2022 Denver Energy Code Residential Contractor & Inspector Training Part 2: Compliance Paths & Existing Buildings

Community Planning and Development /
Office of Climate Action, Sustainability and Resiliency
Presented by Robby Schwarz BUILDTankinc
June 29, 2023

INTERPRETATON INSTRUCTIONS

- This session is available in both English & Spanish. Click on the “Interpretation” icon at the bottom of the Zoom window and choose either "English" or “Spanish”

- Esta sesión está disponible en inglés y español. Haga clic en el icono "Interpretación" en la parte inferior de la ventana de Zoom y elija "Inglés" o "Español"

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 - Residential Electrification and Performance Requirements

2023 – **2027** – **2030**

NEW HOMES

New Residential Code Changes

2023: May 1st mandatory use of the 2022 Denver Energy Code

2027: GOAL: New Homes are designed Net Zero Energy

2030: GOAL: New Homes perform as Net Zero Energy

2030: Xcel Energy committed to an 80% Renewable electricity Grid by 2030

2022 Denver Energy Code

- This training provides a **high-level overview** of the construction and inspection requirements of the 2022 Denver Energy Code for Residential projects, **focusing on the unique considerations for each compliance pathway and for existing buildings.**
- 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

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
- Rebates for electrification equipment for existing homes

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.

Tips for referencing code

2022 Denver Amendments

+

2021 International Energy Conservation Code (IECC)

=

2022 Denver Energy Code (DEC)

Note: Chapter 11 in the Denver Residential Code is replaced in its entirety by the Residential Provisions of the 2022 Denver Energy Code

Agenda

- Considerations by Compliance Path
  - Prescriptive
    - Building Envelope
    - Additional Efficiency Packages
  - Total Building Performance
  - Energy Rating Index (ERI)
- Existing Buildings

Purpose: This presentation provides an overview of the installation and testing requirements and considerations for residential building projects.

See recordings of pervious trainings for more details on design and building permit submittal considerations.

Definition: Residential 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.

(DEC Section C202)

Definition: All-Electric Property

Photo credit: Kalen Jesse Photography

An *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*.

2022 DEC Compliance Pathways

Residential projects may select from three compliance options:

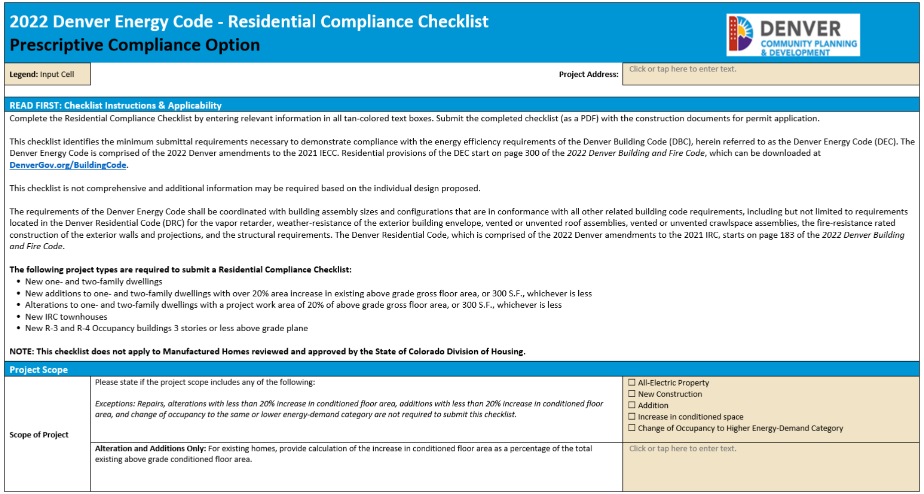
Prescriptive	Total Building Performance	Energy Rating Index (ERI)
Each element of the building must meet a minimum standard defined in prescriptive provisions Additional efficiency options are selected from a standard menu	Energy modeling analysis is used to show an annual energy cost savings for the proposed design over a baseline	Energy rating software is used to show the ERI of the proposed design is less than or equal to the code defined maximum

See previous trainings for more information on each compliance option.

Submittal Requirements

Projects submitting for permit must provide:

- Completed **Energy Code checklist** for the selected compliance path
- **Supplemental Reports or Calculations** as required (e.g., REScheck report, ACCA Manual J, S and D Packages)
- **Construction Documents** showing all required elements, stamped & signed by licensed design professional (if applicable)



2022 Denver Energy Code - Residential Compliance Checklist
Prescriptive Compliance Option

Legend: Input Cell

Project Address: Click or tap here to enter text.

READ FIRST: Checklist Instructions & Applicability

Complete the Residential Compliance Checklist by entering relevant information in all tan-colored text boxes. Submit the completed checklist (as a PDF) with the construction documents for permit application.

This checklist identifies the minimum submittal requirements necessary to demonstrate compliance with the energy efficiency requirements of the Denver Building Code (DBC), herein referred to as the Denver Energy Code (DEC). The Denver Energy Code is comprised of the 2022 Denver amendments to the 2021 IECC. Residential provisions of the DEC start on page 300 of the *2022 Denver Building and Fire Code*, which can be downloaded at DenverGov.org/BuildingCode.

This checklist is not comprehensive and additional information may be required based on the individual design proposed.

The requirements of the Denver Energy Code shall be coordinated with building assembly sizes and configurations that are in conformance with all other related building code requirements, including but not limited to requirements located in the Denver Residential Code (DRC) for the vapor retarder, weather-resistance of the exterior building envelope, vented or unvented roof assemblies, vented or unvented crawlspace assemblies, the fire-resistance rated construction of the exterior walls and projections, and the structural requirements. The Denver Residential Code, which is comprised of the 2022 Denver amendments to the 2021 IRC, starts on page 183 of the *2022 Denver Building and Fire Code*.

The following project types are required to submit a Residential Compliance Checklist:

- New one- and two-family dwellings
- New additions to one- and two-family dwellings with over 20% area increase in existing above grade gross floor area, or 300 S.F., whichever is less
- Alterations to one- and two-family dwellings with a project work area of 20% of above grade gross floor area, or 300 S.F., whichever is less
- New IRC townhouses
- New R-3 and R-4 Occupancy buildings 3 stories or less above grade plane

NOTE: This checklist does not apply to Manufactured Homes reviewed and approved by the State of Colorado Division of Housing.

Project Scope

Scope of Project	Please state if the project scope includes any of the following: *Exceptions: Repairs, alterations with less than 20% increase in conditioned floor area, additions with less than 20% increase in conditioned floor area, and change of occupancy to the same or lower energy-demand category are not required to submit this checklist.*	☐ All-Electric Property ☐ New Construction ☐ Addition ☐ Increase in conditioned space ☐ Change of Occupancy to Higher Energy-Demand Category
	Alteration and Additions Only: For existing homes, provide calculation of the increase in conditioned floor area as a percentage of the total existing above grade conditioned floor area.	Click or tap here to enter text.

Compliance checklists for each pathway and an instructional video on how to complete the checklists can be found here.

Construction Documents

New in 2021 IECC
New in 2022 DEC

DEC R103.2 Information on Construction Documents

1. Energy compliance path.
2. Insulation materials and their *R*-values.
3. Fenestration *U*-factors and *solar heat gain coefficients* (SHGC).
4. Area-weighted *U*-factor and *solar heat gain coefficients* (SHGC) calculations.
5. Mechanical system design criteria.
6. Mechanical and service water-heating systems and equipment types, sizes and efficiencies.
7. Equipment and system controls.
8. Duct sealing, duct and pipe insulation and location.
9. Air sealing details.
10. Total area of glazed *vertical* fenestration as a percentage of conditioned floor area.

Additional Requirements from DEC Provisions:

- Construction documents shall graphically indicate and label all ***EV ready spaces*** and associated termination locations
- Construction documents shall indicate the **solar ready zone**

Preconstruction Considerations

- What is the **energy compliance path**?
  - Understand the specific provisions, testing requirements, and compliance documentation based on the selected pathway
- Is this an **all-electric property**?
- *For Prescriptive*: What **additional efficiency packages** were selected?
  - Review DEC-amended prescriptive tables
- DEC specific considerations:
  - Minimum on-site renewables OR solar-ready?
  - EV charging
  - Electric ready-infrastructure
  - Water heater location / demand response

Identify **critical components** of the design and construction and what is required to **achieve success**

Energy Requirements for Certificate of Occupancy

- The *building* shall have a final inspection and **shall not be occupied until *approved*** (Certificate of Occupancy is issued)
- **R105.2.5.1 Final inspection reporting:** Reporting needed for certificate of occupancy in addition to what may be called for within a specific compliance path:
  - DEC Sections R401.3 Certificate & R401.4 Homeowner Manual
  - Blower door, duct leakage, ventilation testing results
  - Proposed and Confirmed R405 & R406 reports
    - For Total Building Performance or Energy Rating Index

Certificate

DEC R401.3: A **permanent certificate** shall be completed by the builder or other approved party and **posted by the time of the project's final inspection**.

