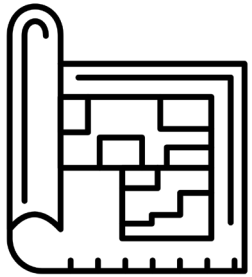
Table C406.1 Additional energy efficiency credit requirements for Denver		Group B		Group R and I		Group E		Group M		Other Occupancies[a]		
Enter Floor Area by Use Group (sf)												
Check: Too many credits selected for (OK if blank):												
Included Credits by Use Group			**0**		**0**		**0**		**0**			**0**
Total Floor Area Weighted Included Credits												
Section	Included in COMcheck IECC-2021 OR Denver Specific	Enter Y if included	Denver Credits	Enter Y if included	Denver Credits	Enter Y if included	Denver Credits	Enter Y if included	Denver Credits	Enter Y if included		Denver Credits
C406.2.1: 5% Heating Efficiency Improvement	COMcheck IECC-2021		1		1		1		2			1
C406.2.2: 5% Cooling Efficiency Improvement	COMcheck IECC-2021		2		1		1		1			1
C406.2.3: 10% Heating Efficiency Improvement	COMcheck IECC-2021		2		2		3		3			3
C406.2.4: 10% Cooling Efficiency Improvement	COMcheck IECC-2021		4		1		2		2			2
C406.2.5: >10% Cooling Efficiency Improvement	Denver Specific											

Submitting the 2022 DEC Prescriptive Checklist

Note new policy for submitting Checklists:

- Complete all tabs and print each to pdf
- Complete energy credits checklist tab (C406)
- Put each tab onto drawing sheets within the Construction Documents, separately by discipline
- Drawing sheets have stamp and signature by discipline
- No other signatures required!

CHECKLIST TABS:
General Compliance
Building Envelope
HVAC & Kitchen
Service Water Heating
Power & Lighting
C406



Compliance Documentation - COMcheck

- Select 2022 Denver Energy Code as local code in COMcheck Web when available (~Fall 2023)
- Use COMcheck for 2021 IECC with supplemental documentation and calculations in the interim
- Include compliance documentation and COMcheck inspection checklists in construction documents

All Pathways – Denver Green Buildings Ordinance

Green Buildings Ordinance (GBO) applies to:

- New buildings and additions 25,000 square feet or larger
- Existing buildings 25,000 square feet or larger, upon roof recover or replacement
- Some multifamily residential projects need only comply with roof reflectance requirements and not additional green building options

NOTE: New construction options which require an extra **12% or 5% energy savings** beyond code also require the project to be an **All-Electric Property***

denvergov.org/greenroofs

**Green Building Ordinance updates for Council approval June 2023 and effective October 1, 2023*

All Pathways – Denver Green Code (DGC)

Limited mandatory use for new and *major renovation commercial* projects

denvergov.org/GreenCode

	Table 101.4.1 Limited Mandatory Use: Quantity of Provisions Required	New Construction	Major Renovation
Chapter 1	Scope and Administration: Ecological Impact Statement (EIS)	0	0
Chapter 2	Reserved	n/a	n/a
Chapter 3	Definitions	n/a	n/a
Chapter 4	Residential Energy [RE]	0	0
Chapter 5	Site Sustainability	4	2
Chapter 6	Water Use Efficiency [WE]	1	0
Chapter 7	Commercial Energy	1	1
Chapter 8	Indoor Environmental Quality [EQ]	1	1
Chapter 9	Materials and Resources [MR]	3	1
Chapter 10	Construction and Plans for Operation [CX]	2	2

Envelope

2022 Denver Energy Code
Key Prescriptive Changes – Envelope

- C402.1.5 Component performance alternative – minimum insulation requirements
- C402.5.11 Operable openings interlocking – setback for heating/cooling setpoints
- C402.5 Air leakage testing requirements for commercial buildings and residential dwelling and sleeping units
  - Commercial buildings require diagnostic evaluation and sealing if test exceeds 0.40 cfm/sf but is less than 0.6 cfm/sf at 0.3 in water gauge
  - Dwelling units require diagnostic evaluation and sealing if test exceeds 0.30 cfm/sf but is less than 0.45 cfm/sf at 0.2 in water gauge
  - Requires corrective action and retest until air leakage test result is at or below than 0.6 cfm/sf for commercial or 0.45 cfm/sf for residential

C402.1.5 Minimum Insulation Requirements

- All conditioned areas are insulated
  - Cores (i.e., stair/elevator in an unconditioned parking garage)
  - Back of house spaces
- Can exclude spandrel and up to 5% of remaining envelope
- Exception for data centers or computer rooms

Component	NEW Maximum U-Factor	C402.1.3 R-Value Reference	C402.1.4 U-Factor Reference
Roof insulation above deck	**0.048**	R-30	U-0.032
Roof metal building	**0.055**	R-19+R-11 LS	U-0.035
Roof attic and other	**0.027**	R-49	U-0.021
Wall mass	**0.090**	All Other: R-11.4ci Group R: R-13.3ci	All Other: U-0.090 Group R: U-0.080
Wall metal building	**0.069**	R-13+R-14ci	U-0.050
Wall metal framed	**0.064**	R-13+R-10ci	U-0.055
Wall wood framed and other	**0.064**	R-13+R-7.5ci OR R-20+R-3.8ci	U-0.051
Above grade floors mass	**0.074**	All Other: R-14.6ci Group R: R-16.7ci	All Other: U-0.057 Group R: U-0.051
Above grade floors framed	**0.074**	R-30	U-0.033

Prescriptive Insulation Requirement Update

C402.1.3 R-value table

- Roof – Increased insulation for attics
- Walls – Increased in continuous insulation

