CITY COUNCIL WORK SESSION

448 E. 1st Street, Room 190 Salida, Colorado 81201
May 20, 2024 - 6:00 PM

AGENDA

Please register for the City Council Work Session
https://attendee.gotowebinar.com/register/8054749917914710285
After registering, you will receive a confirmation email containing information about joining the webinar.

To watch live meetings: http://www.youtube.com/@cityofsalidacolorado

DISCUSSION ITEMS

1. Extraordinary Teen Council
2. Space to Create 1st & D Apartments Update and Presentation
3. Places to Age Project – Presentation and Discussion
4. Energy Amendments to the 2021 IECC Code

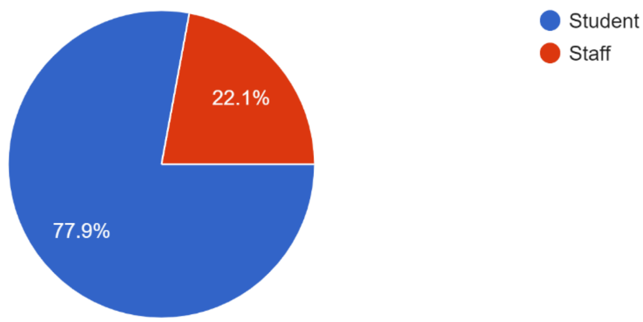
Individuals with disabilities needing auxiliary aid(s) may request assistance by contacting the City Clerk at 448 E. 1st Street, Ste. 112, Salida, CO 81201, Ph.719-530-2630 at least 48 hours in advance.

ETC Agenda:

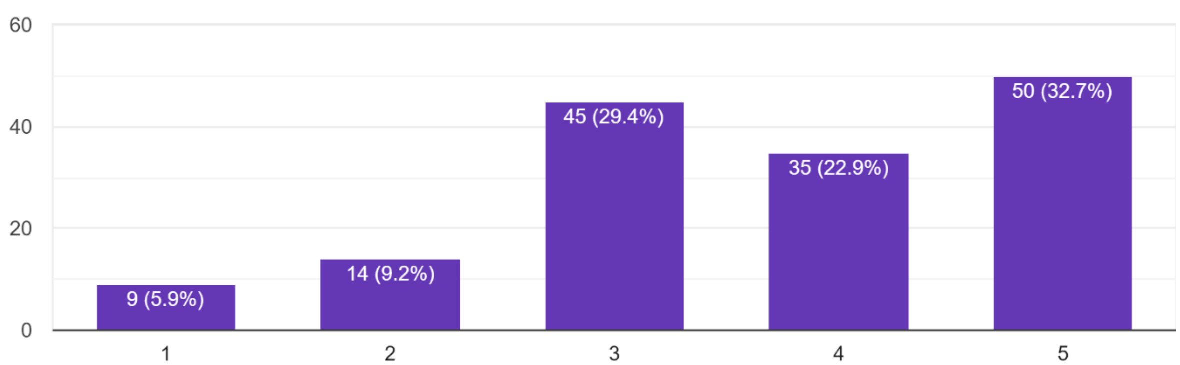
1. Introductions! Maddox Tolsma will be our latest Youth Liaison.
2. Mocktails: Continuing a tradition at the Sunfest Celebrations.
3. SRO Survey Summary.

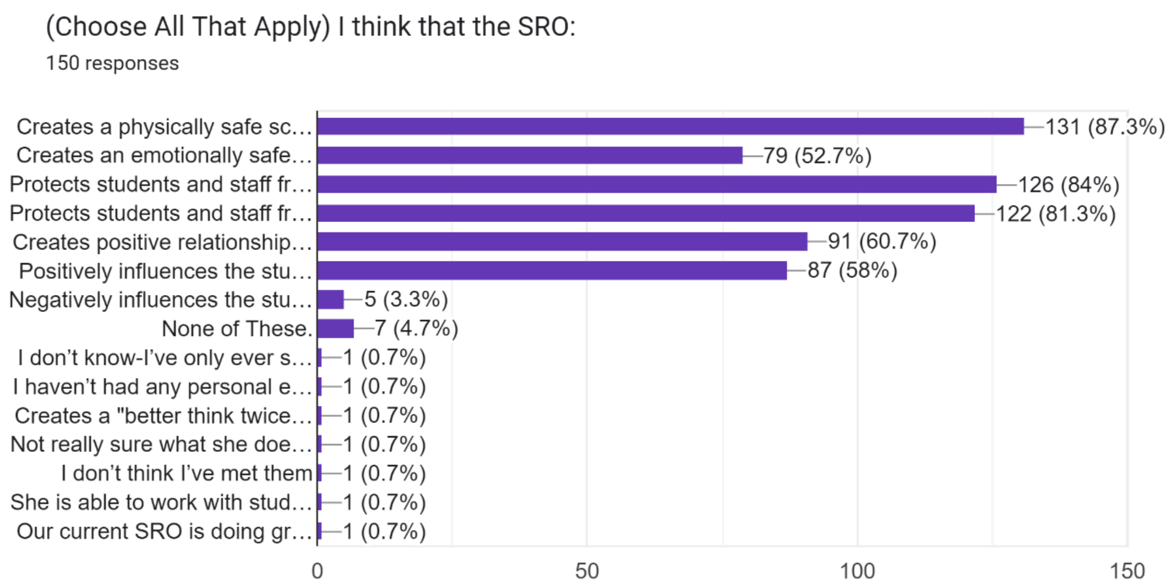
2024 SHS SRO Survey Results

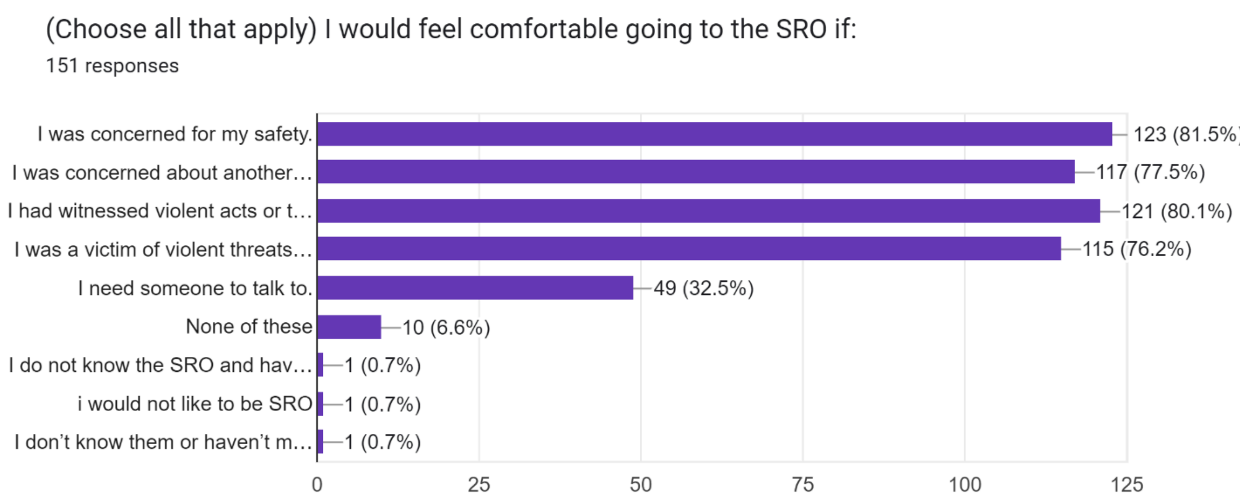
Are you a student or staff?
154 responses



Rate this statement: I know what the role of the School Resource Officer (SRO) is. (Officer Bri Tucker is the current SRO at Salida High School).
153 responses







Short Answer Summary:

1..Do you have experiences with the SRO to share?

- Bri is helpful and nice, always friendly
- She is used as a sounding board for staff and students
- She holds strong boundaries while building meaningful relationships with students

- She is helpful with specific issues
- Best SRO I have seen in 20+ yrs teaching

2. Do you have suggestions to make the SRO program better?

- Go into advisories- have informal conversations on different topics.
- Make her more known to student body-many don't know who she is
- Make kids aware of things that are going on (incidents?)
- Come around during lunch and classes to start conversations
- Be in the parking lot during high traffic times. This would have a proactive effect.
- Add another SRO to lighten Bri's load.

3. If the SRO were to do short presentations during advisory, what topics would you be interested in hearing about?

- Legal rights, how to interact with the police when you are pulled over or are stopped, safety when going to college/moving out, resources for the community. What to do if a police officer asks to search your bag? Basically explaining to students their rights. Also how to make a 911 call.
- The SRO position - Their role, her background and how she got into being an SRO, duty procedures, how they protect students, career opportunities in Law Enforcement
- How can students help the SRO and how to stay calm in an emergency
- Effects of drugs and vape on the teen brain
- Online safety and bullying
- How to talk to SRO if something happened

CITY COUNCIL WORK SESSION MEMO

DEPARTMENT	PRESENTED BY	DATE
Community Development	Bill Almquist - Community Development Director	May 20, 2024

ITEM

Space to Create 1st & D Apartments Update and Presentation (with Artspace and Cushing Terrell)

BACKGROUND

Artspace and Cushing Terrell unveiled two initial design concepts for the 1st & D project at an open house on March 6th. Following the open house, an online survey was made available to the public through March 22nd. Results from that survey are in and the more "traditionally historic" concept design was preferred 3-to-1 over the more "modern" design. Artspace and the architects have taken this and other feedback from the survey to create a singular updated concept design. At this meeting, they will review the results from the survey and present the new concept design (which will be unveiled at the work session). Artspace and City staff would like to know whether the updated design is acceptable to City Council so that work can be done to put the finishing touches on the design, select a general contractor (who will establish more specific cost estimates), and pursue funding for the project. Council's feedback is appreciated.

Attachment:

Memo from Cushing Terrell to Artspace and City of Salida re: survey results

Cushing Terrell.

MEMORANDUM

Date:	May 15, 2024
To:	City of Salida / Artspace
RE:	1st & D Apartments Project, A Workforce Housing Initiative by Space to Create Open House & Survey Results

To whom it may concern:

Below is the feedback gathered from the open house held on March 6, 2024, and the survey was conducted to solicit input on 1st & D Apartments Design Concepts. The insights gathered from these interactions are invaluable in shaping our project's direction and ensuring alignment with community expectations. Below is a general overview of the format and findings of the survey.

On March 6, 2024, an open house was held at the Scout Hut where two design concepts were presented. An online survey was held on the SurveyMonkey platform and was available for three weeks for public input. It comprised 18 questions covering various aspects of design concepts with a "this or that" format. The survey delved into specific design elements and material preferences. Participants were also asked about their preferences for color palettes, textures, and finishes. We had a total of 222 participants.

Below is the summary of key findings:

a. Concept 1 is generally preferred, emphasizing traditional materials, highly visual art murals as accents, traditional storefront color, hanging signage, and a two-material scheme on D.
b. Certain items, like cornices and D Street unit entrances, require finding a cost-effective middle ground. Balconies on D Street lean towards a warm accent material proposed in concept 2 but may clash with the two-material scheme of preferred concept 1.
c. Materials:
    i. Darker Brick is highly favored.
    ii. Accent Materials: Black, Gray, and Wood are preferred.
    iii. Siding: Wood and lap siding are favored; gray and panelized options are less popular.

General Feedback highlights a desire to avoiding a commercial or industrial look and to tie it to the Historic Downtown. Along D Street, there are concerns about façade blending with surroundings, not feeling part of a "Mountain Town," and suggestions for breaking up the facade to create a more residential feel through the distinction of the levels and detailing at roof and windows

Based on the finding above, we have studied articulated porch entries, breaking up the facade into residential unit bays, and refining materials among D Street. Materiality remains a challenge; there is a desire for all brick but need to explore economical options.

Please find attached a detailed report containing the complete survey results. Should you have any questions or require further clarification, please do not hesitate to reach out.

Sincerely,

Charlie Deese
Director of Design
Cushing Terrell

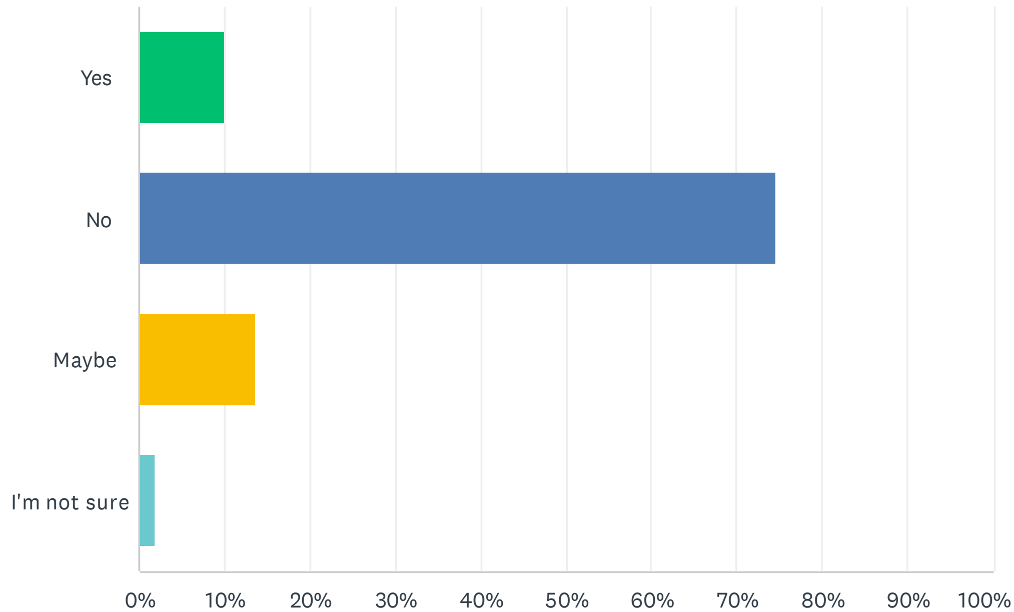
Attached:

2024-03-28_1st&D Apartments_Summary Results.pdf

Item 2.

Q1 Do you envision applying to live in this development or a similar affordable housing development?

Answered: 220   Skipped: 2

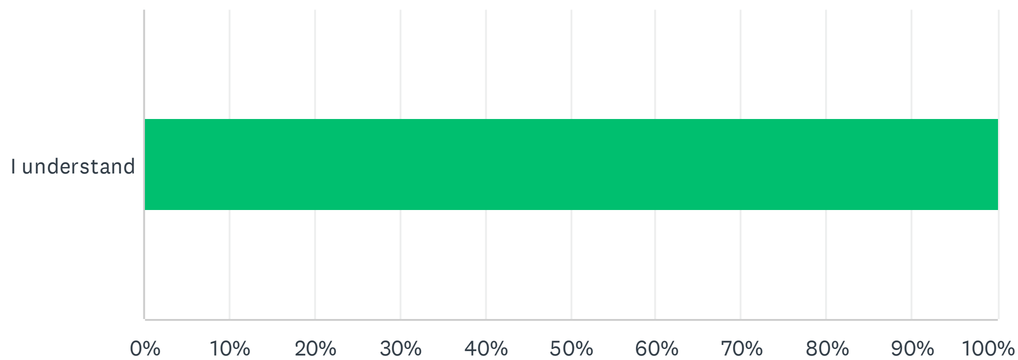


ANSWER CHOICES	RESPONSES	
Yes	10.00%	22
No	74.55%	164
Maybe	13.64%	30
I'm not sure	1.82%	4
TOTAL		220

Item 2.

Q2 Specific colors and artistic representations (ex. mural art) are approximate and for example purposes only and do not reflect the final detailing. Please acknowledge this statement.

Answered: 222 Skipped: 0

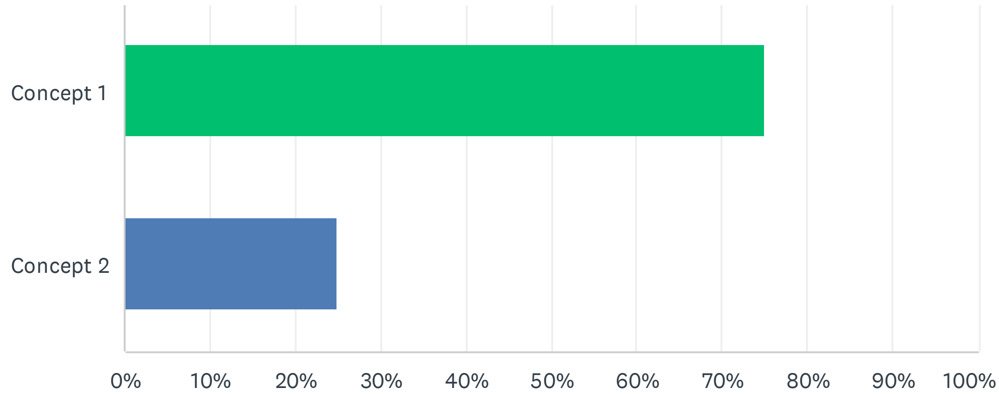


ANSWER CHOICES	RESPONSES	
I understand	100.00%	222
Total Respondents: 222		

Item 2.

Q3 Here are two concepts for the 1st & D Apartments, as shown from 1st Street heading towards the downtown core. Which building concept appeals to you more at first glance and why?

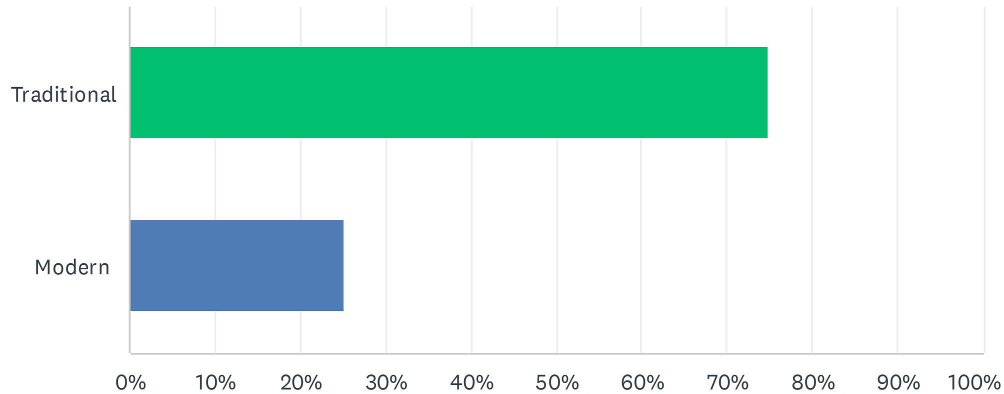
Answered: 208 Skipped: 14



ANSWER CHOICES	RESPONSES	
Concept 1	75.00%	156
Concept 2	25.00%	52
TOTAL		208

Q4 Concept 1 uses traditional materials, while Concept 2 uses more modern materials. Which do you prefer?

Answered: 215 Skipped: 7

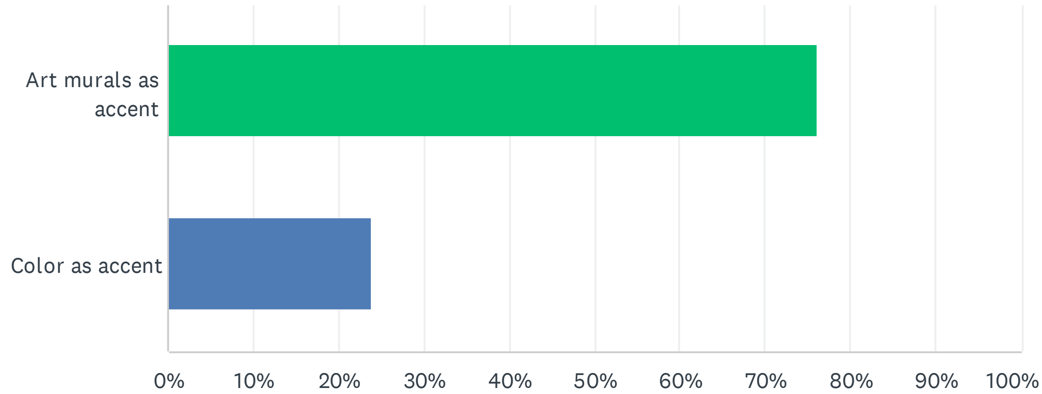


ANSWER CHOICES	RESPONSES	
Traditional	74.88%	161
Modern	25.12%	54
TOTAL		215

Item 2.

Q5 Concept 1 uses artistic murals as a playful detail of the building. Concept 2 relies on pops of color in the architectural details to achieve this same effect. Which do you prefer?

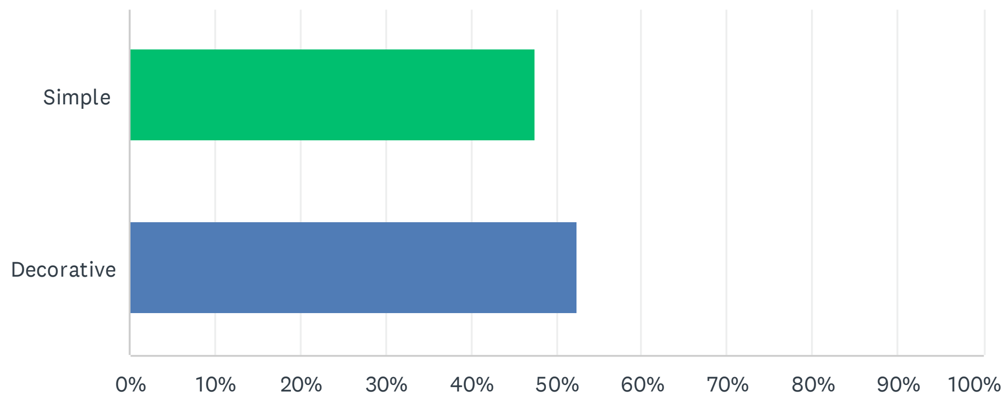
Answered: 217   Skipped: 5



ANSWER CHOICES	RESPONSES	
Art murals as accent	76.04%	165
Color as accent	23.96%	52
TOTAL		217

Q6 Concept 1 has a simple, clean cornice (roofline treatment), while Concept 2 takes a more historically decorative approach. Either roofline treatment can be applied to either building style. Which do you prefer?

Answered: 210 Skipped: 12

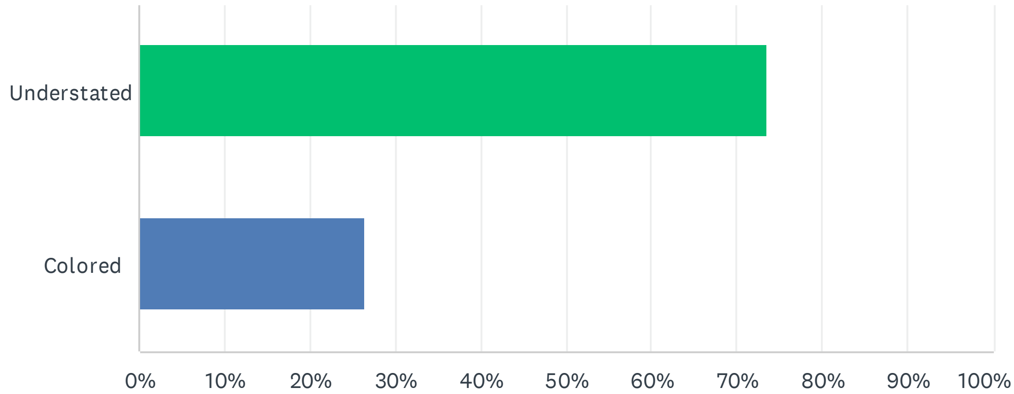


ANSWER CHOICES	RESPONSES	
Simple	47.62%	100
Decorative	52.38%	110
TOTAL		210

Item 2.

Q7 Concept 1 utilizes a traditional brick-look façade with understated "storefront" windows. Concept 2 features a modern take on brick with colored accents around the "storefront" windows. Which do you prefer?

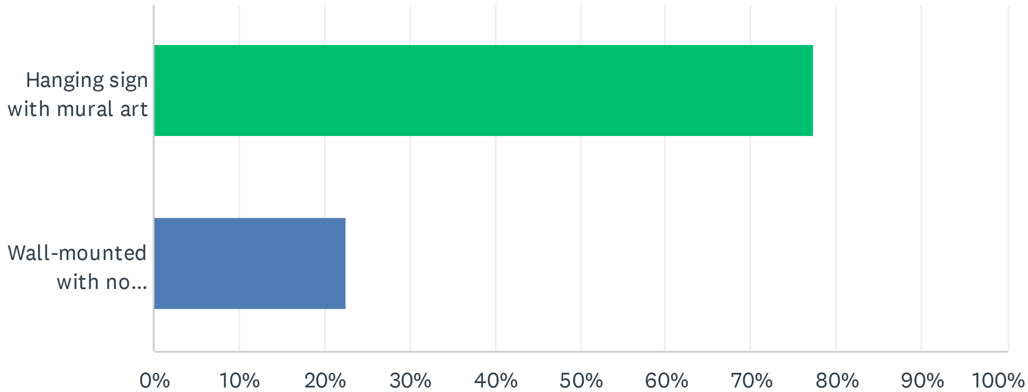
Answered: 211   Skipped: 11



ANSWER CHOICES	RESPONSES	
Understated	73.46%	155
Colored	26.54%	56
TOTAL		211

Q8 Looking at the northern corner of the building upon approach from downtown, each concept features signage which will feature the building's name (name to be determined). Which style of signage do you prefer?

Answered: 207 Skipped: 15

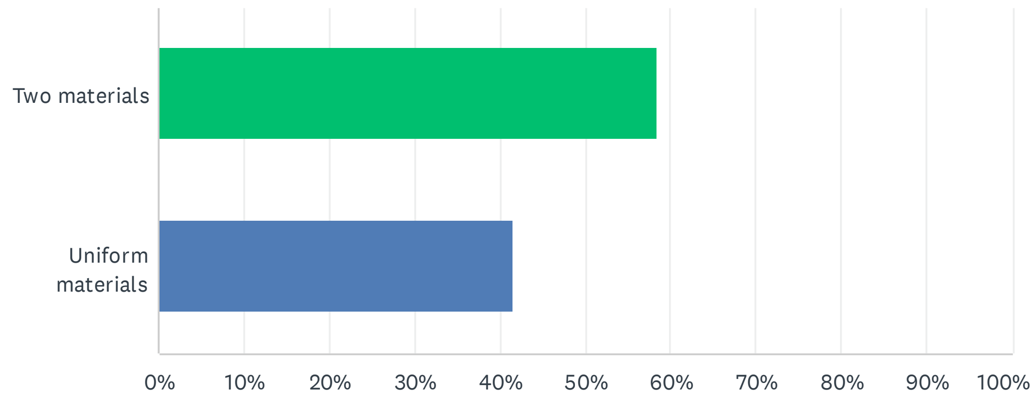


ANSWER CHOICES	RESPONSES	
Hanging sign with mural art	77.29%	160
Wall-mounted with no additional art	22.71%	47
TOTAL		207

Item 2.

Q9 The primary distinction on D St. between the two concepts is the use of two differing materials (top two thirds, bottom one third) in Concept 1 and the use of uniform materials (no top/bottom) in Concept 2. Which do you prefer?

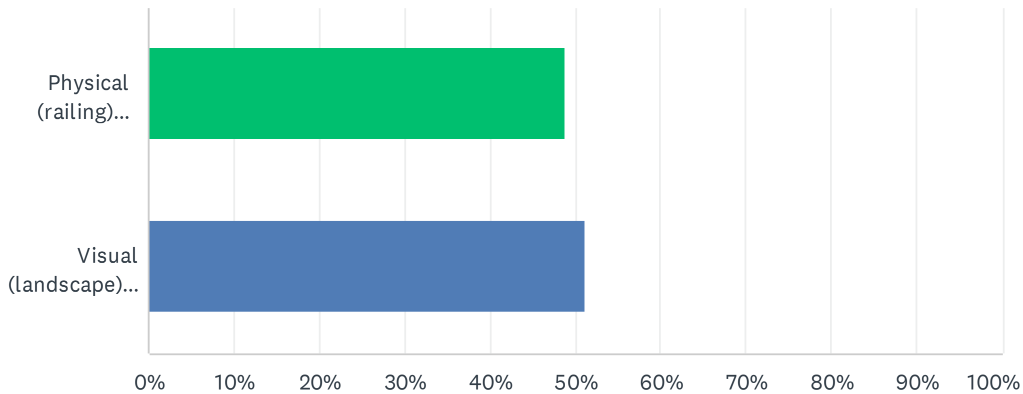
Answered: 204 Skipped: 18



ANSWER CHOICES	RESPONSES	
Two materials	58.33%	119
Uniform materials	41.67%	85
TOTAL		204

Q10 For those units whose entrance is at street level, there are different treatments in Concept 1 and Concept 2. Concept 1 has a railing creating a physical highlight of the entrance, whereas Concept 2 relies on landscape plantings to indicate the entrance. Which do you prefer?