- Minimum information to include:
  - Insulation R-values
  - Fenestration U-factors and SHGC (predominant or area weighted average)
  - Duct and air leakage testing results
  - Type, sizes and efficiencies of heating, cooling and service water-heating equipment
  - On-site PV system information
  - ERI score with and without on-site generation (where applicable)
  - The code edition and the compliance path used

DEC Section R401.3

Certificate Examples

ENERGY EFFICIENCY CERTIFICATE OF COMPLIANCE (ALL COMPLIANCE OPTIONS)
CITY & COUNTY OF DENVER
COMMUNITY PLANNING & DEVELOPMENT

Address:		
Record ID:		
Residential Compliance Option (only one shall apply)		
Prescriptive Compliance ☐ *U-factor/R-value Tables* ☐ or *Total UA Alternative* ☐	Total Building Performance ☐	Energy Rating Index (ERI) ☐
Component Values		
Building Envelope Air Leakage: Air Changes Per Hour (Max) 3 ☐ (Except as amended per DEC Section R402.4.1.2 Exception 2) ☐	Duct System Air Leakage (cfm per 100sf): Rough-in Testing ☐ Post Construction Testing ☐	
Ceiling R or U-value:	Heating System Efficiency:	
Wood Frame Wall R or U-value:	Cooling System Efficiency:	
Mass Wall R or U-value:	Water Heating Efficiency:	
Floor R or U-value:	Basement Wall R-value:	
Slab R-value:	Crawl Space R-value:	
Crawl Space R-value:	Gas Fired Unvented Room Heater: ☐	
Fenestration U-value:	Electric Furnace: ☐	
Skylight U-factor:	Baseboard Electric Heat: ☐	
Ducts Outside of Thermal Envelope R-value: Supply R-8 ☐ Return R-8 ☐	Mandatory Renewable ☐	

I (builder or other approved party) certify the information contained on the certificate is true and complete:

(Print) Full Name: ______________________ Signature: ______________________ Date: ______________________

The energy Efficiency Certificate of Compliance shall be completed and posted as outlined in DEC Section R101.3 Certificate.

IECC 2021 Label

Model: D437 Salida

Ekotrope RATER - Version: 4.0.0.3154

Building Envelope Specs

Ceiling: R-60
Above Grade Walls: R-25
Foundation Walls: R-15 ci
Exposed Floor: N/A
Slab: R-10
Infiltration: 3 ACH50
Duct Insulation: Supply: R0, Return: R0
Duct Lkg to Outdoors: 10 CFM @ 25Pa (0.32 / 100 ft^2)

Window & Door Specs

U-Value: 0.27, SHGC: 0.4
Door: R-6

Mechanical Equipment Specs

Heating: Furnace • Natural Gas • 80 AFUE
Cooling: Air Conditioner • Electric • 13 SEER
Hot Water: Residential Water Heater • Natural Gas • 0.59 UEF
Average Mechanical Ventilation: 74.5 CFM

Builder or Design Professional

Signature: ______________________

BUILDTank INC.
A Pragmatic Building Think Tank
Analyst, Synergist, Catalyst

2021 IECC R401 Label/Certificate Date:12/26/2022

Builder:	**Best Builder Ever**	**RESNET HERS ERI: N/A**
Address:	**123 Best place to live**	**IECC ERI with PV: N/A**
Jurisdiction:	The Best County Colorado	**IECC ERI w/out PV: N/A**
Compliance Path:	Prescriptive	

Building Envelope Specifications:		
▪ Ceiling	R - 60	
▪ Above Grade Walls	R – 23+5	
▪ Exposed Floors	R – 50	
▪ Foundation Walls	R - 19	
▪ Slab/Slab edge	R – 10	
▪ Duct in unconditioned space	R – 8	
▪ Exterior Door R-Value	R - 6	
▪ Window/Skylight U-Value / SHGC	U-value: 0.27	SHGC: 0.27

Mechanical Equipment Specification		
	Type	**Efficiency**
Heating	Gas Furnace	AFUE 96
Cooling	Air Conditioner	SEER 16
Water Heating	Gas 50 Gallon	UEF 96

Building Performance Data	
Envelope Infiltration: Air Changes Per Hour @50 Pascals	1.5 ACH50
Ventilation Type: Balanced	75 CFM flow
Duct Leakage compliance target: 4CFM/100sqft of conditioned floor area	N/A Sqft conditioned space served: 4000 N/A CFM target 160
Measured Total Duct Leakage:	50 CFM25
Measured Duct Leakage to Outside:	25 CFM25

Photovoltaic systems			
Array Capacity	Inverter Efficiency	Panel Tilt	Panel Orientation
N/A	N/A	N/A	N/A

Robby Schwarz
IECC Residential Energy Inspector/Plans Examiner/HERS/ERI Performance Specialist

Download the Residential Energy Code submittal policy at Denvergov.org/BuildingCode

Other formats are accepted as long as all required information is shown.

Homeowner Manual

DEC R401.4: The builder or owner's agent **shall provide the owner with a binder of all equipment and appliance manufacturers' installation manuals**, except for manuals that are required to be affixed to the equipment, and any information required to be included on the permanent certificate in accordance with R401.3.

- This **includes any energy assessment report and/or ERI certificate.**

Image Source: Mungo Homes

Considerations for Prescriptive Path: Building Thermal Envelope

DEC Sections R402.1.2 through R402.1.5

Building Thermal Envelope

- **Two** options for Prescriptive Compliance:

Prescriptive Tables	Total UA Alternative
Meet the assembly *U*-factor (DEC Table R402.1.2) or component *R*-value (DEC Table R402.1.3) and fenestration requirements. May follow DEC Section R402.1.4, *R-value computation,* where insulation is installed in multiple layers	Meet the requirements of section DEC R402.1.5, which allows for tradeoffs between the thermal performance of different assemblies

Option 1: Prescriptive Tables

DEC Sections R402.1.2 through R402.1.4

- All building thermal envelope assemblies **must meet either**:
  - **Maximum assembly *U*-factors** (DEC Table R402.1.2)
  - **Minimum *R*-values by component** (DEC Table R402.1.3)

- 2021 IECC changes *U*-factor table to default, *R*-values as an alternative

- You can install more insulation but not less

U-factor vs. *R*-value

- *U*-factor describes Thermal Transmittance or the **rate of heat transfer through 1 ft^2 of material**
- Mathematically, *U*-factor is the reciprocal of *R*-value
  - U = 1/R and R = 1/U
  - *Example*: 1/R-5 = 0.20 U-factor

U-factor	*R*-value
Applied to **assemblies**	Applies to **construction components** (measured in *R*-value/inch)
Cannot be added, but can calculate an area weighted *U*-factor*	Can be added together**

*The rate of heat transfer through an assembly of different material with different U-factors
**Only where allowed by DEC R402.1.4 R-value computation

Image Source: wincorewindows.com

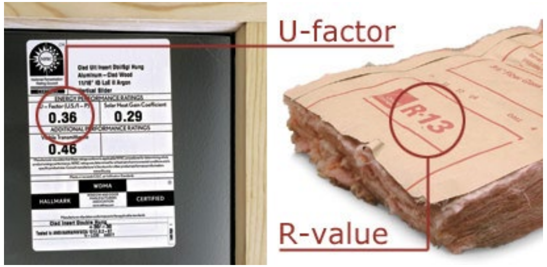


Image Source: finehomebuilding.com

R-Values

- *R*-value describes a **material's ability to resist heat flow** from more to less
  - The higher the number, the greater the resistance
- The *R*-values in Table R402.1.3 apply to the **insulation materials only**
  - Nominal R-Value is the rated insulation value that is provided by the manufacturer

DEC R402.1.4 R-Value Computation

- Cavity insulation or continuous insulation alone shall be used to meet the *R*-value requirements of Table R402.1.3
- Where cavity or continuous insulation is installed in multiple layers:
  - The *R*-values of the <u>cavity insulation layers</u> shall be summed to meet cavity insulation *R*-value requirements
  - The *R*-values of the <u>continuous insulation layers</u> shall be summed to meet continuous insulation *R*-value requirements
- Cavity insulation *R*-values cannot be used to determine compliance with the continuous insulation *R*-value requirements
- Computed *R*-values shall not include an *R*-value for other building materials or air films

2022 DEC: U-factor/R-value Revisions

Revisions to prescriptive U-factors and R-values increase the thermal performance of some assemblies

Tables R402.1.2 and R402.1.3: Summary of Revised Values

Code	Fenestration *U*-factor	Skylight *U*-factor	Glazed Fenestration SHGC	Wood Frame Wall *R*-value	Floor *U*-factor / *R*-value
2022 DEC	0.27/0.25*	0.45	0.40	30 or 20 + 5ci or 13 + 10ci or 0 + 20ci	0.026 / 38
2021 IECC	0.32	0.55	NR	20 + 5ci or 13 + 10ci or 0 + 15ci	0.033 / 30

2022 DEC Footnote: Where the proposed glazing area is Greater than or equal to 15% of the conditioned floor area, **the second lower U-factor shall not be exceeded.**

Window-to-floor Ratio

DEC R103.2: 10. Total area of glazed vertical fenestration as a percentage of conditioned floor area

- Windows are the weakest link
- Wall R-value vs. window R-value
  - Wall: R-20 – R-30
  - Window:
    - » U 0.35 = R-2.86
    - » U 0.25 = R-4
    - » U 0.15 = R-6.67
- Lower window-to-floor ratio:
  - Higher total wall R-value less heat loss in cold months
  - Less internal heat gain in warm months

