Quantifying the Cost and Benefits of Upgrading the NH IECC 2018 Building Energy Code to the IECC 2024 Code

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Abstract

During the 2023 and 2024 New Hampshire (NH) legislative sessions, bills were introduced to update the NH Building Code standards to more recent editions. Currently, NH follows the **2018 International Energy Conservation Code (IECC)** with state-specific amendments.

In both House and Senate deliberations, discussion focused on the potential costs of implementing more stringent energy standards for newly constructed homes and commercial buildings. Testimony presented to lawmakers contained widely varying cost estimates, making it difficult to reach an informed decision. Many of the studies cited—both in support of and against the updates—were based on analyses of buildings located outside New Hampshire and therefore did not reflect the state's unique climate conditions or regional material and energy costs.

In early 2025, the NH local chapter of **ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers)** formed a working group to evaluate the potential impact of updating the state's energy building code from 2018 to the 2024 IECC level. The study was conducted under the guidance of the NH Building Code Review Board's (BCRB) Energy Subcommittee. Its goal was to assess both the cost implications and the projected energy savings associated with stricter code requirements utilizing costs specific to New Hampshire. The committee includes a professional cost estimator with over 30 years of experience, along with leading engineering professionals from across the state. A recently designed multi-family building—provided by a BCRB member—was used as the reference model.

The analysis found that moving from the IECC 2018 building code, including the New Hampshire amendments, to the IECC 2024 code would have a minor (.2%) impact on the "upfront" cost to build the structure, and immediately reduce the operating costs of the building by approximately 15%. The operational savings would offset the incremental increase in costs within the first two years (simple payback of 1.7 years). Moreover, the benefits would continue to accrue over the life of the building with a Life Cycle Cost (LCC) savings of $202,264 over the assumed 30-year life of the building. The results of this study will be presented in fall 2025 to help inform legislation in the 2025-26 session.

Introduction

Energy codes govern up to 80 percent of a building's energy load,[1] and 60 percent of the buildings projected to exist by 2050 have yet to be built.[2] Upfront decisions largely drive a building's environmental impact;[3] therefore energy codes present an unparalleled opportunity to ensure significant current and future energy savings through efficient design, technologies, and practices.

The International Energy Conservation Code (IECC) is a widely adopted set of building energy efficiency standards designed to reduce energy consumption in residential and commercial buildings. Updated every three years by the International Code Council (ICC), the IECC establishes minimum requirements for insulation, lighting, HVAC systems, and other building components to promote sustainable construction practices and lower energy costs. The IECC-Commercial and IECC-Residential provisions are maintained by separate committees within the ICC. Their adoption by states and local jurisdictions plays a critical role in advancing energy conservation goals and mitigating environmental impact while saving homeowners and renters money. As building materials, appliances, and construction methods improve, updated codes ensure that new and renovated buildings achieve higher energy efficiency, reducing overall energy consumption and greenhouse gas emissions. Timely code revisions also support state and local commitments to sustainability and climate resilience by promoting healthier, more resilient, and more cost-effective buildings.

Out of the 50 states, the District of Columbia, and Puerto Rico, 39 of 52 currently operate under a variation of the IECC. An additional four states (California, Florida, Oregon, and Washington) have developed their own energy codes.[4] The remaining states have not adopted any statewide energy code, though there may be codes adopted locally. New Hampshire still operates under the 2018 IECC with amendments. Two new versions of the IECC have since been published by the ICC, in 2021 and in 2024, which New Hampshire has yet to adopt.

Other divisions of the New Hampshire government have recognized the need for this form of policy. The State of New Hampshire Priority Climate Action Plan (PCAP), prepared with input from the Department of Environmental Services and the Air Resources Division, listed "Prioritize cost-effective energy policies"[5] as the *first item* in New Hampshire's 10-Year State Energy Strategy in March 2024. Energy efficiency is a cost-effective energy policy in general, and the analysis in this study further elucidates how cost-effectiveness and energy efficiency are aligned with building code upgrades.