C402.1.4 U-Factor table

- U-factors reduced in alignment with the R-value table

Component	C402.1.3 R-Value	C402.1.4 U-Factor	2019 DEC R-Value	2019 DEC U-Factor
Roof insulation above deck	No change	No change	R-30	U-0.032
Roof metal building	No change	No change	R-19+R-11 LS	U-0.035
Roof attic and other	R-49	U-0.021	Group R: R-38	Group R: U-0.027
Wall mass	No change	No change	All Other: R-11.4ci Group R: R-13.3ci	All Other: U-0.090 Group R: U-0.080
Wall metal building	R-13+R-14ci	U-0.050	R-13+R-7.5ci	U-0.064
Wall metal framed	R-13+R-10ci	U-0.055	R13+R-13ci	U-0.052
Wall wood framed and other	R-13+R-7.5ci OR R-20+R-3.8ci	U-0.051	All Other: R-13+R-3.8ci or R-20 Group R: R-13.3+ R-7.5 or R-20+R-3.8ci	All Other: U-0.064 Group R: U-0.055
Above grade floors mass	All Other: R-14.6ci Group R: R-16.7ci	All Other: U-0.057 Group R: U-0.051	All Other: R-10ci Group R: R-12.5ci	All Other: U-0.074 Group R: U-0.064

C402.1.4.3 Effective R-Value of Exterior Cladding with Z-girts

- Adjustment factor for continuous insulation that is installed between Z-girt supports
  - 0.7 for horizontal z-girts
  - 0.6 for vertical z-girts aligned with steel studs
- Requires additional insulation for some assemblies
- **Example:** A 2x4-steel-framed wall with R-13 cavity insulation and 2” of rigid insulation (R-12) using vertical Z-girts has a combined U-factor, from Equation 4-1:

  Steel-framed Wall U-factor assembly COMcheck = 0.122

  Continuous Insulation derated R-value = 12 x 0.6 = 7.2

  Assembly U-factor = 1 /(1/0.122 + 7.2) = **0.065**

C402.4 Fenestration

Issue when using COMcheck:

- Project uses windows that are not curtainwall, storefront, or type AW (team should apply the "all other" category)
- The Denver "All Other" window baseline should be U-0.30, which does not exist in standard 2021 IECC

VERTICAL FENESTRATION		
	U-FACTOR FOR VERTICAL CURTAIN WALLS, STOREFRONT, AND SITE-BUILT FENESTRATION TYPE AW PRODUCTS[a]	
FIXED FENESTRATION	0.36	
OPERABLE FENESTRATION	0.45	
Denver requirement	U-FACTOR FOR ENTRANCE DOORS	
	0.63	
	U-FACTOR FOR ALL OTHER VERTICAL FENESTRATION	
	0.30	
SHGC		
	Fixed	Operable
PF < 0.2	0.38	0.33
0.2 ≤ PF <0.5	0.46	0.40
PF ≥ 0.5	0.61	0.53
SKYLIGHTS		
U-FACTOR	0.50	
SHGC	0.40	

Interim COMcheck Workaround

Solution:

- Tradeoffs cannot be permitted for "All Other" windows in interim COMCheck
- For fixed all other: Select "Metal Frame Fixed", which has baseline U-0.36
- For operable all other: Select "Metal Frame Operable", which has baseline U-0.45
- Enter actual SHGC

Do not inadvertently claim savings!

- If window is compliant, enter window U-value to match baseline U-value
- Note the actual U-value in the window description
- Document actual Baseline and Proposed window U-values in the design documents

COMcheck-Web™

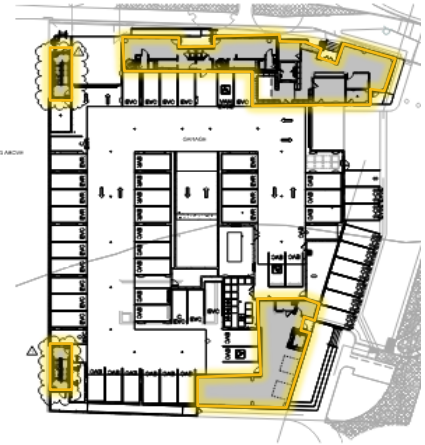
Envelope Assemblies

Assembly	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Proposed U-Factor	Budget U-Factor(a)
NORTH					
Ext. Wall: Steel-Framed, 16in. o.c., [Bldg. Use 1 - Office]	4500	20.0	10.0	0.052	0.055
Storefront Window: Metal Frame: Fixed, Perf. Specs.: Product ID Storefront, SHGC 0.38, VT 0.60, [Bldg. Use 1 - Office] (b)	100	---	---	0.360	0.360
Punched Window U-0.30: Metal Frame: Fixed, Perf. Specs.: Product ID Punched Window, SHGC 0.38, VT 0.50, [Bldg. Use 1 - Office] (b)	100	---	---	0.360	0.360

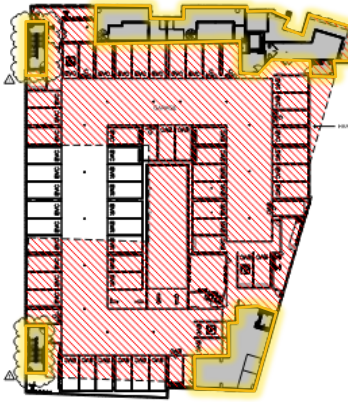
Type actual U-value in description

Enter proposed U-value to match budget baseline so as not to claim savings

Air Barrier and Thermal Envelope Example

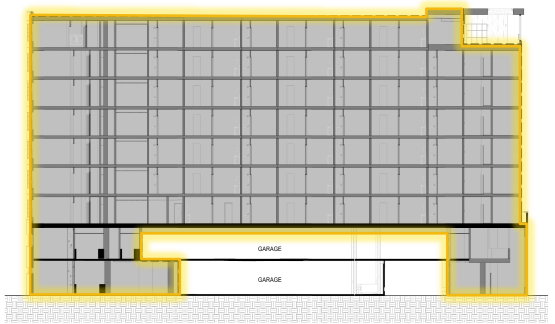


1 LEVEL 1 ENVELOPE PLAN



2 LEVEL 1.5 ENVELOPE PLAN

3 LEVEL 2 ENVELOPE PLAN



1 BUILDING SECTION 1 ENVELOPE
1/16" = 1'-0"

ENVELOPE LEGEND	
	THERMAL ENVELOPE AND AIR BARRIER BOUNDARY
	THERMAL ENVELOPE BOUNDARY: HEATED DROP CEILING AT GARAGE SHOWN ON PLANS VIEWS ONLY