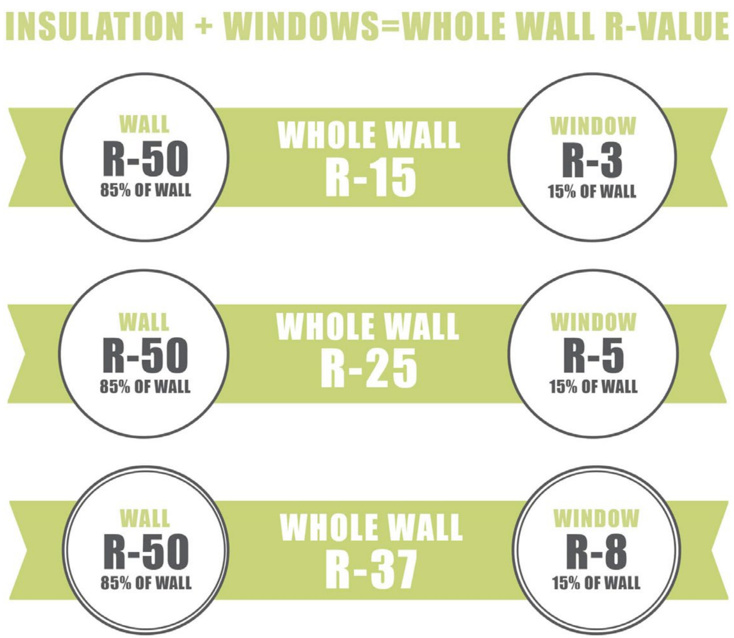


Image Source: glowindows.com

Option 2: Total UA Alternative

DEC Section R402.1.5

- Baseline set by the ***U*-factors in Table R402.1.2** and assembly areas
- Requires **energy modeling software** to determine the total building thermal envelope area weighted U-factor (UA)
- This allows for **tradeoffs**
- **SHGC requirements** of Table R402.1.2 and **maximum fenestration *U*-factors** of Section R402.5 also apply

Projects designed to the prescriptive tables: If any installed envelope assemblies are less than required by tables, a Total UA analysis will be required to verify compliance

Software Basics

- The software creates a **reference home** which the home you are analyzing is compared to in order to quantify performance or demonstrate compliance
- Reference Home/Design
  - A standard set of house specifications that generate specific, consistent, and quantifiable energy performance
- Types of reference homes:
  - **UA Alternative Reference home**
  - R405 Total Building Performance Reference Home
  - R406 IECC ERI Reference home
  - RESNET HERS ERI Reference home
  - Energy Star Reference home
  - User defined Reference home used by Utilities

Image Source: Patch.com

Total Area Weighted *U*-factor (UA)

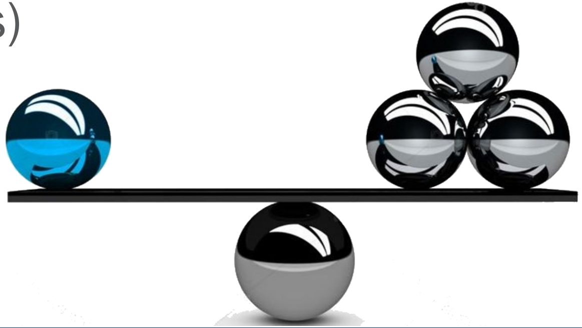
- The total building thermal envelope UA *(sum of U-factor times assembly area for each assembly)* must be **less than or equal to** the total UA resulting from using the *U*-factors in Table R402.1.2 *(multiplied by the same assembly area as in the proposed building)*
- **The UA calculation shall include the thermal bridging effects of framing materials**
- **Backstops** (to ensure a minimum level of performance) are **included for fenestration *U*-factor and SHGC**

Image Source: SBCMag.info

Tradeoffs

- A tradeoff refers to putting something **more in one assembly** so you can put something **less in another**
  - The energy performance scale remains balanced
- Under Total UA Alternative, you can tradeoff the *U*-factors and *R*-values of different assemblies (the performance compliance paths allow for more flexibility with tradeoffs)

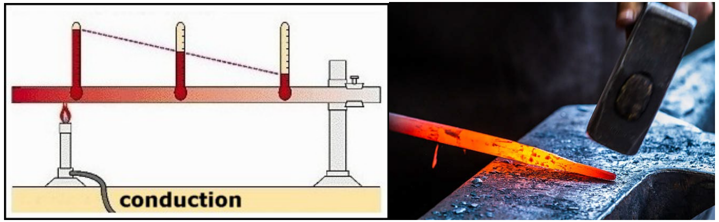
The **blue ball** represents ceiling insulation of R-38 (less than prescriptive R-60)



The **3 silver balls** represent window and wall assemblies that exceed the minimum prescriptive tables, balancing the energy equation

Total UA Alternative

- A method for performing **conductive energy trade-offs**
  - Trading off the *R*-values and *U*-factors in the thermal envelope
  - Mathematically making the proposed building equal to the *U*-factor and *R*-value tables



Total UA Compliance Path

Image Source: TES.com

Software for Total UA Alternative

- Uses a Software Generated **Energy Model**

Image Source: Energy.gov

REScheck-Web™

REMRate and Ekotrope can calculate UA compliance but cannot easily be customized for DEC amendments

REScheck Compliance Certificate

Generated by REScheck-Web Software

Compliance Certificate

Project DOE SF house on Basement 2021 IECC

Energy Code: **2021 IECC**
Location: **Denver, Colorado**
Construction Type: **Single-family**
Project Type: **New Construction**
Orientation: **Bldg. faces 0 deg. from North**
Conditioned Floor Area: **3,564 ft2**
Glazing Area **19%**
Climate Zone: **5 (6020 HDD)**
Permit Date:
Permit Number:

Construction Site: Owner/Agent: Designer/Contractor:

Compliance: Passes using UA trade-off

Compliance: **11.0% Better Than Code** Maximum UA: **328** Your UA: **292**

The % Better or Worse Than Code Index reflects how close to compliance the house is based on code trade-off rules.
It DOES NOT provide an estimate of energy use or cost relative to a minimum-code home.

Slab-on-grade tradeoffs are no longer considered in the UA or performance compliance path in REScheck. Each slab-on-grade assembly in the specified climate zone must meet the minimum energy code insulation R-value and depth requirements.

A 2022 Denver Energy Code specific version of REScheck is in development

Boxed area enlarged on next slide

Envelope Assemblies

Assembly	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Prop. U-Factor	Req. U-Factor	Prop. UA	Req. UA
Ceiling: Raised or Energy Truss	1,188	13.0	47.0	0.016	0.024	19	29
Wall - Front: Wood Frame, 16" o.c. Orientation: Front	592	20.0	5.0	0.044	0.045	21	22
Door 2: Solid Door (under 50% glazing) Orientation: Front	24			0.170	0.320	4	8
Window 2: Vinyl Frame Orientation: Front	89			0.300	0.320	27	28
Wall - Right: Wood Frame, 16" o.c. Orientation: Right side	592	20.0	5.0	0.044	0.045	22	23
Window 2: Wood Frame Orientation: Right side	89			0.300	0.320	27	29
Wall - Back: Wood Frame, 16" o.c. Orientation: Back	592	20.0	5.0	0.044	0.045	20	20

REScheck Compliance Certificate

Compliance Verification

Compliance: Passes using UA trade-off

Compliance: **11.0% Better Than Code** Maximum UA: **328** Your UA: **292**

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Visit EnergyCodes.gov/REScheck for more information on how to use REScheck for your project.

Interim REScheck Workaround

The 2022 Denver Energy Code will not be available in REScheck until Fall 2023

- **Envelope Compliance**
  - 2022 DEC includes revisions to some U-factors in Table R402.1.2
  - To demonstrate compliance with the 2022 DEC, **additional calculations using the amended U-factors** must be provided with a REScheck compliance report based on the 2021 IECC
- **Additional Efficiency Package Options**
  - Additional Efficiency Package selected in REScheck under 2021 IECC does not impact the UA calculations and **DOES NOT** count toward compliance with DEC Section R408
  - Residential projects must show all selected measures using on **2022 Denver Energy Code Residential Prescriptive Checklist**

Table 1. 2022 Denver Energy Code Amendments to Table R402.1.2 Maximum Assembly *U*-factors and Fenestration Requirements

Assembly	2021 IECC	2022 DEC
Fenestration *U*-factor (Glazing area < 15% of conditioned floor area)	0.32*	0.27
Fenestration *U*-factor (Glazing area >= 15% of conditioned floor area)	0.32*	0.25
Skylight *U*-factor	0.55	0.45
Floor *U*-factor	0.033	0.026

**Revised for Climate Zone 5 over 4,000 ft elevation, per IECC footnote f*

Prescriptive

What if something changes in the field?

- If **better than or equal to** (i.e., more insulation than required), no issues
- If installed values **are less than** approved drawings:
  - Provide **REScheck report** verifying as-built conditions meet code
  - **Modified drawings** may be required to be submitted for review and approval

Considerations for Prescriptive Path: Additional Efficiency Packages

DEC Section R408

What does it mean for my project?

Buildings following the prescriptive path must select **additional efficiency packages** to achieve a minimum credit total based on building type.