Answered: 207 Skipped: 15

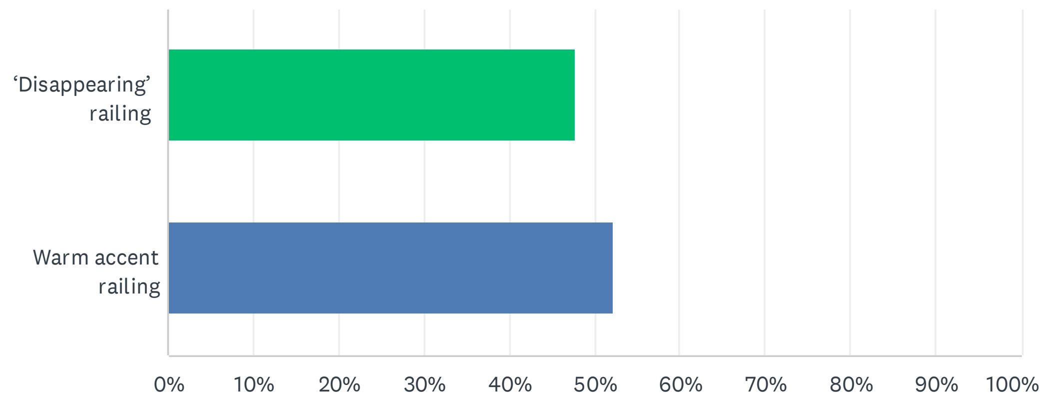


ANSWER CHOICES	RESPONSES	
Physical (railing) entrance	48.79%	101
Visual (landscape) entrance	51.21%	106
TOTAL		207

Item 2.

Q11 Units on the upper level have a feature called a Juliet Balcony. This is not a traditional balcony but rather a safety feature allowing the tenant to open the sliding glass window fully. Concept 1 shows a narrow railing designed to 'disappear' and allow for maximum viewing. Concept 2 uses the balcony railing to create a warm accent to the building. Which do you prefer?

Answered: 203 Skipped: 19

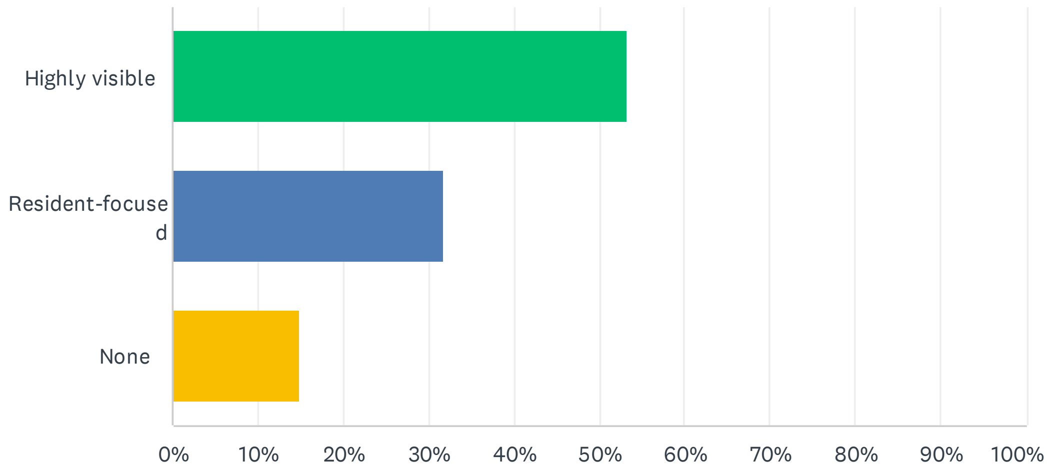


ANSWER CHOICES	RESPONSES	
'Disappearing' railing	47.78%	97
Warm accent railing	52.22%	106
TOTAL		203

Item 2.

Q12 Do you prefer a highly visible mural, such as in Concept 1, a more resident-focused mural in Concept 2, or no exterior mural/artwork on the back side of the building?

Answered: 208   Skipped: 14



ANSWER CHOICES	RESPONSES	
Highly visible	53.37%	111
Resident-focused	31.73%	66
None	14.90%	31
TOTAL		208

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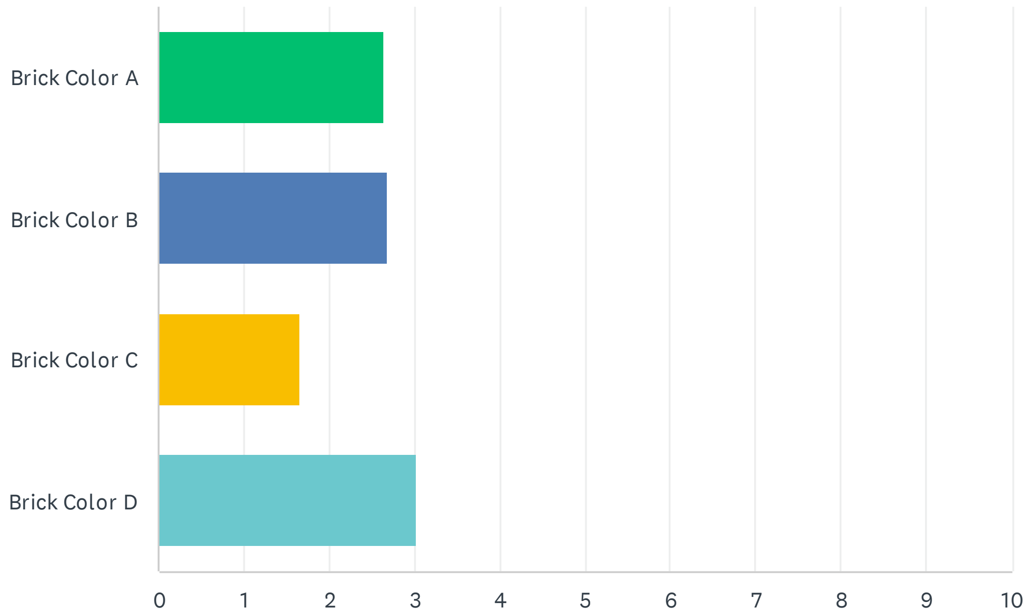
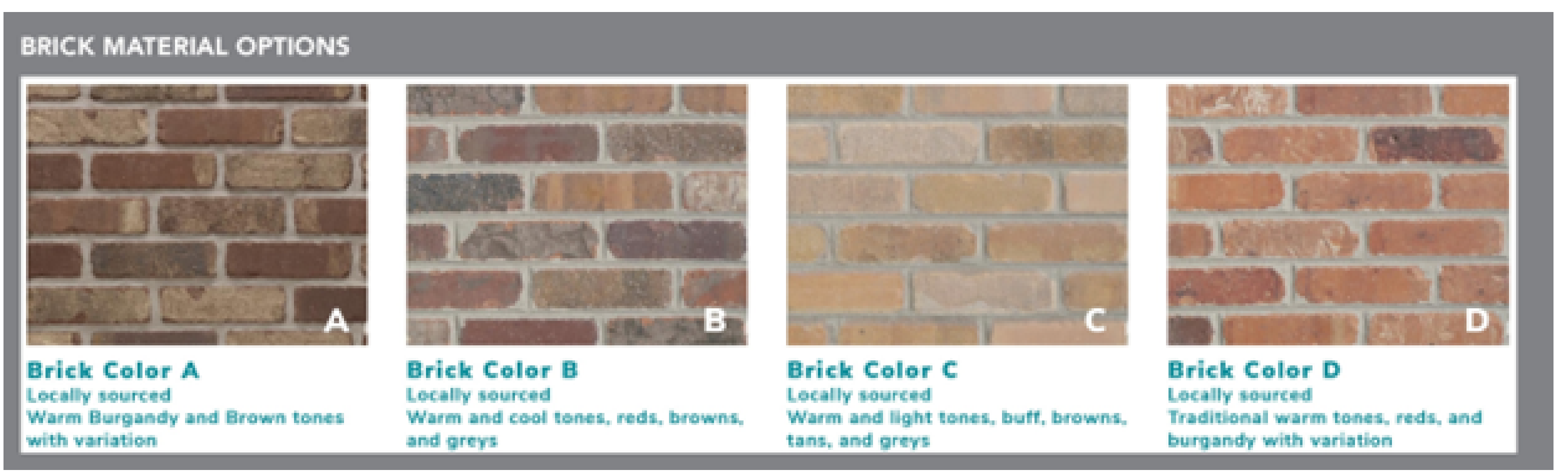
Item 2.

Q13 Above are four (4) exterior brick building material options. Please rank the brick materials in order of your preference from most (1) to least (4).

Answered: 202 Skipped: 20



	1	2	3	4	TOTAL	SCORE
Brick Color A	25.74% 52	29.21% 59	28.22% 57	16.83% 34	202	2.64
Brick Color B	16.83% 34	40.59% 82	36.14% 73	6.44% 13	202	2.68
Brick Color C	7.43% 15	11.88% 24	19.80% 40	60.89% 123	202	1.66
Brick Color D	50.00% 101	18.32% 37	15.84% 32	15.84% 32	202	3.02



Q14 Tell us more about your brick choices.

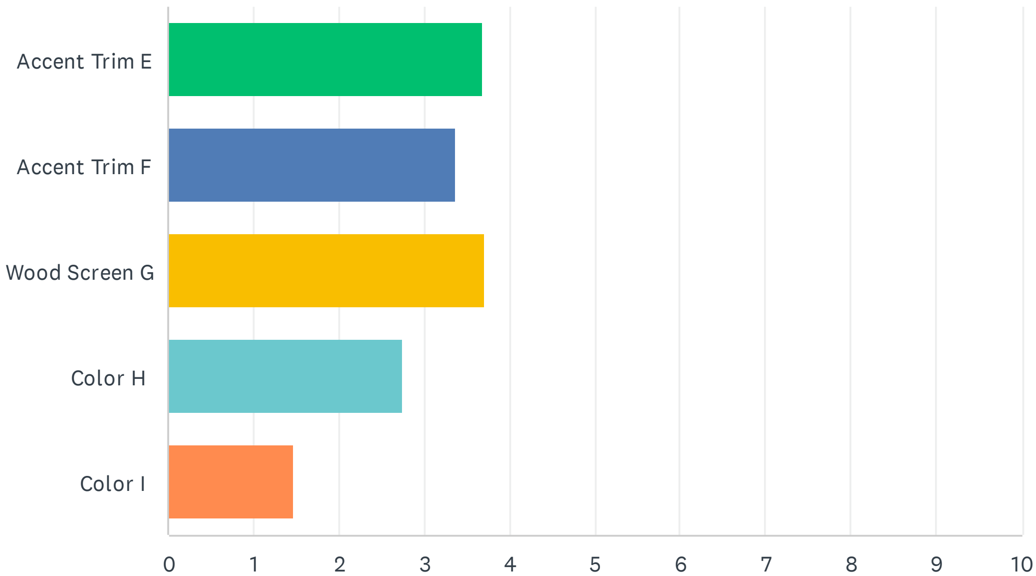
Answered: 96 Skipped: 126

See Excel spreadsheet.

Item 2.

Q15 Above are five (5) exterior accent material options. Please rank the accent materials in order of your preference from most (1) to least (5).

Answered: 176   Skipped: 46



	1	2	3	4	5	TOTAL	SCORE
Accent Trim E	31.25% 55	30.68% 54	19.32% 34	12.50% 22	6.25% 11	176	3.68
Accent Trim F	14.77% 26	34.09% 60	30.68% 54	14.20% 25	6.25% 11	176	3.37
Wood Screen G	41.48% 73	13.07% 23	27.84% 49	10.80% 19	6.82% 12	176	3.72
Color H	11.36% 20	14.77% 26	17.61% 31	51.14% 90	5.11% 9	176	2.76
Color I	1.14% 2	7.39% 13	4.55% 8	11.36% 20	75.57% 133	176	1.47

Q16 Tell us more about your accent material choices.

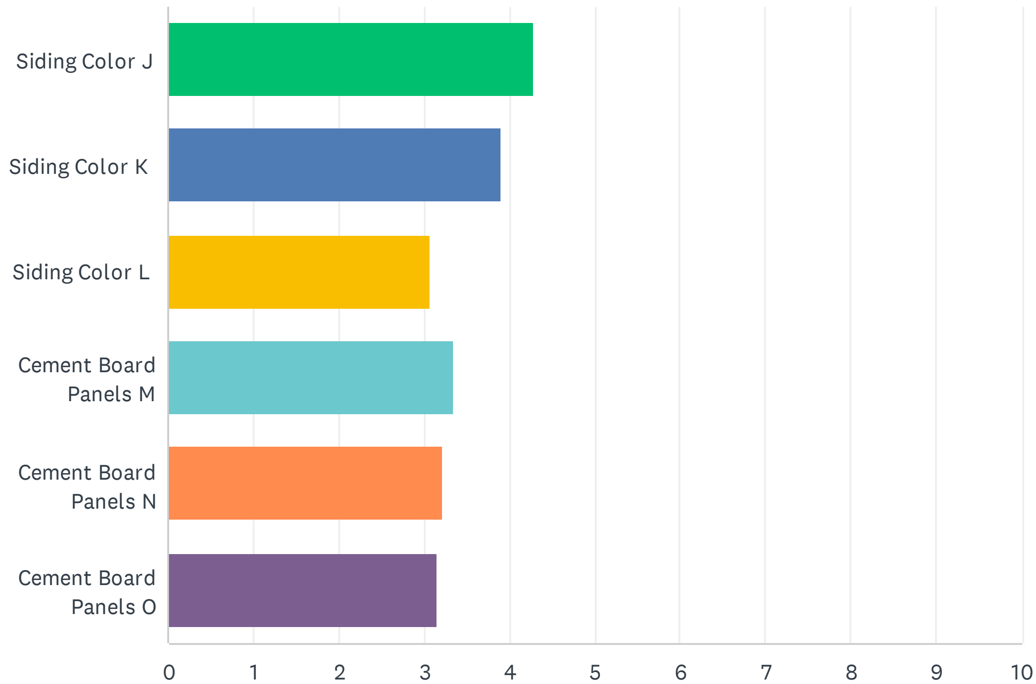
Answered: 84 Skipped: 138

See Excel spreadsheet.

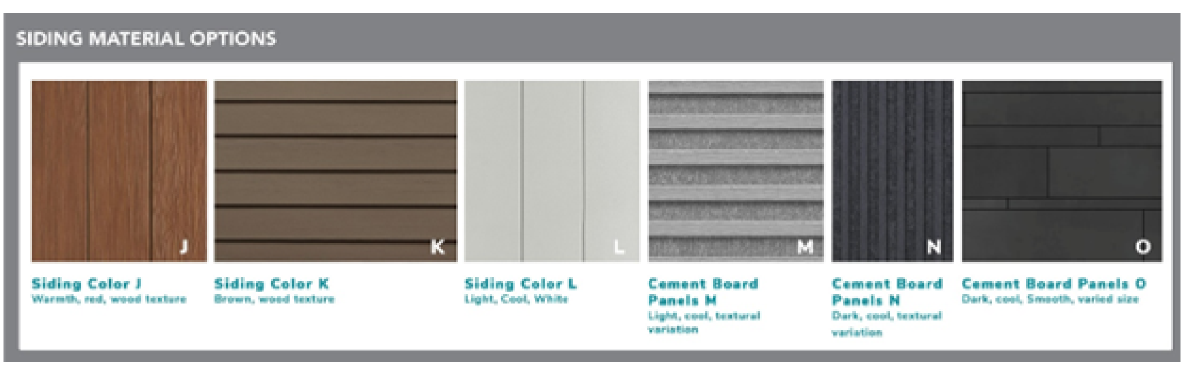
Item 2.

Q17 Above are six (6) exterior siding building material options. Please rank the siding materials in order of your preference from most (1) to least (6).

Answered: 176   Skipped: 46



	1	2	3	4	5	6	TOTAL	SCORE
Siding Color J	42.05% 74	14.77% 26	9.09% 16	9.09% 16	13.07% 23	11.93% 21	176	4.28
Siding Color K	15.91% 28	28.41% 50	18.18% 32	15.91% 28	11.36% 20	10.23% 18	176	3.91
Siding Color L	4.55% 8	13.07% 23	26.70% 47	15.91% 28	21.02% 37	18.75% 33	176	3.08
Cement Board Panels M	9.09% 16	10.80% 19	24.43% 43	28.98% 51	14.77% 26	11.93% 21	176	3.35
Cement Board Panels N	9.09% 16	15.34% 27	14.77% 26	20.45% 36	30.68% 54	9.66% 17	176	3.23
Cement Board Panels O	19.32% 34	17.61% 31	6.82% 12	9.66% 17	9.09% 16	37.50% 66	176	3.16



Q18 Tell us more about your siding material choices.

Answered: 78 Skipped: 144

See Excel spreadsheet.

CITY COUNCIL WORK SESSION MEMO

DEPARTMENT	PRESENTED BY	DATE
Community Development	Bill Almquist - Community Development Director	May 20, 2024

ITEM
Place to Age Project – Presentation and Discussion

BACKGROUND
Places to Age is a recently-formed 501(c)3 organization that is interested in developing a senior-living community. Specifically, the group is looking to develop 10 acres that are currently owned by Jim Treat on the west side of Salida. Mr. Treat's parcel encompasses a total of approximately 43 acres and is currently located in the County between CR 120 and CR 140, immediately west of the proposed Angelview PD and Major Subdivision. Applications to annex and zone the property are anticipated to be submitted soon by the property owner and Places to Age. Following presumed annexation and zoning of the property, the group intends to submit a land use application for the proposed development.

Representative of Places to Age would like to make a presentation to Council regarding the project and potential partnership opportunities between the City and the organization and next steps.

WORK SESSION MEMO

DEPARTMENT	PRESENTED BY	DATE
Administration	Sara Law- Sustainability Coordinator/PIO	May 20, 2024

BACKGROUND

This memo is intended to provide the justification for the Sustainability Committee's support for Electric Preferred as the most cost-effective solution to reduce greenhouse gas emissions and advance the City's Climate Action Plan.

On July 20th, 2021 City Council adopted Resolution 2021-27 adopting a Climate Action Plan for the City of Salida. In subsequent years, City Council began the implementation for an Energy Action Plan with our Partners in Excel Energy and codified our Ssustainability Committee. As part of these steps, the Salida Municipal Code empowers the Sustainability Committee to both assist the City Council to implement its Climate Action and Energy Action Plans and update and advocate for the advancement of local guidelines and codes to lower energy consumption. § 2-18-40 (b) and (d), Salida Municipal Code.

Pursuant to this charge, the Committee recommends the City Council pass a resolution supporting Chaffee County's adoption of electric preferred amendments to the County's Energy Conservation Code. Salida's Climate Action Plan specifically recommends the city adopt energy efficiency standards for new construction that exceed the minimum standards. In addition to this, the Committee determined that the electric preferred amendments to the Energy Conservation Code would be a modest and meaningful step the City should take towards achieving its overarching goal to reduce energy-related carbon emissions by at least 50% by 2030, but the amendments would also reduce the energy burden for homeowners and businesses, while preserving developer choice and options to meet energy efficiency goals.

The United States' most recent National Climate Assessment concluded that while greenhouse gas emissions are falling, the current rate of decline is not nearly enough to meet targets necessary to avoid the greatest risks of climate change. Moreover, the Assessment indicated that every fraction of a degree of additional warming we can avoid decreases climate-related risks in the future. Since time is of the essence, the City's biggest bang for its buck in terms of reducing greenhouse gas emissions is in the City's largest source of greenhouse gas emissions – energy use from buildings. Residential and commercial building energy use in Salida make up 38% of Salida's GHG emissions according to the 2018 Salida GHG Emission Inventory. Importantly, nearly 75% of energy use in Salida buildings is fueled by methane, the primary component of gas fossil fuel, which is 28 times as potent as carbon dioxide at trapping heat in the atmosphere. The electric preferred amendments would effectively curb GHG emissions in new homes and commercial spaces by encouraging all-electric construction or, alternatively, requiring that new construction using gas include additional energy efficiency measures.

The Committee believes adopting the electric preferred amendments presents a fair compromise between maintaining developers' choice to include gas appliances in new construction, while at the same time reducing GHG emissions and utility bills for new home and business owners through electrification and additional energy efficiency. In addition, adopting more energy efficient energy code standards now future-proofs new home and business owners from increasing costs of fossil fuels and from future rules and laws, which may mandate a more aggressive transition to clean energy.

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DEPARTMENT	PRESENTED BY	DATE
Administration	Sara Law- Sustainability Coordinator/PIO	May 20, 2024

The Sustainability Committee also recommends that the Council not lose sight of the intergenerational equity at stake when it comes to reducing GHG emissions to limit the impacts of climate change. As a tourist based economy, we are arguably more subject to the consequences of climate change to our industries like skiing, rafting, biking etc. The decisions that Council makes now to reduce GHG impacts future generations of Salidans from the impacts of climate change.

Key Questions

The section below intends to provide latest research, literature, and case studies on how electric preferred could impact Salida's housing affordability, provide an update on Colorado's, long term energy forecasting and supply, and address the benefits of such a decision to Salida's business sector.

1) **Housing Affordability**

Local and regional cost studies conclude that the electric preferred amendments to the Energy Code are unlikely to have significant cost impacts to affordable housing. Instead, affordable housing proposals coupled with energy efficient designs are more likely to reduce the energy burden for low-income homeowners and renters and may be more competitive for state and federal housing grants. In 2022, Eagle County, Colorado contracted Denver-based consultant, Lotus Engineering and Sustainability, to evaluate the benefits and costs of potential updates to the county's energy code, including electric preferred, in a code update analysis report. At the time Lotus' report was drafted, data wasn't available to quantify benefits and costs for every energy code update scenario, however, Lotus concluded that the upfront costs to build to the potential update standards were not significantly higher than the upfront costs to build to the 2021 IECC standards. This conclusion is in line with other regional reports, including Rocky Mountain Institute's 2020 analysis, which found that upfront costs to build all electric, single-family homes were lower than mixed fuel homes in six out of seven of the cities it evaluated and the net present value of new all-electric, single family homes is lower than mixed-fuel homes in all seven of the cities it evaluated. Moreover, Lotus' report found that under any energy code update scenario building occupants could expect to benefit from annual energy cost savings and reductions in greenhouse gas emissions. Although electric appliances can in some cases be more expensive than their gas equivalents the big savings on upfront costs come from avoiding gas connection and piping costs. Notably, in 2023 the Colorado Legislature passed and the Governor signed SB23-291, which among other things requires gas utility companies to remove incentives that lower the cost of establishing gas service to new properties. In other words, the cost of establishing gas connections at new homes and commercial spaces is continuing to rise.

Finally, there is an array of affordable housing grants that require or incentivize applicants to submit proposals that incorporate energy efficiency. Both the federal Low Income Tax Credit and Colorado's Prop 123 affordable housing program prioritize and preference applications that can show the proposed housing developments will be energy efficient and address federal and state climate change objectives. Adopting the electric preferred amendments to the energy code would likely increase Salida's odds of being awarded critical affordable housing grants.

2) **Impact on Local Businesses**

As is the case in the affordable housing context, the Lotus report also found that updates to the energy code further incentivizing electrification and energy efficiency would be unlikely to significantly increase the cost to new commercial space development. In fact, Lotus' analysis revealed that all-electric commercial buildings have an upfront cost savings as compared to mixed-fuel commercial buildings. Similar to new residential buildings, new commercial buildings constructed according to updates to the 2021 energy code would also reduce the energy burden for local businesses and their greenhouse gas emissions. It's important to reiterate that the electric preferred amendments to the

WORK SESSION MEMO

DEPARTMENT	PRESENTED BY	DATE
Administration	Sara Law- Sustainability Coordinator/PIO	May 20, 2024

energy code would only apply to newly constructed commercial spaces, not existing commercial space. Lastly, adopting electric preferred amendments would also make it more likely for local commercial developers to take advantage of once-in-a-generation tax incentives through the Inflation Reduction Act, such as the Section 179D tax deduction and Section 45L tax credits, which are only available to developers that can meet heightened energy efficiency requirements.

3) Colorado Energy Forecast

Encouraging the development of electric homes and businesses in Colorado and in Salida, in particular, will not pose electricity supply challenges for the electric utilities charged with supplying this power. In a May 6, 2024 email communication with Imogen Ainsworth, Xcel Energy's contracted facilitator for Salida's Energy Action Plan, Ainsworth confirmed there are no concerns with Xcel's grid capacity as it relates to the electric preferred adoption. Moreover, under Colorado law, every four years the electric utilities serving Salida must forecast and produce an Electric Resource Plan (ERP) that ensures each utility's electric supply meets current and forecasted electric demand. For example, Xcel Energy produced its most recent plan in 2021, which forecasted electric supply and demand out to 2030. In addition to ensuring Xcel's electric supply meets current and future electric demand, Xcel Energy also maintains an 18% planning reserve margin above peak energy demand. In other words, Xcel Energy maintains the capability to produce more energy than it expects to need at peak demand to ensure reliability. No electric utilities serving the City of Salida have reported an inability to meet current or future electric needs in this community.

Eagle County Energy Code Modeling Report

NOVEMBER 2022

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Executive Summary

Background

In 2019, energy use in residential, commercial, and industrial buildings in Eagle County (the County) generated **exactly half** of all County greenhouse gas (GHG) emissions. In 2020, GHG emissions from energy use rose just slightly to 51%, but emissions produced from natural gas use surpassed the emissions from electricity use.

Utility and State Renewable Energy Efforts

- **Holy Cross Energy:** 100% renewable electricity by 2030.
- **Xcel Energy**: 100% carbon-free electricity by 2050.
- **The Colorado Public Utilities Commission:** directed by State Statute to work with investor-owned utilities on resource plans that outline emissions reduction goals. Investor-owned utilities in the state must reach 80% renewable electricity by 2030.
- **Colorado Regulations for Building Code:** Starting July 1, 2023, any Colorado jurisdiction that updates their building code must, at a minimum, adopt the 2021 IECC with electric-ready, solar-ready, and EV-ready standards. Starting July 1, 2026, any Colorado jurisdiction that updates their building code must adopt the State's low carbon code. This code will be developed by an Energy Code Board administered by the Colorado Energy Office.

Across Colorado, natural gas emissions have become the primary source of building energy emissions because the Colorado electric grid becomes cleaner each year. As utilities continue to increase their portfolios of renewable energy resources, GHG emissions from electricity use will continue to fall. Holy Cross Energy has already achieved 50% renewable energy and the utility expects to reach 100% renewably powered electricity generation by 2030. While these goals robustly address electricity emissions, **natural gas emissions could continue to be a significant source of emissions in the County without intentional policy updates.**

Updating building code for all building types offers a crucial opportunity for Eagle County to address emissions from buildings, with an emphasis on curbing those from natural gas. Transitioning the fuel source of new buildings from natural gas to electricity (called electrification) capitalizes on clean grid efforts from Holy Cross Energy and produce significant greenhouse gas emissions savings. Peer communities are already codifying the transition to electrification. Crested Butte passed the first ordinance in Colorado requiring all new construction to be all-electric, beginning in 2023 (with the exception of commercial kitchens). The Town of Basalt and Town of Vail each require new construction to include the pre-wiring and panel capacity for all-electric systems to be installed in the future (called electric-ready). Many more jurisdictions in the front range are also pursuing electrification codes with varying stringencies in preparation for a renewably powered electric grid.

Project Scope

Eagle County contracted with Lotus Engineering and Sustainability (Lotus) to evaluate new construction energy code packages to determine how they compare to Eagle County's current energy code, the 2015 International Energy Conservation Code (IECC/energy code). The scope of work is outlined in Figure ES1.

Upfront Cost Literature Review

Cost impacts of updating the base energy code:

From the 2015 energy code to the 2021 energy code.

Cost impacts of three electrification code standards that build on the 2021 energy code:

Electric-Readiness

Electric-Preferred

All-Electric

Energy Modeling

Building Type

Single Family Home

Multifamily Building

Mixed-Use Commercial

Code Standards

2015 IECC

2021 IECC

2021 IECC + Electric-Preferred

2021 IECC + All-Electric

Modeling Outputs

Annual energy use

Annual energy cost

Greenhouse gas emissions (over 40-year building lifetime)

Figure ES1: Project Scope.

Key Findings

OVERALL

1. Adoption of the 2021 IECC will result in lower annual energy use, lower annual energy cost, and lower GHG emissions in new homes and buildings than the County's current code, the 2015 IECC, for all building types and does not represent a significant increase in upfront construction costs.

2. The 2021 IECC with an all-electric requirement resulted in:

- The lowest annual energy use (MMBTU) and the lowest greenhouse gas (GHG) emissions of all the code standards reviewed, for single family homes, and multifamily and commercial buildings.
- 87% or higher GHG savings compared to buildings built to the 2015 IECC, over the lifetime of the building for all building types.
- The lowest annual energy costs for multifamily and commercial buildings.
- Upfront cost **savings** when building an all-electric commercial building compared to the same building built to the 2021 IECC with natural gas.