Mechanical

2022 Denver Energy Code
Key Prescriptive Changes - HVAC

- C403.2.3 Fault Detection and Diagnostics –buildings 25,000 sf or larger
- C403.2.4 Limits on Fossil-Fuel Space Heating – (effective 1/1/2024) requires electricity-sourced space heating for most new systems, with some exceptions for heat pump supplemental heating and reheat in VAV systems
- C403.5 Economizers – required for systems with rated capacity of 33,000 Btu/h or greater
- C403.7.4.1 Outdoor air energy recovery systems shall be provided for dwelling units
- C403.7.4.2 Energy recovery for systems with outside air requirements exceeding Tables C403.7.4.2 (1 or 2)
- C403.7.8* Outside air controls to regulate and measure outdoor air, and fault on excessive outside air

*Numbering from update for Council approval June 2023

HVAC Fault Detection & Diagnostics

C403.2.3 – Fault Detection and Diagnostics

- Mandatory requirement
- New buildings with an HVAC system serving a conditioned floor area of 25,000 SF or larger are required to include a fault detection and diagnostics (FDD) system
- Exceptions: warehouse buildings with heating-only systems AND R1 and R2 occupancies

Partial Electrification for Space Heating

C403.2.4 – Space heating equipment

- Effective date of **January 1st, 2024**
- Fossil-fuel warm air furnaces and electric resistance space heating equipment are not be permitted for space heating
- Focus on systems with design, technology, and equipment that is currently available
- Aligns with Energize Denver requirements

- **Exceptions:**
  - Emergency power or standby power, as approved by building official
  - Makeup air systems where ERV is prohibited by Denver Mechanical Code
  - Electric resistance used for heat pump supplementary heat
  - Electric resistance up to 5 W/sf
  - Gas furnaces or electric resistance in heated plenums
  - Electric resistance in buildings that use a performance path for compliance
  - Replacement furnaces that comply with Alterations C503.3.3

Partial Electrification for Space Heating

C403.2.4 – Space heating equipment

Allowed Gas/Electric Resistance Equipment Examples
Boilers – fossil fuel and electric
Unit heaters – fossil fuel and electric
Radiant heat
Electric reheat in VAV boxes

Prohibited Equipment Examples with Limited Exceptions*
Furnaces
Gas RTUs
Gas DOAS / MAU*
Electric resistance FCUs*
Electric resistance PTAC/VTAC*

Electrification System Options

Single Zone Systems:
Packaged Heat Pumps
Split System Heat Pumps

Central System Options:
Air-to-Water Heat Pumps
Water-Source Heat Pumps
Variable Refrigerant Flow Heat Pumps

Air-to-Water Heat Pump
Courtesy: Carrier

Variable Refrigerant Flow (VRF) Schematic
Courtesy: Trane

Multifamily Mechanical Ventilation Requirements

Denver Mechanical Code Section 401.2 – Ventilation Required

- Occupied spaces (other than R) must provide natural or mechanical ventilation
- Dwelling units must provide balanced mechanical ventilation
  - **Natural ventilation is NOT allowed in dwelling units** due to 2022 Denver Energy Code air leakage requirements

Denver Mechanical Code Section 403.1 – Ventilation System

- Mechanical ventilation must be balanced with supply air approximately equal return or exhaust air
- **Exhaust-only ventilation is NOT allowed**
- The system can produce a space with negative or positive pressure

Why?

- Building envelopes are getting tighter (air leakage requirements) therefore reducing infiltration and rendering natural ventilation or exhaust-only not effective multifamily ventilation methods

Data Centers

C403.1.2 – Requires data centers to comply with Sections 6 and 8 of ASHRAE 90.4, with the following additional requirements:

- Data center efficiency – maximum allowed Mechanical Load Component (MLC)
  - 0.20 for ITE Equipment Design Power <= 300 kW
  - 0.12 for ITE Equipment Design Power > 300 kW
- Only adiabatic humidification is allowed when ITE design load exceeds 35 kW and 20 W/sq. ft.
- Hot aisle / cold aisle containment required when ITE design load exceeds 35 kW and 20 W/sq. ft.
- Evaporative cooling shall use utility-recycled water when available
- Water use effectiveness must be reported for data centers

Economizer Requirements

C403.5 – Economizers - Air or water economizers are required for the following cooling systems for prescriptive compliance:

Chilled water systems – chilled-water capacity less capacity of cooling units with air economizers

- Local water-cooled systems: cooling capacity > 1,320,000 Btu/h
- Air-cooled or district systems: cooling capacity > 1,720,000 Btu/h

Individual Fan Systems

- *Group R: total cooling capacity greater than 270,000 Btu/h*
- Other than Group R: total cooling capacity greater than 33,000 Btu/h
- Systems with cooling capacity greater than 75,000 Btu/h require two stages of mechanical cooling
- Systems with capacity greater than 33,000 Btu/h may use the economizer as the first stage (but many systems can use integrated economizers)
- VRF Systems with Dedicated Outside Air Systems (DOAS) do not require economizers*

**Update for Council approval June 2023*

Energy Recovery Requirements

TABLE C403.7.4.2 (1)
ENERGY RECOVERY REQUIREMENTS
(Ventilation systems operating less than 8,000 hours per year)

CLIMATE ZONE	PERCENT (%) OUTDOOR AIR AT FULL DESIGN AIRFLOW RATE							
	≥10 & < 20	≥20 & < 30	≥30 & < 40	≥40 & < 50	≥50 & < 60	≥60 & < 70	≥70 & < 80	≥80
	DESIGN OUTSIDE OR EXHAUST AIRFLOW RATE (CFM)							
5B Outside	NR	NR	NR	NR	6,000	5,500	5,000	4,000
5B Exhaust	NR	NR	NR	NR	4,500	4,125	3,750	3,000

TABLE C403.7.4.2 (2)
ENERGY RECOVERY REQUIREMENTS
(Ventilation systems operating 8,000 or more hours per year)

CLIMATE ZONE	PERCENT (%) OUTDOOR AIR AT FULL DESIGN AIRFLOW RATE							
	≥10 & < 20	≥20 & < 30	≥30 & < 40	≥40 & < 50	≥50 & < 60	≥60 & < 70	≥70 & < 80	≥80
	DESIGN OUTSIDE OR EXHAUST AIRFLOW RATE (CFM)							
5B Outside	500	400	300	200	84	84	80	80
5B Exhaust	1,500	1,200	900	600	252	252	240	240

Energy Recovery for Office HVAC System

Question. An office that operates on a 6 AM - 6 PM schedule, five days a week, uses a 30-ton rooftop HVAC system with a design supply airflow of 12,000 cfm and a minimum outside airflow of 7,200 cfm. Is heat recovery required?