<table>
<tr><th>Requirements for
All-Electric Properties</th><th>Requirements for
All Other Buildings</th></tr>
<tr><td>Compliance with High OR Premium Performance Electric Space Heating package (R408.8.2 OR R408.3)</td><td rowspan="3">18 Credits from Table R408.1</td></tr>
<tr><td>Compliance with High Performance Electric Water Heating in Conditioned OR Unconditioned Space package (R408.10.2 OR R408.10.3)</td></tr>
<tr><td>3 Credits form Table R408.1</td></tr>
</table>

Additional Efficiency for All-Electric Properties

Choose one measure from Space Heating and Water Heating:

Required Measures for All-Electric Properties	
Category	*Measure*
Space heating equipment efficiency (select one)	R408.8.2: High Performance Electric Space Heating
	R408.8.3: Premium Performance Electric Space Heating
Water heating equipment efficiency (select one)	R408.10.2: High Efficiency Electric Water Heating in conditioned space
	R408.10.3: High Efficiency Electric Water Heating in unconditioned space

- Space Heating
  - R408.8.2: Defines **High Performance Heat Pumps** as COP ≥ 1.75 (at 5 °F) and HSPF ≥ 10 (non-ducted) or 9 (ducted) and **limits total electric resistance load**
  - R408.8.3: Defines **Premium Performance Heat Pump** technology as HSPF ≥ 11.2
- Water Heating
  - R408.10.2/R408.10.3 : Defines High Efficiency Electric Water Heating as UEF ≥ 2

Additional Efficiency for All-Electric Properties

AND Choose 3 credits from list below:

Table R408.1 Additional Energy Efficiency Credits (Options for All-Electric Properties)		
Category	*Credit Value*	*Measure*
Energy Star Appliance	4	R408.2: Energy Star Appliances
Reduced envelope UA (select only one)	2	R408.3.1: ≥ 5% reduction in total UA
	3	R408.3.2: ≥ 7.5% reduction in total UA
	4	R408.3.3: ≥ 10% reduction in total UA
Reduced air leakage (select only one)	2	R408.4.1: ≤ 2 ACH50 air leakage rate
	3	R408.4.2: ≤ 1 ACH50 air leakage rate
Low duct leakage	2	R408.5: ≤ 2 CFM of total duct leakage
Duct location	5	R408.6: Ducts in Conditioned Space
Heat/Energy Recovery Ventilation (select only one)	4	R408.9.1: High Performance Heat/Energy Recovery Ventilation
	7	R408.9.2: Premium Performance Heat/Energy Recovery Ventilation
Drain water heat recovery (select only one)	2	R408.11.1: Drain Water Heat Recovery Units
	3	R408.11.2: High Performance Drain Water Heat Recovery Units
High efficacy lighting	2	R408.12: High Efficacy Lighting
Demand responsive controls	1	R408.13: Demand Responsive Thermostats
Controls	1	R408.14: Controls

Additional Efficiency for All Other buildings

Choose 18 credits from Table R408.1:

Table R408.1 Additional Energy Efficiency Credits (Options for All Other Buildings)		
Category	*Credit Value*	*Measure*
Energy Star Appliance	4	R408.2: Energy Star Appliances
Reduced envelope UA (select only one)	2	R408.3.1: ≥ 5% reduction in total UA
	3	R408.3.2: ≥ 7.5% reduction in total UA
	4	R408.3.3: ≥ 10% reduction in total UA
Reduced air leakage (select only one)	2	R408.4.1: ≤ 2 ACH50 air leakage rate
	3	R408.4.2: ≤ 1 ACH50 air leakage rate
Low duct leakage	2	R408.5: ≤ 2 CFM of total duct leakage
Duct location	5	R408.6: Ducts in Conditioned Space
Space cooling equipment efficiency (select only one)	1	R408.7.1: High Performance Space Cooling
	2	R408.7.2: Premium Performance Space Cooling
Space heating equipment efficiency (select only one)	2	R408.8.1: High Performance Gas Space Heating
	8	R408.8.2: High Performance Electric Space Heating
	10	R408.8.3: Premium Performance Electric Space Heating
Heat/Energy Recovery Ventilation (select only one)	4	R408.9.1: High Performance Heat/Energy Recovery Ventilation
	7	R408.9.2: Premium Performance Heat/Energy Recovery Ventilation
Water heating equipment efficiency (select only one)	2	R408.10.1: High Efficiency Gas Water Heating
	6	R408.10.2 High Efficiency Electric Water Heating in conditioned space
	4	R408.10.3 High Efficiency Electric Water Heating in unconditioned space
	8	R408.10.4: Premium Efficiency Electric Water Heating in conditioned space
	5	R408.10.5: Premium Efficiency Electric Water Heating in unconditioned space
Drain water heat recovery (select only one)	2	R408.11.1: Drain Water Heat Recovery Units
	3	R408.11.2: High Performance Drain Water Heat Recovery Units
High efficacy lighting	2	R408.12: High Efficacy Lighting
Demand responsive controls	1	R408.13: Demand Responsive Thermostats
Controls	1	R408.14: Controls

Additional Efficiency Package Options

Submittal Requirements & Considerations

Required Measures for All-Electric Properties

Category	*Measure*	*Selected?*
Space heating equipment efficiency *(select one)*	R408.8.2: High Performance Electric Space Heating	☐
	R408.8.3: Premium Performance Electric Space Heating	☐
Water heating equipment efficiency *(select one)*	R408.10.2: High Efficiency Electric Water Heating in conditioned space	☐
	R408.10.3: High Efficiency Electric Water Heating in unconditioned space	☐

Table R408.1 Additional Energy Efficiency Credits (Options for All-Electric Properties)

Category	*Credit Value*	*Measure*	*Selected?*
Energy Star Appliance	4	R408.2: Energy Star Appliances	☐
Reduced envelope UA *(select only one)*	2	R408.3.1: ≥ 5% reduction in total UA	☐
	3	R408.3.2: ≥ 7.5% reduction in total UA	☐
	4	R408.3.3: ≥ 10% reduction in total UA	☐
Reduced air leakage *(select only one)*	2	R408.4.1: ≤ 2 ACH50 air leakage rate	☐
	3	R408.4.2: ≤ 1 ACH50 air leakage rate	☐
Low duct leakage	2	R408.5: ≤ 2 CFM of total duct leakage	☐
Duct location	5	R408.6: Ducts in Conditioned Space	☐
Heat/Energy Recovery Ventilation *(select only one)*	4	R408.9.1: High Performance Heat/Energy Recovery Ventilation	☐
	7	R408.9.2: Premium Performance Heat/Energy Recovery Ventilation	☐
Drain water heat recovery *(select only one)*	2	R408.11.1: Drain Water Heat Recovery Units	☐
	3	R408.11.2: High Performance Drain Water Heat Recovery Units	☐
High efficacy lighting	2	R408.12: High Efficacy Lighting	☐
Demand responsive controls	1	R408.13: Demand Responsive Thermostats	☐
Controls	1	R408.14: Controls	☐
		Total Selected Credits (Minimum of 3 Required)	Click or tap here to enter text.

Table R408.1 Additional Energy Efficiency Credits (Options for All Other Buildings)

Category	*Credit Value*	*Measure*	*Selected?*
Energy Star Appliance	4	R408.2: Energy Star Appliances	☐
Reduced envelope UA *(select only one)*	2	R408.3.1: ≥ 5% reduction in total UA	☐
	3	R408.3.2: ≥ 7.5% reduction in total UA	☐
	4	R408.3.3: ≥ 10% reduction in total UA	☐
Reduced air leakage *(select only one)*	2	R408.4.1: ≤ 2 ACH50 air leakage rate	☐
	3	R408.4.2: ≤ 1 ACH50 air leakage rate	☐
Low duct leakage	2	R408.5: ≤ 2 CFM of total duct leakage	☐
Duct location	5	R408.6: Ducts in Conditioned Space	☐
Space cooling equipment efficiency *(select only one)*	1	R408.7.1: High Performance Space Cooling	☐
	2	R408.7.2: Premium Performance Space Cooling	☐
Space heating equipment efficiency *(select only one)*	2	R408.8.1: High Performance Gas Space Heating	☐
	8	R408.8.2: High Performance Electric Space Heating	☐
	10	R408.8.3: Premium Performance Electric Space Heating	☐
Heat/Energy Recovery Ventilation *(select only one)*	4	R408.9.1: High Performance Heat/Energy Recovery Ventilation	☐
	7	R408.9.2: Premium Performance Heat/Energy Recovery Ventilation	☐
Water heating equipment efficiency *(select only one)*	2	R408.10.1: High Efficiency Gas Water Heating	☐
	6	R408.10.2 High Efficiency Electric Water Heating in conditioned space	☐
	4	R408.10.3 High Efficiency Electric Water Heating in unconditioned space	☐
	8	R408.10.4: Premium Efficiency Electric Water Heating in conditioned space	☐
	5	R408.10.5: Premium Efficiency Electric Water Heating in unconditioned space	☐
Drain water heat recovery *(select only one)*	2	R408.11.1: Drain Water Heat Recovery Units	☐
	3	R408.11.2: High Performance Drain Water Heat Recovery Units	☐
High efficacy lighting	2	R408.12: High Efficacy Lighting	☐
Demand responsive controls	1	R408.13: Demand Responsive Thermostats	☐
Controls	1	R408.14: Controls	☐
		Total Selected Credits (Minimum of 18 Required)	Click or tap here to enter text.