> ***Note:*** *While the studies give a generalized estimate of incremental and upfront construction costs of building to the 2021 IECC compared to a prior code cycle baseline, these numbers are point-in-time estimates and are subject to change based on volatile economic parameters and developer preferences during building design and construction. In addition, the upfront cost analysis was only conducted for the energy code provisions of the building code.*

3. The upfront construction cost to build to the 2021 IECC, 2021 IECC + electric-preferred, and the 2021 IECC + all-electric is not significantly higher than the upfront construction costs to build to the 2015 IECC. Costs to build to each above code standard are returned through annual energy savings that result from the code update.

Simple Payback (years) for New Construction Built to 2021 IECC Base Code		
Single Family Home	Multifamily Building	Commercial Building
7.2	9.2	3.7

- The upfront additional costs to build all-electric homes, the most expensive code for single family homes, is $6,000.
- Multifamily buildings have the highest incremental upfront cost with the high range being an additional $70,000 for an all-electric building.
- Commercial buildings range from cost neutral or cost savings to an additional $4,000 to build to the above code standards evaluated.

4. The 2021 IECC with an electric-ready amendment will be required by law for Colorado jurisdictions beginning July 1, 2023. Installing electric-ready infrastructure in new construction avoids costly retrofits of existing buildings and encourages builders to build all-electric because the infrastructure is in place.

5. All code packages investigated in this study will yield annual energy cost savings for the building occupants for all building types in Eagle County's climate zone (CZ6).

6. For all building types, the 2021 IECC with an all-electric requirement creates the greatest greenhouse gas emissions savings over the 2015 IECC baseline.

    - 2021 IECC without amendments yielded the smallest amount of GHG savings across building types, followed by the 2021 IECC + electric-preferred which yielded slightly more GHG savings than the 2021 IECC without amendments.
    - 2021 IECC + all-electric yielded the highest emissions savings across all building types, with at least an 87% decrease in emissions from the baseline 2015 code.

All-electric new construction creates a minimum 87% reduction in GHG emissions from the 2015 IECC over a 40-year period, across all building types.

PROJECT SUMMARY CHARTS

The visuals below provide a summary of overall results from the upfront cost and modeling analyses. The energy use and GHG savings for each code package are compared against the baseline 2015 IECC for all code packages. The upfront additional cost values use the 2015 IECC as the baseline for the 2021 IECC base code, and then the IECC 2021 as a baseline for the electric-preferred and all-electric standards. The quadrants are colored to demonstrate impact on energy savings and GHG emissions. The darker the shade of green, the higher the savings are.

In all scenarios, the all-electric buildings can be found in the darkest shades of green, meaning they generate the most energy cost savings and GHG emissions savings. This code option is followed by the electric-preferred standard which can also be found in the darker shades of green on the charts. **The circles for upfront additional construction cost indicate that each of the above code standards, apart from all-electric multifamily buildings, do not represent significant additional cost to implement.**

Single Family Home

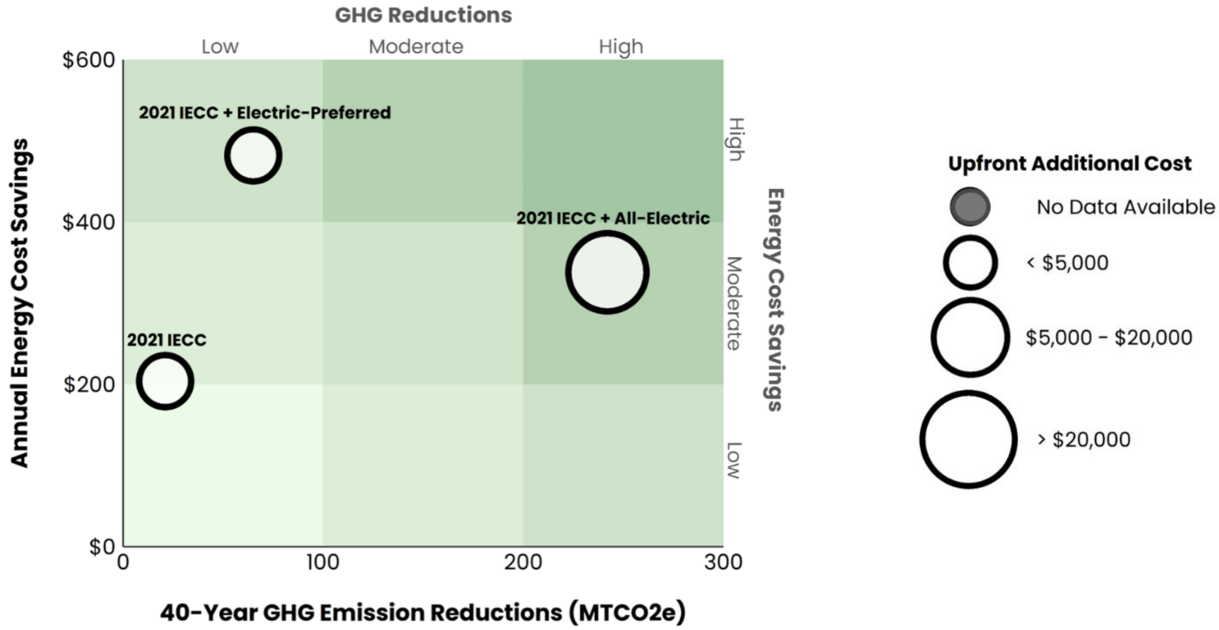

Figure ES2: Single family home GHG emission reductions, energy costs, and additional upfront costs from the baseline code.

Multifamily Building

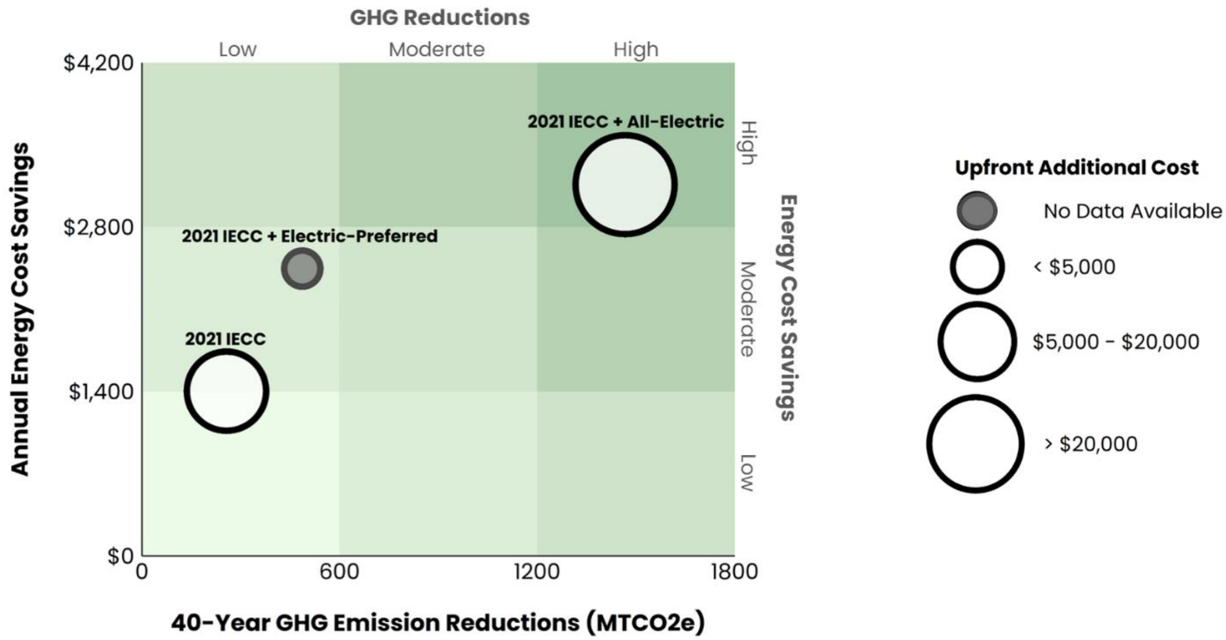

Figure ES3: Multifamily building GHG emission reductions, energy costs, and additional upfront costs from the baseline code. No upfront additional cost data was available for the 2021 IECC with electric preferred scenario.

Commercial Building

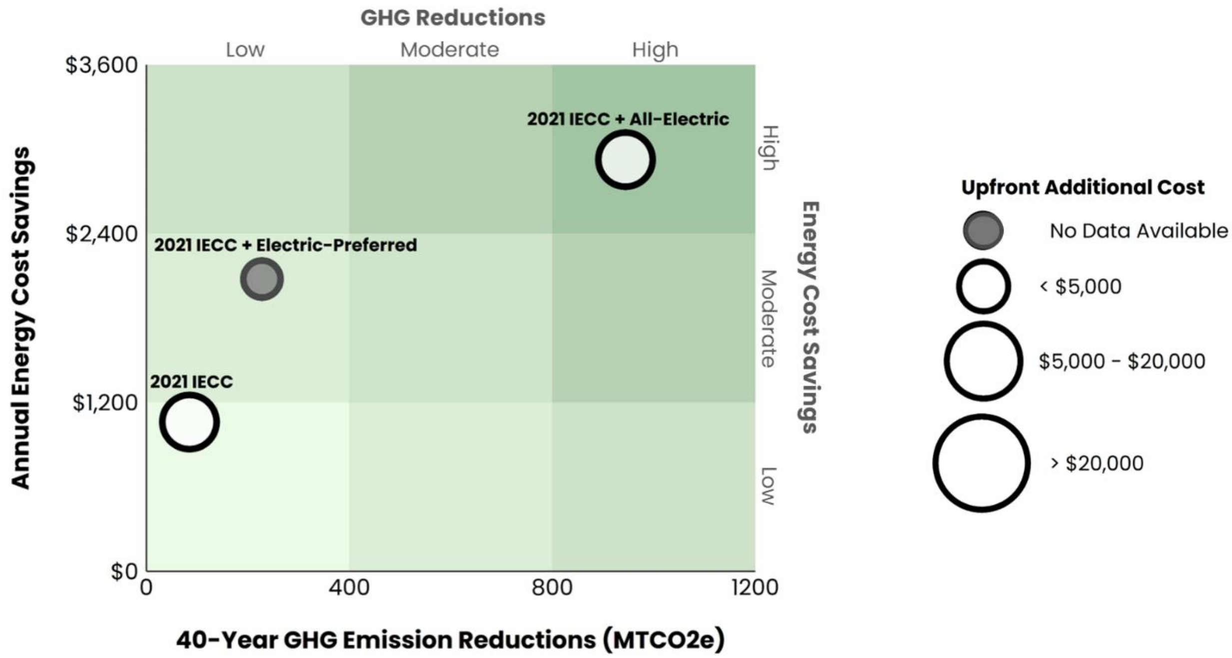

Figure ES4: Commercial building GHG emission reductions, energy costs, and additional upfront costs from the baseline code. No upfront additional cost data was available for the 2021 IECC with electric preferred scenario.

Summary Table

Each code package is summarized in the table below based on the change in upfront cost, annual energy use, annual energy cost, and GHG emissions from the baseline code. As noted above, the baseline for the annual energy use, annual energy cost, and GHG emissions is the 2015 IECC. The upfront additional cost values use the 2015 IECC as the baseline for the 2021 IECC base code, and then the IECC 2021 as a baseline for the electric-preferred and all-electric standards. All green numbers represent savings from the baseline.

The savings from each code package that goes above and beyond the 2015 IECC is made clear by the green text throughout the chart. **The most significant annual GHG savings, along with the most significant energy use savings come from the all-electric buildings.**

Code Package	Upfront / Incremental Cost to Build ($)	Total Annual Energy Use (MMBtu)	Total Annual Energy Use Reduction from Baseline (%)	Total Annual Energy Cost	Total Annual Energy Cost Savings from Baseline	40-year Cumulative Emissions (mtCO2e)	40-year Cumulative Emissions Reduction from Baseline (%)
Single Family Home							
2015 IECC Baseline	**N/A**	**144**	**N/A**	**$2,564**	**N/A**	**270**	**N/A**
2021 IECC	$1,470	132	-8%	$2,360	($204)	248	-8%
2021 IECC Electric-Ready	$925 - $2,700*	132	-8%	$2,360	($204)	248	-8%
2021 IECC Electric-Preferred	$870 - $2,028*	111	-23%	$2,082	($482)	205	-24%
2021 IECC All-Electric	$4,000 - $6,000*	68	-53%	$2,226	($338)	28	-90%
Multifamily Building							
2015 IECC Baseline	**N/A**	**985**	**N/A**	**$21,229**	**N/A**	**1,685**	**N/A**
2021 IECC	($657) - $1,065 per unit (9,198) – $14,910 whole building	869	-12%	$19,826	($1,403)	1,429	-15%
2021 IECC Electric-Ready	$1,350 per unit* $18,900* whole building	869	-12%	$19,826	($1,403)	1,429	-15%
2021 IECC Electric-Preferred	Not available.	771	-22%	$18,783	($2,446)	1,198	-29%
2021 IECC All-Electric	$3,000-$5,000 per unit* $42,000 - $70,000* whole building	536	-46%	$18,067	($3,161)	218	-87%
Commercial Building							
2015 IECC Baseline	**N/A**	**609**	**N/A**	**$11,079**	**N/A**	**1,060**	**N/A**
2021 IECC	($10,849) - $3,918	563	-9%	$10,018	($1,061)	975	-8%
2021 IECC Electric-Ready	Not available.	563	-9%	$10,018	($1,061)	975	-8%
2021 IECC Electric-Preferred	Not available.	492	-21%	$9,002	($2,077)	832	-21%
2021 IECC All-Electric	($18,100)	285	-54%	$8,153	($2,926)	116	-89%

Table ES1: Results Summary.

**Indicates the baseline is the 2021 IECC. All other data uses the 2015 IECC as the baseline.*

Project Overview

1.1 Introduction

Eagle County has demonstrated a strong commitment to climate action through several adopted goals and frameworks. "Protect our mountain ecosystem" is one of three main principles guiding Eagle County Government. Embedded in this guiding principle is the goal of annually reducing greenhouse gas (GHG) emissions in the community by 75,000 metric tons (mT) and in County operations by 500 mT, to achieve the goal of 50% emissions reduction by 2030 (from 2014 baseline levels), established by the *Climate Action Plan for the Eagle County Community* (CAP).

New construction provides a crucial opportunity for emissions mitigation. Buildings constructed today could last 30 to 130 years[1] and could either lock in carbon emissions for generations or be used as a means for achieving emission reduction goals. Adopting the above building code standards for new and remodeled residential and commercial buildings is an immediate priority action listed in the CAP due to the building decarbonization potential of code improvements. Regular updates to Eagle County building codes are critical for future-proofing Eagle County communities, accelerating clean energy use, and keeping the County resilient amid climate change.

1.2 Project Overview

Eagle County contracted with Lotus Engineering and Sustainability (Lotus) to analyze new construction energy code standards as they compare to Eagle County's current construction code, the 2015 International Energy Conservation Code (IECC). The purpose of each task was to investigate options the County could consider for its next round of code adoption. The scope of work consisted of:

1) **Upfront Cost Analysis:** A literature review of existing studies analyzing the cost impacts of updating energy codes from prior code cycles, in this case, the 2015 and/or 2018 IECC, to the 2021 IECC. Additional studies were reviewed to understand the upfront cost impacts and the cost-effectiveness of three additional above-building code standards which include electric-readiness, electric-preferred, and all-electric provisions.

[1] https://www.mckinsey.com/industries/engineering-construction-and-building-materials/our-insights/call-for-action-seizing-the-decarbonization-opportunity-in-construction

2) **Energy Modeling:** Energy modeling for three building types typical of Eagle County construction: a single-family home, a multifamily building, and a mixed-use commercial building. Each building type was modeled to meet four code standards: the County's current energy code (2015 IECC), the 2021 IECC, the 2021 IECC plus an electric-preferred standard, and the 2021 IECC with all-electric systems. The modeling was conducted to evaluate total annual energy consumption, total annual energy costs, and greenhouse gas emissions over the lifetime of the building (40-year period) to understand the emissions and cost implications of advancing to a new building code. The single-family and multifamily energy models were developed using the National Renewable Energy Laboratory's (NREL) Building Energy Optimization Tool (BEopt)[2]. The commercial building energy model was developed using the Department of Energy's eQUEST tool[3].

The upfront cost analysis and the energy modeling will demonstrate which code options are the most cost-effective and which will have the greatest contribution to reducing greenhouse gas emissions in the County. In addition, Eagle County will be participating in a code cohort with surrounding jurisdictions to review and adopt supporting amendments alongside the 2021 I-codes. This effort will help advise Eagle County on which supporting amendments will support the achievement of their climate action goals through their next phase of energy code adoption.

1.3 Energy Code Standards Evaluated

This report evaluates four energy code standards that are more stringent than Eagle County's current adopted energy code. The goal in evaluating these energy code standards is to understand which energy codes can be cost-effective in implementation and support the County in achieving its climate action goals. Cost-effective is defined by the US Department of Energy (DOE) as a change that is "economically justified from the perspective of a public policy that balances costs against energy savings over time" and uses life-cycle costs (energy savings minus additional costs) over a 30-year period as a metric.[4] The following code standards are those that were evaluated for cost-effectiveness in Eagle County.

1) **2021 IECC:** Meets the prescriptive requirements of the 2021 IECC. Note: for base code compliance, all building types must implement additional efficiency measures detailed

[2] https://www.nrel.gov/buildings/beopt.html
[3] https://www.doe2.com/equest/
[4] https://www.energycodes.gov/sites/default/files/2021-07/residential_methodology_2015.pdf

in the "Additional Efficiency" sections of the IECC (sections C406 for commercial and multifamily and R408 for single-family homes).[5]

2) **2021 IECC + electric-readiness:** Meets the base requirements of the 2021 IECC, including additional efficiency for base code compliance. This code package also includes provisions that prepare a building for an all-electric future by installing the necessary pre-wiring and panel capacity for space heating, water heating, clothes drying, and cooking appliances. Under this code package, installing electric HVAC systems and appliances is not a requirement.
3) **2021 IECC + electric-preferred:** Meets the base requirements of the 2021 IECC, including additional efficiency for base code compliance. This code package builds upon electric-readiness, requiring all new construction be electric-ready, and encourages all-electric construction through required additional efficiency measures if a building uses natural gas. Buildings under this code have the following options:
    a. Build all-electric OR,
    b. Build with natural gas AND adopt additional efficiency requirements from commercial and residential 2021 IECC sections C406 and R408, respectively, beyond those required for base code compliance.
4) **2021 IECC + all-electric new construction:** Meets the base requirements of the 2021 IECC, including additional efficiency for base code compliance. This code package also mandates new construction to be built all-electric, with no natural gas systems.

Note: electric-readiness, as a code standard, does not impact energy consumption, energy savings, or GHG emissions in a building over the base code. Therefore, the project team did not develop an energy model for the electric-ready standard. Any building built with electric-readiness infrastructure will yield the same energy performance results as the 2021 IECC base code energy modeling. The code standards in Table 1 were modeled to evaluate energy savings, energy cost, and GHG emissions for Eagle County-specific building types.

[5] https://codes.iccsafe.org/content/IECC2021P1

Modeled Code	Description
2015 IECC	Meets the prescriptive requirements of the 2015 IECC.
2021 IECC *[& 2021 IECC + Electric-Ready]*	Meets the prescriptive requirements of the 2021 IECC. Note: additional efficiency package(s) must be implemented in all building types for base code compliance. • Single-Family Homes: One additional efficiency package (R408). • Multifamily: 10 points in additional efficiency section (C406). • Commercial: 10 points in additional efficiency section (C406). Electric-ready standards to not impact energy performance, therefore the energy model is the same for both the 2021 IECC and the 2021 IECC + electric-ready code standards.
2021 IECC + Electric-preferred	Meets the prescriptive requirements of the 2021 IECC, including the additional efficiency package(s) for base code compliance. Electric-preferred buildings modeled must also implement more efficiency measures, beyond base code compliance, if they build with natural gas. • Single-Family Home: Two additional efficiency packages (R408). • Multifamily: 20 points in additional efficiency section (C406). • Commercial: 20 points in additional efficiency section (C406). Electric-preferred standards also assume the home is electric-ready when built with natural gas systems.
2021 IECC All-Electric	Meets the prescriptive requirements of the 2021 IECC, including the additional efficiency package(s) for base code compliance. HVAC systems and appliances are all-electric.

Table 1: Building Code Standards used for energy modeling.

1.4 Building Types Evaluated

Each energy code standard was investigated for three building types in Eagle County: a single-family, multifamily, and commercial building. The size and type of each building were determined through discussions with County staff and a review of the assessor's data to identify average building sizes for each building type in the County. Table 2 summarizes the assumptions for each building type used for energy modeling. In the upfront cost analysis, each study had unique size and space use types for single-family, multifamily, and commercial buildings. In conducting a review of these studies, buildings that aligned most closely with the buildings modeled were chosen for comparison.

Building Type	Square Footage	Stories	Building Use
Single-Family Home	3,184	2	Includes an unconditioned 19' x 20' garage.
Multifamily	19,989	2	Composed of 14 individual units.
Commercial	6,027	2	Mixed Use: • Retail space on the ground floor. • Multi-family space on the top floor.

Table 2: Building type descriptions.

1.5 Upfront Cost Review Methodology

Two approaches were used to assess the upfront costs of the four code package options.

The first was a literature review of existing studies examining the cost-effectiveness of the four energy code standards as they compare to the County's current adopted energy code. The second was outreach to local general contracting companies to understand the on-the-ground perception of the cost of energy code compliance. Note: the studies reviewed in this report cover cost impact data for the energy code only. The 2021 I-Codes include several books each directing construction practices for different elements of a building, including Fire Code, Mechanical Code, Plumbing Code, and more. The cost impacts of additional provisions in code books outside of the Energy Conservation Code were not reviewed in this study.

When reviewing the published resources available on the IECC 2021 and the three additional energy code standards that build on the 2021 IECC, relevancy to the project and Eagle County's climate zone, as well as resource type and credibility were all considered. Eagle County is in Climate Zone 6, so information from the reports for this climate zone only are summarized in this review. The final sources reviewed in this report are listed in Appendix B.

Most of the publicly available studies analyze the cost-effectiveness of the 2021 IECC as compared to the 2018 IECC cycle, due to these being the two most recent codes. The difference between the 2015 and the 2018 IECC are limited with most of the changes focused on administrative updates and tightening up code language. There are only a few updates between the two energy codes that result in improved energy performance, and those have been shown to yield energy savings of 1.62% for Climate Zone 6.[6] Because of the relatively few differences between these energy codes the studies using the 2018 IECC for comparison have been included in this analysis for additional context.

[6] https://www.energycodes.gov/sites/default/files/2021-07/EERE-2018-BT-DET-0014-0008.pdf

Additionally, some of the cost studies reviewed for commercial and multifamily investigate the cost to comply with ASHRAE design standards as opposed to the IECC code. ASHRAE stands for the American Society of Heating, Refrigerating, and Air-Conditioning Engineers. This professional association releases energy efficiency standards for the design and installation of equipment in multifamily buildings and all other commercial buildings and the standards are then referenced by the IECC. The ASHRAE design standard (ASHRAE 90.1) is a compliance path option in the commercial IECC and therefore provides a useful tool to compare the cost of IECC commercial building compliance when studies directly related to the IECC are not available. ASHRAE updates fall behind IECC updates by two years, but each new IECC cycle adopts the latest ASHRAE standard and any amendments and/or new data that accompany it. The 2021 IECC references the ASHRAE Standard 90.1-2019 edition, and the 2018 IECC references the ASHRAE Standard 90.1-2016 edition.

It is important to note that the assumptions and the building specifications in the referenced reports vary. In addition, equipment costs, inflation rates, and other economic parameters detailed in these reports are point-in-time data sets and may not reflect present-day pricing. The costs reflected in the studies also illustrate the cost to builders. Home buyers may experience different cost increases due to community factors such as proximity to school districts, amenities, and housing market rates for a specific location impact price. Consequently, the applicability of the findings from these reports to Eagle County will also be variable.

1.6 Energy Modeling Methodology

The single-family and multifamily buildings were modeled using the National Renewable Energy Laboratory's (NREL) Building Energy Optimization Tool (BEopt)[7]. The commercial building was modeled using the Department of Energy's eQUEST tool[8].

Eagle County provided average square footage and other descriptive information about each building type (Table 2). This information was used to create a basic template for each building type in the modeling software from which the baseline and code package models were developed.

In addition to this building-level information, localized geographic data were input into the models to produce accurate results for Eagle County. Eagle County was selected as the location to model the building and the typical meteorological year data for Eagle County were

[7] https://www.nrel.gov/buildings/beopt.html
[8] https://www.doe2.com/equest/

downloaded and imported into BEopt and eQUEST. Electricity and natural gas utility rates for Holy Cross Energy (HCE) and Black Hills Energy (BHE) were added to the models to use for energy cost calculations. Table 3 lists the electricity and natural gas rates used in the models. Rates taken from HCE and BHE tariff reports.

Building Type	Electricity		Natural Gas	
	Monthly Fixed Rate	$/kWh	Monthly Fixed Rate	$/therm
Single-Family Home	$12	$0.105	$13.43	$1.30241
Multifamily	$12	$0.105	$13.43	$1.30241
Commercial (<50 kW Peak Demand)	$18	$0.095	$26.01	$1.36

Table 3: Electricity and natural gas rates used in the building models.

Based on the above information, a baseline building in compliance with the 2015 IECC was modeled for each building type. This model was duplicated for each code option and specifications were adjusted to align with the requirements for each additional code package. Note that for all code options and building types, efficiencies of natural gas equipment were reduced to account for the impacts of elevation. Eagle, CO is 6,601 feet above sea level. For every 1,000 above 3,000 feet in elevation, natural gas appliance efficiency required in the code was reduced by 4%.[9] For a full list of the inputs used to model each building and each code option see Appendix A.

Annual energy use and cost results were exported from BEopt and eQUEST for each building type and code package. Single-year energy use and cost results for each code package were compared to the baseline building energy use and cost. Cumulative 40-year GHG emissions for each building type and code package were calculated based on annual energy use. It was assumed that annual energy use for a given building type and code package would not change over time. Cumulative 40-year GHG emissions are calculated as opposed to annual emissions to understand building life cycle impacts and to account for forecasted changes in the electricity grid.

GHG emissions were calculated for each year from 2022 through 2061 based on annual natural gas and electricity usage. The electricity emission factor (metric tons of CO_2e emissions produced per MWh of electricity consumed) was assumed to be zero by 2030 in alignment with HCE's goal of 100% renewable energy by 2030. The 2020 emission factor for HCE was taken from HCE's 2020 CO_2 Emission Report.[10] A linear decrease in the emission factor from the 2020 value to 0 in 2030 was assumed. Natural gas emission factors were taken from the US Community

[9] https://www.nfpa.org/assets/files/AboutTheCodes/54/54-A2002-rop.pdf
[10] https://www.holycross.com/wp-content/uploads/2021/12/co2_EMISSION_REPORT_2020_V1.1.pdf

Protocol for Accounting and Reporting Greenhouse Gas Emissions.[11] Natural gas emission factors do not change over time. Energy use, operational costs, and GHG emissions are compared for each building type and code package.

2. Project Results

The results from this study have been organized by building type and include a summary of the upfront cost, operational cost, and GHG emissions of each code standard applied to each building type, compared to Eagle County's 2015 International Energy Conservation Code.

2.1 2021 IECC Compared to 2015 IECC

2.1.1 Upfront Cost of 2021 IECC for Single-Family Home

In February 2022, Pacific Northwest National Laboratory (PNNL) conducted a Colorado-specific cost analysis that compares the residential provisions of the 2021 IECC to the 2015 IECC, based on models of typical homes built to be code compliant. This study evaluated each climate zone within the State of Colorado. According to the report, the incremental construction cost for a single-family home built to the base 2021 IECC over the 2015 IECC in Colorado in Climate Zone 6 is **$1,470.** Additional details on energy savings over the lifetime of the building were reported in the study. Results from this study are summarized in Table 4.

Building Type	Incremental Construction Cost	First-Year Energy Cost Savings	Energy Cost Savings	Life-cycle Cost Savings ($/Unit) *
Single-Family Home	$1,470	$116	6.3%	$1,144

*Life-cycle cost, by the study's definition, indicates savings over a 30-year time period.

Table 4: Summary results from the PNNL study comparing the residential provisions of the 2021 IECC and the 2015 IECC.