Answer: This system provides more than 50% outside air, and per Table C403.7.2(1), energy recovery system required. The energy recovery system must have enthalpy recovery ratio (ERR) of 60% at balanced airflow, and cannot exceed a pressure drop of 1.1” w.g. at design airflow and 0.6” in economizer mode (bypass).

Service Water Heating

Service Water Heating key changes

- C404.10 Fossil-fuel and electric resistance instantaneous water heaters are prohibited, with a few exceptions
- C404.11 Demand-responsive water heating required for electric storage water heaters with storage between 40 and 120 gallons

Partial Electrification for Water Heating

C404.10 Water Heaters

Allowed Equipment Examples
Boilers – fossil fuel and electric
Heat pump water heaters - individual
Heat pump water heaters - central

Prohibited Equipment Examples with Limited Exceptions*
Gas storage water heaters
Electric resistance storage water heaters*
Gas instantaneous water heaters
Electric instantaneous water heaters*

Partial Electrification for Water Heating

C404.10 Water Heaters

- Substitution options – **one for one**
  - Heat pump water heaters
- Substitution options – **whole system**
  - Central boiler with separate storage
  - Central heat pump water heater with electric resistance backup

- Heat pump water heaters – design considerations
  - Need air to pull heat
  - Discharge air-conditioned air
  - Larger size than gas or electric equivalents
  - Preferable location in garage, closet or semi-conditioned space
  - Noise considerations

Water Heating Equipment Locations

C404.12 Water Heating Equipment Locations

- When required by C405.15 – Additional electric infrastructure
- 3’ x 3’ x 7’ or larger
- 760 cubic feet

OR

- 16” x 24” grill to a heated space AND 8” duct less than 10’ for exhaust air

- Exceptions:
  - Less than 20 gallons of storage
  - Instantaneous heaters within 10’ of point of use
  - Manufacturer recommendations for a specific heat pump water heater

Power & Lighting

Power and Lighting key changes

- C405.1.1 Dwelling units require high-efficacy luminaires with minimum efficacy of 65 lm/W

More stringent than 2021 IECC:

- No exemption given to kitchen appliances
- 100% of luminaires must meet efficacy level (compared to 90% with base 2021 Code)
- C405.3.2 The Building Area Method must now include residential sleeping and dwelling units in the interior lighting power allowance calculation for mixed use occupancies
- C405.3.2 Dwelling unit lighting power covered under Building Area Method (footnote exceptions removed) - Multifamily Buildings not exceed 0.45 W/sf lighting power
- C405.2 Adds control requirement to reduce lighting power by at least 10 percent in response to a demand control signal

Multifamily Lighting Compliance Options

- **Example**: a Multifamily building with four floors and 24 units, with a gymnasium, lobby and retail shop wishes to comply with the lighting requirements. The project is 30,000 sf, and the total interior lighting for the building is 16 kW, or 0.53 W/sf.
- **Solution:** If the Building Area Method is used, the lighting from ALL spaces in the building is counted towards the lighting allowance. Since the project exceeds the allowance of 0.45 W/sf, the project must pursue the Space-By-Space Method to meet compliance. The Space-By-Space method requires manual calculations to compute the watts per square foot for each room with interim COMcheck.

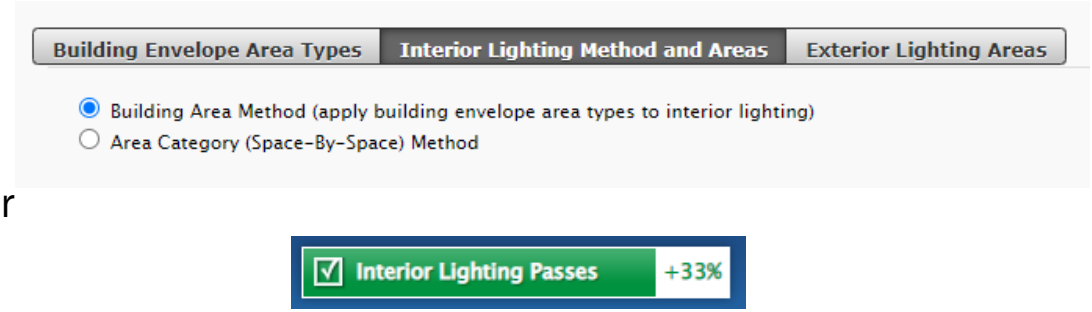
Interim COMcheck Workaround

Issue:

- Multifamily project wants to claim lighting savings
- COMcheck IECC 2021 does not have a space category for dwelling units

Solution:

- Use COMcheck IECC 2021 Building Area Method
- Use % savings to calculate credits for C406 planning tool



2022 Denver Energy Code
Key Prescriptive Changes - Infrastructure

- C405.13 Electric Vehicle Parking Infrastructure
- C405.14 Solar Access
- C405.15 Additional Electric Infrastructure – Covered in **Electrification Training**

C405.12 Energy Monitoring

New buildings 25,000 sf or larger shall be equipped to measure, monitor, record and report electricity consumption data for all end uses in Table C405.12.2 separately

- Exemptions:
  - HVAC/DHW equipment serving individual dwelling units
  - Tenant spaces 2,500 sf or less

Energy Use Load Categories
Total HVAC system
Interior lighting
Exterior lighting
Plug loads
Process loads
Building operations and other miscellaneous loads

C405.15 Electric Ready Infrastructure

Fossil fuel appliances and equipment or connections serving new buildings:

- Provide a junction box within same space as fossil fuel appliance or equipment connected to an electrical panel by continuous raceways
- Junction box, raceway, and bus bar in the electric panel and conductors serving the electric panel shall be sized to accommodate electric equipment sized to serve the same load as the fossil fuel appliance or equipment
- Panel shall have reserved physical space for a three-pole circuit breaker
- Junction box and electrical panel directory entry for the dedicated circuit breaker space shall have labels stating, “For future electric equipment”