Buildings account for approximately 40% of energy consumption in the United States.[6] In New Hampshire, given the cold climate, this is primarily correlated to the energy used to heat buildings. Over time, the IECC

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[1] U.S. Department of Energy. DOE Buildings Energy Data Book. U.S. Department of Energy, n.d. Web.
[2] Global Alliance for Buildings and Construction. "Flagship Products." Global ABC, n.d.
[3] U.S. Department of Energy. "Why Building Energy Codes?" Energy.gov, n.d.
[4] National Association of Home Builders. State Adoption Status — IECC. November 2024.
[5] State of New Hampshire. State of New Hampshire: Priority Climate Action Plan. n.d. Web.
[6] U.S. Energy Information Administration. "Annual Energy Outlook." U.S. Energy Information Administration, n.d.

energy codes have increased the amount of roof and wall insulation and improved air tightness to address this issue. Although this adds cost related to the material and labor to install these improvements, the operating costs of the building or home decline. In this study, a recently developed multifamily building with 30 apartments located in the city of Laconia was analyzed using incremental cost estimates from the same suppliers used to construct the building. The energy consumption was modeled using the de facto standard energy modeling software.

The analysis focuses on the incremental cost of compliance and energy cost savings associated with moving from the current IECC 2018 energy code to the proposed IECC 2024 standard. In addition, there are many other important inherent benefits to an energy efficient building as defined by the proposed IECC 2024 building code that were outside the scope of this study. These benefits include:

- Improvements of human health in indoor environments. Energy-efficient buildings provide a healthier environment for their occupants due to improved indoor air quality. The quantity and quality of indoor air is filtered and controlled, thereby increasing the amount of clean fresh air, improving human health and cognitive brain response.[7]
- Energy-efficient buildings are more resilient to weather events and power outages. The improved building envelope allows for stable temperatures for longer periods, independent of outdoor weather conditions or power outages. They also reduce the demand for the local power distribution system, thereby reducing the need or timeframe for local electricity distribution upgrades to transformers and substations.
- Energy-efficient buildings have a higher residual value placed on assets that perform better than traditional building assets. This point will become more important over time as more people recognize the value of energy efficient buildings.[8]
- They extend the useful life of the building by eliminating issues that can cause building degradation, such as mold and rot.[9]
- Energy-efficient buildings reduce carbon emissions, thereby contributing to the decarbonization of the planet and the reduction of greenhouse gases.[10]

The analysis also considered the impact of preferential interest rates and load terms on energy-efficient building design. Lending institutions are becoming more cognizant of the lower risk associated with energy-efficient buildings. The lower building operating costs reduce the risk of default by the mortgage holder, reflected in a preferred interest rate. This dynamic can be seen in products offered by the FHA (Federal Housing Administration), HUD (Housing and Urban Development), and, most recently, the C-PACE (Commercial Property Assessed Clean Energy) program here in New Hampshire.

[7] Lessons Learned from a California Study on Improving Indoor Environmental Quality in K-12 Schools Wanyu Chan February 24, 2021

[8] North Carolina Building Performance Association https://buildingnc.org/wp-content/uploads/NCBPA-2017-Inventory-Report_030918.pdf

[9] https://www.energycodes.gov/sites/default/files/2023-07/Efficiency_for_Building_Resilience_PNNL-32727_Rev1.pdf

[10] https://www.c2es.org/document/decarbonizing-u-s-buildings/

Analysis Methodology

The NH ASHRAE led committee analyzed the costs and relative savings associated with changes to the IECC energy codes. This methodology was applied to the multi-family building analyzed in this study but can also be used on any subsequent energy code change and/or building type. The methodology consists of the following:

1. Determine the differences between the current energy code and the proposed code for the specific building under consideration.
2. Perform cost analysis to determine incremental labor and material costs
    a. Consider materials improvements as appropriate
3. Develop an energy model of the building using design parameters from the current 2018 energy code and the 2024 energy code
4. Predict energy cost savings as compared to the incremental capital cost
    a. Consider "right sizing" HVAC as appropriate
5. Include financing tools available in the market in the financial analysis.