- At permit, completed Table R408.1 from DEC checklist will be **included (as screenshot or similar) on a sheet within drawing set**
- Review early in project and **understand the selected measures before selecting systems**
  - Mechanical equipment fuel types and required efficiencies, appliance requirements
  - Tightened air/duct leakage requirements
  - Lighting and controls requirements
- Important to **build to approved drawings** and communicate early if changes are needed to ensure minimum required credits are still met

Prescriptive Compliance Path

Energy Documentation Required for Certificate of Occupancy

- **If no changes from approved construction documents**, no additional documentation required
- Prescriptive Tables or Total UA with **field revisions**:
  - Final **REScheck report** verifying as-built conditions meet code
- Checklist of **final R408 measures**
  - Energy Efficiency Certificate of Compliance*

Required for All Paths
• Certificate (R401.3) • Homeowner Manual (R401.4) • Insulation certificate • Air leakage (blower door) testing report • Duct leakage testing report • Ventilation measurement report

*Download the Residential Energy Code submittal policy at Denvergov.org/BuildingCode

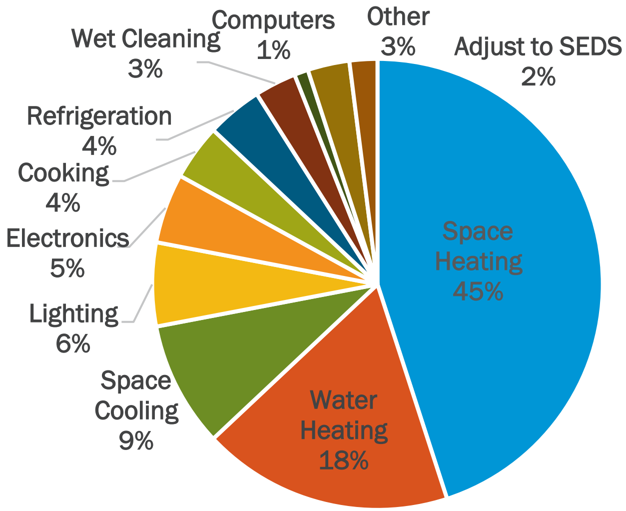
Considerations for Total Building Performance Compliance Option

DEC Section R405

Total Building Performance

Scope of Analysis

- **DEC R405.1 Scope.** This section establishes criteria for compliance using Total Building Performance analysis
- Such analysis shall include
  - Heating
  - Cooling
  - Mechanical ventilation
  - Service water heating energy only
- **No mechanical or solar trade offs**



Residential Site Energy Consumption by End Use

Source: CaliforniaGeo.org

Twin House Concept

Proposed Design

- Geometric Twin
- Envelope *U*-factors based on design specifications (minimum efficiency set by back stop)

vs.

Standard Reference Design

- Geometric Twin
- Envelope as defined by the reference home specifications in DEC Table R405.4.2(1)

What does it mean for my project?

DEC Section R405.2

- Requirements for the *proposed design*:
  1. Meet all requirements of sections in Table R405.2
  2. Building thermal envelope greater than or equal to efficiency levels of 2009 IECC (backstop)
  3. Annual **energy cost savings in $** (compared to the *reference design*):

All-Electric Properties	All Other Buildings
5%	18%

Image Source: TES.com

Total Building Performance

DEC Table R405.2

Tables R405.2 REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE	
SECTION	**TITLE**
General	
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.8.1	Basement Wall Insulation Installation
R402.2.9.1	Slab-on-grade floor insulation installation
R402.2.10.1	Crawl space wall insulation installation
R402.4.1.1	Installation
R402.4.1.2	Testing
R402.4.2	Fireplaces
R402.4.3	Fenestration air leakage
R402.4.4	Rooms containing fuel burning appliances
R402.4.5	Recessed lighting
R402.4.6	Electrical and communication outlet boxes (air Sealed boxes

See first training in series for more information on provisions required for all pathways

Tables R405.2 (Continued) REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE	
SECTION	**TITLE**
Mechanical	
R403.1	Controls
R403.2	Hot water boiler temperature reset
R403.3	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water circulation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.5.4	Water heating equipment location
R403.5.5	Demand Responsive Water Heating
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
R404.2	Interior lighting controls
R404.4	Electric Vehicle Charging Requirements
R404.5	Additional Electrical Infrastructure
R404.6	Solar Ready Zone
R404.7	Minimum renewable energy system capacity

Key Considerations for Construction

- Energy Code is unique from other codes
  - Crosses disciplines/trades
  - Focuses on **overall building performance over individual components**
  - Changes in one area could have unintended impacts on another trade
- With a performance-based compliance approach, **more important to build to the approved drawings**
  - Do not default to prescriptive tables (for both construction and inspections)
  - If something needs to change, work with the energy modeler to update the compliance model and find a code compliant solution

Total Building Performance

Compliance Documentation

DEC R405.3 Documentation:

- A final compliance report based on the **confirmed as-built conditions** shall be submitted before the certificate of occupancy is issued
  - Software generated report demonstrating that the final building meets the requirements of R405.2

Report must include:

1. **Address** or other identification of the building
2. **Declaration of Total Building Performance Compliance option** on title page of building plans
3. **Name of individual** completing the compliance report
4. Name and version of the **compliance software tool**
5. **Documentation of all inputs** in the software used for the reference design and/or the rated home
6. A **certificate** indicating confirmed design has an annual energy cost that is less than or equal to required target based on building type

Total Building Performance

Report Example: REM/Rate™

Note: REM/Rate does not include DEC amendments, submitter must confirm the energy savings meet the required threshold based on building type

2021 IECC Energy Cost Compliance

BUILDTank inc.

Property	Organization	HERS
Best House Ever	BuildTank, Inc.	Confirmed
, CO 80237	303-927-0025	4/2/2021
	Robby Schwarz	Rating No:kLZVQq8L
		Rater ID:9124083
Weather: Denver Intl AP, CO		
2021 IECC test house	Builder	
DRH House for Denver.blg	DRH	

Annual Energy Cost — $/yr

	2021 IECC	As Designed
Heating	340	289
Cooling	134	139
Water Heating	108	108
Mechanical Ventilation Fan	19	23
SubTotal - Used to Determine Compliance	601	559
Lights & Appliances (minus MechVent)	627	576
Photovoltaics	-0	-0
Service Charge	240	240
Total	1468	1375

"This home MEETS the annual energy cost requirements of Section 405 of the **2021 IECC** based on a climate zone of 5B. In fact, this home **surpasses the requirements by 7.0%**"

Mandatory Requirements

Annual Energy Cost Check	PASSES
Duct Insulation R-Value Check (per Section 405.2)	PASSES
Window U-Value and SHGC Check (per Section 402.5)	PASSES
Skylight U-Value Check (per Section 402.5)	PASSES
Home Infiltration (Section 402.4.1)	PASSES
Duct Testing (Section 403.3.5)	PASSES
Mechanical Ventilation (Section 403.6)	PASSES
Mechanical Ventilation Fan Efficacy (Section 403.6.1)	PASSES
Mandatory Requirements Check Box (2021 IECC)	PASSES
High efficacy lights installed(100 %)	PASSES

This home MEETS the annual energy cost requirements of Section 405 of the 2021 International Energy Conservation Code based on a climate zone of 5B. In fact, this home surpasses the requirements by 7.0%.

Name	Robby Schwarz	Signature	
Organization	BuildTank, Inc.	Date	10 May 2023

In accordance with IECC, building inputs, such as setpoints, infiltration rates, and window shading may have been changed prior to calculating annual energy cost. Furthermore, the standard reference design HVAC system efficiencies are set equal to those in the design home as specified in the 2021 IECC. These standards are subject to change, and software updates should be obtained periodically to ensure the compliance calculations reflect current federal minimum standards.

REM/Rate - Residential Energy Analysis and Rating Software v16.3.4

This information does not constitute any warranty of energy costs or savings.

Total Building Performance

Report Example: ekotrope

Note: ekotrope does not include DEC amendments, submitter must confirm the energy savings meet the required threshold based on building type

IECC 2021 Performance Compliance

BUILDTank

Property
, CO
Model: D437 Salida

Ft Collins DR Horton - D437 Salida
2021 IECC test house

Organization
BuildTank, Inc.
Robby Schwarz
303-927-0025

Builder
Dr Horton

Inspection Status
Results are projected

This report is based on a proposed design and does not confirm field enforcement of design elements.

Annual Energy Cost

Design	IECC 2021 Performance	As Designed
Heating	$564	$535
Cooling	$78	$82
Water Heating	$145	$145
Mechanical Ventilation	$41	$25
SubTotal - Used to determine compliance	$829	$787
Lights & Appliances w/out Ventilation	$707	$707
Onsite generation	$0	$0
Total	**$1,535**	**$1,493**

R405.3 Source Energy Exception: The proposed home uses 4.89 MBtu LESS source energy than the reference home.

"Design exceeds the requirements for 2021 IECC Performance compliance by 5%"

Requirements

R405.2	Performance-based compliance passes by 5.0%	The proposed house meets the IECC 2021 Performance reference energy bill requirement by $41.6 (4.89 MBtu).
R405.2 Item 2	Total UA alternative compliance passes by 23.1%.	The proposed home meets the UA requirement by 23.1%
R405.2 Item 2	Glazed Fenestration SHGC	
R402.4.1.2	Air Leakage Testing	Air sealing is 3.00 ACH at 50 Pa and 0.21 CFM50 / ft² Shell Area. It must not exceed 5.00 ACH at 50 Pa or 0.28 CFM50 / ft² Shell Area.
R403.3.1	Duct Insulation	All ducts outside the thermal envelope must be insulated to at least R6.0.
R404.1	Lighting Equipment	At least 100.0% of fixtures shall be high-efficacy lamps, currently 100.0% are high-efficacy.
Mandatory Checklist	Mandatory code requirements that are not checked by Ekotrope must be met.	2021 IECC Required Items must be checked as complete.
R403.6.2	Mechanical Ventilation Efficacy	
R403.6.1	Mechanical Ventilation Energy Recovery	
R402.5	Area-weighted average fenestration SHGC	Area-weighted average fenestration SHGC is 0.4. The maximum allowed value is [No Limit].
R402.5	Area-weighted average fenestration U-Factor	
R401.2.5 Option 2	Additional energy efficiency	R401.2.5: 2.2 - 95% Threshold Met.