Applicable fossil fuel appliances/equipment
Water heating equipment < 300 MBH
Warm air furnaces serving spaces without space cooling
Fireplaces, ranges, and stoves not defined as commercial cooking appliances
Commercial cooking appliances
Fossil fuel appliances and equipment serving dwelling units or sleeping units

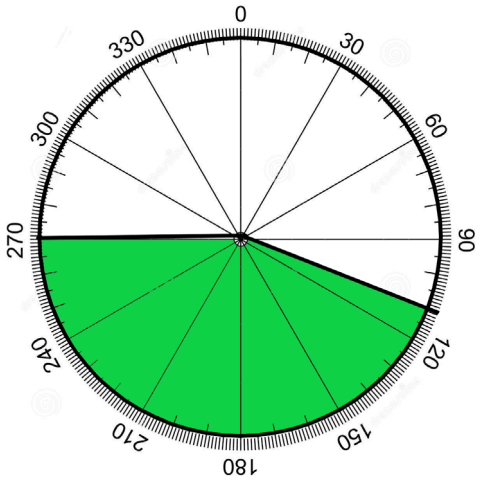
C405.14 Solar Access (Appendix CB)

Solar Ready Zone:

- Roof oriented between 110 and 270 degrees from true north or low-slope
- At least 60 percent of the roof area, excluding area occupied by skylights, roof decks, vegetative roof areas and mandatory access or setback areas

Exceptions for:

- Buildings with 6 or more stories above grade
- Buildings with permanently installed renewable energy system of capacity 1 W/sf of roof area or 5 kW DC
- Buildings where the solar-ready zone is shaded for more than 70% of daylight hours



C405.13 Electric Vehicle Requirements

Changes from 2019 Denver Energy Code:

- New requirements for minimum charging rate and minimum circuit capacity
- Energy load management systems for EVs are now allowed without admin modification
- Increased the percent of *installed* charging stations for commercial and multifamily buildings
- Direct-current Fast Charging (DCFC) Stations allow for a reduction of 10 charging stations per DCFC, not to exceed a reduction of 50 for A, B, E, I, M and S-2 Occupancies
- Multifamily:
  - Decreased the code-required number of EV capable spaces (conduit only) 80% to 40%
  - Decreased EV infrastructure from 100% of spaces to 60%

Occupancy	EVSE Installed Spaces	EV Ready Spaces	EV Capable Spaces
Group A, B, E, M	10%	5%	10%
Group I	5%	0%	5%
Group R-1 and R-2	15%	5%	40%
Group R-3 and R-4	2%	0%	5%
Group S-2 Parking Garages	10%	5%	0%

- EVSE installed spaces are required to meet the accessible / universal requirements in accordance with DCBC (amended IBC) section 1107
- Where all (100%) parking serving R-2 occupancies are EV ready spaces, requirement for EVSE spaces for R-2 occupancies shall not apply

C406 Additional Efficiency

C406 Additional Efficiency Credits

Prescriptive Path - C401.2.1 Option 1

- Comply with C402 through C406 and C408
- C406 Additional Efficiency Credits dependent on building type and if it is All-Electric Property or not
- Fewer credits required for All-Electric Properties to incentivize electrification
- C406.1.1 – Tenant spaces must attain a total of 10 credits from the lighting and HVAC sections of C406

Building Type	Credit Requirement for All-Electric Properties	Credit Requirement for All Other Buildings
Multifamily	10	40
Healthcare/Hospital	10	40
Hotel/Motel	10	36
Office	10	31
Retail	10	35
School	10	24
Warehouse	10	48
All Other	10	40

C406 Envelope Credits

Sub-section	Group B	Group R & I	Group E	Group M	Other[a]
C406.8.1: Reduced envelope UA** • **15% Reduction**	10	4	2	4	5
C406.8.2: Further reduced envelope UA** • **25% Reduction**	15	6	3	6	8
C406.9.1: Reduced air infiltration* • **Tested 0.25 cfm/sf**	4	5	N/A	2	4
C406.9.2: Further reduced air infiltration** • **Tested 0.15 cfm/sf**	7	8	N/A	3	7

*Credits supported by COMcheck IECC-2021

**Credits supported by COMcheck IECC-2021 with Denver Specific Instructions

Other credits are Denver Specific

C406 Lighting & Energy Monitoring Credits

Sub-section	Group B	Group R & I	Group E	Group M	Other Occupancies [a]
C406.3: Reduced light power**	7	2	8	12	7
C406.3.2: Reduced light power by 15%**	11	3	12	18	11
C406.3.2: Reduced light power by >15%**	Proportional Credit				
C406.4: Enhanced digital light control*	2	N/A	2	3	2
C406.10: Energy monitoring*	2	1	2	3	2

C406 Electrification Credits

Sub-section	Group B	Group R & I	Group E	Group M	Other[a]
C406.13: All-electric space heating	4	6	6	9	6
C406.15: All-electric water heating	9	13	13	4	9

C406 HVAC Credits

Sub-section	Group B	Group R & I	Group E	Group M	Other Occupancies [a]
C406.2.1: 5% Heating eff imprv.*	1	1	1	2	1
C406.2.2: 5% Cooling eff imprv.*	2	1	1	1	1
C406.2.3: 10% Heating eff imprv.*	2	2	3	3	3
C406.2.4: 10% Cooling eff imprv.*	4	1	2	2	2
C406.2.5: >10% Cooling eff imprv.**			Proportional Credit		
C406.2.6: >10% Heating eff imprv.**			Proportional Credit		
C406.6 Dedicated OA sys (DOAS)*	5	8	N/A	2	5
C406.11: Fault detection*	1	1	1	1	1
C406.14: Cold climate heat pumps	4	5	5	9	6
C406.16: Demand responsive thermostats	1	1	1	1	1
C406.17.1: Reduced fan power	2	N/A	6	7	3
C406.17.2: Further reduced fan power	4	N/A	11	14	6

C406 Service Water Heating Credits

Sub-section	Group B	Group R & I	Group E	Group M	Other Occupancies [a]
C406.7.2: Recovered/renew SWH_b*	N/A	14	1	N/A	14
C406.7.3: Eff fossil fuel SWH_b*	N/A	9	2	N/A	6
C406.7.4: Heat pump SWH_b*	N/A	5	1	N/A	5