The energy modeling software utilized for the study was Integrated Environmental Solutions Virtual Environment (IESVE) 2024. Since its founding in 1994, IESVE has established itself as a leading building performance simulation software widely used by professionals worldwide to model energy use, thermal comfort, daylighting, and carbon emissions in buildings. It incorporates advanced physics-based modeling and integrates seamlessly with architectural design tools, providing accurate and detailed analysis tailored to local climate conditions.

This methodology is intentionally conservative as it does not place any economic value on the improved health and productivity of the building occupants, the increased life cycle of the building, or the benefit to public health due to reduced pollutants including greenhouse gas emissions. It is designed to answer the basic question of "is the upfront investment of migrating to the IECC 2024 energy building code worth the investment?", independent of all the additional benefits that the investment will yield.

Analysis Results for "The Villages at Province Street" Multi-Family

The Commercial building analyzed using this methodology was provided by a member of the NH BCRB, which had been recently completed in the town of Laconia, NH. The building is a 3-story building with 30 dwelling units. Construction on the building was completed in early 2025 and is currently undergoing testing and commissioning. An overview of the building, along with related assumptions, is shown in Figure 1 below:

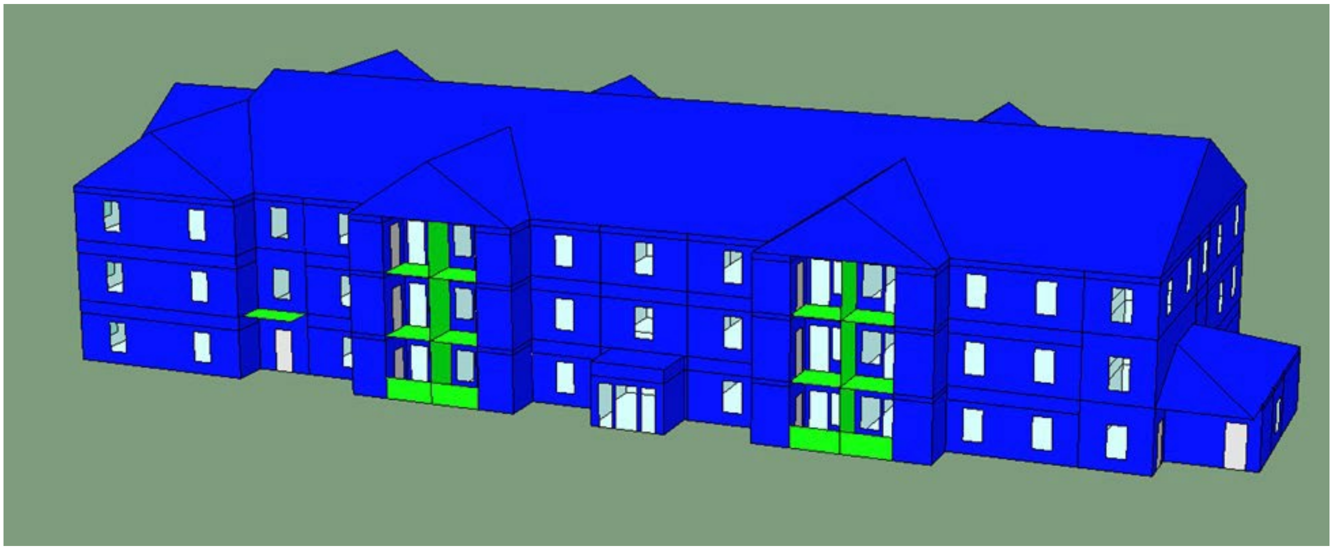

Figure 1:
The Villages at Province Street

General Building Assumptions

- Building type: Multifamily 3-story high (governed by residential code)
- Areas: Conditioned ~ 37,372 ft^2, Exterior Wall ~ 19,700 ft^2, Windows ~ 3,015 ft^2
- Location: Laconia, NH, Climate Zone 6A
- Weather file for energy model: USA_NH_Laconia.Muni.AP.726155_TMY3.epw