Design exceeds requirements for IECC 2021 Performance compliance by 5%.

As a 3rd party extension of the code jurisdiction utilizing these reports, I certify that this energy code compliance document has been created in accordance with the requirements of Chapter 4 of the adopted International Energy Conservation Code based on LARIMER County. If rating is Projected, I certify that the building design described herein is consistent with the building plans, specifications, and other calculations submitted with the permit application. If rating is Confirmed, I certify that the address referenced above has been inspected/tested and that the mandatory provisions of the IECC have been installed to meet or exceed the intent of the IECC or will be verified as such by another party.

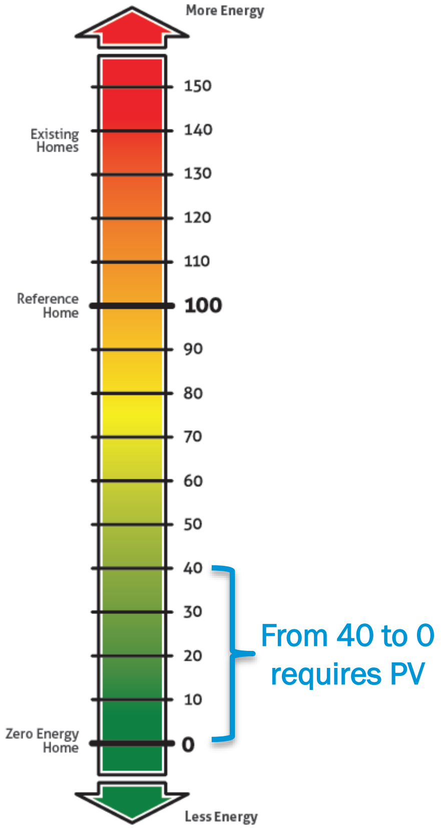
Name: Robby Schwarz
Signature: Robby Schwarz
Organization: BuildTank, Inc.
Digitally signed: 5/8/23 at 8:00 PM

Considerations for Energy Rating Index (ERI) Compliance Option

DEC Section R406

What is the Energy Rating Index (ERI)?

- A home energy rating is a calculated measure of a home's energy efficiency compared to a baseline reference home
  - Total building energy model, including mechanical systems
  - Most well-known: HERS Energy Rating Index
- An index scale – lower is better
  - Miles/gallon rating system for homes
- The ERI Reference Home is 100 on the scale
  - Equal to the 2006 IECC
  - ERI Index of 0 = Net-Zero Energy home
- ERI Index of 130 = Average existing home (DOE)



DEC Amends ERI Scope from IECC

DEC Amended Provision

DEC Section R406.3 Energy Rating Index

- DEC ERI based only on ANSI/RESNET/ICC 301 to **align with HERS ERI**
  - Amends out a ventilation equation in IECC that causes divergence in scores
  - Goal: to simplify process, eliminate confusion

A RESNET HERS ERI report meets the requirements for 2022 DEC ERI

Home Energy Rating Certificate
Projected Report
Based on Plans

Rating Date: 2021-03-13
Registry ID:
Ekotrope ID: 12377mY2

BUILDTank

HERS® Index Score: 50
Your home's HERS score is a relative performance score. The lower the number, the more energy efficient the home. To learn more, visit www.hersindex.com

Annual Savings* $4,050
*Relative to an average U.S. home

Home: 9446 Cherrywood Trail
Littleton, CO 81611
Builder: Gordy Cardner

Your Home's Estimated Energy Use:

	Use [MBtu]	Annual Cost
Heating	157.6	$1,566
Cooling	0.0	$1
Hot Water	11.8	$106
Lights/Appliances	36.1	$1,212
Service Charges		$0
Generation (e.g. Solar)	0.0	$0
Total:	**205.6**	**$2,884**

This home meets or exceeds the criteria of the following:
2021 International Energy Conservation Code
2018 International Energy Conservation Code
2015 International Energy Conservation Code
2012 International Energy Conservation Code

HERS® Index
More Energy
Existing Homes
Reference Home
Zero Energy Home
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
50
This Home
Less Energy
©2013 RESNET

Home Feature Summary:

Home Type:	Single family detached
Model:	N/A
Community:	N/A
Conditioned Floor Area:	6,516 ft²
Number of Bedrooms:	4
Primary Heating System:	Furnace • Natural Gas • 96.5 AFUE
Primary Cooling System:	Air Conditioner • Electric • 16 SEER
Primary Water Heating:	Residential Water Heater • Natural Gas • 0.96 UEF
House Tightness:	2 ACH50
Ventilation:	175 CFM • 50 Watts • Exhaust Only
Duct Leakage to Outside:	25 CFM @ 25Pa (0.77 / 100 ft²)
Above Grade Walls:	R-46
Ceiling:	Vaulted Roof, R-60
Window Type:	U-Value: 0.22, SHGC: 0.35
Foundation Walls:	R-23
Framed Floor:	R-51

Rating Completed by:
Energy Rater: Robby Schwarz
RESNET ID: 9124083
Rating Company: BuildTank, Inc.
robby@btankinc.com
303-927-0025
Rating Provider: EnergyLogic
PO Box N, Berthoud, CO 80513
(970) 556-0839

Robby Schwarz, Certified Energy Rater
Digitally signed: 5/10/23 at 4:53 PM

ekotrope
Ekotrope RATER - Version:4.0.1.3154
The Energy Rating Disclosure for this home is available from the Approved Rating Provider.

Energy Rating Index (ERI)

Twin House Concept

Proposed Design	vs.	Standard Reference Design
• Geometric Twin • Envelope *U*-factors/*R*-values and mechanical systems based on design specifications		• Geometric Twin • ANSI Standard 301 Reference Home – equivalent to 2006 IECC

Energy Rating Index (ERI)

What does it mean for my project?

DEC Section R406.2

- Requirements for the *rated design*:
  1. Meet all the requirements of sections in Table R406.2
  2. Have an **ERI score less than or equal to** values indicated in Table R406.4

Table R406.4 Maximum Energy Rating Index (ERI)	
All-Electric Properties	All Other *Buildings*
55	50

Energy Rating Index (ERI)

DEC Table R406.2

Tables R406.2 REQUIREMENTS FOR ENERGY RATING INDEX	
SECTION	**TITLE**
General	
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.8.1	Basement Wall Insulation Installation
R402.2.9.1	Slab-on-grade floor insulation installation
R402.2.10.1	Crawl space wall insulation installation
R402.4.1.1	Installation
R402.4.1.2	Testing
R402.4.2	Fireplaces
R402.4.3	Fenestration air leakage
R402.4.4	Rooms containing fuel burning appliances
R402.4.5	Recessed lighting
R402.4.6	Electrical and communication outlet boxes (air Sealed boxes

See first training in series for more information on provisions required for all pathways

Tables R406.2 (Continued) REQUIREMENTS FOR ENERGY RATING INDEX	
SECTION	**TITLE**
Mechanical	
R403.1	Controls
R403.2	Hot water boiler temperature reset
R403.3	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water circulation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.5.4	Water heating equipment location
R403.5.5	Demand Responsive Water Heating
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
R404.2	Interior lighting controls
R404.4	Electric Vehicle Charging Requirements
R404.5	Additional Electrical Infrastructure
R404.6	Solar Ready Zone
R404.7	Minimum renewable energy system capacity

Total Building Performance

Additional Efficiency Packages **NOT** Required

DEC Section R408 is only required for Prescriptive Compliance

Requirements for **All Electric Properties**	Requirements for **All Other Buildings**
Compliance with High **OR** Premium Performance Electric Space Heating package (R408.8.2 OR R408.3)	**18 Credits** from Table R408.1
Compliance with High Performance Electric Water Heating in Conditioned **OR** Unconditioned Space package (R408.10.2 OR R408.10.3)	
3 Credits form Table R408.1	

Energy Rating Index

Key Considerations for Construction

- Energy Code is unique from other codes
  - Crosses disciplines/trades
  - Focuses on **overall building performance over individual components**
  - Changes in one area could have unintended impacts on another trade
- With a performance-based compliance approach, **more important to build to the approved drawings**
  - Do not default to prescriptive tables (for both construction and inspections)
  - If something needs to change, work with the energy modeler to update the compliance model and find a code compliant solution

Energy Rating Index (ERI)

Compliance Documentation

DEC R406.7 Documentation:

- A final compliance report based on the **confirmed as-built conditions** shall be submitted before the certificate of occupancy is issued
  - Software generated report demonstrating that the final building meets the requirements of R406.4