To help validate the findings from the PNNL report, the project team reviewed two additional cost-impact studies. These studies investigated the upfront cost of building to the 2021 IECC compared to the 2018 IECC. In June 2021, Home Innovation Research Labs (HIRL) and the Pacific Northwest National Laboratory (PNNL) published national cost-effectiveness studies of the 2021 IECC compared to the 2018 IECC. The results of each report differed significantly, prompting a third study conducted by ICF, a global consulting company, to check the accuracy of the two reports. The ICF report demonstrated the HIRL study had significant errors in its methodology,

[11] https://icleiusa.org/ghg-protocols/

so the results of this study have been excluded from this report. [12] ICF reported incremental construction costs for a single-family home built to the 2021 IECC, as compared to the 2018 IECC, ranging from **$870 - $2,028**, depending on which additional efficiency package is selected for base code compliance. The PNNL Report found the average incremental cost for a single-family home to build to the 2021 IECC compared to the 2018 IECC to be **$1,477**.

These cost studies indicate that the incremental cost to build to the 2021 IECC is small and can differ depending on the pathway a builder chooses for base code compliance.

2.1.2 Single-Family Home Energy Model: 2015 IECC Compared to 2021 IECC

To investigate the changes in operational cost and GHG emissions that would result from adopting the 2021 IECC, an energy model of a single-family home was developed to compare a typical Eagle County home built to the IECC 2015 and the IECC 2021. The following single-family home was modeled in the BEopt software:

- 3,184 square feet (average single-family home size based on information from the Eagle County Assessor's office).
- 2 stories above-grade.
- Total square footage includes an unconditioned 19' x 20' garage.

Single-family homes must comply with the residential provisions of the IECC. The residential provisions include a requirement that all homes must implement one additional efficiency package to be compliant with code. The efficiency package selected for the 2021 single-family home model is as follows:

- R408.2.2 More efficient HVAC option.

See Appendix A for a full detailed list of the specifications made in BEopt to model the single-family building for each code package.

Energy Use

Figure 1 compares the annual energy usage for the modeled single-family home between the 2015 IECC baseline and the 2021 IECC. A single-family home built to be compliant with the 2021 IECC reduces annual energy use by 8% from the 2015 IECC. This change is mainly due to a decrease in natural gas used for space heating and hot water. Electricity usage declined slightly due to improved lighting efficiency, lower heating fan usage, and efficiency

[12] https://energyefficientcodes.org/wp-content/uploads/2022/05/Comparison-of-2021-IECC-Residential-Cost-Effectiveness-Analyses.pdf

improvements to the air conditioning system. Minor improvements to building envelope insulation also slightly reduced energy used for heating and cooling.

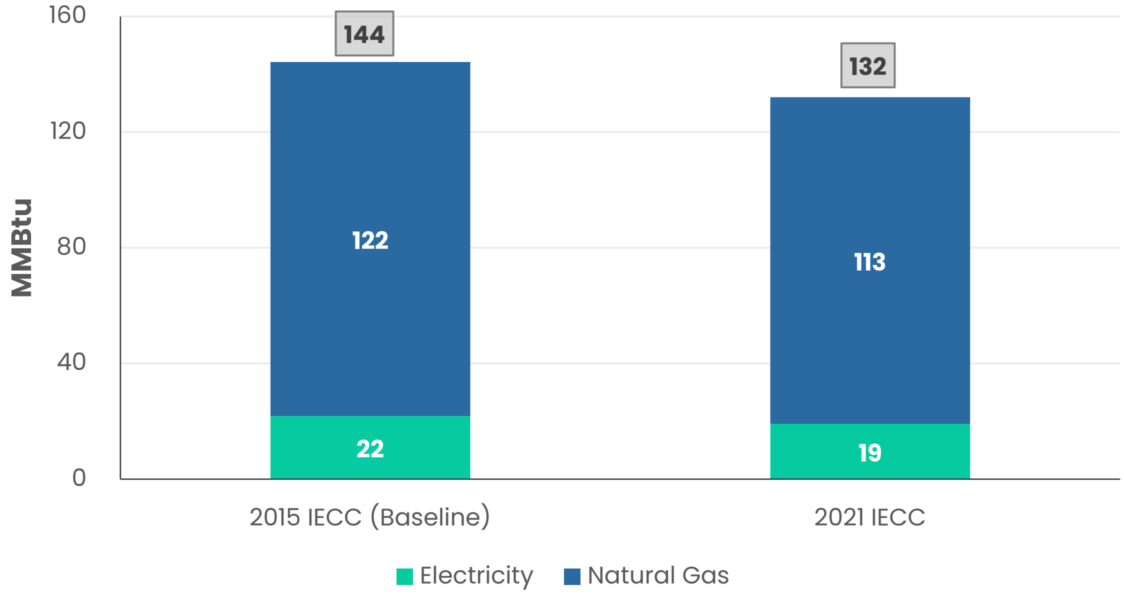

Figure 1: Comparison of single-family home annual energy use (MMBtu) between the 2015 IECC and the 2021 IECC.

Cost Savings

The 8% reduction in energy use described above would provide an 8% decrease in annual utility bills ($204.47, Figure 2). Electricity use decreased by 12% and natural gas use decreased by 8%. Savings from natural gas reductions are higher than savings from electricity due to a higher cost per unit of energy for natural gas at the time of modeling. Overall, annual utility costs would decrease from $2,564 with the 2015 IECC to $2,360 with the 2021 IECC. Over 40 years, single-family homeowners would spend $8,178.80 less on energy in a home built to the 2021 IECC compared to a home built to the 2015 IECC.

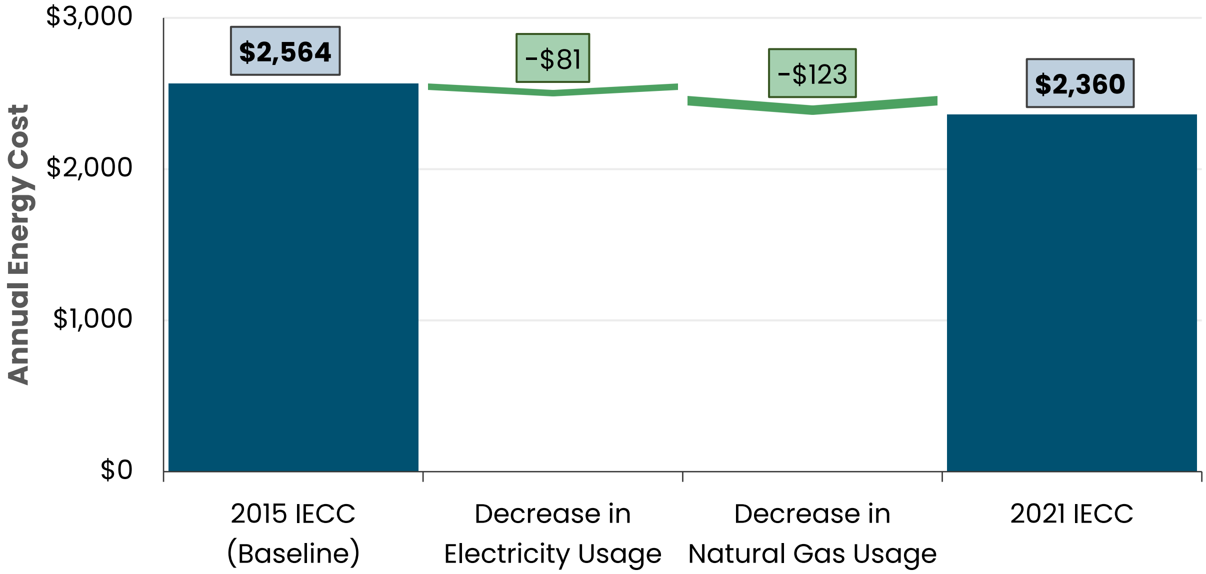

Figure 2: Cost savings breakdown of single-family home annual energy costs between the 2015 IECC and the 2021 IECC.

GHG Emissions

A single-family home built to the 2015 IECC would produce 270 mt CO_2e (metric tons of carbon dioxide equivalent) over 40 years. The 2021 IECC provides an 8% decrease in GHG emissions (248 mt CO_2e, a decrease of 21 mt CO_2e) compared to the 2015 IECC. Natural gas makes up the majority of both the 2015 IECC and 2021 IECC buildings' 40-year emissions (Figure 3). This is expected because electricity emissions fall to zero after 2030 due to HCE's renewable energy goal.

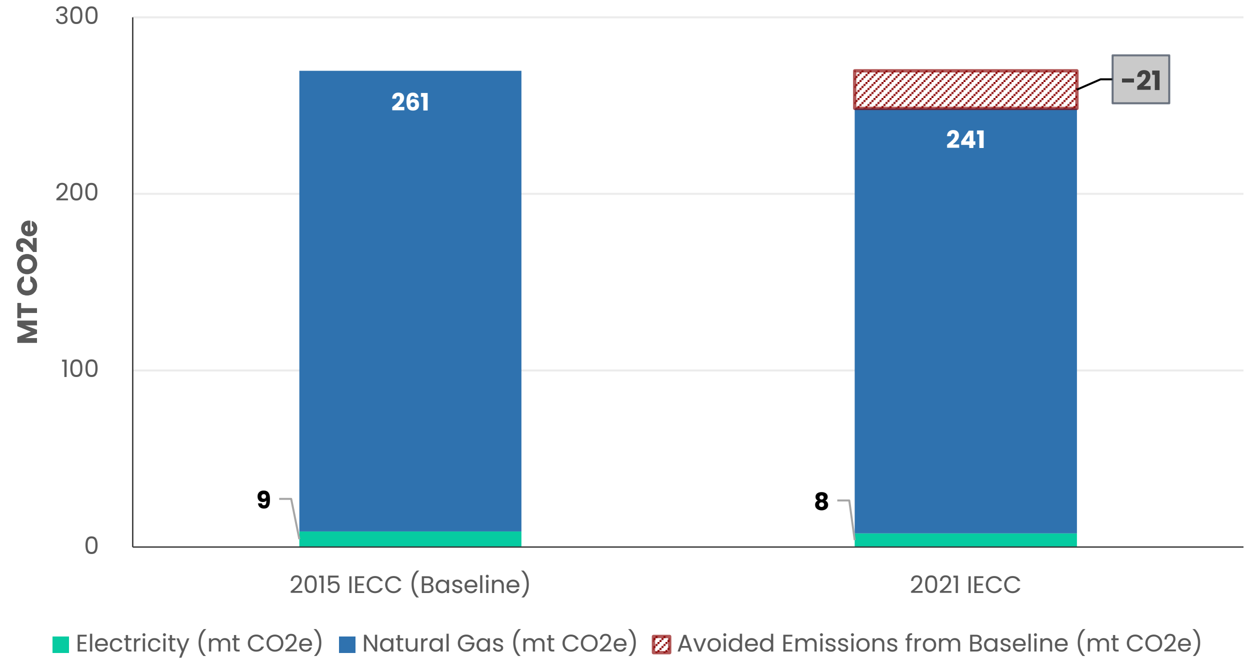

Figure 3: Comparison of single-family home 40-year GHG emissions between the 2015 IECC and the 2021 IECC.

2.1.3 Upfront Cost of 2021 IECC for a Multifamily Building

Two studies were available that analyzed the cost-effectiveness of the 2021 energy code against the 2015 energy code for multi-family buildings. The first is the Colorado-specific PNNL study completed in February 2022, (referenced above) which demonstrated that the total incremental cost to build to the 2021 energy code in Climate Zone 6 is **$1,065/unit** (Table 5).

*Table 5: Summary results from the PNNL study comparing the residential provisions of the 2021 IECC and the 2015 IECC. *Life-cycle cost, by the study's definition, indicates savings over a 30-year time period.*

Building Type	Incremental Construction Cost	First-Year Energy Cost Savings	Energy Cost Savings	Life-cycle Cost Savings ($/Unit) *
Multifamily Apartment (cost per unit)	$1,065	$116	6.3%	$1,144

The second study was also conducted by PNNL, and it examined the cost differences resulting from moving to the ASHRAE Standard 90.1-2019 (2021 IECC) from the Standard 90.1-2016 edition (2018 IECC). The ASHRAE 90.1 standard is a compliance pathway in the commercial section of the IECC. This study demonstrated the incremental cost to build a mid-rise apartment building is **($0.46)/square foot**.

Results for Climate Zone 6 include results broken out by building type which are listed in Table 6. Each column represents results compared to the baseline 2016 ASHRAE Standard (which is referenced in the 2018 IECC).

Building Type	Square Footage Modeled in Building Prototype	Incremental Construction Cost for ASHRAE 2019 ($/sq ft)	Net Lifetime Cost Savings ($/sq ft) Publicly Owned Buildings	Net Lifetime Cost Savings ($/sq ft) Privately Owned Buildings	Annual Energy Cost Savings ($/sq ft)	Energy Cost Savings (%) for ASHRAE 2019
Mid-Rise Apartment	33,740	($0.46)	$2.27	$2.04	$0.03	2.3%

Table 6: Cost data for commercial buildings per building type resulting from upgrading to the 2019 ASHRAE Standard from the 2016 ASHRAE Standard.

Applying the cost per unit and cost per square foot associated with the two PNNL studies to the square footage and the number of units in the multifamily building modeled for this report, the following for incremental construction cost to build to the 2021 IECC over the 2015 IECC is estimated to be **$(9,194.94)-$14,910.**

Numbers in parentheses indicate negative values, which equate to a lower cost to build to the 2019 ASHRAE Standard as opposed to the 2016 ASHARE Standard. While this may seem counter-intuitive, the study suggests upfront cost savings could result from upgrading light fixtures from fluorescent to LED technology, the need for fewer light fixtures due to reduced allowed lighting power between the two code standards and smaller HVAC equipment sizing based on increased efficiency measures. It is also important to note that the two PNNL studies use different baseline energy codes for their analysis. The lower end of the incremental cost estimate comes from the comparison to the 2018 energy code, while the higher end of the incremental cost estimate comes from the comparison to the 2015 energy code.

2.1.4 Multifamily Energy Model: 2015 IECC Compared to 2021 IECC

To investigate the changes in operational cost and GHG emissions that would result from adopting the 2021 IECC, an energy model of a multifamily building was developed to compare a typical Eagle County multifamily complex built to the 2015 IECC and the 2021 IECC. The following multifamily building was modeled in the BEopt software:

- 19,989 square feet (average multifamily building size based on information from the Eagle County Assessor's office).
- 2 stories above-grade.
- Composed of 14 units and a conditioned corridor on each floor.

Multifamily buildings must comply with the commercial section of the IECC. The 2021 commercial IECC requires 10 credits in additional energy efficiency provisions on top of compliance with the base code. The efficiency packages selected for the 2021 multifamily model are as follows:

- C406.7.3 Efficient fossil fuel water heater.
- C406.3 Reduced lighting power.

See Appendix A for a full detailed list of the specifications made in BEopt to model the multifamily building for each code package.

2015 IECC Baseline and 2021 IECC Comparison

Energy Use

Compared to the 2015 IECC, a multifamily building constructed in compliance with the 2021 IECC base code results in a 12% decrease in energy use (Figure 4) due to a decrease in natural gas use. Electricity usage increases slightly between the 2015 and 2021 IECC due to the efficient fossil fuel water heater selected in the 2021 IECC model. A condensing water heater was selected for modeling. This type of water heater uses electricity to power the condensing fan, resulting in a slight increase in electricity consumption. An improvement in required furnace heater efficiency between the 2015 and 2021 IECC is responsible for most of the natural gas use reduction.

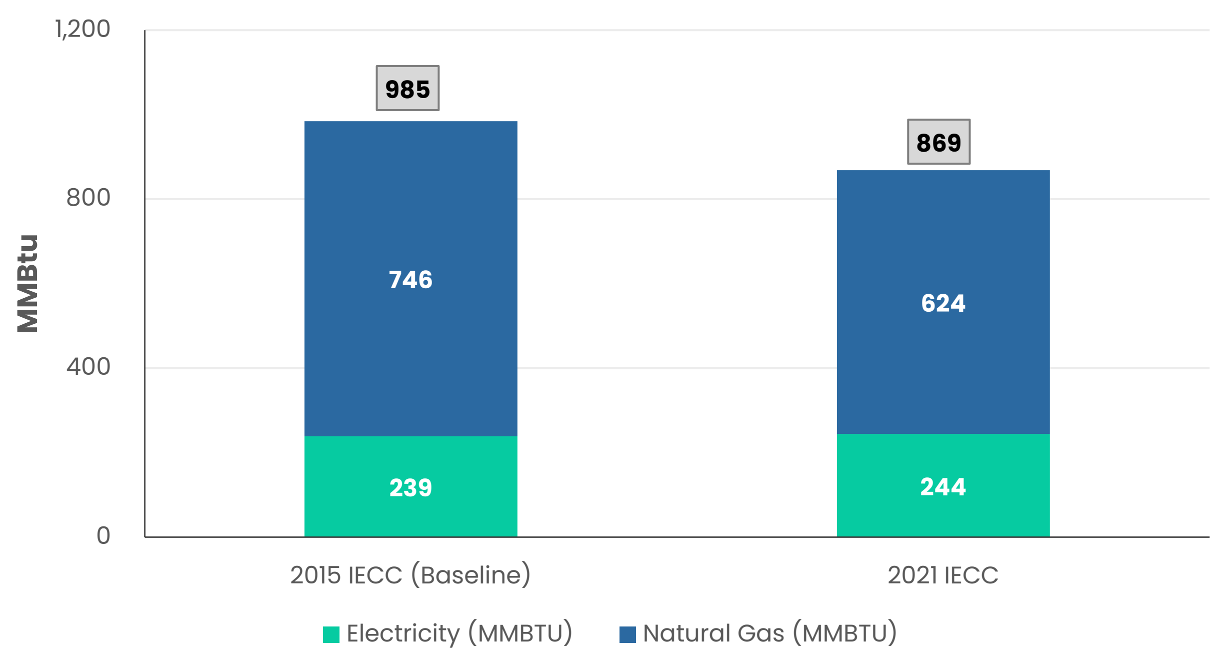

Figure 4: Comparison of multifamily building annual energy use between the 2015 IECC and the 2021 IECC.

Cost Savings

Total annual energy costs decrease by 7% between the 2015 and 2021 IECC (Figure 5). Overall, annual energy costs would decrease by $1,403 with the 2021 IECC. Over 40 years, the multifamily building would save $56,115 in energy costs with the 2021 IECC compared to the 2015 IECC.

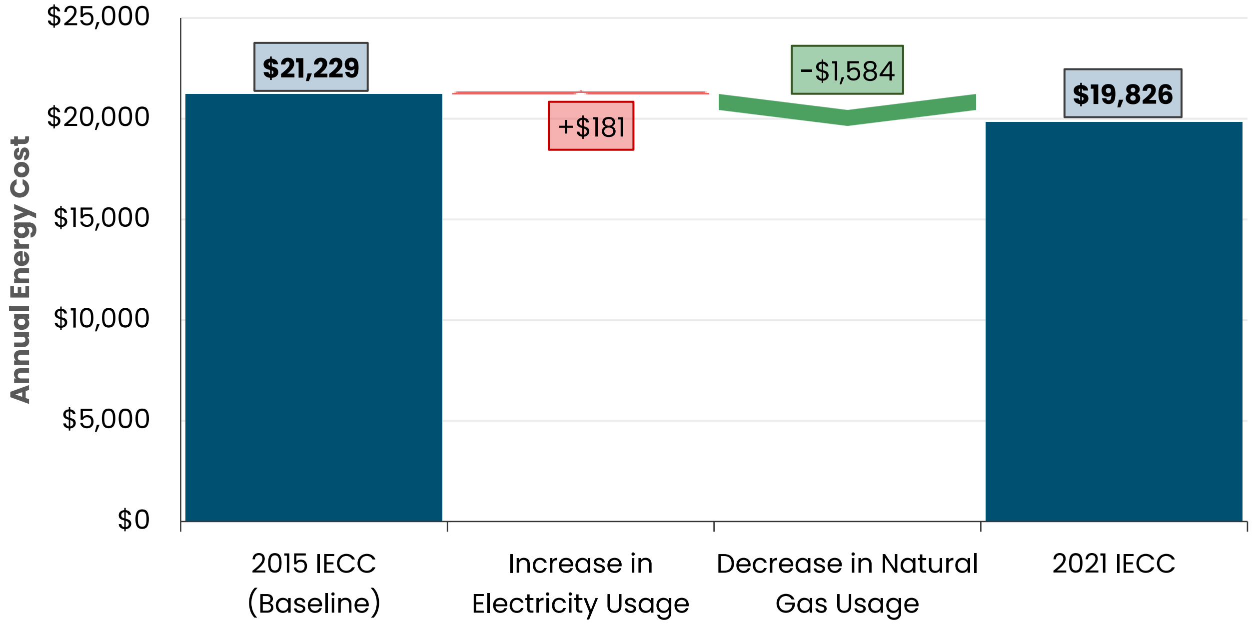

Figure 5: Cost savings breakdown of multifamily building annual energy costs between the 2015 IECC and the 2021 IECC.

GHG Emissions

The modeled multifamily building would produce 1,685 mt CO_2e over 40 years based on the 2015 IECC. The 2021 IECC provides a 15% decrease in GHG emissions (1,429 mt CO_2e, a decrease of 257 mt CO_2e) compared to the 2015 IECC (Figure 6). Reductions in natural gas use drive this difference between the two codes since electricity demand from the water heater condensing fan slightly increased overall electricity use.

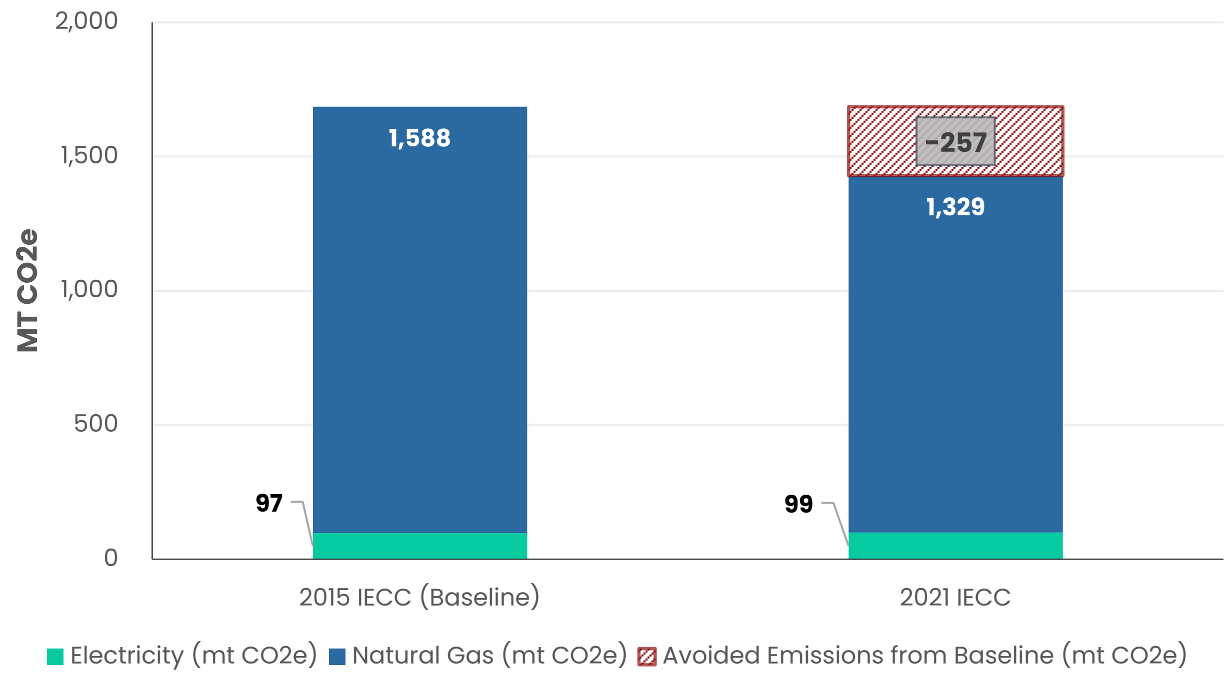

Figure 6: Comparison of cumulative 40-year GHG emissions from each code package for the multifamily building.

2.1.5 Upfront Cost of 2021 IECC for a Commercial Mixed-Use Building

Only one study was available that investigated the incremental cost to build to the 2021 energy code for commercial buildings. This study is the PNNL study referenced above, which examined the cost differences resulting from moving to the ASHRAE Standard 90.1-2019 (2021 IECC) from the Standard 90.1-2016 edition (2018 IECC), which is a compliance pathway in the commercial section of the IECC. Results for Climate Zone 6 include results broken out by building type which are listed in Table 7. Each column represents results compared to the baseline 2016 ASHRAE Standard (which is referenced in the 2018 IECC).

Building Type	Square Footage Modeled in Building Prototype	Incremental Construction Cost for ASHRAE 2019 ($/sq ft)	Net Lifetime Cost Savings ($/sq ft) Publicly Owned Buildings	Net Lifetime Cost Savings ($/sq ft) Privately Owned Buildings	Annual Energy Cost Savings ($/sq ft)	Energy Cost Savings (%) for ASHRAE 2019
Small Office	5,500	($1.66)	$3.76	$3.18	$0.04	5.7%
Large Office	498,640	($1.80)	$3.31	$2.72	$0.04	2.5%
Stand-Alone Retail	24,690	($1.28)	$3.76	$3.25	$0.06	5.9%

Primary School	73,970	($2.41)	$5.47	$4.62	$0.07	7.3%
Small Hotel	43,210	$0.65	$12.55	$12.12	$0.08	7.1%

Table 7: Cost data for commercial buildings per building type resulting from upgrading to the 2019 ASHRAE Standard from the 2016 ASHRAE Standard.

Applying the cost per square foot of the commercial building types to the square footage of the commercial building modeled for this report, the following for incremental construction cost to build to the 2021 IECC over the 2018 IECC is estimated to be a savings of **$(10,005)-$(7,714).**

As stated above, the numbers in parentheses indicate negative values, which equate to a lower cost to build to the 2019 ASHRAE Standard as opposed to the 2016 ASHARE Standard. The same rationale for the lower cost to build for multifamily applies to commercial buildings, including more efficient HVAC systems, and reduced lighting power densities, among others. The commercial building design is extremely variable, thus there may be other interactions between code updates and specific applications that also result in either upfront cost savings or higher upfront costs.

2.1.6 Commercial Energy Model: 2015 IECC Compared to 2021 IECC

To investigate the changes in operational cost and GHG emissions that would result from adopting the 2021 IECC, an energy model of a commercial building was developed to compare a typical Eagle County multifamily complex built to the IECC 2015 and the IECC 2021. The following commercial building was selected based on the average size and use of commercial buildings in Eagle County and was modeled using eQUEST:

- 6,027 square feet.
- 2 stories above grade.
- Composed of retail space on the ground floor and three multifamily units on the top floor.

The 2021 commercial IECC requires 10 credits in additional energy efficiency provisions on top of compliance with base code. Credits awarded for energy efficiency provisions differ between building occupancy types (i.e., the same energy efficiency strategy awards different number of credits to retail space compared to multifamily space). As the modeled commercial building includes retail and multifamily space, credits from additional energy efficiency provisions are weighted by the floor area of each occupancy type. The efficiency packages selected for the 2021 commercial model are as follows:

- C406.8 Enhanced envelope performance.

- C406.7.4 Efficient fossil fuel water heater (applies to the multifamily floor only).

See Appendix A for a full detailed list of the specifications made in eQUEST to model the commercial building for each code package.

2015 IECC Baseline and 2021 IECC Comparison

Energy Use

To account for differences in energy usage between the two occupancy types included in the mixed-use commercial building, several building components were specified separately for the retail and multifamily space. Occupancy, lighting, and fan schedules along with space-specific lighting power densities were included in the model for each occupancy type. Water heater capacities were also specified for the different spaces (i.e., the multifamily space requires more gallons of hot water per person than the retail space). Compared to the 2015 IECC, compliance with the 2021 IECC base code results in a 9% decrease in energy use (Figure 7), primarily due to decreases in natural gas consumption from improvements to the building envelope—leading to decreased energy need for heating and cooling—and higher efficiency water heaters.