C406 Kitchen & Renewable Credits

Sub-section	Group B	Group R & I	Group E	Group M	Other[a]
C406.12: Efficient kitchen equipment*	See Section				
C406.5.1: Basic renewable credit*	9	7	6	7	2
C406.5.2 Enhanced renewable credit	9-18	7-14	6-12	7-14	7-14

C406 Example Project

18-story mixed use multifamily project

- Parking garage
- Future tenant on the ground floor
- Outdoor pool served by gas-fired boiler

Design strategies:

- Residential spaces – High eff water source heat pumps supplemented with gas boiler
- Ventilation via Dedicated Outdoor Air System with energy recovery
- Tenant requirements for future retail HVAC
- Reduced infiltration throughout
- Central heat pump DHW system
- Lighting designed to 0.30 W/sf, allowance 0.45 W/sf

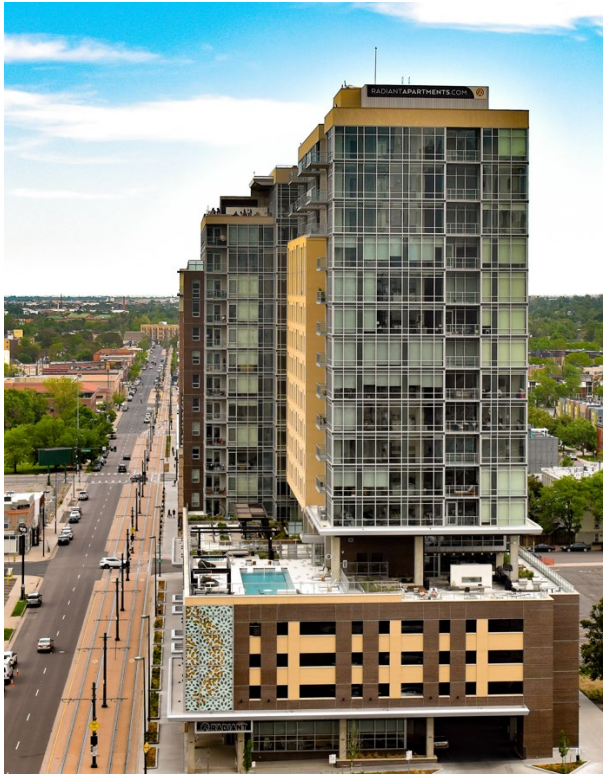


Image courtesy Energetics Consulting Engineers, LLC

C406 Planning Tool Demonstration

C406.14 Cold Climate Heat Pumps

Improved Performance - provides increased capacity and efficiency (COP) at low outdoor temperatures

- **C406.14 Requirements:**
- Minimum COP of 1.75 at outdoor conditions of 5F – improved performance reduces the need for electric resistance heating
- Minimum COP of 1.5 for Packaged Terminal Heat Pumps
- Electric resistance space heating limited to 1.35 W/sf conditioned floor area

Listing of Cold-Climate Heat Pump Products:

https://neep.org/heating-electrification/ccashp-specification-product-list

C406.2.5 HVAC Credit >10% Cooling Efficiency

Example: A Group B office building uses five high-efficiency rooftop HVAC units for space heating and cooling. There are three four-ton HVAC units and two ten-ton HVAC units.

- The (3) four-ton units have a SEER2 rating of 19
- The (2) ten-ton units have a full-load rating (EER) of 13.8 and a part-load rating (IEER) of 17.0

How many energy credits are available for this equipment?

C406.2.5 More than 10-percent cooling efficiency improvement. Where equipment exceeds the minimum annual cooling and heat rejection efficiency requirements by more than 10 percent, energy efficiency credits for cooling may be determined using Equation 4-12, rounded to the nearest whole number. Where multiple cooling performance requirements are provided, the equipment shall exceed the annual energy requirement, including IEER, SEER and IPLV.

EECHEC = EEC10 [1 + ((CEI – 10 %) / 10%)]

C406.2.5 HVAC Credit >10% Cooling Efficiency

Answer Step 1:

First, determine the percent improvement over minimum efficiency requirements of the DEC for each metric. The required efficiency levels are:

- 4-ton units: SEER2 = 13.4 Improvement = (19-13.4)/13.4 = 41.7%
- 10-ton unit: EER = 11.0 Improvement = (13.8-11.0)/11.0 = 25.4%
- 10-ton unit: IEER = 14.6 Improvement = (17.0-14.6)/14.6 = 17.1%

The smallest of the efficiency improvement percentages over the minimum code requirement is used in the equation from C406.2.5 to determine the available credits for this measure.

C406.2.5 HVAC Credit >10% Cooling Efficiency

Answer Step 2:

Use Equation 4-12 to calculate the available credits. Use the available credits from sub-section C406.2.4 for EEC_{10}. CEI = your smallest efficiency improvement.

Sub-section	Group B
C406.2.4: 10% Cooling eff imprv.	4

$$EEC_{HEC} = 4 \times [(1 + (0.171 - 0.10) / 0.10)] = 6.84$$

The credits are rounded to the nearest whole number, so 7 credits are available.

Equation 4-12:

$EECHEC = EEC10\ [1 + ((CEI - 10\%) / 10\%)]$

EECHEC = Energy efficiency credits for cooling efficiency improvement. Round to the nearest whole number
EEC10 = Section C406.2.4 credits
CEI = Improvement above minimum cooling and heat rejection efficiency requirements

C406.17 HVAC Fan Power Credit

Example: A grocery store contains (5) 10-ton rooftop HVAC systems, each with a constant volume supply fan with a design airflow of 4,000 cfm, return fans, and heat recovery.

- The heat recovery device effectiveness is 70%
- The total bhp of all systems is 23

Would this system be eligible for the fan power credit?

C406.17.2 Further reduced HVAC system fan power. The total design fan power for all HVAC units shall be no less than 20 percent lower than the fan power allowance defined in Table C403.8.1, Option 2.