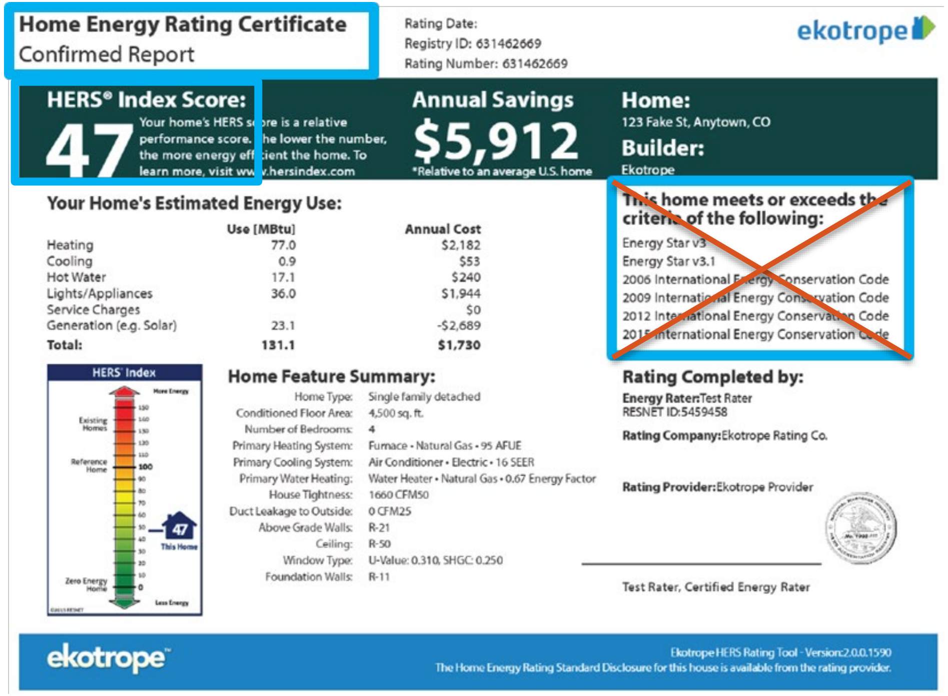
Report must include:

1. **Address** or other identification of the building
2. **Declaration of ERI Compliance option** on title page of building plans
3. **Name of individual** completing the compliance report
4. Name and version of the **compliance software tool**
5. **Documentation of all inputs** in the software used for the reference design and/or the rated home
6. A **certificate** indicating confirmed design has an ERI less than or equal to required target

Energy Rating Index (ERI)

Compliance Reporting

- **Proposed** can be worst case orientation & specifications
- **Confirmed** must be **site specific** and certify the actual specifications and testing results found during site inspections



Home Energy Rating Certificate
Confirmed Report

Rating Date:
Registry ID: 631462669
Rating Number: 631462669

ekotrope

HERS® Index Score:
47
Your home's HERS s ore is a relative performance score. he lower the number, the more energy eff ient the home. To learn more, visit ww .hersindex.com

Annual Savings
$5,912
*Relative to an average U.S. home

Home:
123 Fake St, Anytown, CO
Builder:
Ekotrope

Your Home's Estimated Energy Use:

	Use [MBtu]	Annual Cost
Heating	77.0	$2,182
Cooling	0.9	$53
Hot Water	17.1	$240
Lights/Appliances	36.0	$1,944
Service Charges		$0
Generation (e.g. Solar)	23.1	-$2,689
Total:	**131.1**	**$1,730**

This home meets or exceeds the criteria of the following:
Energy Star v3
Energy Star v3.1
2006 International Energy Conservation Code
2009 International Energy Conservation Code
2012 International Energy Conservation Code
2015 International Energy Conservation Code

HERS Index
More Energy
Existing Homes
Reference Home
100
47
This Home
Zero Energy Home
Less Energy

Home Feature Summary:

Home Type:	Single family detached
Conditioned Floor Area:	4,500 sq. ft.
Number of Bedrooms:	4
Primary Heating System:	Furnace • Natural Gas • 95 AFUE
Primary Cooling System:	Air Conditioner • Electric • 16 SEER
Primary Water Heating:	Water Heater • Natural Gas • 0.67 Energy Factor
House Tightness:	1660 CFM50
Duct Leakage to Outside:	0 CFM25
Above Grade Walls:	R-21
Ceiling:	R-50
Window Type:	U-Value: 0.310, SHGC: 0.250
Foundation Walls:	R-11

Rating Completed by:
Energy Rater: Test Rater
RESNET ID: 5459458

Rating Company: Ekotrope Rating Co.

Rating Provider: Ekotrope Provider

Test Rater, Certified Energy Rater

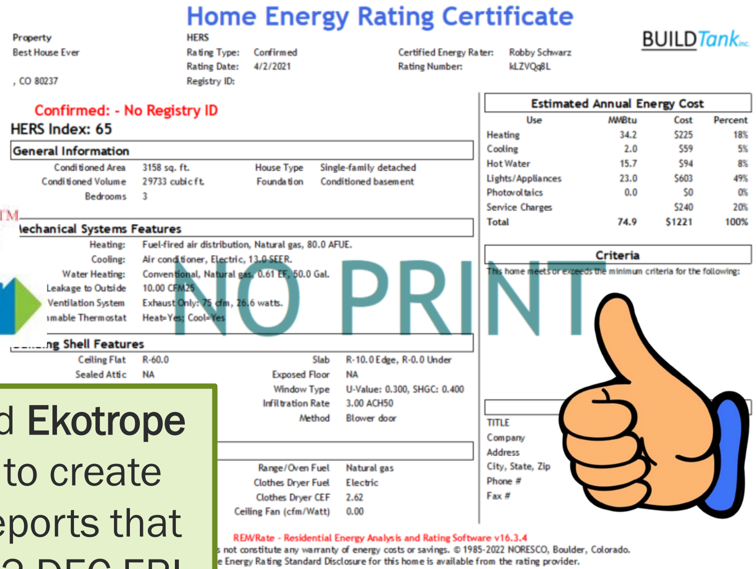
ekotrope™
Ekotrope HERS Rating Tool - Version: 2.0.0.1590
The Home Energy Rating Standard Disclosure for this house is available from the rating provider.

Energy Rating Index (ERI)

Compliance Software Tools

REM/Rate™

ekotrope



Home Energy Rating Certificate

Property
Best House Ever
, CO 80237

HERS
Rating Type: Confirmed
Rating Date: 4/2/2021
Registry ID:

Certified Energy Rater: Robby Schwarz
Rating Number: kLZVQq8L

BUILDTank Inc.

Confirmed: - No Registry ID
HERS Index: 65

General Information

Conditioned Area	3158 sq. ft.	House Type	Single-family detached
Conditioned Volume	29733 cubic ft.	Foundation	Conditioned basement
Bedrooms	3		

Mechanical Systems Features

Heating: Fuel-fired air distribution, Natural gas, 80.0 AFUE.
Cooling: Air conditioner, Electric, 13.0 SEER.
Water Heating: Conventional, Natural gas, 0.61 EF, 50.0 Gal.
Leakage to Outside: 10.00 CFM25
Ventilation System: Exhaust Only: 75 cfm, 26.6 watts.
Programmable Thermostat: Heat=Yes; Cool=Yes

Building Shell Features

Ceiling Flat	R-60.0	Slab	R-10.0 Edge, R-0.0 Under
Sealed Attic	NA	Exposed Floor	NA
		Window Type	U-Value: 0.300, SHGC: 0.400
		Infiltration Rate	3.00 ACH50
		Method	Blower door

Range/Oven Fuel	Natural gas
Clothes Dryer Fuel	Electric
Clothes Dryer CEF	2.62
Ceiling Fan (cfm/Watt)	0.00

Estimated Annual Energy Cost

Use	MMBtu	Cost	Percent
Heating	34.2	$225	18%
Cooling	2.0	$59	5%
Hot Water	15.7	$94	8%
Lights/Appliances	23.0	$603	49%
Photovoltaics	0.0	$0	0%
Service Charges		$240	20%
Total	74.9	$1221	100%

Criteria

This home meets or exceeds the minimum criteria for the following:

TITLE
Company
Address
City, State, Zip
Phone #
Fax #

REM/Rate - Residential Energy Analysis and Rating Software v16.3.4
...s not constitute any warranty of energy costs or savings. © 1985-2022 NORESCO, Boulder, Colorado.
...e Energy Rating Standard Disclosure for this home is available from the rating provider.

NO PRINT

REM/Rate and Ekotrope can be used to create compliance reports that meet the 2022 DEC ERI requirements

2021 IECC R-406 Projected Energy Rating Index Report

DOES NOT PASS

Property
Builder:
Address: Example House, , CO 80211

Organization
Company: BuildTank, Inc.
Phone: 303-927-0025
Rater: Robby Schwarz

Energy Rating Information
Project ... Rating
Rating
Rater ... (RTIN) ... 083
Date R...

STOP

Estimated Annual Energy Consumption*

	Rated Home Calculated Energy Use (MBtu)	
Heating	41.6	...8
Cooling	2.4	$94
Water Heating	20.5	$480
Lights & Appliances	25.7	$1,009
Photovoltaics	0.0	$0
Total	90.2	$2,635

*Based on standard operating conditions

ERI with PV:78
ERI without PV:78

Annual Estimates
Electric (kWh): 7,776.0
Natural Gas (Therms): 636.4
CO2 Emissions (Tons): 11.2

Maximum Energy Rating Index: 55

This home DOES NOT MEET the Energy ... 5. It DOES NOT MEET all of the requireme... the 2nd page of this report, some of which...

Name: Robby Schwarz
Organization: BuildTank, Inc.