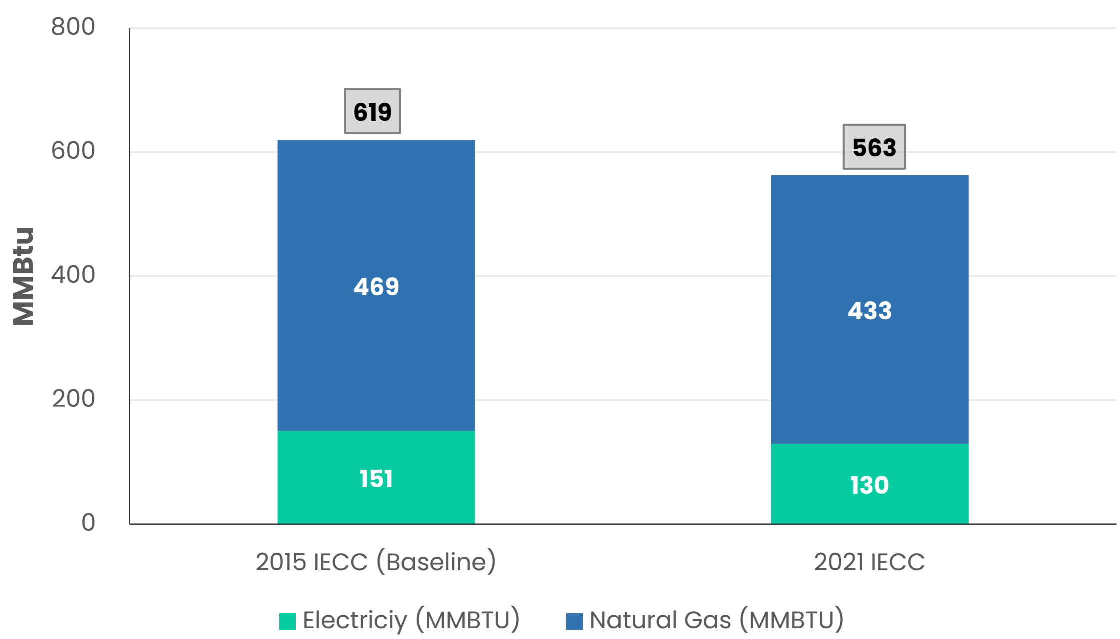

Figure 7: Comparison of commercial building annual energy use between the 2015 IECC and the 2021 IECC.

Cost Savings

Compliance with the 2021 IECC provides a 10% decrease in total annual energy costs compared to the 2015 IECC ($1,061 saved per year). The decrease in electricity used for lighting and the decrease in natural gas used for space and water heating are the primary drivers in this cost reduction. Over 40 years, the commercial building would save $42,440 compared to the 2015 IECC.

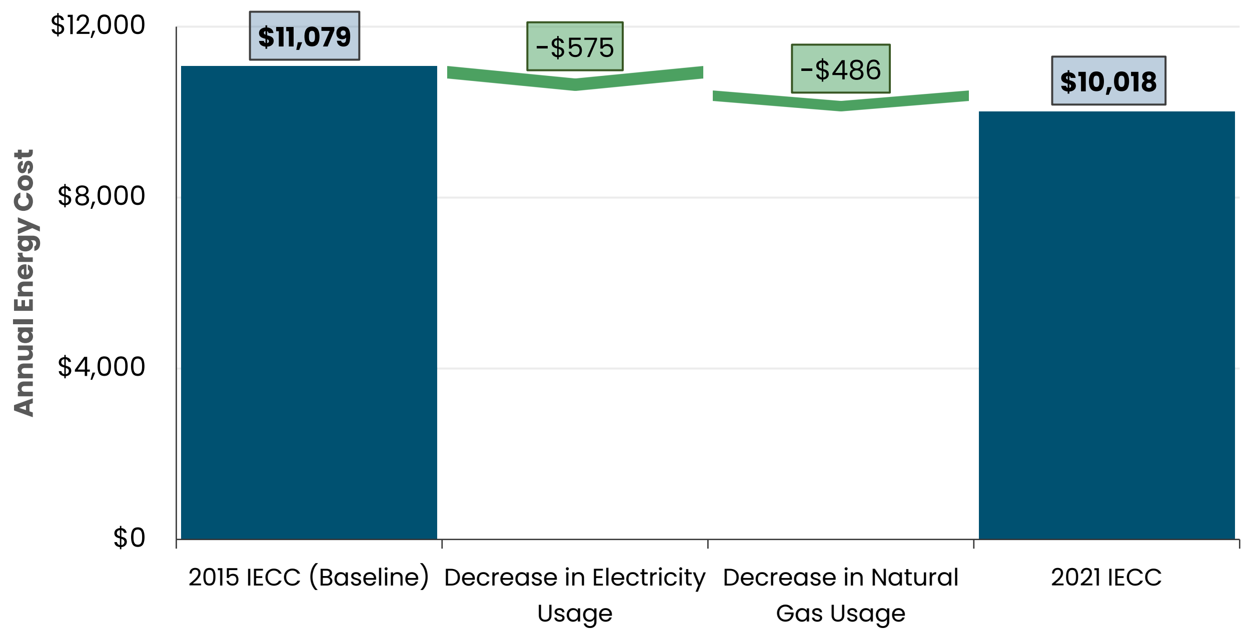

Figure 8: Cost savings breakdown of commercial building annual energy costs between the 2015 IECC and the 2021 IECC.

GHG Emissions

Over 40 years, the commercial building modeled to 2015 IECC standards would produce 1,060 mt CO_2e. Compliance with the 2021 IECC would reduce 40-year building emissions by 85 mt CO_2e, an 8% decrease (Figure 9). This reduction is primarily driven by natural gas savings from space and water heating. Given Holy Cross Energy's renewable energy goals, electricity savings from improved lighting efficiency have a limited impact on total building emissions compared to natural gas reductions.

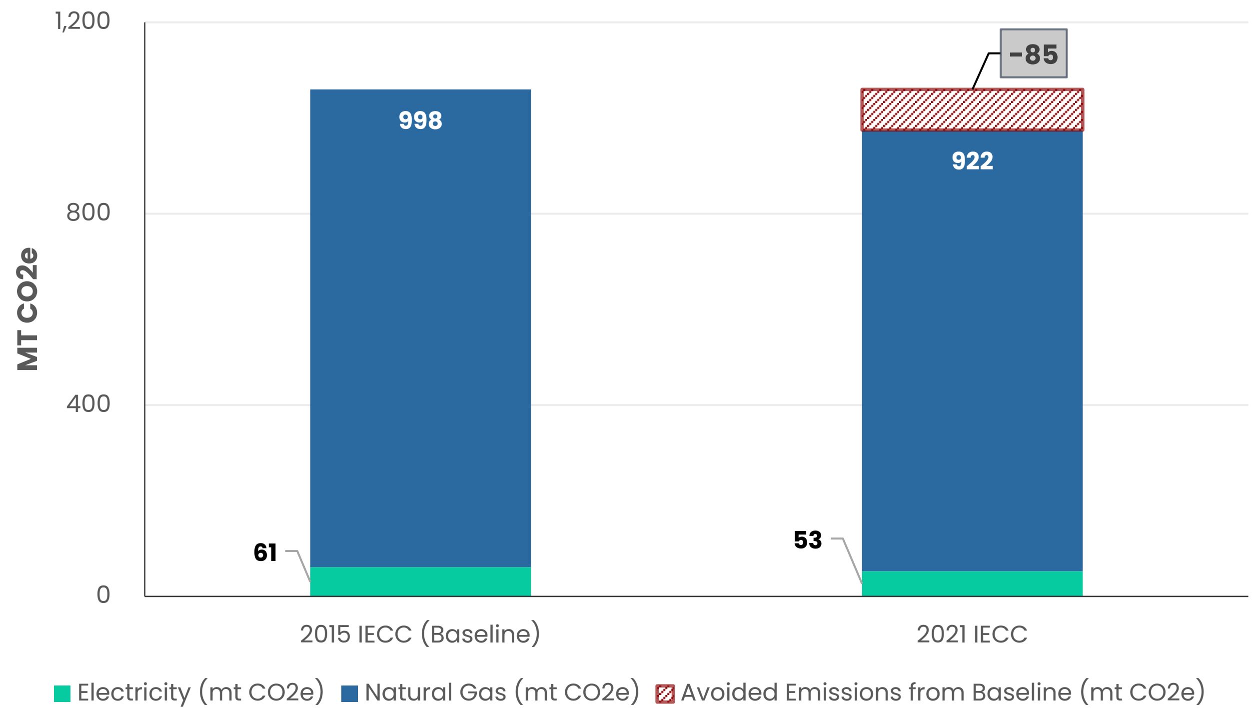

Figure 9: Comparison of cumulative 40-year GHG emissions between the 2015 IECC and 2021 IECC for the commercial building.

2.2 2021 IECC Electric-Ready Standard Compared to 2015 IECC

2.2.1 Upfront Cost of Electric-Readiness for All Building Types

Electric-readiness includes code provisions that prepare a building for an all-electric future by installing the necessary pre-wiring and panel capacity for space heating, water heating, clothes drying, and cooking appliances. Studies conducted by Utah Clean Energy (UCE) and Group14 (this study uses PNNL data) detail the upfront cost of building electric-ready new construction and costs for panel upgrades to existing buildings. Results are outlined in Table 8.

Authoring Entity	Assumptions / Methodology Notes	Upfront Cost for Single-Family Home (SFH)	Cost for Service Panel Upgrades for SFH	Upfront Cost for Medium-Sized Commercial Building	Cost For Service Panel Upgrades for Commercial Building
UCE	• Estimates based on a literature review and input from building experts in Utah.	$925	$2,300	$1,350 (low-rise multifamily)	$1,500 (low-rise multifamily)

Group14/ PNNL	• Single-family home: 2,820 square feet, 4 bedrooms.	$2,700	$3,342	Not available.	Not available.

Table 8: Upfront costs for electric-readiness provisions.

Electric-readiness is a future-proofing strategy used to avoid costly upgrades to new homes after they've been built. The Utah Clean Energy study estimates that the cost to retrofit an average single-family home in Utah with electric-ready infrastructure is 4.2 times (416%) the cost of including the same infrastructure in new construction. The estimated premium to retrofit a low-rise multifamily property is 2.7 times (267%) the new construction cost.

Additionally, electric-readiness does not require installation of all-electric equipment, thereby giving builders a choice of fuel use, but it is still an effective mechanism for ensuring cost is less of a deterrent when an occupant decides to move toward all-electric equipment and systems.

Note: electric-readiness infrastructure does not impact energy consumption, energy savings, or GHG emissions in a building. Therefore, the project team did not model each building type to an electric-ready standard. Any building built with electric-readiness infrastructure will yield the same energy performance results as the 2021 IECC energy modeling in Section 2.1.

2.3 2021 IECC Electric-Preferred Standard Compared to 2015 IECC

2.3.1 Upfront Cost of Electric-Preferred for All Building Types

Electric-preferred amendments build upon electric-readiness. This code package still allows for fuel choice but builders that opt to use natural gas must implement extra efficiency measures, in addition to being electric-ready. To comply with an electric-preferred code amendment, a builder has two choices. First is to build all-electric and the second is to build with natural gas and electricity. If a builder chooses to use natural gas along with electricity, they must implement additional efficiency measures. The additional efficiency requirements for an electric-preferred code can vary.[13] Typically, electric-preferred codes use the additional efficiency sections of the IECC 2021 code (Sections R408 and C406) to identify the additional efficiency measures a natural gas building must pursue, such as high-efficiency gas equipment or building envelope improvements.

[13] City of Denver and City of Louisville represent a range of electric-ready code language options. For the City of Denver, a building must implement additional efficiency measures totaling to 40 points (as outlined by Sections R408 and C406 in the 2021 IECC). In the City of Louisville, a building must simply install higher-efficiency gas equipment.

For the electric-preferred upfront cost analysis, additional costs are incurred from electric-ready infrastructure and the additional efficiency requirements. Costs for building all-electric, a compliance option under electric-preferred codes, are reviewed in Section 2.4.

Reports estimating the upfront cost impacts of electric-preferred are only available for single-family homes. These estimates come from the ICF report, referenced in Section 2.1.1, and cost modeling conducted by Group14 and PNNL.[14] There are currently no published studies that examine electric-preferred upfront or incremental costs for multifamily and commercial buildings.[15]

The cost for additional efficiency measures will vary depending on the additional efficiency package chosen. Note: For IECC 2021 base code compliance, all homes must select at least one of the additional efficiency package options from Section R408 of the IECC Residential provisions. A second efficiency package must be selected to comply with an electric-preferred standard. The efficiency package options for single-family homes include:

1) Enhanced building envelope.
2) Higher efficiency HVAC equipment.
3) Higher efficiency service-hot water heater.
4) More efficient duct thermal distribution system.
5) Improved air sealing and ventilation.

Modeling results from the ICF study detailing the incremental construction cost for each efficiency measure, relative to the 2018 IECC, are shown in Table 9. ICF opted not to model costs for enhanced building envelope, due to the variability of components that contribute to insulation and the complications that would add to modeling. However, it is important to consider that the upper range of costs could be higher if the enhanced building envelope scenario were modeled. An electric-preferred code would at minimum require single-family homes to implement at least two of the listed efficiency package options if they build with natural gas.

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[14] https://www.louisvilleco.gov/home/showdocument?id=34232&t=637814040411046672

[15] To be compliant with the base code, a building must select efficiency packages that add up to at least 10 points for their respective climate zone. In an electric-preferred code, buildings must earn more than 10 points if they build with natural gas and the additional points they must earn depend on the electric-preferred standard. For the full suite of options available for commercial buildings, refer to Section C406 Additional Efficiency Requirements in the 2021 IECC.

Additional Efficiency Option	Incremental Construction Cost	Energy Cost Savings
With higher efficiency HVAC option	$1,464	11.5%
With reduced energy-use water heater option	$870	4.5%
With improved air sealing and efficient ventilation option	$2,028	5.7%
With a more efficient duct thermal distribution system option, slab house	$926	10.6%

Table 9: Costs modeled by ICF for the 2021 IECC and additional efficiency options, relative to the 2018 IECC.

2.3.2 Single-Family Home Energy Model: 2021 IECC + Electric-Preferred Compared to 2015 IECC

To develop the energy model for the electric-preferred standard, the team selected two additional efficiency packages to model.

- R408.2.2 More efficient HVAC option.
- R408.2.4 More efficient duct thermal distribution system.

Energy Use

The 2021 IECC with electric-preferred code package complies with 2021 IECC base code and improves HVAC system and duct thermal distribution efficiency above the base requirements. The electric-preferred package would reduce annual energy use for a single-family home by 23% from the baseline and 16% from the 2021 IECC base code (Figure 10). The improvements to the HVAC and duct systems lead to minor electricity use reductions from cooling and ventilation and natural gas reductions from heating.

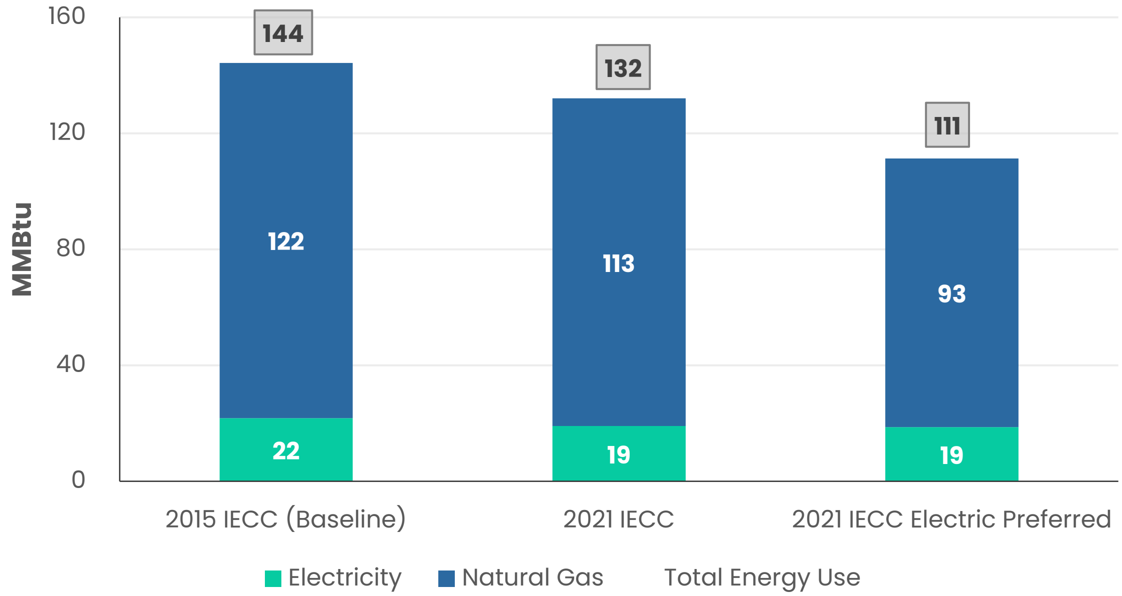

Figure 10: Comparison of single-family home annual energy use between the 2015 IECC and the 2021 IECC with electric-preferred provisions.

Cost Savings

Annual energy costs with the electric-preferred package would be $2,082, a 19% ($481.94) reduction in annual costs from the 2015 IECC baseline (Figure 11). Electric-preferred provisions would provide an additional $277 in savings per year over the 2021 IECC base code.

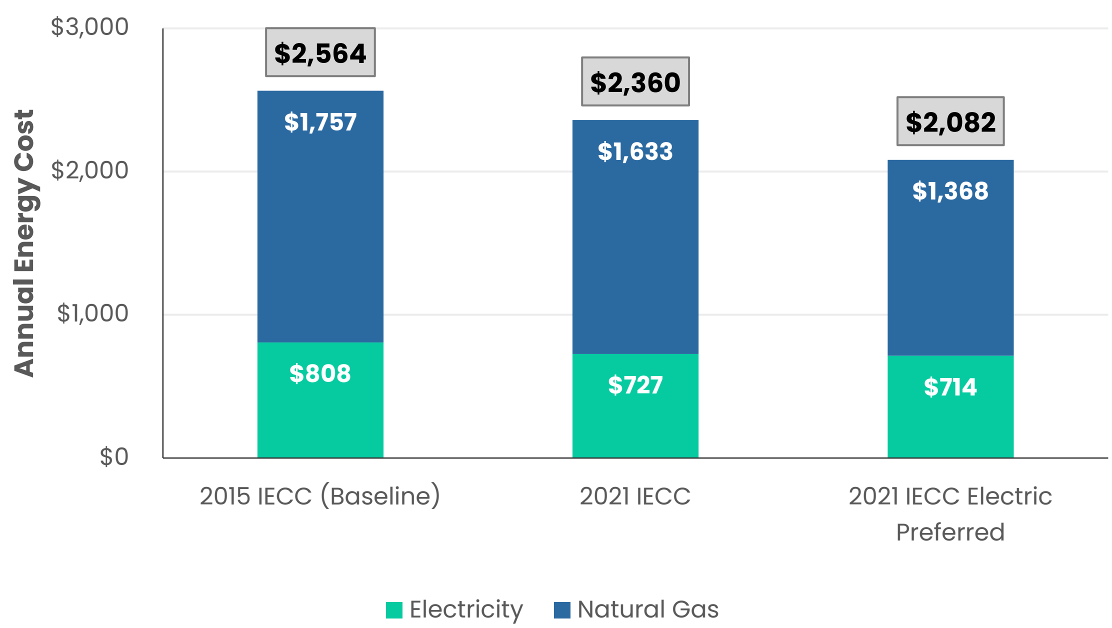

Figure 11: Comparison of single-family home annual energy costs between the 2015 IECC and the 2021 IECC with electric-preferred provisions.

As most of the energy savings from this code package are due to the decrease in natural gas usage, annual natural gas costs are $389 lower than the 2015 IECC baseline (Figure 12). The electric-preferred provisions would provide an additional $12 per year in electricity savings from the 2021 IECC base code ($81 saved from 2021 IECC and $93 from electric-preferred). Over 40 years, an average single-family home in Eagle County built to the 2021 IECC with electric-preferred provisions would save $19,277.60 compared to the 2015 IECC baseline.

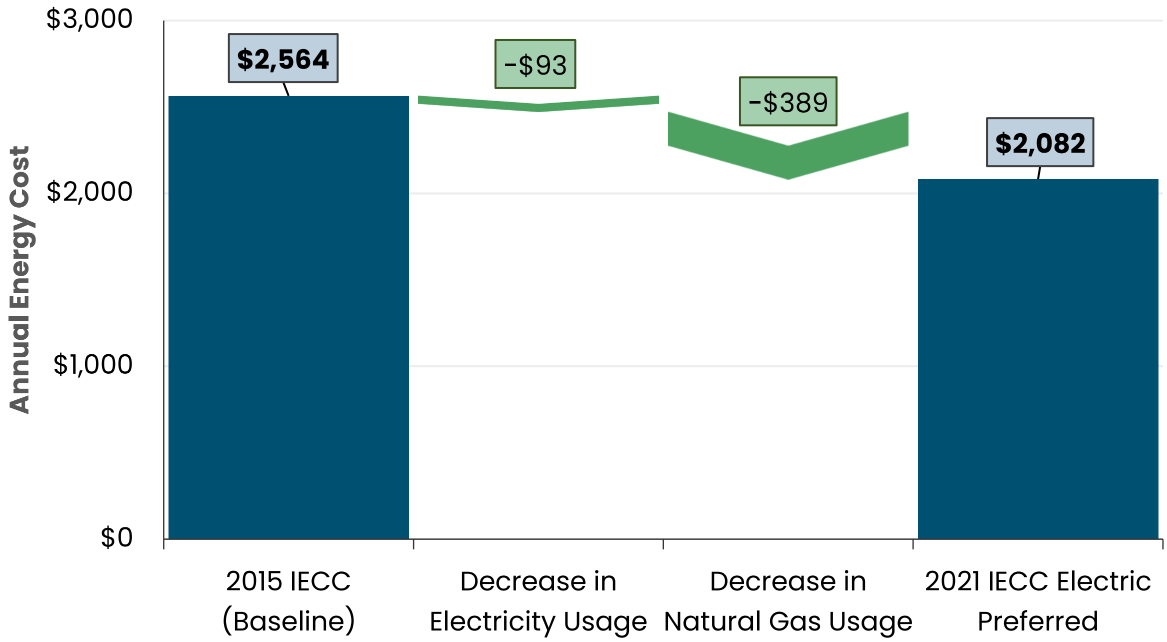

Figure 12: Cost savings breakdown of single-family home annual energy costs between the 2015 IECC and the 2021 IECC with electric-preferred provisions.

GHG Emissions

Over 40 years, a typical single-family home in Eagle County built to the 2021 IECC with electric-preferred provisions would produce 205 mt CO_2e, resulting in a 24% reduction from the 2015 IECC (Figure 13). There were minimal changes to equipment between the 2021 IECC and 2021 IECC electric-preferred code packages, so this reduction in emissions comes entirely from natural gas use reduction from more efficient HVAC and ducting systems that result in less energy use for heating. Efficiency improvements to ducting are primarily responsible for the energy, cost, and GHG emission savings from this code package.

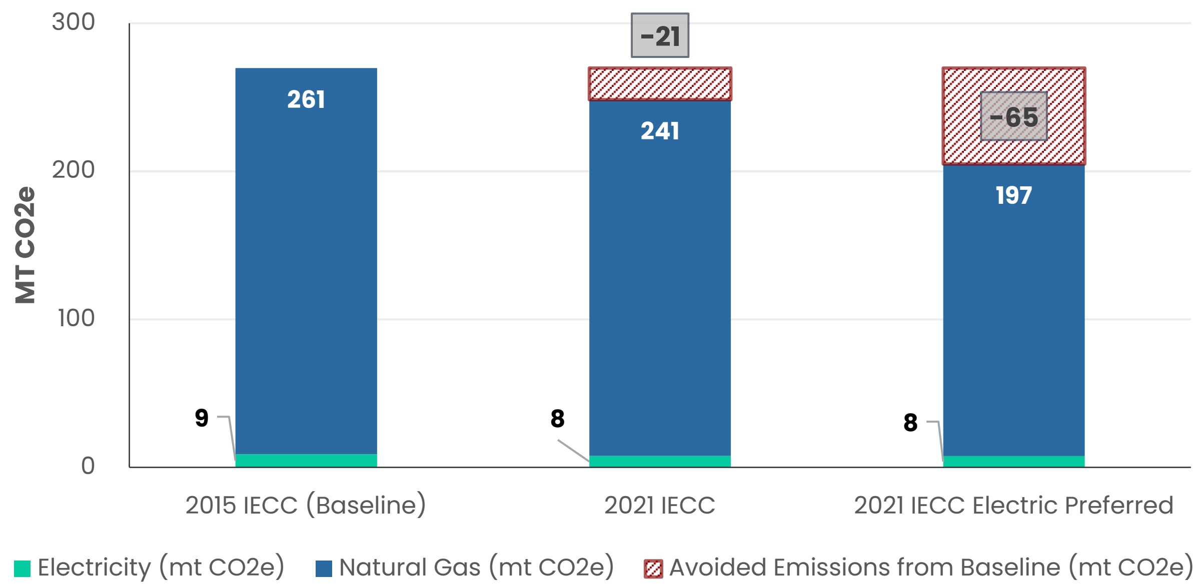

Figure 13: Comparison of single-family home 40-year GHG emissions between the 2015 IECC and the 2021 IECC with electric-preferred provisions.

2.3.3 Multifamily Building Energy Model: 2015 IECC Baseline and 2021 IECC + Electric-preferred Comparison

To develop the multifamily energy model for the electric-preferred standard, the team selected efficiency packages to model which total 20 points from the tables in the additional efficiency requirements in section C406.

- C406.7.3 Efficient fossil fuel water heater.
- C406.3 Reduced lighting power.
- C406.8 Enhanced envelope performance.
- C406.6 Dedicated outdoor air system.

Energy Use

The electric-preferred code package for multifamily also includes the efficient fossil fuel water heater and reduced lighting power provisions modeled in the 2021 IECC package. Additionally, a 15% improvement in building envelope performance and a dedicated outdoor air system were modeled for the electric-preferred package. These provisions reduce overall energy use by 22% compared to the 2015 IECC (Figure 14).

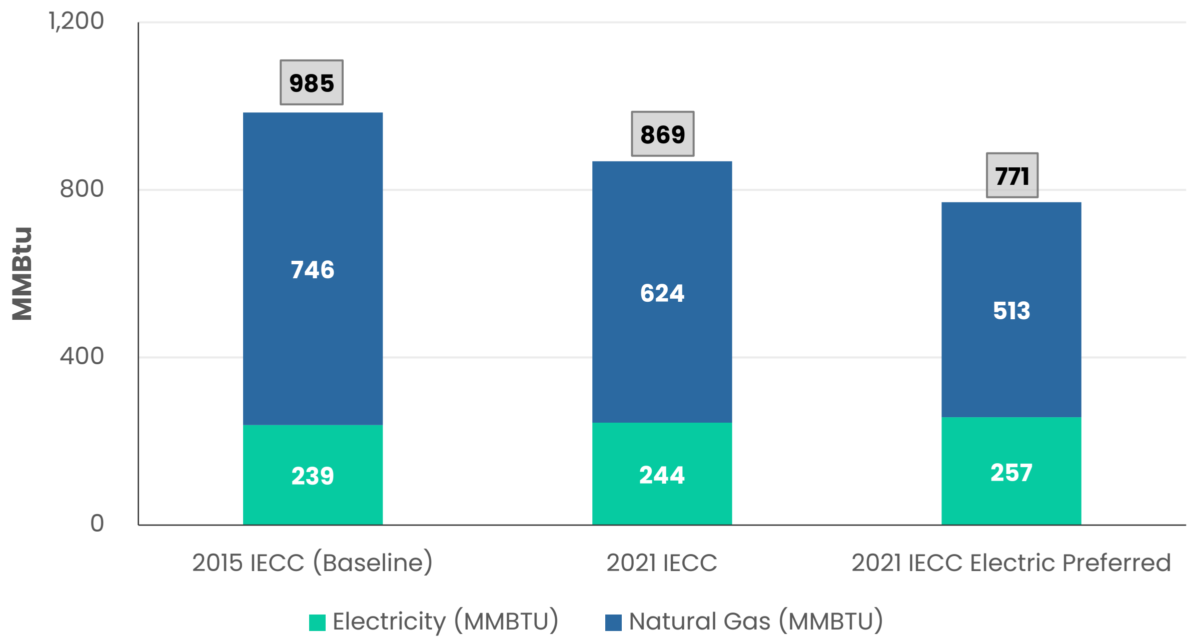

Figure 14: Comparison of multifamily annual energy use between the 2015 IECC and the 2021 IECC with electric-preferred provisions.

Electricity usage increased between the 2021 IECC and the 2021 IECC with electric-preferred provisions due to the dedicated outdoor air system included in the model. This system is required by the 2021 IECC to provide energy recovery, so an energy recovery ventilator (ERV) was included in the model. The ERV increased electricity use from ventilation but significantly decreased the natural gas used for space heating, resulting in an overall net reduction in energy use.

Cost Savings

Annual energy costs from the 2021 IECC with electric-preferred provisions total $18,782.68, resulting in a 12% reduction from the 2015 IECC (Figure 15). The additional efficiency provisions included in the electric-preferred package provide an additional $1,043.07 in annual savings on top of the 2021 IECC.