TABLE C403.8.1(1)
FAN POWER LIMITATION

	LIMIT	CONSTANT VOLUME	VARIABLE VOLUME
Option 1: Fan system motor nameplate hp	Allowable nameplate motor hp	$hp \leq CFM_S \times 0.0011$	$hp \leq CFM_S \times 0.0015$
Option 2: Fan system bhp	Allowable fan system bhp	$bhp \leq CFM_S \times 0.00094 + A$	$bhp \leq CFM_S \times 0.0013 + A$

C406.17 HVAC Fan Power Credit

Answer Step 1: Calculate your base allowance, including pressure drop adjustments from Table C403.8.1(2):

Base Allowance: bhp = 0.00094 x CFM + A
A = PD x CFM_D/4131

Calculate pressure drop adjustment A for all 5 units @4000 cfm each:

- Return: A1 = 5 x (0.5 x 4000) / 4131 = 2.421
- Heat recovery: A2 = 5 x (((2.2 x 0.7) - 0.5) x 4000) / 4131 = 5.0351

C406.17 HVAC Fan Power Credit

Answer Step 2:

Allowed System bhp = 0.00094 x (5 x 4000) + 2.421 + 5.0351 = 26.256
Design System bhp = 23

(26.256 - 23) / 26.256 = **12.4% reduction**

From Table C406.1(1), 7 credits are available for the fan systems.

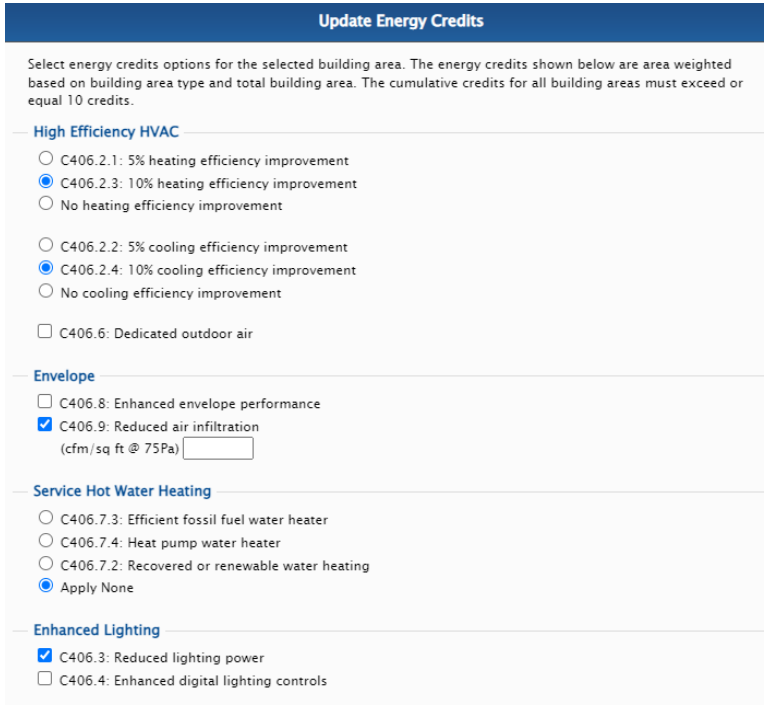
Sub-section	Group M
C406.17.1: Reduced fan power • 10% reduction	7
C406.17.2: Further reduced fan power • 20% reduction	14

C406 Interim COMcheck Workaround

Issue:

The efficiency credits in 2021 IECC COMCheck do not match Denver's list.

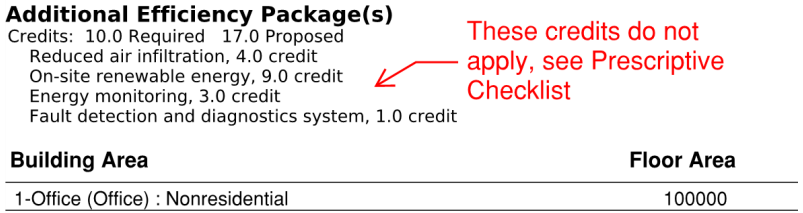
How can teams document compliance?



C406 Interim COMcheck Workaround

Solution:

- Do the best you can and provide supplemental documentation before COMcheck for 2022 Denver Energy Code is available
- Identify C406 efficiency credits in the Planning Tool and Prescriptive Checklist
- Apply the efficiency credits that you are using that would impact Lighting or Mechanical COMcheck targets, such as efficient lighting or cooling. This will make those inputs easier to document.
- Add markups to your final COMcheck pdf if needed to add clarification



Instructions for CPD Plans Reviewers

Action for Reviewer

Note: dedicated Accela fields for this information are in development

To facilitate inspections, record in Permit Scope of Work text box on permit:

1. If C406 Renewable Energy is used, record one of
   - C406.5.1 Basic Renewable Credit with ___ kW array
   - C406.5.2 Enhanced Renewable Credit with ___ kW array
2. If C406 Reduced Air Infiltration is used, record one of
   - C406.9.1 Reduced Air Infiltration 0.25 cfm/sq. ft.
   - C406.9.2 Further Reduced Air Infiltration 0.15 cfm/sq. ft.

Commissioning & Envelope Verification

C408 Commissioning

C408.2 - Mechanical & Service Water System Commissioning:

- ✓ Commissioned by a Colorado registered design professional or approved agency
- Exceptions for
  - Small capacity systems in C408.2
  - Systems for individual sleeping and dwelling units
  - Systems in existing buildings where the area of work is less than 10,000 square feet
- ✓ Air balancing testing (TAB) to be completed by an approved contractor

C408.3 - Lighting Controls Functional Testing:

- ✓ Commissioned by a Colorado registered design professional or approved agency
- Exception for systems in existing buildings where the area of work is less than 10,000 square feet and the new installed lighting load is less than 10 kW*