Building Envelope Assumptions

Category	*2018 IECC with NH Amendments*	*2024 IECC*	*Impact*
Wall Insulation	R-20 + 5ci or R-13 + 10ci (Table R402.1.2)	R-30, R-20 + 5ci, R-13 + 10ci, or R-20ci only (Table R402.1.3)	**No change** – same insulation levels, just more options and flexibility
Ceiling/Attic Insulation	R-49 (Table R402.1.2)	R-49 (Table R402.1.3)	**No change** – insulation requirement remains the same
Basement/Crawl Walls Insulation	R-15 ci or R-19 cavity (Table R402.1.2)	R-15 ci or R-19 cavity (Table R402.1.3)	**No change** – Identical insulation levels
Slab Edge Insulation	R-10, 4 ft vertical depth (NH amendment)	R-10, 4 ft for unheated; R-10, 4 ft + R-5 full slab for heated (Table R402.1.3)	**Improved** for heated slabs
Windows (U- Factor)	U-0.30 (Table R402.1.2)	U-0.28 (Table R402.1.3)	**Improved** – tighter requirement means more efficient windows
Air Leakage (ACH50)	5.0 ACH50 (blower door test required)	≤ 2.5 ACH50 (blower door test required) (R402.5.1.3)	**Improved** – homes must be much tighter

	(R402.4.1.2)		
Duct Leakage	≤ 4 CFM25/100 ft² (R403.3.5)	≤ 4–6 CFM25/100 ft² depending on return ducts (Table R403.3.8)	**Similar** – some flexibility added
Hot Water	Pipe insulation R-3 on key lines (R403.5.3)	≥ 1-inch thickness (≈ R 6) (R403.5.2)	**Improved** – thicker insulation reduces heat loss
Lighting	≥90% high efficacy (LED/CFL) (R404.1)	100% capable of efficiency of ≥ 45 LPW (R404.1)	**Improved** – full transition to efficient lighting (LED)
Solar/ Renewables	Not required; optional for ERI credit or R406 package	Not required; optional efficiency points under new R408 path	**No change** – not required in either version
Compliance Paths	1) Prescriptive (R401- R404) 2) UA trade off (R402.1.5) 3) Performance (R405) 4) ERI (R406-ERI for CZ6: 61)	1) Prescriptive (R401-R404: + ≥10 efficiency credits, homes over 5,000 sq ft need 5 extra credits) 2) Performance (each dwelling unit have ≤ 85% of the annual energy costs of the standard reference design. For any dwelling unit over 5,000 sq ft, another 5% reduction in energy costs is required) 3) ERI (CZ6 ERI without OPP: 53; with OPP:43)	**Improved** – all paths establish higher efficiency levels and reduced energy use

Table 1
2018 vs. 2024 IECC Comparison

HVAC Systems Description

Identical for IECC 2018 and IECC 2024 model cases

Dwelling Units

- Single-zone AHUs with DX cooling, gas furnace, and energy recovery ventilator.
- Setpoints: 70˚F heating, 75˚F cooling.

Common Spaces

- Central energy recovery ventilator with heat pumps.
- Electric heaters in utility rooms.
- Setpoints/setbacks: 70/65˚F heating, 75/80˚F cooling.

Note: DHW (Domestic Hot Water) production, laundry makeup air, and exhaust are not modeled: they would not be a differentiating factor between the 2 models. All HVAC equipment is auto sized per ASHRAE 90.1 requirements, based on Laconia's design conditions.