The **IECC ERI certificate** uses the ventilation rate that is amended out of 2022 DEC

Considerations for Existing Residential Buildings

DEC Chapter 5 [RE]

Existing Buildings

Residential renovations can affect the energy use of the building as a whole – the DEC address such renovations in order to maintain, if not improve, the conservation of energy by the renovated or altered building

Work Category	Definition
Repair	The reconstruction or renewal of any part of an *existing building* for the purpose of its maintenance or to correct damage.
Alteration	Any construction, retrofit or renovation to an existing structure other than *repair* or *addition*. Also, a change in a building, electrical, gas mechanical, or plumbing system that involves an extension, addition or change to the arrangement, type, or purpose of original installation.
Addition	An extension or increase in the *conditioned space* floor area, number of stories or height of a building or structure.
Change of Occupancy or Use	A change in the occupancy classification of a building or a change in the use of a building or portion of a building that involves a change in the application of the requirements of this code.

Considerations for Existing Building Projects

Question	*Answer*
Does your **project scope fall into more than one work category** (addition, alteration, repair, or change of occupancy)?	If yes, you **must follow the requirements of each applicable section.**
For additions: What is the **increase in conditioned floor area** as a percentage of the total existing above grade conditioned floor area?	Additions that **do not exceed a 20% increase or 300 sf, whichever is less**, are **not required** to provide air barrier details, or heating and cooling equipment sizing calculations.
Does the project qualify as a **historic building**?	If it meets one of the conditions in the code, **the historic building is exempted** from most 2022 DEC provisions.

Key Considerations for Construction

- Home renovation projects are a **great opportunity to upgrade the energy efficiency** of existing homes
  - Reduce energy losses → **save money and increase occupant comfort**
  - Adding insulation, improving air sealing and duct sealing, and switching to high-efficacy lighting are relatively **low cost yet high impact upgrades**
- Consider available **rebates or tax incentives** to lower costs
  - Visit Denvergov.org/HomeEnergy to learn more about home energy rebates and find other resources for existing homes
- Understand **testing requirements** for selected compliance path
  - Is a pre-construction blower door test needed? Complete this before starting any demolition work

Compliance is Simplified for Existing Homes

- **DEC Section R408** Additional Efficiency Package Options **is NOT required** for additions, alterations or repairs following the prescriptive path
- Most 2022 DEC specific provisions apply only to new construction
  - Solar-ready zone and minimum onsite renewables **are not required for existing buildings**
  - Electric Vehicle (EV) charging requirements **may apply if new** garage or carport, new on-site parking space
- **No electrification requirements for existing homes**
  - If replacing or installing new space or water heating equipment, consider benefits of electrifying and learn more about available programs and rebates

Two Types of Additions

Total Building Performance & Energy Rating Index **requirements are the same** for both types of additions

Changes in Space Conditioning

Unconditioned or low-energy space is changed to conditioned space

Examples: finishing an existing attic or basement, turning an unconditioned garage into a new bedroom

All Other Additions

The addition is comprised of all new, added conditioned space

Prescriptive Compliance for Additions

Building Envelope Assemblies

DEC Section R502

- Two options for new building envelope assemblies:
    1. **Prescriptive Tables**
    2. **Total UA Alternative**
        - » **DEC R502.2:** Total UA of existing building with addition and any alterations **must be less than or equal to** the Total UA of the original existing buildings
        - » Likely requires upgrades to existing envelope assemblies
- Must also meet provisions for **specific insulation requirements, fenestration, and air barrier and air sealing**
    – Comply with DEC R402.1 through R402.4

Prescriptive Compliance for Additions

Air Leakage Testing

DEC Section R502.3.1 Exceptions by addition type:

Changes in Space Conditioning	All Other Additions
• **Pre- and post-blower door testing required** • The air leakage rate with addition and any alterations **must be less than** air leakage rate of original existing building	• New envelope assemblies are **exempt from air leakage testing** • Third-party inspections may be required if envelope assemblies fail to exhibit envelope tightness based on physical inspection

Total Building Performance

DEC Section R502.2

- **Two options** for using Total Building Performance:
  - The annual energy cost of the proposed design (addition + existing buildings) may be **110% of the annual energy cost** of the standard reference design
    - » Must also meet all required sections per Table R405.2
  - Alternatively, the annual energy cost or energy use of the addition and the existing building, and any alterations that are part of the project, **must be less than or equal to the annual energy cost of the existing building**
    - » The addition and any alterations that are part of the project shall comply with Section R405 in its entirety (*includes R402.4.1.2 Testing*)

Compliance for Additions

Energy Rating Index (ERI)

DEC Specific Amendment

DEC Section R502.2

- When using the Energy Rating Index compliance option, the ERI of the addition and the existing building, and any alterations that are part of the project, **must be less than or equal to the ERI of the existing building**

  » The addition and any alterations that are part of the project shall comply with Section R406 in its entirety (*includes R402.4.1.2 Testing*)

Alterations

Prescriptive Path Only

DEC Section R503.1.1 Building Thermal Envelope

- Envelope assemblies that are part of the alteration must follow the Prescriptive Tables
- Comply with limited prescriptive provisions (see section)
- **Exceptions:**
    1. Storm windows over existing windows
    2. Existing ceiling, wall or floor cavities exposed during construction (fill with insulation)
    3. Construction where existing roof, wall or floor cavity is not exposed
    4. Roof recover
    5. Roofs without insulation in cavity: must insulate above or below sheathing if exposed
    6. Surface-applied window film on existing single pane windows

Replacement Fenestration

- Replacement windows must meet *U*-factor & SHGC requirements of Table R402.1.3
- An area-weighted average may be used when multiple windows are replaced

Prescriptive Compliance for Additions

Additional Provisions

DEC Section R502.3

New HVAC ducts

Meet requirements of R403

- *Exception:* ducts extended from existing heating and cooling system

New Service Hot Water Systems

Meet requirements of R403.5

- Includes new DEC provisions for location and demand response

New Lighting Systems

Meet requirements of R404.1

- 100% high-efficacy lighting

Repairs

Prescriptive Path Only

- Repairs must follow the requirements of **DEC Sections R501.3** and **R504.**
  - Components of a building or system must be maintained to **meet the requirements of the code edition under which they were installed**
  - Work on nondamaged components necessary for the required repair or damaged components is considered part of the repair **and does not need to meet the requirements for alterations**
- **Repairs include:**
  - Glass-only replacements in an existing sash and frame
  - Roof repairs
  - Replacement of only the bulb, ballast, or both within an existing luminaire, provided the installed interior lighting power is not increased

Change of Occupancy or Use

DEC Specific Amendment

DEC Section R505.1: A project with a change or occupancy or use to residential must meet the applicable requirements of Chapter 5 [RE] for additions, alterations, and repairs

- If changing **from a lower energy-demand category** (*IBC occupancies F, H, or S*), must meet all requirements for new construction, unless change does not result in increased energy demand
- **Exceptions:**
  - **Total UA Alternative:** Total UA of proposed design may be up to 110% of the Total UA calculated using *U*-factors in Table R402.1.4
  - **Total Building Performance:** The annual energy cost of the proposed design may be up to **110%** of the standard reference design
  - No exceptions for Energy Rating Index (*must meet maximum ERI in R406*)

Existing Home Support and Resources

www.denvergov.org/HomeEnergy

- Resources for:
  - Rebates for existing homes
  - How to electrify your home and work with contractors
  - Income Qualified Rebates

www.denvergov.org/CAREContractorResources

- Resources for:
  - Instructions for Installers Applying for Rebates

Space Heating and Cooling

Heating and cooling account for the majority of energy we use in our homes. As the grid moves to 100% renewable power, electric appliances like heat pumps are the clear path to reducing carbon emissions generated by our homes.

Water Heating

Your water heater might not be the first thing you think of when changing your home appliances to electric. But it can be a great place to try a heat pump and improve efficiency and indoor air quality!

Home Solar

Adding solar to your home or subscribing to a solar co-op is a great way to save money on your utilities bills and reduce carbon emissions from your house. Learn about all the ways we can help you become a solar household as well!

Income Qualified Rebates

Qualified households are eligible for additional rebates and incentives to offset the costs of equipment upgrades. Learn whether you might qualify, and find out how to work with our partners at Energy Resource Center to start saving.

Healthy Homes Program

The Healthy Homes Program will provide extensive home energy and weatherization upgrades for income qualified homes where someone in the household also has a respiratory condition. If you think you might qualify, reach out to our program partners.

Electric Vehicles

Electrifying your home includes more than just the house itself. Your transportation can also be electrified, which improves our city's air quality and eliminates expensive trips to the gas station. Learn about the other benefits of electric vehicles and how you can save money when you purchase one.

How is electrification in existing buildings going for you?

CASR's existing building electrification team would love to hear stories and feedback from contractors and building professionals about how heat pump installation is going for you!

If you'd like to share your experience with CASR email electrification@denvergov.org

Key Takeaways

Energy is **interdisciplinary and holistic**. The DEC touches many components and trades that must be coordinated for successful compliance.

Know your **compliance path** and the unique considerations

- Changes may require energy modeling updates and modified drawings
- Understand final documentation and reporting requirements

Home renovation projects are a great opportunity **to upgrade the energy efficiency of existing homes**

- Renovated elements must comply with the code and meet all provisions required under the selected pathway

Questions?

- 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 code: energy.review@denvergov.org

Questions about programs & resources: sustainability@denvergov.org