**Updates for Council approval June 2023*

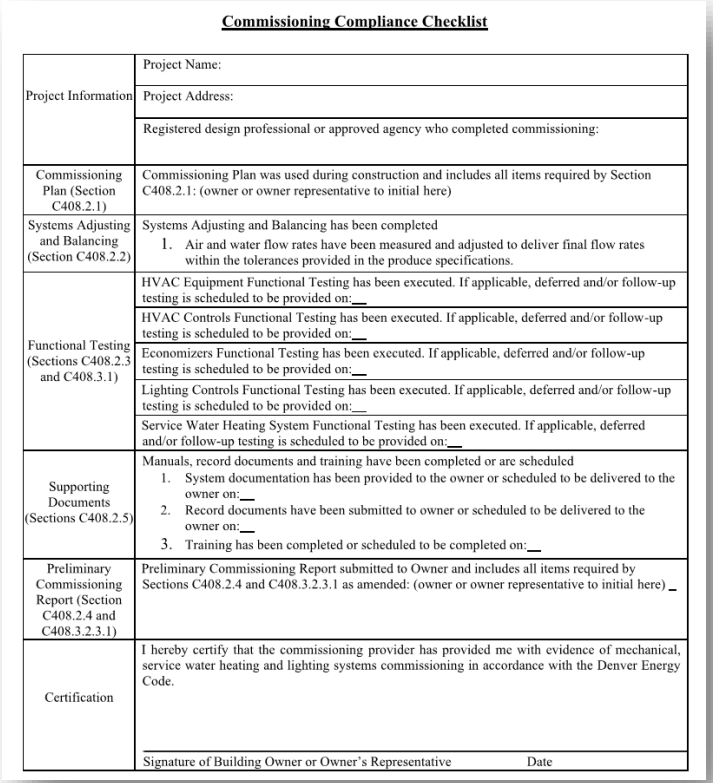
C408 Commissioning

Required at Permit:

- ✓ Letter with qualifications of the commissioning agent

Required at project completion:

- ✓ Preliminary Commissioning Report
- ✓ Final Commissioning Report
- ✓ HVAC, SHW, and Lighting Controls



Commissioning Compliance Checklist

Project Information	Project Name:
	Project Address:
	Registered design professional or approved agency who completed commissioning:
Commissioning Plan (Section C408.2.1)	Commissioning Plan was used during construction and includes all items required by Section C408.2.1: (owner or owner representative to initial here)
Systems Adjusting and Balancing (Section C408.2.2)	Systems Adjusting and Balancing has been completed 1. Air and water flow rates have been measured and adjusted to deliver final flow rates within the tolerances provided in the produce specifications.
Functional Testing (Sections C408.2.3 and C408.3.1)	HVAC Equipment Functional Testing has been executed. If applicable, deferred and/or follow-up testing is scheduled to be provided on:__
	HVAC Controls Functional Testing has been executed. If applicable, deferred and/or follow-up testing is scheduled to be provided on:__
	Economizers Functional Testing has been executed. If applicable, deferred and/or follow-up testing is scheduled to be provided on:__
	Lighting Controls Functional Testing has been executed. If applicable, deferred and/or follow-up testing is scheduled to be provided on:__
	Service Water Heating System Functional Testing has been executed. If applicable, deferred and/or follow-up testing is scheduled to be provided on:__
Supporting Documents (Sections C408.2.5)	Manuals, record documents and training have been completed or are scheduled 1. System documentation has been provided to the owner or scheduled to be delivered to the owner on:__ 2. Record documents have been submitted to owner or scheduled to be delivered to the owner on:__ 3. Training has been completed or scheduled to be completed on:__
Preliminary Commissioning Report (Section C408.2.4 and C408.3.2.3.1)	Preliminary Commissioning Report submitted to Owner and includes all items required by Sections C408.2.4 and C408.3.2.3.1 as amended: (owner or owner representative to initial here) _
Certification	I hereby certify that the commissioning provider has provided me with evidence of mechanical, service water heating and lighting systems commissioning in accordance with the Denver Energy Code. Signature of Building Owner or Owner's Representative Date

C402.5.1.5 Envelope Performance Verification

Colorado registered design professional or approved agency shall

- ✓ Review of continuous air barrier in construction documents
- ✓ Inspect continuous air barrier components and assemblies during construction while the air barrier is still accessible for inspection and repair
- ✓ Provide commissioning report for completed inspections

C402.5 Air Leakage Testing

- Required for
  - New commercial buildings and new envelope assemblies of alterations
- For R and I occupancies: C402.5.2 Dwelling and sleeping unit enclosure testing
  - Sampling permitted for 8 units or more
  - Apply weighted average
- For all other occupancies: C402.5.3 Building thermal envelope testing
  - Entire envelope of stories with a roof, entrance, exposed floor, or below grade
  - Building sections totaling at least 25% of walls for remaining conditioned space

Resources for Air Leakage Testing Success

C402.5 Air Leakage Rates

Test with corrective action until measured air leakage is

1) At or below target

-OR-

2) At or below the maximum limit (from exceptions) plus

- Conduct a diagnostic evaluation using smoke tracer or infrared imaging while building is pressurized along with a visual inspection of the air barrier
- Any leaks noted shall be sealed
- Submit additional report identifying corrective actions taken

Measured Air Leakage	C402.5.2 Dwelling and Sleeping Units	C402.5.3 All Other
Pressure Differential	50 Pa	75 Pa
Target	0.3 CFM/SF	0.4 CFM/SF
Maximum Limit	0.45 CFM/SF	0.6 CFM/SF

When to Choose a Performance Path

- Design not aligned with some of the prescriptive requirements (for example, window area, window performance)
- Projects with complex HVAC systems
- Projects with high-performance systems or features not directly covered by energy credits

Summary

Projects may **follow one of four pathways** to comply with the 2022 DEC

- Prescriptive, C407 energy cost, Appendix SE site energy, and Appendix PT performance target
- This presentation covered code requirements for the prescriptive path

Successful permit submittals include Energy Code checklists in the drawings, compliance documentation (COMcheck/supplemental documentation or energy model report), and construction documents that show how all requirements are met in the proposed design

Updates to the 2022 DEC are **designed to support electrification**

- Key new provisions: partial electrification of space and water heating effective 1/1/2024, demand responsive water heating, electric-ready infrastructure, and permit process parity for alterations replacing furnaces, unitary air conditioning for heated spaces and service water heating

Questions?

- Time is reserved at the end of the presentation for Q&A
- Please use the Q&A feature to submit your questions

- Responses to all questions not addressed today will be sent out by email to registered participants
- Additional questions may be sent to: energy.review@denvergov.org

Thank you!

For more information, visit:

Denvergov.org/EnergyCode

Denvergov.org/BuildingCode

Contact us:

Questions about energy code: energy.review@denvergov.org

Questions about programs & resources: sustainability@denvergov.org