Cost Estimates

An independent organization was contracted by NH ASHRAE to perform the cost analysis for this study. Project Resources Group, under the leadership of John Pietroniro, performed the analysis utilizing cost data specific to New Hampshire. Material costs for the building were calculated based on the average from the following sources:

- Hamshaw Lumber
- Jackson Lumber
- Belletete's Lumber
- Home Depot
- Lowe's
- Lansing Building Products
- Hancock Lumber
- New England Air Barrier

Labor rates were derived from prevailing wage rates in Belknap County and included a 40% markup for payroll burden and 25% for overhead for billing. Air sealing to reduce the ACH@ 50 Pa from the 2018 IECC specification of <5 ACH to the 2024 specification of < 2.5 ACH was assumed to be 2 man-hours per dwelling unit at a labor rate of $75/man-hr. yielding a total cost for the building to be 30 units x 150/unit = $4500. An additional $5000 was added to the cost for potential repeat testing for a total of $9500. Assuming a conditioned space of 37,732 sf, the incremental cost per square foot is projected to be $.252/sf.

A summary of the incremental cost estimate for increasing the building from the IECC 2018 code base to the IECC 2024 code base can be seen in Table 2 below:

ITEM	SPECIFICATION	CODE YEAR	QTY	UNIT	$/UNIT	TOTAL	FROM 2018
FOUNDATION INSULATION	R-10 @ 2 FT* 4 ft for CZ6A	2018	1100	SF	$2.02	$2,222	$2,222
	R-10 @ 4 FT	2024	2200	SF	$2.02	$4,444	
SLAB VAPOR BARRIER	6 MIL	2018	17000	SF	$0.09	$1,530	$680
	10 MIL	2024	17000	SF	$0.13	$2,210	
WINDOWS	U 0.30 (U 0.29)	2018	109	EA	$496	$54,064	$1,417
	U 0.28 (U 0.25)	2024	109	EA	$509	$55,481	
GLAZED DOORS	U 0.30	2018	32	EA	$1,200	$38,400	$6,400

	U 0.28	2024	32	EA	$1,400	$44,800	
OPAQUE DOORS	U 0.30	2018	33	EA	$500	$16,500	$2,475
	U 0.28	2024	33	EA	$575	$18,975	
EXTERIOR WALLS	R-13 + 10 c.i.	2018	19700		$2.82	$55,554	$0
	R-13 + 10 c.i.	2024	19700		$2.82	$55,554	
AIR-SEALING	ACH50<5	2018	37372	SF	$0.00		$9,343
	ACH50<2.5	2024	37372	SF	$0.25	$9,343	
	SUBTOTAL ALL						**$22,537**

Table 2
Cost analysis of assuming the IECC 2024 Building Code Specifications as compared to the IECC 2018 specifications.
**Specific to Climate Zone 5.*
The NH amendment increased this to 4 ft for climate zone 6. Therefore, the actual cost increase is less than shown.

The cost increment when considering the impact of the IECC 2024 energy efficiency improvements as compared to the IECC 2018 NH baseline is estimated to be $22,537. The largest item of the incurred cost is related to reducing the air leakage from the 2018 standard of < 5 ACH@50 Pa to the tighter <2.5 ACH@50 Pa that is required by the 2024 IECC code specification. The remaining cost increments include improvements to the doors, windows, and a thicker 10 mm (about 0.39 in) slab vapor barrier. Assuming this building costs approximately $10 million to construct (confirmed by the building owner), these energy improvements would have increased the total cost of constructing the building by .225%.

Energy Model Output

Figure 2 below is a prediction of the heating (red) and electricity (blue) energy consumption by MBTU for each month of the last year. Weather data for temperature was provided by the Laconia Airport Weather Station. As can be seen in the figure, the dominant energy parameter is the heating load over the 12-month period.