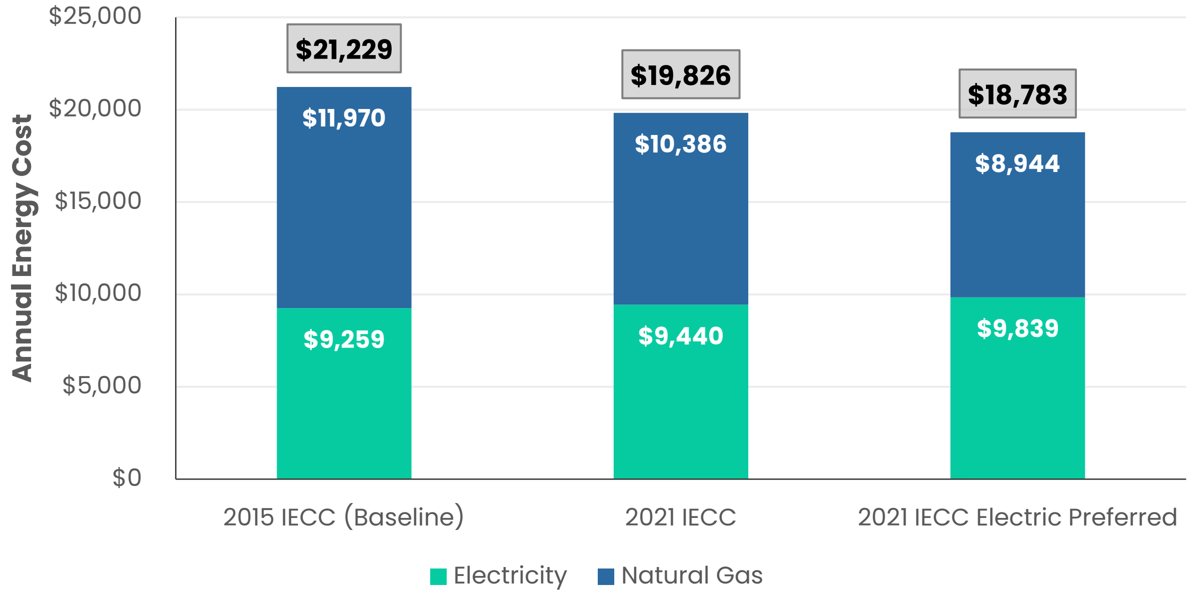

Figure 15: Comparison of multifamily annual energy costs between the 2015 IECC and the 2021 IECC with electric-preferred provisions.

This reduction is driven by the decrease in natural gas usage due to the ERV and the improved building envelope (Figure 16). Electricity costs increase due to the additional electricity consumed by the ERV and the tankless condensing water heater fan.

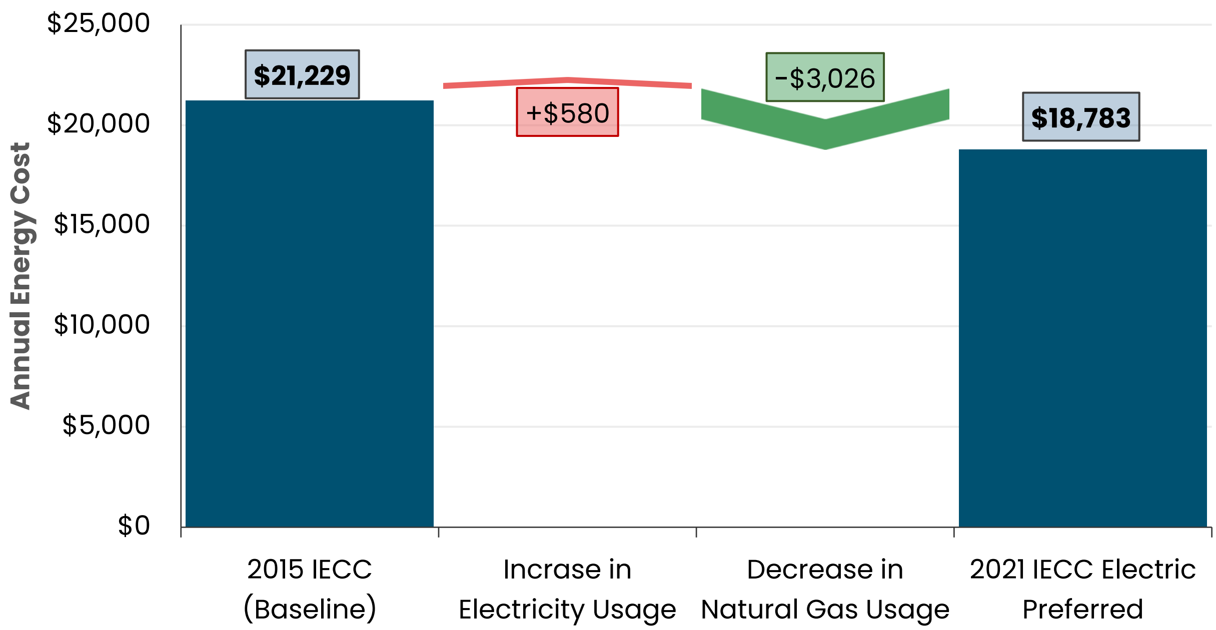

Figure 16: Cost savings breakdown of multifamily annual energy costs between the 2015 IECC and the 2021 IECC with electric-preferred provisions.

GHG Emissions

Over 40-years, the modeled multifamily building built to the 2021 IECC with electric-preferred provisions would produce 1,198 mt CO_2e, resulting in a 29% reduction from the 2015 IECC (Figure 17). The slight increase in electricity emissions is offset by the significant decrease in natural gas emissions.

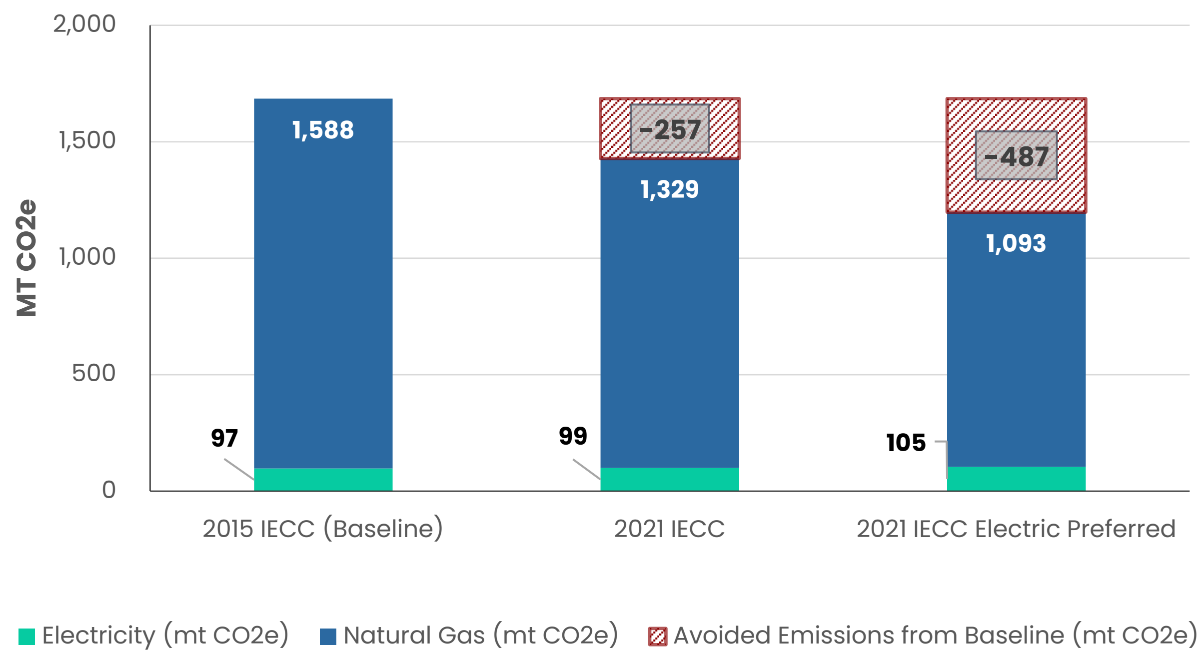

Figure 17: Comparison of cumulative 40-year GHG emissions from each code package for a multifamily building.

2.3.4 Commercial Building Energy Model: 2015 IECC Baseline and 2021 IECC + Electric-preferred Comparison

To develop the commercial energy model for the electric-preferred standard, the team selected efficiency packages to model which total 20 points from the tables in the additional efficiency requirements in section C406.

- C406.8 Enhanced envelope performance.
- C406.7.3 Efficient fossil fuel water heater.
- C406.2 More efficient HVAC equipment performance.
  - 10% Heating efficiency improvement.
  - 10% Cooling efficiency improvement.
- C406.3 Reduced lighting power.

Energy Use

The 2021 IECC with electric-preferred provisions includes additional energy efficiency measures in addition to the measures needed for 2021 IECC base code compliance. The additional measures selected for the electric-preferred package for the modeled commercial building include 10% efficiency improvements in HVAC equipment performance and reduced lighting power. These additional measures reduce energy usage by an additional 12.5% from the 2021 IECC base code and a total of 21% from the 2015 IECC (Figure 18). HVAC efficiency improvements provide significant energy savings as space heating is the largest end use of energy for the modeled building.

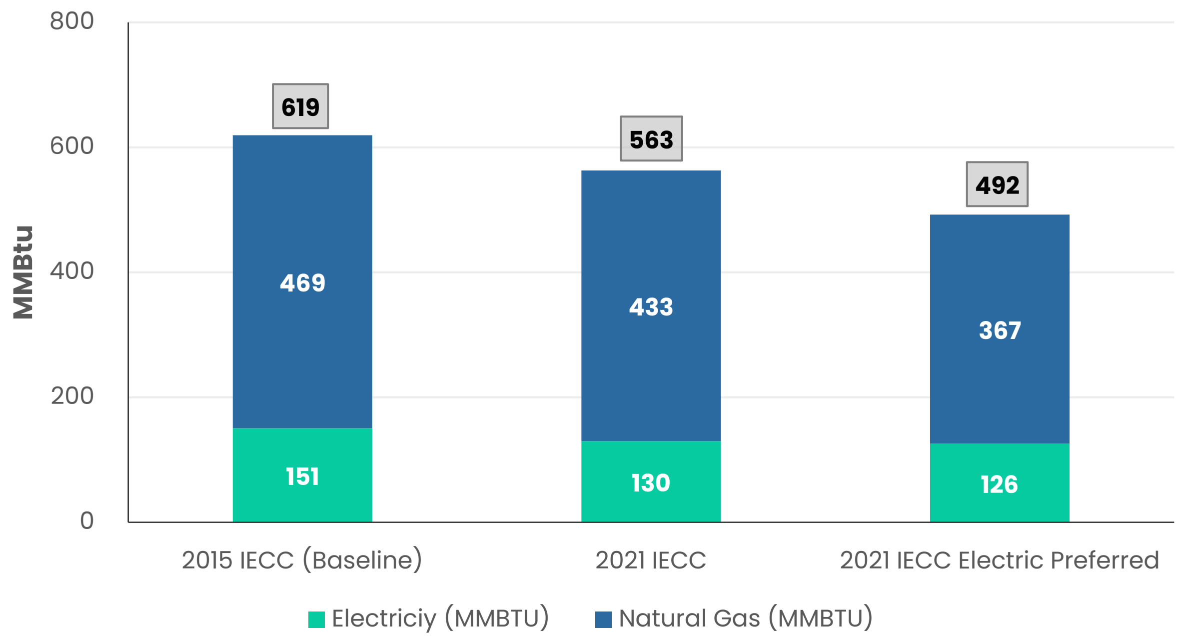

Figure 18: Comparison of commercial building annual energy use between the 2015 IECC and the 2021 IECC with electric-preferred provisions.

Cost Savings

Annual energy costs with the 2021 IECC electric-preferred code package are 19% lower than energy costs with the 2015 IECC. The electric-preferred provisions provide an additional $1,016 in savings compared to the 2021 IECC base code package (Figure 19). Over 40 years, the commercial building would save $83,080 in energy costs compared to the 2015 IECC.

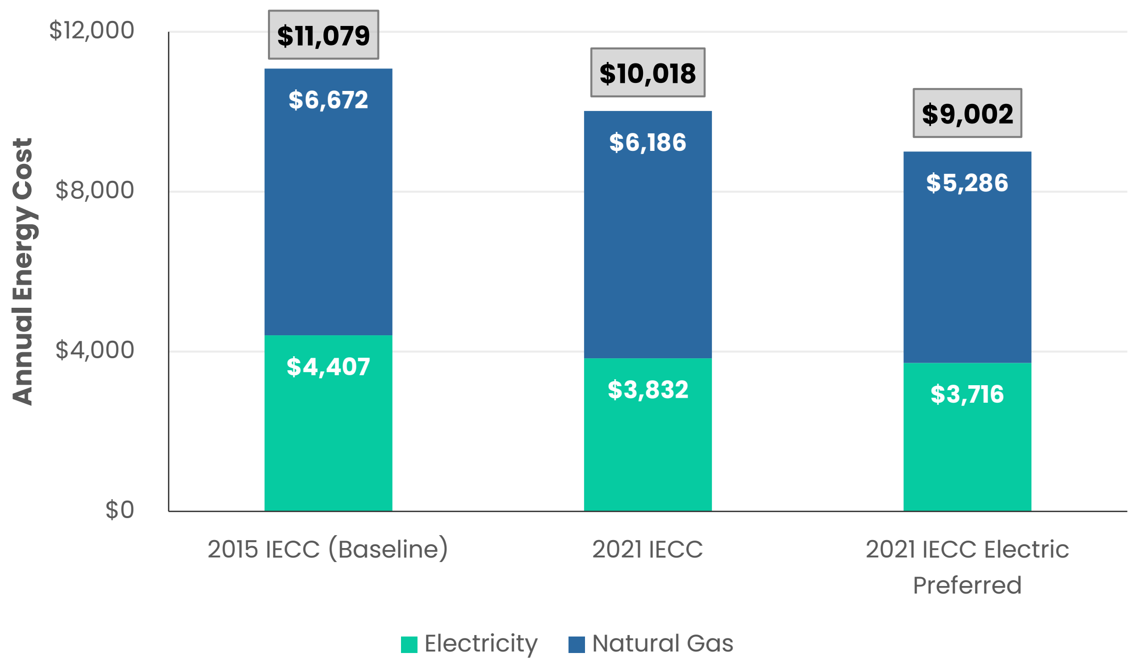

Figure 19: Comparison of commercial building annual energy costs between the 2015 IECC and the 2021 IECC with electric-preferred provisions.

Natural gas cost savings make up 67% of total energy cost savings for the building. (Figure 20).

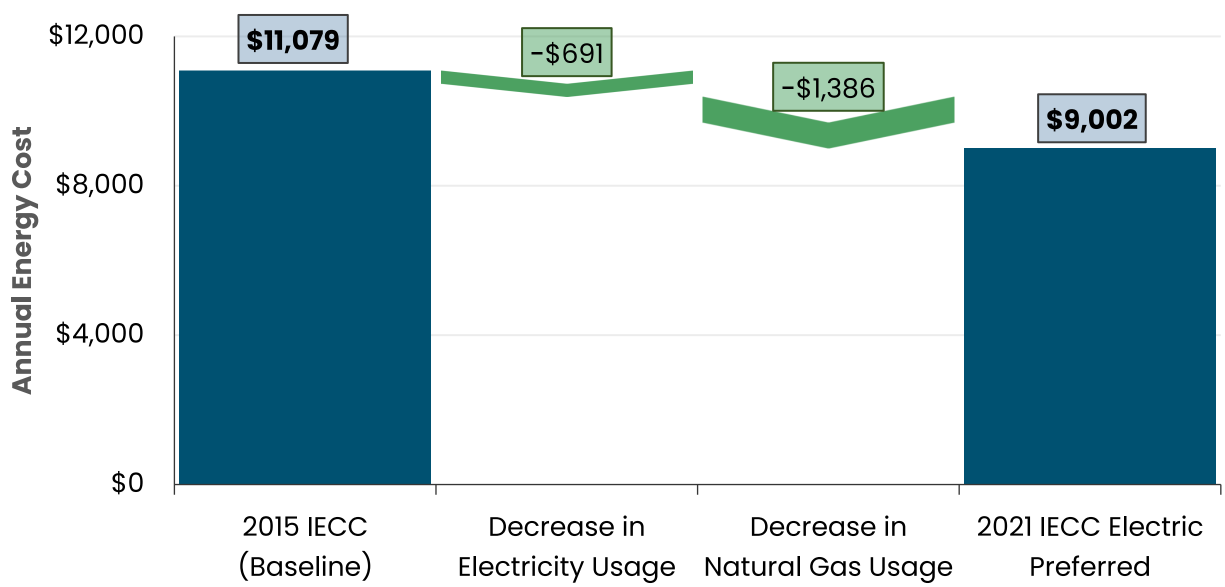

Figure 20: Cost savings breakdown of commercial building annual energy costs between the 2015 IECC and the 2021 IECC with electric-preferred provisions.

GHG Emissions

The electric-preferred provisions provide an additional 143 mt CO_2e in emissions reductions over 40 years for the commercial building compared to the 2021 IECC base code package. The electric-preferred scenario leads to a total of 228 mt CO_2e in reductions from the 2015 IECC (Figure 21). Electricity emissions decrease by 2 mt CO_2e and natural gas emissions decrease by 141 mt CO_2e from the 2021 IECC base code.

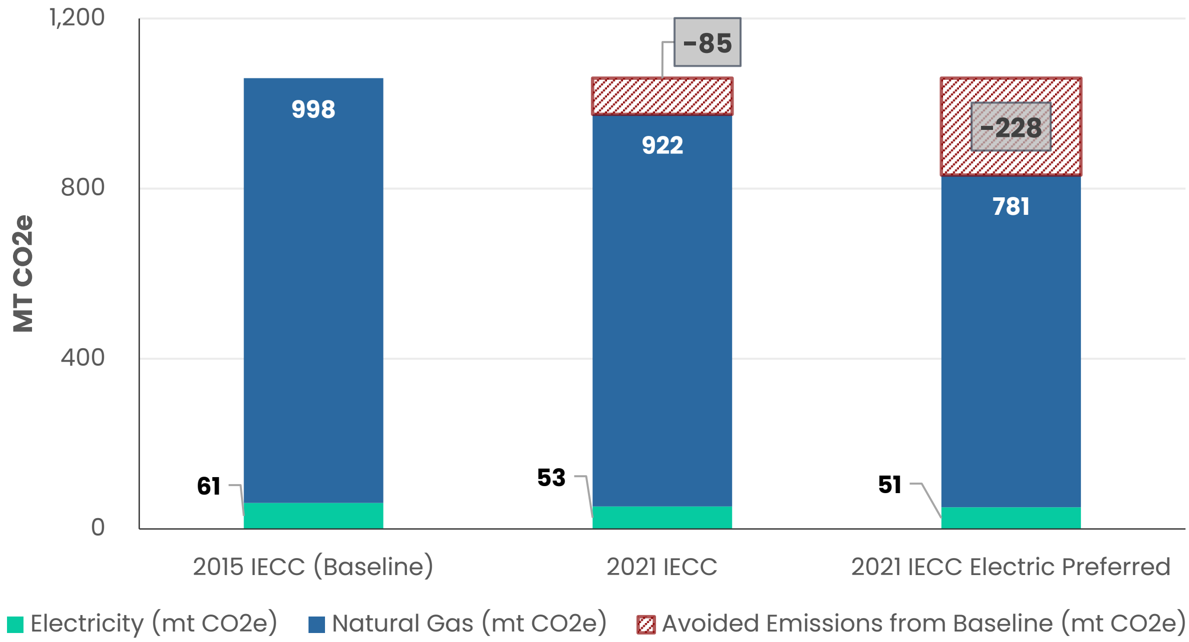

Figure 21: Comparison of commercial building 40-year GHG emissions between the 2015 IECC and the 2021 IECC with electric-preferred provisions.

2.4 2021 IECC All-Electric Standard Compared to 2015 IECC

2.4.1 Upfront Cost of All-Electric Construction for All Building Types

Lotus worked with David Petroy, an energy consultant, to look at data relevant to Eagle County for heating system costs to understand the cost difference between typical all-electric and natural gas HVAC systems. David continuously tracks current equipment pricing, and using his database, he was able to determine incremental installation costs of an all-electric heating system compared to a natural gas system in a single-family home and a multifamily building (Table 10).

Building Type	Assumptions and Heating Systems	Incremental Installation Cost for All-Electric System Compared to a Natural Gas System
Single-family home	• 2000-2500 sq ft • **Electric system:** Ducted 4-ton cold climate heat pump system with integrated 10kW electrical heater • **Gas system:** Fully ducted 96% two-speed furnace and 18+ SEER, 3-ton AC system	$4,000 - $6,000
Multifamily building	• 1,318 sq ft per unit • **Electric system:** Ducted 3-ton cold climate heat pump system with integrated 10kW electrical heater • **Gas system:** Fully ducted 96% two-speed furnace and 18+ SEER, 2.5 ton AC system	$3,000 - $5,000

Table 10: Incremental installation costs of an all-electric heating system vs. a natural gas heating system, for single-family and multifamily buildings.

Before rebates are applied, the cold climate heat pump system costs more than the gas furnace and AC system. However, in both building types, the cost of the all-electric heating system is lower than the natural gas system when rebates and tax incentives are applied. Holy Cross Energy customers may apply for $4,000 (25% rebate) for a new heat pump beginning in 2023. In addition, Colorado provides a 10% income tax credit for the purchase and installation of heat pump systems.

Further cost savings can be found in all-electric new construction by avoiding the piping needed to bring gas into the home. In a study conducted by Southwest Energy Efficiency Project (SWEEP) in 2022, savings of $2,500-$5,000 from not installing the gas lines in new single-family home developments are reported.[16]

A modeling study conducted by Group14 in November 2020 evaluated the economics of electrifying commercial buildings in Colorado. The study utilized equipment cost insights from Denver-based contractors and these estimates have likely changed as of the time of writing for this report (September 2022). Assumptions used for office building modeling and the cost analysis results are outlined in Table 11. Avoiding natural gas infrastructure (gas connections and piping) in the office building modeled saved $21,000, contributing to the net negative incremental installation cost for an all-electric system, as compared to a natural gas system (Table 11).

[16] https://www.swenergy.org/pubs/heat-pump-study-2022

Building Type	Assumptions	Incremental Installation Cost for All-Electric System Compared to a Natural Gas System
Office Building	• Located in Lakewood, CO • 28,000 sq ft • Costs include heat pump, a heat pump water heater, and electrical modifications.	($18,100)

Table 11: Total equipment costs for new construction of an office building with all-electric systems vs. natural gas systems.

2.4.2 Single-Family Home Energy Model: 2021 IECC + All-Electric Compared to 2015 IECC

To develop the single-family home model for the all-electric standard, the team selected one additional efficiency package for base code compliance that was specific to all-electric construction.

- R408.2.2 More efficient HVAC option (all-electric).

Energy Use

The 2021 IECC all-electric code provides the greatest reduction in energy use out of all code packages for a single-family home and reduces energy use from the 2015 IECC baseline by 53% (Figure 22). The improvement in efficiency from switching from natural gas to all-electric equipment allows a typical home to operate on much less overall energy. The all-electric option reduces energy use by 39% from the 2021 IECC electric-preferred package.

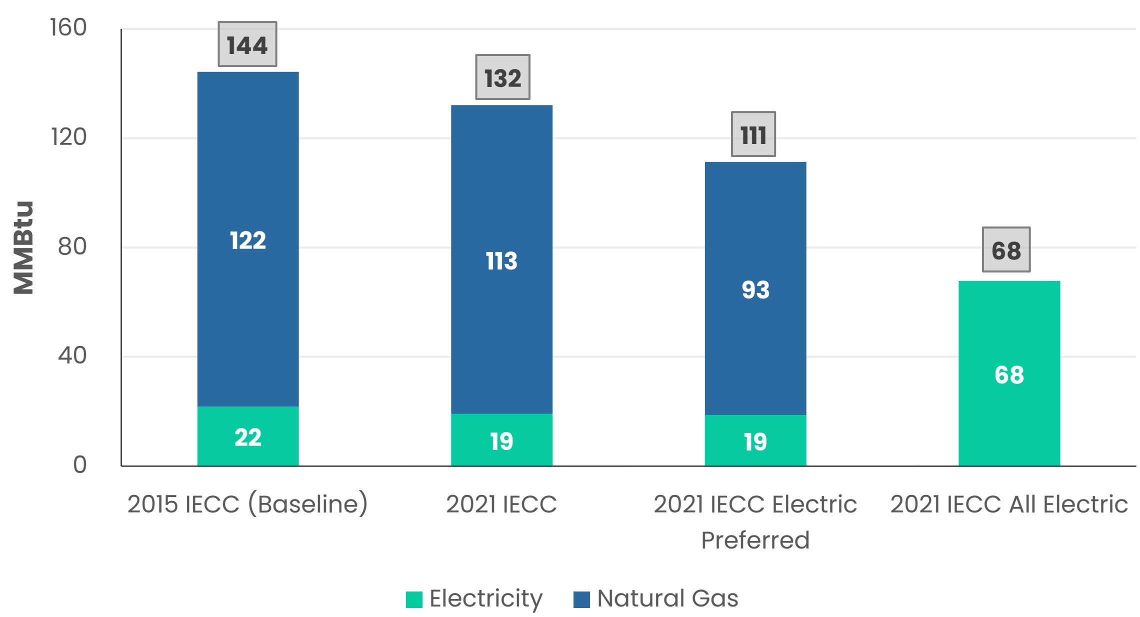

Figure 22: Comparison of single-family home annual energy use between all code packages.

Cost Savings

A single-family home built to the 2021 IECC all-electric code package would save $338 per year in energy costs compared to the 2015 IECC (Figure 23). Energy costs with the all-electric package are $144 higher per year compared to the electric-preferred scenario. This growth in energy costs is due the significant increase in electricity consumption needed to support all-electric appliances, an air source heat pump, and a heat pump water heater. Additionally, the electric preferred scenario included HVAC ducts in conditioned space while the all-electric scenario does not, increasing heating and cooling energy consumption. Over 40 years, this code package would save $13,525 in energy costs compared to the 2015 IECC.

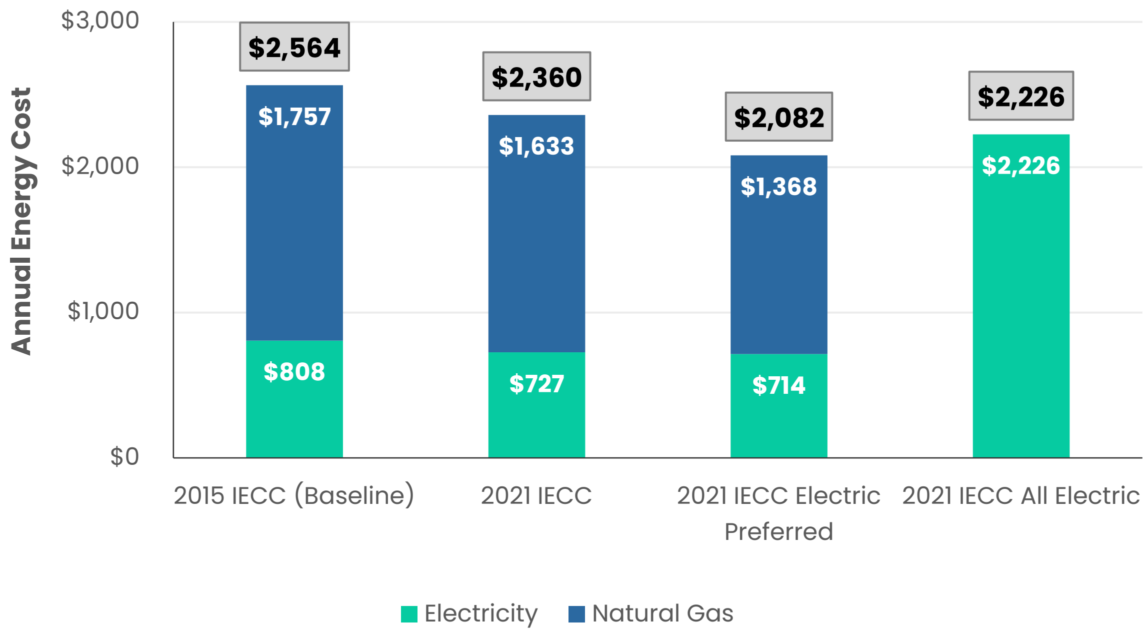

Figure 23: Comparison of single-family home annual energy costs all code packages.

The all-electric code package removes all natural gas costs ($1,757 per year with the 2015 IECC) and increases electricity costs by $1,418 per year. Changes in electricity costs due to cheaper renewable energy or other fluctuations are not captured in this analysis. Energy cost savings from the all-electric code package have the potential to be even greater if electricity costs become cheaper.

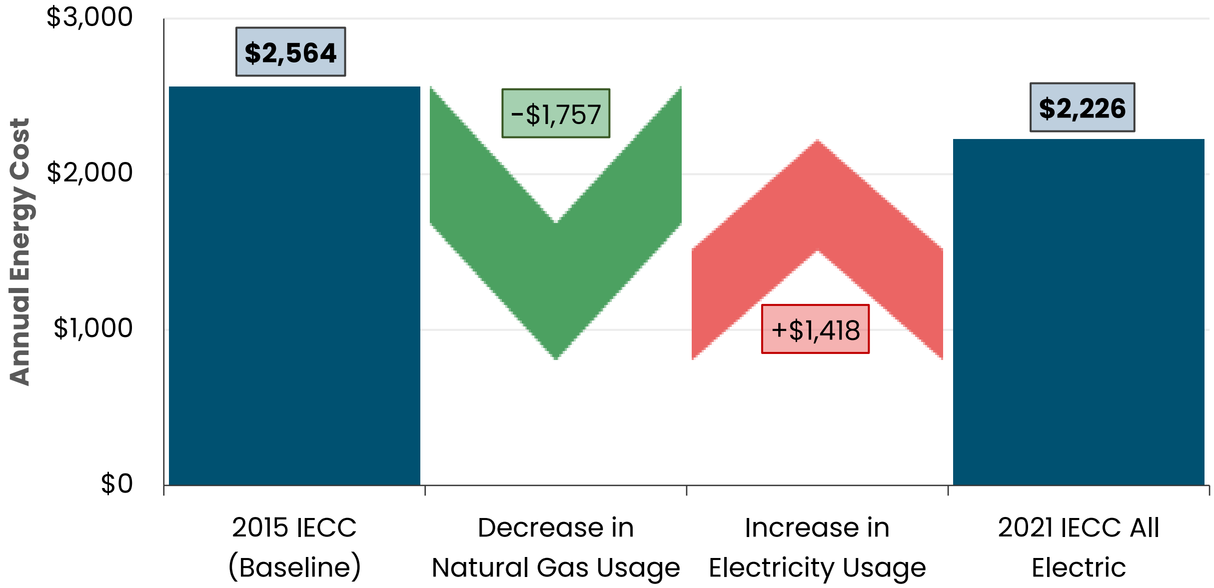

Figure 24: Cost savings breakdown of single-family home annual energy costs between the 2015 IECC and the 2021 IECC with all-electric provisions.

GHG Emissions

The all-electric code package provides the greatest GHG emissions reductions compared to the 2015 IECC. With no natural gas usage and a 100% renewable electric grid in 2030, an average single-family home in Eagle County built to the 2021 IECC all-electric code would produce 28 mt CO_2e over 40 years (Figure 25). This code package would avoid 242 mt CO_2e compared to the 2015 IECC, which equates to a 90% emissions reduction from the 2015 IECC. This highlights how building electrification paired with renewable energy is a powerful strategy for reducing GHG emissions.

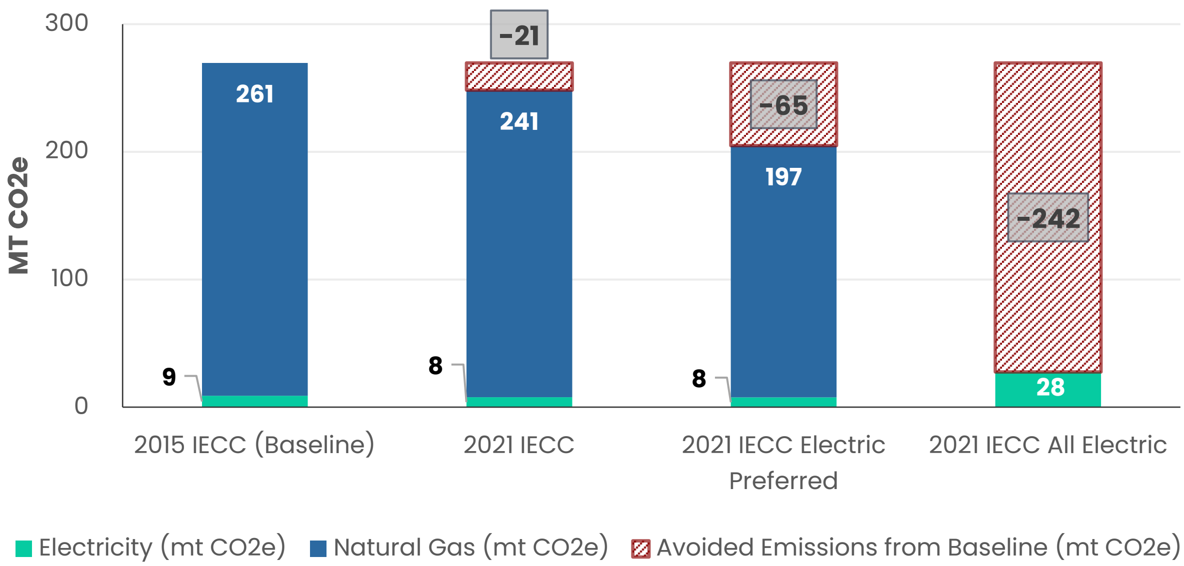

Figure 25: Comparison of cumulative 40-year GHG emissions from each code package for a single-family home.

2.4.3 Multifamily Building Energy Model: 2015 IECC Baseline and 2021 IECC + All-Electric Comparison

To develop the multifamily energy model for the all-electric standard, the team selected efficiency packages to model which total 10 points in the tables in additional efficiency requirements in section C406, for base code compliance, and reflect all-electric construction.

- C406.3 Reduced lighting power.
- C406.8 Enhanced envelope performance.
- C406.7.4 Heat pump water heater.

Energy Use

The all-electric option for the multifamily building includes the building envelope improvement and reduced lighting power additional efficiency provisions. Additionally, it includes air source heat pumps, a heat pump water heater, and all-electric appliances. The all-electric code package provides the modeled multifamily building with the greatest reduction in energy use out of all code packages, with a 46% decrease from the 2015 IECC (Figure 26).

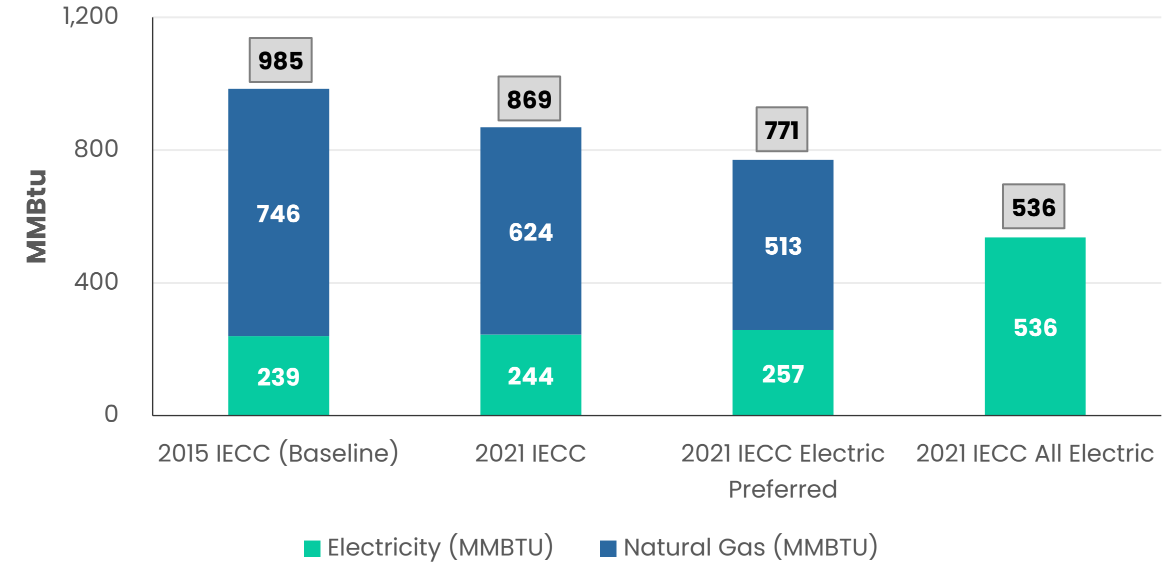

Figure 26: Comparison of multifamily annual energy use between all code packages.

Cost Savings

Annual energy costs with the all-electric code package are only slightly lower than energy costs with the electric-preferred code package. This is due to the significant increase in electricity usage due to switching all equipment away from natural gas. Heating, hot water, and appliances consume the most electricity for the multifamily building with the all-electric code package. Overall energy costs with the all-electric package decreased by 15% from the 2015 IECC (Figure 27).

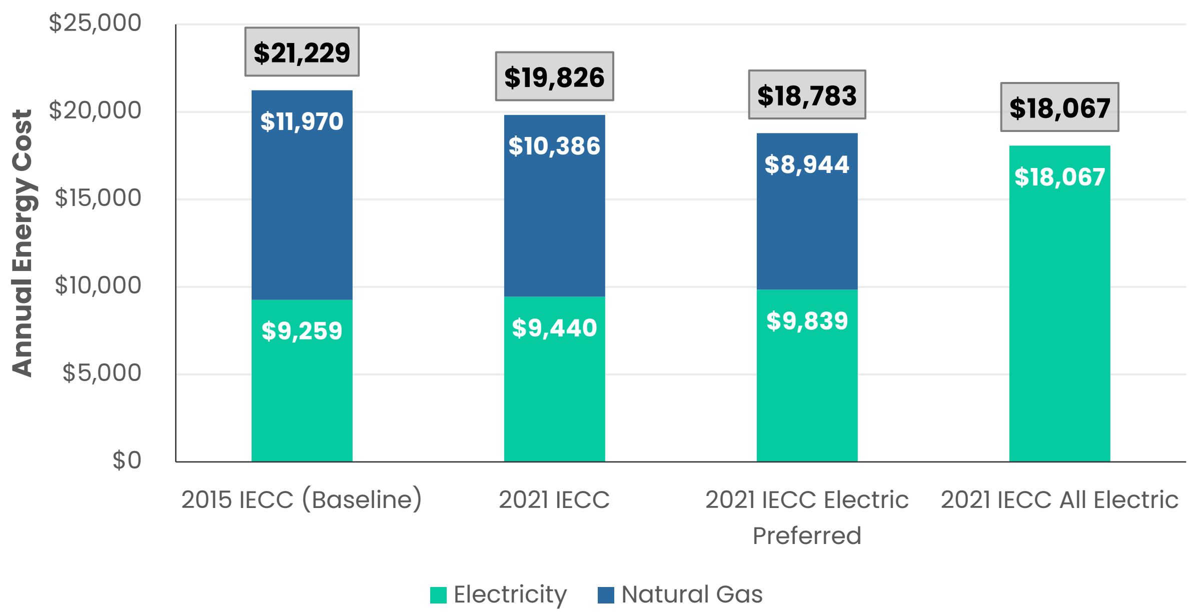

Figure 27: Comparison of multifamily annual energy costs for all code packages.

Replacement of all natural gas appliances and equipment reduces annual energy costs by $11,970. The electricity needed to power the electric equipment is modeled to cost $8,808 per year (Figure 28). Over 40 years, the modeled multifamily building built to the all-electric code package would save $126,458 in energy costs.

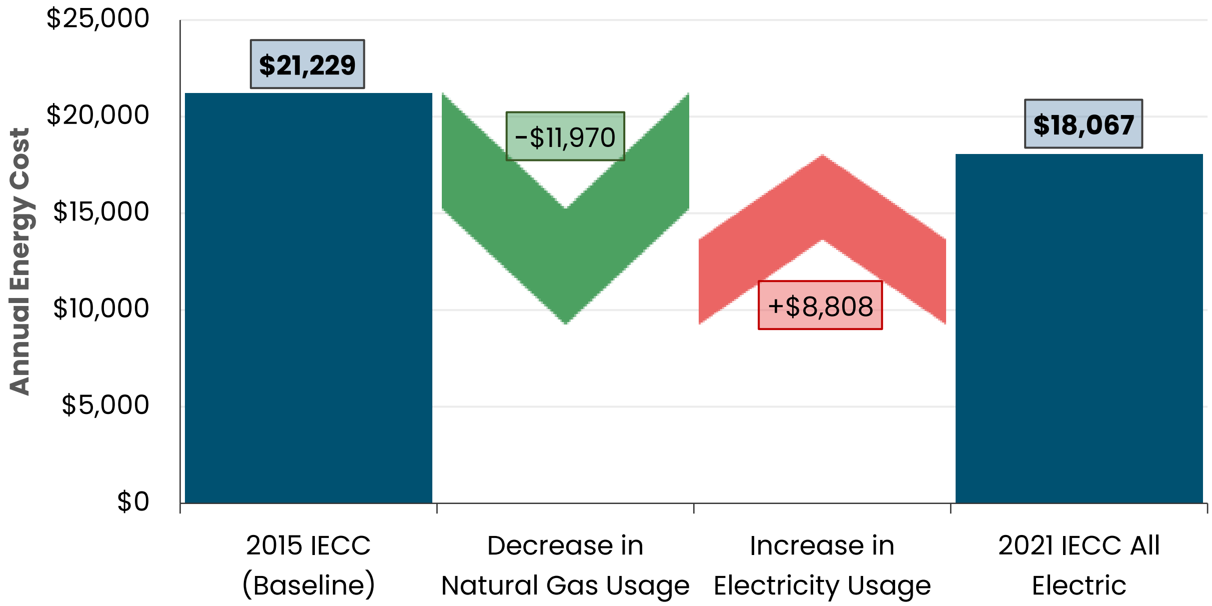

Figure 28: Cost savings breakdown of multifamily annual energy costs between the 2015 IECC and the 2021 IECC with all-electric provisions.

GHG Emissions

The modeled multifamily building built to the 2021 IECC with all-electric provisions would produce 218 mt CO_2e over 40 years. This is an 87% reduction from the 2015 IECC (Figure 29).

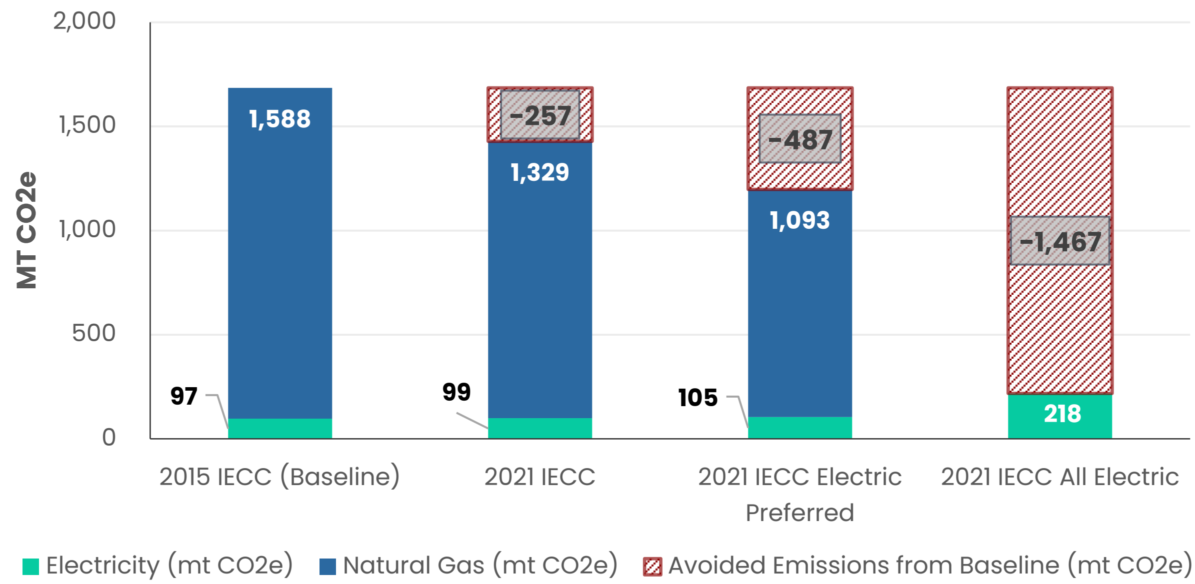

Figure 29: Comparison of cumulative 40-year GHG emissions from each code package for the multifamily building.

2.4.4 Commercial Building: 2015 IECC Baseline and 2021 IECC + All-electric

To develop the commercial energy model for the all-electric standard, the team selected efficiency packages to model which total 10 points in the tables in additional efficiency requirements in section C406, for base code compliance, and reflect all-electric construction.

- C406.3 Reduced lighting power.
- C406.8 Enhanced envelope performance.

Energy Use

The 2021 IECC all-electric code package provides the greatest reduction in energy use in the modeled commercial building compared to the 2015 IECC, resulting in a decrease of 54% (Figure 30). Electricity energy consumption increased by 89% between the all-electric package and the 2015 IECC baseline.

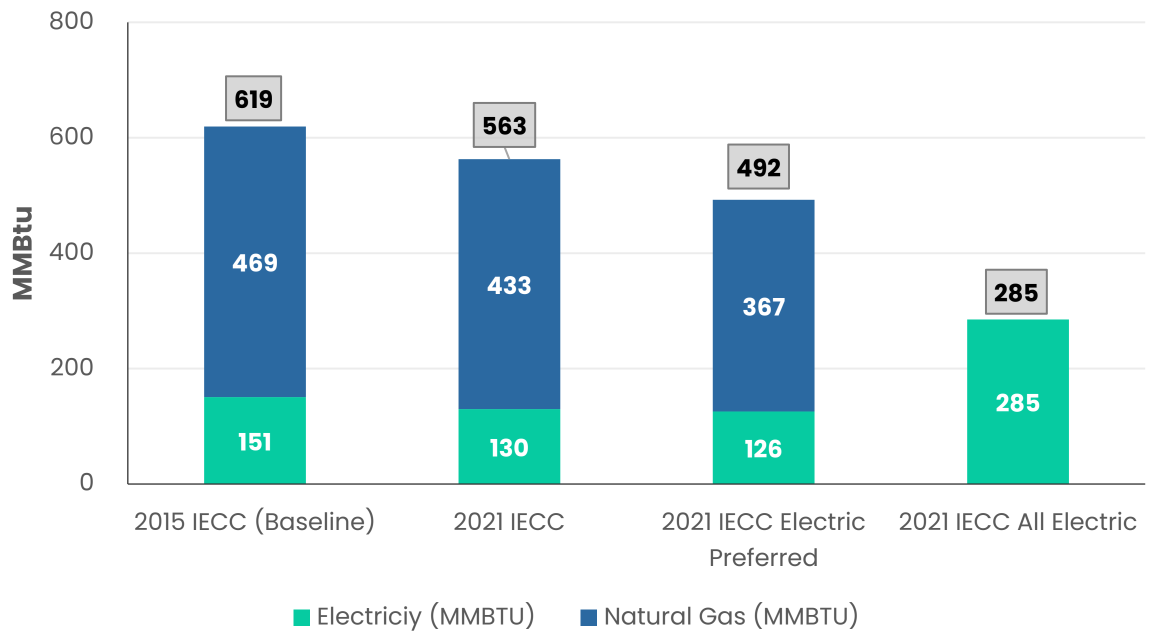

Figure 30: Comparison of commercial building annual energy use between the 2015 IECC and the 2021 IECC with all-electric provisions.

Cost Savings

Annual energy costs with the all-electric code package are 26% lower than annual energy costs from the 2015 IECC (Figure 31). The all-electric package provides an additional $849 in annual savings over the electric-preferred package. Electricity costs are $3,746 higher with the all-electric scenario compared to the 2015 IECC. However, the efficiency of electric equipment over natural gas provides $2,936 in total annual energy cost savings. The all-electric scenario is cheapest option and would save the commercial building $117,040 in energy costs over 40 years.

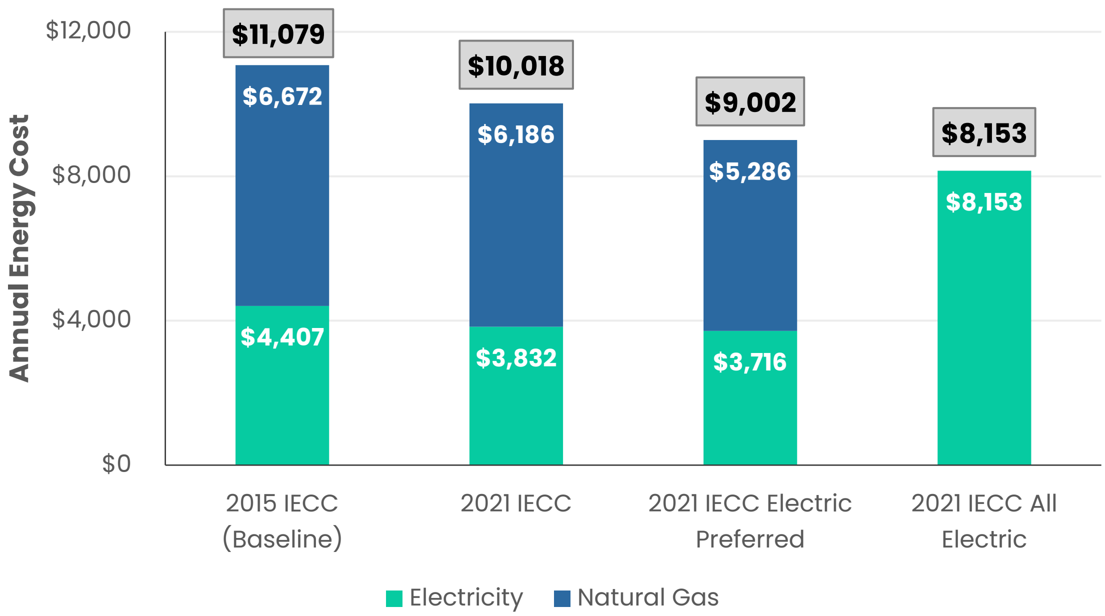

Figure 31: Comparison of commercial annual energy costs between the 2015 IECC and the 2021 IECC with all-electric provisions.

The savings from eliminating natural gas equipment from the building are partially offset by the cost of additional electricity. Total savings from this scenario are dependent on future electricity costs.

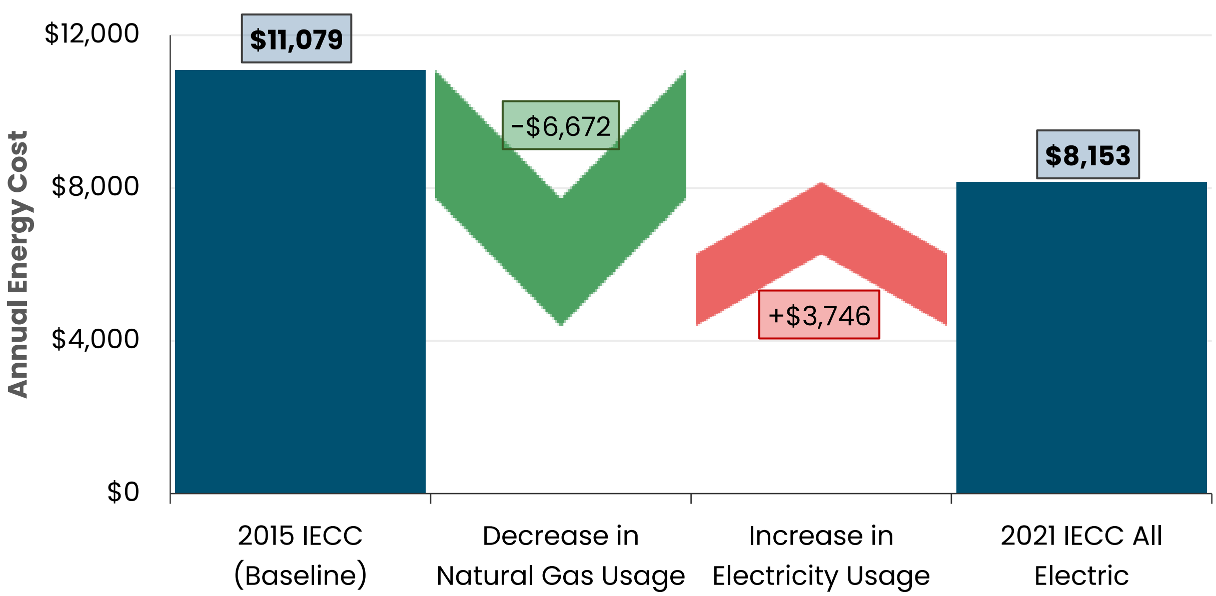

Figure 32: Cost savings breakdown of commercial building annual energy costs between the 2015 IECC and the 2021 IECC with all-electric provisions.

GHG Emissions

The all-electric code package provides the greatest reduction in GHG emissions over 40 years. When modeled with the 2021 IECC all-electric scenario, the building would produce 116 mt CO_2e, an 89% reduction (Figure 33).

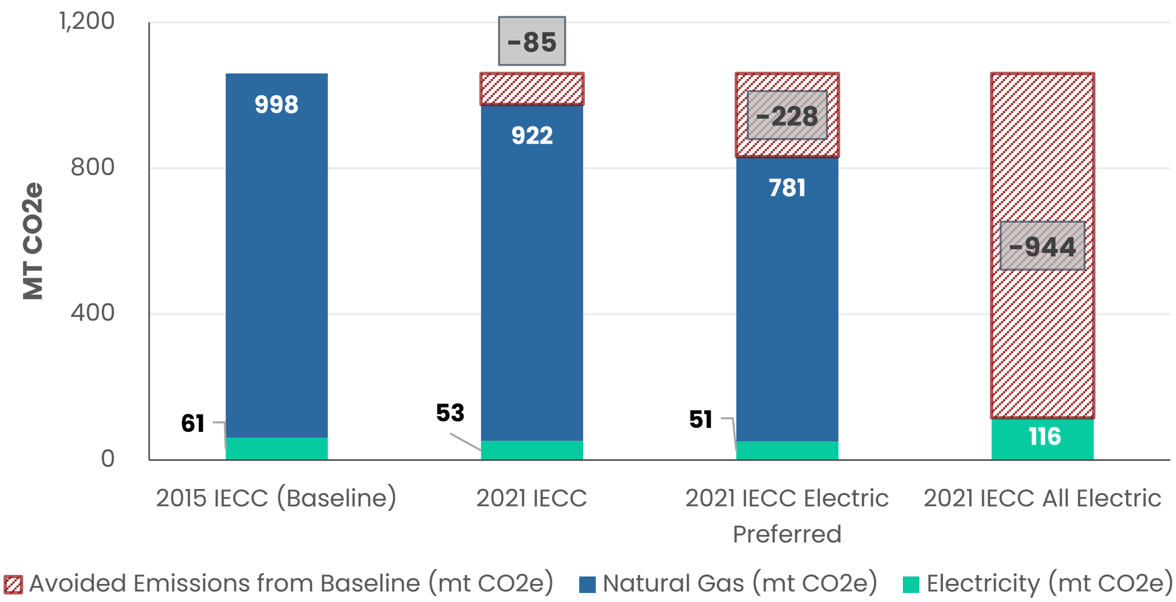

Figure 33: Comparison of commercial building 40-year GHG emissions between the 2015 IECC and the 2021 IECC with all-electric provisions.

2.5 Contractor Outreach Results

Outreach via email and phone calls was conducted to four general contractors (GCs) chosen for their project experience and industry knowledge of building in both front range and mountain communities. Representatives from each company received a questionnaire via email of open-ended questions on cost differences between buildings built to the 2015 and 2021 IECCs, and the cost to build in the mountains as opposed to the front range (see Appendix C).

Two of the four contractors responded to the questionnaire, however, neither completed the questionnaire in full. Both contractors who responded referenced a lack of experience building to the 2021 code and were unable to provide cost estimates or cost comparisons between the two code standards. They were, however, able to share insight on the upfront cost of building, specifically, the higher cost to build in mountain communities. The information received is summarized below:

- There is a 10%-30% increase in construction costs when building in mountain communities, compared to the front range. Studies that only investigate the cost to build in front-range communities will show lower upfront costs than what has been experienced building in mountain communities. Cost increases are driven by several factors including but not limited to:
  - Higher performance windows and insulation for a building envelope dictated by stricter envelope requirements for Climate Zone 6. (Note: front range communities are in Climate Zone 5).
  - Extra fuel costs and delivery fees for getting materials from Denver to mountain communities.
  - Various elements of labor costs such as those associated with faraway projects (hotels, local project supervisors, etc.), accounting for the cost of living, availability of labor, and competing wages with other companies.
- One contractor reported inflation rates to increase roughly 1.5% per month or a total of 15% since January 2022. The other contractor reported general cost increases due to inflation but noted that inflation has not affected markups for projects built in mountain communities as opposed to front-range communities.

Anecdotal information received from general contractors did not provide the project team with insights on the cost to build to the different energy code standards. However, the additional context provided by these local contractors help provide a more holistic picture of how labor rates and other economic factors impact the upfront cost of building to each code standard evaluated.