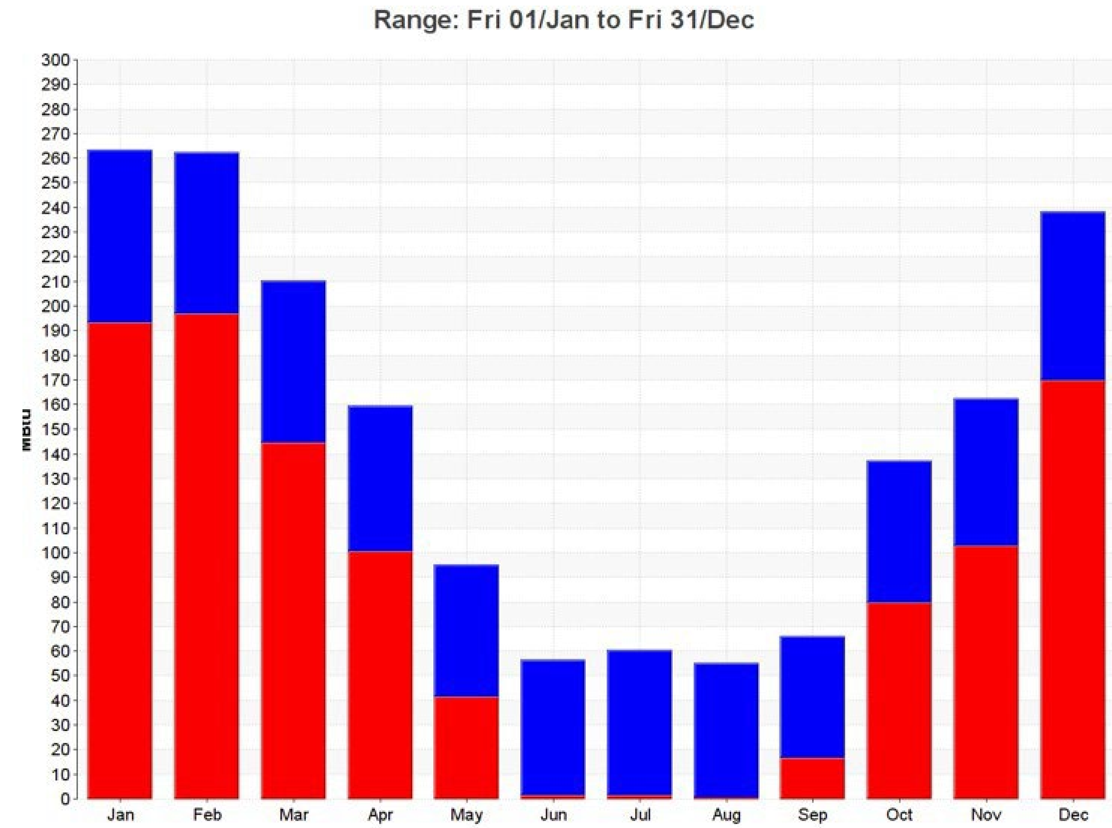

Figure 2

LP Gas consumption in red, Electrical Energy consumption in blue, for each month of a 12-month period

A breakdown of the overall energy consumption is shown in Figure 3 below. Consumption is dominated by heating and cooling requirements. Energy-efficient lights represent approximately 18% of the overall electrical energy consumption and are the same specification in both the IECC 2018 and 2024 building codes.