3. Results Discussion & Conclusion

3.1 Upfront Cost for Updating Energy Codes

The upfront cost to build to the 2021 IECC as opposed to the 2015 IECC does not represent a significant increase in the upfront construction costs for a single-family home, multifamily building, or commercial building.

For those building types and code packages where upfront cost data were available, all were cost-effective, meaning the additional upfront costs of these codes are paid back via energy savings at the building level over a 30-year period (see Table 12). For multifamily and commercial buildings, studies show that there may be an overall incremental cost decrease to build to the 2021 IECC as compared to the 2015 IECC.

The code option with the largest upfront cost burden is the electric-preferred standard if a builder chooses to build with natural gas. The additional efficiency packages that must be implemented to earn compliance with this code add additional costs beyond base code compliance.

For all-electric construction, studies show in all cases that there is no additional upfront cost of building all-electric beyond the cost to build to the 2021 IECC, especially when rebates for all-electric equipment are accounted for.

An important conclusion drawn from the outreach to local contractors is that there is a higher cost to build in the mountains than in the rest of the state due to labor rates and the cost to ship materials. In addition to the higher cost of labor and materials, builders in Eagle County have experienced a 1.5% inflation rate per month on building materials since the beginning of 2022. These two factors will likely show an increased cost to build in Eagle County beyond what is summarized in this report. However, it should be noted the cost increases from inflation, labor, and materials will impact building construction as a whole, and should not be directly attributed to changes in the energy code. The upfront cost impacts summarized here only evaluate the energy code changes, which are one small part of the overall building code. **In reality, costs due to code updates are also dependent on the code compliance pathway and optimal building design determined by the developer.**

Building Type	Code Package	Incremental Construction Costs	30-Year Energy Savings*	Cost-Effective?
Single-Family Home	Base 2021 IECC	$1,470	$6,134	Yes
	2021 IECC + Electric-ready	$925 - $2,700	Cost is the same as base 2021 IECC.	Yes
	2021 IECC + Electric-preferred	$870 - $2,028	$14,458	Yes
	2021 IECC + All-electric	$4,000 - $6,000	$10,144	Yes
Multifamily	Base 2021 IECC	($9,195) - $14,910	$42,086	Yes
	2021 IECC + Electric-ready	$18,900	Cost is the same as base 2021 IECC.	Yes
	2021 IECC + Electric-preferred	Not available.	$73,378	-
	2021 IECC + All-electric	$42,000 - $70,000	$94,844	Yes
Commercial	Base ASHRAE Standard 90.1 - 2019	($10,849) - $3,918	$31,830	Yes
	2021 IECC/ASHRAE 2019 + Electric-ready	Not available.	Cost is the same as base 2021 IECC.	-
	2021 IECC/ASHRAE 2019 + Electric-preferred	Not available.	$62,310	-
	Base 2021 IECC/ASHRAE 2019 + All-electric	($18,100)	$87,780	Yes

Table 12: Summary table of incremental construction costs reported in studies found in a literature review and applied to the building type specifications (square footage, number of units, etc.) modeled by Lotus.[17,18]

3.2 Energy Code to Support Climate Goals

The adoption of the 2021 IECC will, in every case, yield a reduction in energy use, annual energy cost, and GHG emissions compared to the 2015 IECC.

In addition, if Eagle County were to pursue supporting amendments such as electric-preferred and/or all-electric new construction, the result is the same with just a few exceptions. As the code increases in stringency (Figure 34), the annual energy consumption, and GHG emissions decrease in all cases. Annual energy costs also decrease in most cases.

[17] See Appendix B for report details and assumptions. This does not reflect the 10-30% increase estimated by contractors.
[18] To calculate the 30-year energy savings, the annual energy use modeled by Lotus was multiplied by 30.

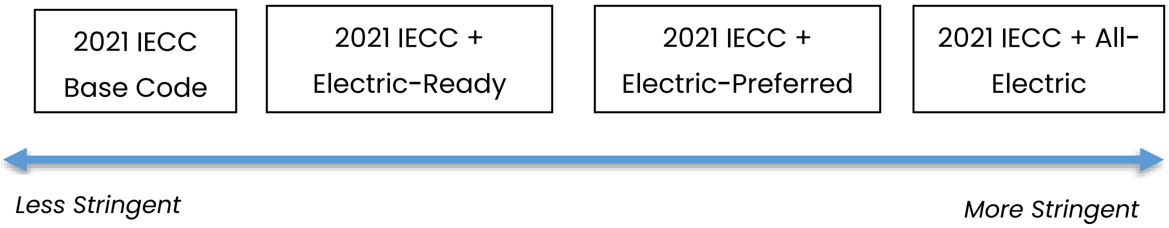

Figure 34: Code options evaluated shown on a spectrum from less stringent to more stringent.

For both multifamily and commercial buildings, the modeling results show that the 2021 IECC with all-electric provisions has the lowest energy use, the lowest cost, and the greatest GHG emissions savings.

For the single-family home model, the 2021 IECC with all-electric provisions leads to buildings with the lowest energy use and the greatest GHG reductions. The most cost-effective code package is the 2021 IECC with electric-preferred amendments, however, there is a minimal cost difference between the 2015 IECC base scenario, the electric-preferred scenario, and the all-electric scenario.

From the modeling, it can be concluded that an all-electric code package would make the most significant progress toward Eagle County Government's emission reduction goals. For multifamily and commercial new construction, an all-electric code is also cost-effective and can show even greater savings if electricity becomes cheaper. The modeling does not consider costs for electric vehicle infrastructure, onsite renewable energy installation, or battery storage, though each may be utilized to improve a building's energy use.

In summary, Eagle County should consider the adoption of the 2021 IECC as a minimum standard for its next code adoption. To advance the County's climate goals, the 2021 IECC with an electric-preferred or all-electric amendment should be considered because they do not represent a prohibitive additional upfront cost and they both yield additional energy use savings, energy cost savings, and GHG emissions reductions over time.

Code Package	Upfront / Incremental Cost to Build ($)	Total Annual Energy Use (MMBtu)	Total Annual Energy Use Reduction from Baseline (%)	Total Annual Energy Cost	Total Annual Energy Cost Savings from Baseline	40-year Cumulative Emissions (mtCO2e)	40-year Cumulative Emissions Reduction from Baseline (%)
Single-Family Home							
2015 IECC Baseline	**N/A**	**144**	**N/A**	**$2,564**	**N/A**	**270**	**N/A**
2021 IECC	$1,470	132	-8%	$2,360	($204)	248	-8%
2021 IECC Electric-Ready	$925 - $2,700*	132	-8%	$2,360	($204)	248	-8%
2021 IECC Electric-Preferred	$870 - $2,028*	111	-23%	$2,082	($482)	205	-24%
2021 IECC All-Electric	$4,000 - $6,000*	68	-53%	$2,226	($338)	28	-90%
Multifamily Building							
2015 IECC Baseline	**N/A**	**985**	**N/A**	**$21,229**	**N/A**	**1,685**	**N/A**
2021 IECC	($657) - $1,065 per unit	869	-12%	$19,826	($1,403)	1,429	-15%
2021 IECC Electric-Ready	$1,350 per unit*	869	-12%	$19,826	($1,403)	1,429	-15%
2021 IECC Electric-Preferred	Not available.	771	-22%	$18,783	($2,446)	1,198	-29%
2021 IECC All-Electric	$3,000-$5,000 per unit*	536	-46%	$18,067	($3,161)	218	-87%
Commercial Building							
2015 IECC Baseline	**N/A**	**609**	**N/A**	**$11,079**	**N/A**	**1,060**	**N/A**
2021 IECC	($10,849) - $3,918	563	-9%	$10,018	($1,061)	975	-8%
2021 IECC Electric-Ready	Not available.	563	-9%	$10,018	($1,061)	975	-8%
2021 IECC Electric-Preferred	Not available.	492	-21%	$9,002	($2,077)	832	-21%
2021 IECC All-Electric	($18,100)	285	-54%	$8,153	($2,926)	116	-89%

Table 13: Annual energy use, annual energy cost, and GHG emissions for each building type, under each code package. The upfront cost to build to 2021 IECC compared to 2015 IECC.
**Indicates the baseline is the 2021 IECC. All other data uses the 2015 IECC as the baseline.*

3.3 Future Considerations

The project team recognizes that several current information gaps should be filled to create a more holistic understanding of the costs associated with energy code updates. A few of these gaps could be addressed by further insight from local contractors. It is possible that the response rate would improve from intentional outreach from the County, and/or if the County paid the contractors for their time and their data.

Future opportunities also lie in more specific cost studies. There is a data gap for code update impacts on commercial building new construction costs. Additionally, no current report addresses a specific breakdown of cost impacts for additional efficiency packages required by electric-preferred provisions. A study addressing these may come from a larger entity such as PNNL or ICF, or the County could contract with a consulting group for further exploration.

Lastly, building code updates will have an impact on climate change mitigation, but they cannot be the sole strategy to impact emissions. Other strategies include implementing a benchmarking ordinance more applicable to Eagle County's building stock than the state-legislated requirements[19] and developing an approach to efficiency improvements and electrification of existing buildings within the County.

[19] For more information see: https://energyoffice.colorado.gov/climate-energy/energy-policy/building-benchmarking#:~:text=The%20bill%20requires%20owners%20of,assess%20energy%20and%20water%20consumption.

Appendix A: Modeling Assumptions

Building energy modeling was conducted to understand the potential energy use, operational cost, and greenhouse gas (GHG) impacts of the four code packages Eagle County is evaluating (Table 1). Each of the code packages were modeled for a single-family, multi-family, and commercial building. The modeling results for each building type and code package option were compared to a baseline model of each building type, modeled in compliance to the 2015 IECC.

Single-Family Home Assumptions

Input	2015 IECC	2021 IECC	2021 IECC + Electric Preferred	2021 All Electric
Building Envelope				
Wall Type	Wood Stud	Wood Stud	Wood Stud	Wood Stud
Wall Insulation	R-20 Open Cell Spray Foam	R-20 Open Cell Spray Foam	R-20 Open Cell Spray Foam	R-20 Open Cell Spray Foam
Wall Continuous Insulation	R-5 XPS	R-5 XPS	R-5 XPS	R-5 XPS
Interzonal Wall Insulation	R-13 Fiberglass Batt	R-20 Open Cell Spray Foam	R-20 Open Cell Spray Foam	R-20 Open Cell Spray Foam
Wall Exterior Finish (Solar Absorptivity, Emissivity)	0.75, 0.9	0.75, 0.9	0.75, 0.9	0.75, 0.9
Roof Material (Solar Absorptivity, Emissivity)	0.75, 0.9	0.75, 0.9	0.75, 0.9	0.75, 0.9
Unfinished Attic Insulation	R-30 Cellulose, Vented	R-60 Cellulose, Vented	R-60 Cellulose, Vented	R-60 Cellulose, Vented
Interzonal Floor Insulation	R-30 Fiberglass Batt	R-30 Fiberglass Batt	R-30 Fiberglass Batt	R-30 Fiberglass Batt
Foundation Type	Slab	Slab	Slab	Slab
Foundation Insulation	4ft R10 Exterior XPS	4ft R10 Exterior XPS	4ft R10 Exterior XPS	4ft R10 Exterior XPS
Window Area	15% of Net Wall Area	15% of Net Wall Area	15% of Net Wall Area	15% of Net Wall Area
Window U-factor	0.3	0.3	0.3	0.3
Door U-factor	0.2	0.2	0.2	0.2
HVAC				

Air Leakage	3 ACH50	3 ACH50	3 ACH50	3 ACH50
Mechanical Ventilation	Exhaust	Exhaust	Exhaust	Exhaust
Central Air Conditioner	SEER 14	SEER 16	SEER 16	Air Source Heat Pump, SEER 16
Space Heater Fuel	Natural Gas	Natural Gas	Natural Gas	Electricity
Space Heater Efficiency	79.2% AFUE (Adjusted for elevation from 92.5% AFUE)	81.3% AFUE (Adjusted for elevation from 95% AFUE)	81.3% AFUE (Adjusted for elevation from 95% AFUE)	3.55 COP
Ducts	R-8	R-8	In Conditioned Space	R-8
Cooling Set Point	75 F	75 F	75 F	75 F
Heating Set Point	72 F	72 F	72 F	72 F
Water Heater Type	Gas Premium	Gas Premium, Condensing	Gas Premium, Condensing	Heat Pump Water Heater
Water Heater Efficiency	0.67 Thermal Efficiency (Adjusted for elevation from 0.78)	0.77 Thermal Efficiency (Adjusted for elevation from 0.9)	0.77 Thermal Efficiency (Adjusted for elevation from 0.9)	2.35 Energy Factor
Water Distribution	R-5, TrunkBranch, PEX	R-5, TrunkBranch, PEX	R-5, TrunkBranch, PEX	R-5, TrunkBranch, PEX
Lighting	80% LED	100% LED	100% LED	100% LED
Appliances				
Refrigerator	Side freezer, EF = 19.6	Side freezer, EF = 19.6	Side freezer, EF = 19.6	Side freezer, EF = 19.6
Cooking Range	Gas	Gas	Gas	Electric
Dishwasher	318 rated kWh	318 rated kWh	318 rated kWh	318 rated kWh
Clothes Washer & Dryer	EnergyStar	EnergyStar	EnergyStar	EnergyStar

Table A1: Single-family home energy model assumptions.

Multifamily Building Assumptions

Input	2015 IECC	2021 IECC	2021 IECC + Electric Preferred	2021 All Electric
Building Envelope				
Wall Type	Wood Stud	Wood Stud	Wood Stud	Wood Stud
Wall Insulation	R-13 Fiberglass Batt	R-13 Fiberglass Batt	R-23 Closed Cell Spray Foam	R-23 Closed Cell Spray Foam
Wall Continuous Insulation	R-10 XPS	R-10 XPS	R-10 XPS	R-10 XPS
Wall Exterior Finish (Solar Absorptivity, Emissivity)	0.75, 0.9	0.75, 0.9	0.75, 0.9	0.75, 0.9
Roof Material (Solar Absorptivity, Emissivity)	0.75, 0.9	0.75, 0.9	0.75, 0.9	0.75, 0.9
Finished Roof Insulation	R-13 Fiberglass, R-15 XPS	R-13 Fiberglass, R-15 XPS	R-38C Fiberglass Batt, R-24 Polyiso	R-38C Fiberglass Batt, R-24 Polyiso
Foundation Type	Slab	Slab	Slab	Slab
Foundation Insulation	4ft R15 Exterior XPS	4ft R20 Exterior XPS	4ft R20 Exterior XPS	4ft R20 Exterior XPS
Window Area	18% of Net Wall Area	18% of Net Wall Area	18% of Net Wall Area	18% of Net Wall Area
Window U-factor	0.39	0.39	0.35	0.35
Door U-factor	0.2	0.2	0.2	0.2
HVAC				
Air Leakage	3 ACH50	3 ACH50	3 ACH50	3 ACH50
Mechanical Ventilation	Exhaust	Supply	ERV, 70%	Supply
Central Air Conditioner	SEER 14	SEER 14	SEER 14	Air Source Heat Pump, SEER 16
Space Heater Fuel	Natural Gas	Natural Gas	Natural Gas	Electricity
Space Heater Efficiency	66.8% AFUE (Adjusted for elevation from 78% AFUE)	68.5% AFUE (Adjusted for elevation from 80% AFUE)	68.5% AFUE (Adjusted for elevation from 80% AFUE)	3.55 COP
Ducts	R-6	R-6	R-6	R-6
Cooling Set Point	75 F	75 F	75 F	75 F
Heating Set Point	72 F	72 F	72 F	72 F
Water Heater Type	Gas Premium	Gas Tankless, Condensing	Gas Tankless, Condensing	Heat Pump Water Heater

Water Heater Efficiency	0.67 Thermal Efficiency (Adjusted for elevation from 0.78)	0.82 Energy Factor (Adjusted for elevation from 0.96)	0.82 Energy Factor (Adjusted for elevation from 0.96)	2.35 Energy Factor
Water Distribution	R-2, TrunkBranch, PEX	R-2, TrunkBranch, PEX	R-2, TrunkBranch, PEX	R-5, TrunkBranch, PEX
Lighting	80% LED	95% LED	95% LED	100% LED
Appliances				
Refrigerator	Side freezer, EF = 19.6	Side freezer, EF = 19.6	Side freezer, EF = 19.6	Side freezer, EF = 19.6
Cooking Range	Gas	Gas	Gas	Electric
Dishwasher	318 rated kWh	318 rated kWh	318 rated kWh	318 rated kWh
Clothes Washer & Dryer	EnergyStar	EnergyStar	EnergyStar	EnergyStar

Table A2: Multifamily building energy model assumptions.

Commercial Building Assumptions

Input	2015 IECC	2021 IECC	2021 IECC + Electric Preferred	2021 All Electric
Building Envelope				
Wall Type	Wood Stud	Wood Stud	Wood Stud	Wood Stud
Wall Insulation	R-13 Fiberglass Batt	R-21 Fiberglass Batt	R-21 Fiberglass Batt	R-21 Fiberglass Batt
Wall Exterior Insulation	R-8, 2 in. Polystyrene	R-9, 1.5 in. Polyurethane	R-9, 1.5 in. Polyurethane	R-9, 1.5 in. Polyurethane
Wall Exterior Finish (Solar Absorptivity)	0.6	0.6	0.6	0.6
Roof Material (Solar Absorptivity)	0.6	0.6	0.6	0.6
Finished Roof Insulation	R-30, 5 in. Polystyrene	R-42, 6 in. Polyiso	R-42, 6 in. Polyiso	R-42, 6 in. Polyiso
Foundation Type	Slab	Slab	Slab	Slab
Foundation Insulation	R-10, 2 ft deep	R-20, 4 ft deep	R-20, 4 ft deep	R-20, 4 ft deep
Window Area	40% of Net Wall Area	40% of Net Wall Area	40% of Net Wall Area	40% of Net Wall Area
Window U-factor	0.36	0.3	0.3	0.3
Door U-factor	0.77	0.5	0.5	0.5
HVAC				
Central Air Conditioner	SEER 13	SEER 13	SEER 14.3	Air Source Heat Pump, SEER 14

Space Heater Fuel	Natural Gas	Natural Gas	Natural Gas	Electricity
Space Heater Efficiency	0.68 Thermal Efficiency (Adjusted for elevation from 0.8 thermal efficiency)	0.68 Thermal Efficiency (Adjusted for elevation from 0.8 thermal efficiency)	0.75 Thermal Efficiency (Adjusted for elevation from 0.88 thermal efficiency)	2.9 COP
Cooling Set Point	75 F	75 F	75 F	75 F
Heating Set Point	72 F	72 F	72 F	72 F
Water Heater Type	Gas Storage	Gas Storage	Gas Storage	Heat Pump Water Heater
Water Heater Efficiency (Non-Residential)	0.68 Thermal Efficiency (Adjusted for elevation from 0.8 thermal efficiency)	0.577 Thermal Efficiency (Adjusted for elevation from 0.68 thermal efficiency)	0.577 Thermal Efficiency (Adjusted for elevation from 0.68 thermal efficiency)	2.06 Energy Factor
Water Heater Efficiency (Residential)	0.68 Thermal Efficiency (Adjusted for elevation from 0.8 thermal efficiency)	0.81 Thermal Efficiency (Adjusted for elevation from 0.95 thermal efficiency)	0.81 Thermal Efficiency (Adjusted for elevation from 0.95 thermal efficiency)	2.06 Energy Factor
Water Distribution	R-12	R-12	R-12	R-12

Table A3: Commercial building energy model assumptions.

Appendix B: Upfront Cost Literature Review Reports and Assumptions

List of Sources Reviewed for Cost Analysis

Authoring Entity	Title	Publish Date	Resource Type	Property Type Assessed	Code(s) and/or Topics Examined	Relevancy to Eagle County
Pacific Northwest National Laboratory (PNNL)	Cost-Effectiveness of the 2021 IECC for Residential Buildings in Colorado – 2015 IECC Baseline	Dec. 2021	Study/Report	Residential	2021 IECC and 2015 IECC	High
	National Cost Effectiveness of the Residential Provisions of the 2021 IECC	June 2021	Study/Report	Residential	2021 IECC and 2018 IECC	Medium
	Cost-Effectiveness of ANSI/SHRAE/IES Standard 90.1-2019 for Colorado	July 2021	Study/Report	Commercial	ASHRAE 90.1-2019 and ASHRAE 90.1-2016	Medium
Home Innovation Research Labs (HIRL)	2021 IECC Residential Cost Effectiveness Analysis	June 2021	Study/Report	Residential	2021 IECC and 2018 IECC	Low
ICF International (ICF)	Cost Effectiveness of the Residential Provisions of the 2021 IECC	Jan. 2022	Study/Report	Residential	2021 IECC and 2018 IECC	Medium
Utah Clean Energy (UCE)	Memorandum in Support of UCEs and Salt Lake City's (SLC) Joint Application to Include Electric Ready Provisions in the State Building Code.	Nov. 2021	Memorandum	Residential	2021 IECC + electric-readiness	High

Group14/ PNNL	Residential Construction Cost Analysis	Feb. 2022	Study/Report	Residential	2021 IECC + Amendments	Medium
Group14	Electrification of Commercial and Residential Buildings	Nov. 2020	Study/Report	Residential and Commercial	All-electric new construction	Medium
Southwest Energy Efficiency Project	Benefits of Heat Pumps for Colorado Homes	Feb. 2022	Study/Report	Residential	All-electric new construction	Medium
David Petroy, Energy Consultant	HVAC Incremental Cost Data	Sept. 2022	Data Analysis	Residential	All-electric heating systems	High

Table B1: List of sources reviewed for a cost analysis.

2021 IECC Cost-Effective Study Assumptions

Study	Builder profit margin	Energy rates	Modeled Single-Family Home Size (square ft)	Other methodology notes
PNNL National Study	Unknown	**Electricity:** $0.125/kWh **Gas.:** $0.584/therm	3 bedrooms 2,376 SF*	• 1.4% inflation rate. • Additional economic parameters (i.e., property tax rate, home price escalation rate, and down-payment rates.). • 256 total permutations of building models.
ICF	17.5%	**Electricity:** $0.1301/kWh **Gas:** $1.051/therm	3 bedrooms 2,500 SF	• Deemed several administrative code changes to have negligible costs. • Updated material costs from the HIRL report.

Table B2: Baseline 2021 IECC cost-effective studies and assumptions.

**The PNNL study also analyzed a 2 bedroom, 1,200 SF multifamily unit.*

Appendix C: Contractor Questionnaire

Purpose:

Lotus Engineering & Sustainability is working with Eagle County to model the greenhouse gas (GHG), operational cost, and upfront cost of building to the 2021 IECC as compared to the 2015 IECC. In addition to the IECC 2021 base code, the County is investigating two more stringent code options that go above and beyond the IECC 2021 base code.

While a number of studies have been conducted on the upfront cost of building to the IECC 2021 as opposed to the 2018 or 2015 codes, Eagle County would like to ensure that the data from these reports is reflective of the on-the-ground costs for builders operating in Eagle County or surrounding mountain communities.

We recognize that over the last year construction costs have risen across the board stemming from supply chain issues and labor shortages. Please keep in mind, while answering the questions below, that we are interested in investigating the **incremental costs to build to the IECC 2021 code as compared to the IECC 2015 code.** We are not investigating the cost to meet the general requirements of the IBC or other I-Codes, simply the additional costs to meet the new efficiency requirements in the IECC.

To this end, we are looking for your help! We have a few questions below we are hoping your team can answer for us.

Note all data shared by your team will be kept confidential.

Please send your responses in 10 business days to Kim Schlaepfer (kim@lotussustainability.com) and Claire Kantor (claire@lotussustainability.com).

General Cost Questions

1. Typically, do you experience a higher cost to build in Eagle County (or Summit / Pitkin Counties) than you do on the front range of CO?
    a. If you could estimate the higher cost to build in the mountain communities listed above vs the front range, what percentage increase would you assign?
    b. What do you see as the primary driver of increased construction costs in the mountains (i.e., labor costs, material costs)?

2. Do you add a mark-up for projects built in the mountain communities as opposed to the front range?
3. In 2022, with inflation, have you marked up projects in the mountains and/or the front range to cover higher costs?
    a. If so, what percentage is your mark-up for the front range inflation?
    b. If so, what percentage is your mark-up for mountain building?
    c. Do you see inflation as a larger issue in the mountains as opposed to the front range?
4. Do you have experience building all-electric buildings? If so, have you experienced a cost premium to build all-electric vs mixed fuel?
    a. If yes, what do you see as the major contributing factors of the cost premium? (Educating labor/workforce, technology costs and availability, and/or other reasons?).
    b. If yes, have supply side issues impacted your all-electric building plans?
        i. Do you experience the same supply side issues with mixed-fuel buildings?

2021 Code Questions

Single-Family Home

1. Are you currently working on a single-family home project built to the 2021 I-Codes? What type of project?
    a. Approx. SF
    b. Location
    c. Is the IECC 2021 applicable to your project?
        i. What compliance pathway are you pursuing? Total building performance, prescriptive, etc.?
2. Are there any community-specific additional energy or efficiency requirements on the project that will make its energy performance “above code”? What are those things?
3. Can you provide an estimate of the cost to comply with the **Energy Conservation Code** requirements? These include envelope efficiency, HVAC efficiency, mechanical ventilation, additional efficiency packages, insulation, fenestration, etc.
    a. Please indicate which building systems/elements are included in your cost estimate.
4. Can you provide the estimated total construction cost for the project?
5. Have you worked on an equivalent size / type project in the last 5 years that was built to the 2015 code?

   a. If so, can you provide equivalent information (size, location, IECC applicability, estimate for IECC code, and total construction cost) for this project?
6. Can you estimate the average cost for pre-wiring a home for an all-electric system?
7. Can you estimate the average cost of an electric panel capacity upgrade to accommodate all-electric systems?
8. Can you estimate the average cost of a natural gas hookup to an average home?

Multi-Family Building

1. Are you currently working on a multi-family building project built to the 2021 I-Codes? What type of project?
   a. Approx. SF
   b. Location
   c. Is the IECC 2021 applicable to your project?
      i. What compliance pathway are you pursuing? Total building performance, prescriptive, etc.?
2. Are there any community-specific additional energy or efficiency requirements on the project that will make its energy performance "above code"? What are those things?
3. Can you provide an estimate of the cost to comply with the **Energy Conservation Code** requirements? These include envelope efficiency, HVAC efficiency, mechanical ventilation, additional efficiency packages, insulation, fenestration, etc.
   a. Please indicate which building systems/elements are included in your cost estimate.
4. Can you provide the estimated total construction cost for the project?
5. Have you worked on an equivalent size / type project in the last 5 years that was built to the 2015 code?
   a. If so, can you provide equivalent information (size, location, IECC applicability, estimate for IECC code, and total construction cost) for this project?
6. Can you estimate the average cost for pre-wiring a multi-family building for an all-electric system?
7. Can you estimate the average cost of an electric panel capacity upgrade to accommodate all-electric systems?
8. Can you estimate the average cost of a natural gas hookup to an average multi-family building?

Commercial Building

1. Are you currently working on a multi-family building project built to the 2021 I-Codes? What type of project?
    a. Approx. SF
    b. Location
    c. Is the IECC 2021 applicable to your project?
        i. What compliance pathway are you pursuing? Total building performance, prescriptive, etc.?
2. Are there any community-specific additional energy or efficiency requirements on the project that will make its energy performance “above code”? What are those things?
3. Can you provide an estimate of the cost to comply with the **Energy Conservation Code** requirements? These include envelope efficiency, HVAC efficiency, mechanical ventilation, additional efficiency packages, insulation, fenestration, etc.
    a. Please indicate which building systems/elements are included in your cost estimate.
4. Can you provide the estimated total construction cost for the project?
5. Have you worked on an equivalent size / type project in the last 5 years that was built to the 2015 code?
    a. If so, can you provide equivalent information (size, location, IECC applicability, estimate for IECC code, and total construction cost) for this project?
6. Can you estimate the average cost for pre-wiring a commercial building for an all-electric system?
7. Can you estimate the average cost of an electric panel capacity upgrade to accommodate all-electric systems?
8. Can you estimate the average cost of a natural gas hookup to a commercial building?

2015 Code Questions

1. Are you currently working on a project built to the 2015 I-Codes? What type of project (SFH, multi-family, commercial, hotel, etc.)?
    a. Approx. SF
    b. Location
2. Is the IECC 2015 applicable to your project?
    a. What compliance pathway are you pursuing? Total building performance, prescriptive, etc.?
3. Are there any community-specific additional energy or efficiency requirements on the project that will make its energy performance “above code”? What are those things?

4. Can you provide an estimate of the cost to comply with the **Energy Conservation Code** requirements? These include envelope efficiency, HVAC efficiency, mechanical ventilation, additional efficiency packages, insulation, fenestration, etc.
    a. Please indicate which building systems/elements are included in your cost estimate.
5. Can you provide the total construction cost for the project?