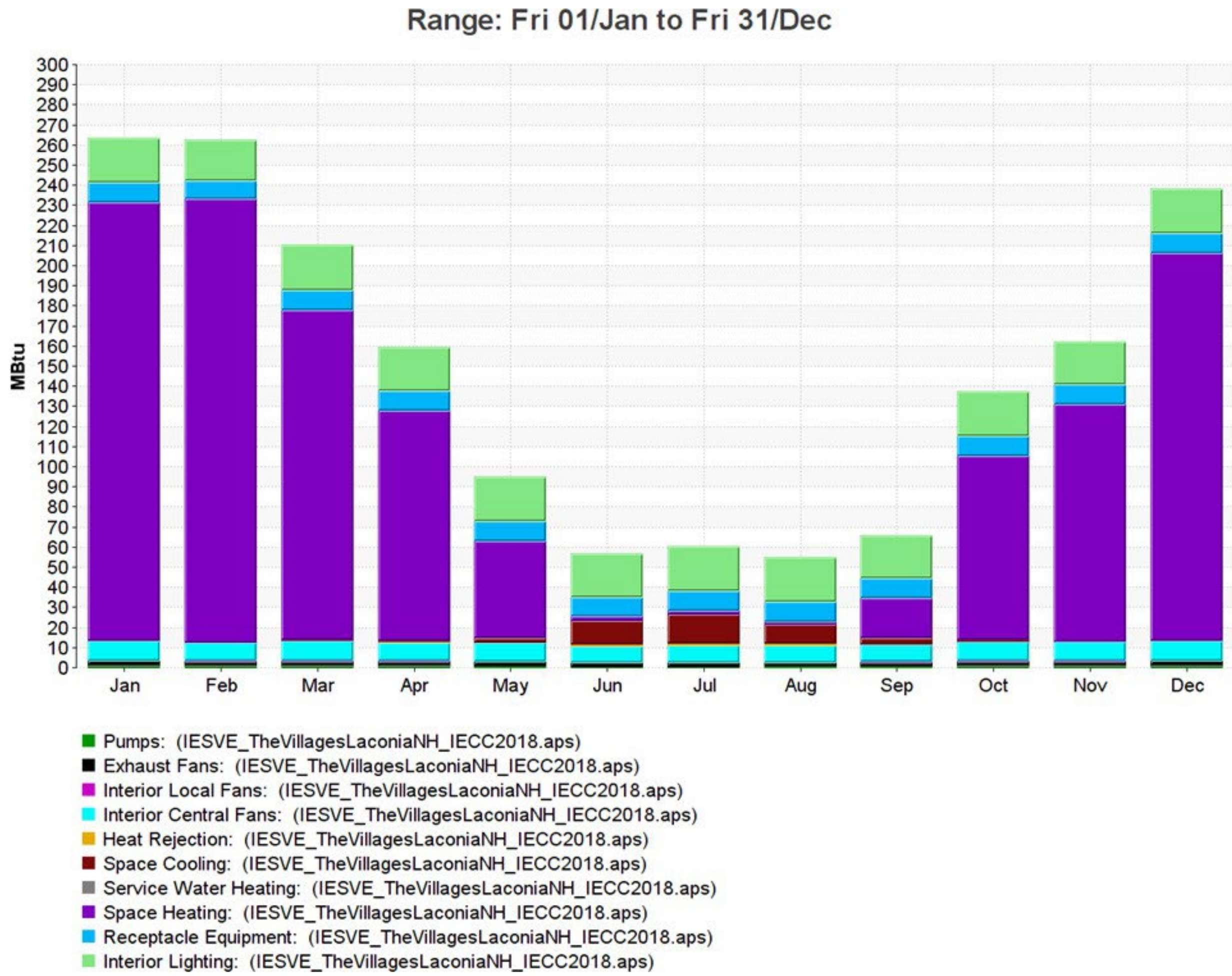

Figure 3
Breakdown of total energy use for "The Villages at Province Street"

In the late 1980's ASHRAE and the US Department of Energy (DOE) began promoting the Energy Utilization Index through research and modeling tools. EUI (Energy Utilization Intensity) is a metric used to measure a building's energy efficiency related to the conditioned space in the building. Institutions, including the US Green Building Council, ENERGY STAR, and the DOE's Energy/Plus simulation programs, incorporated EUI as a key metric to enable performance ratings for buildings of differing types. A chart of median EUI values for "common commercial property types" can be seen in Table 3 and Figure 4 below. The Villages at Province Street is classified as residential according to the NH amended 2018 IECC building code, but the chart provides an overall summary of similar building types.

Building Type	Typical Site EUI (kBtu/ft²·yr)	Typical Source EUI (kBtu/ft²·yr)
Office	~ 50–60	~ 75–90
School (K–12)	~ 40–50	~ 60–70
Retail	~ 40–60	~ 60–85
Hospital	~ 200–250	~ 300–350
Lodging (Hotel)	~ 80–100	~ 120–150
Data Center	~ 300+	~ 400+

Table 3
Median Site and Source EUI for Common Commercial Property Types
Source: Building Performance Database, bpd.lbl.gov

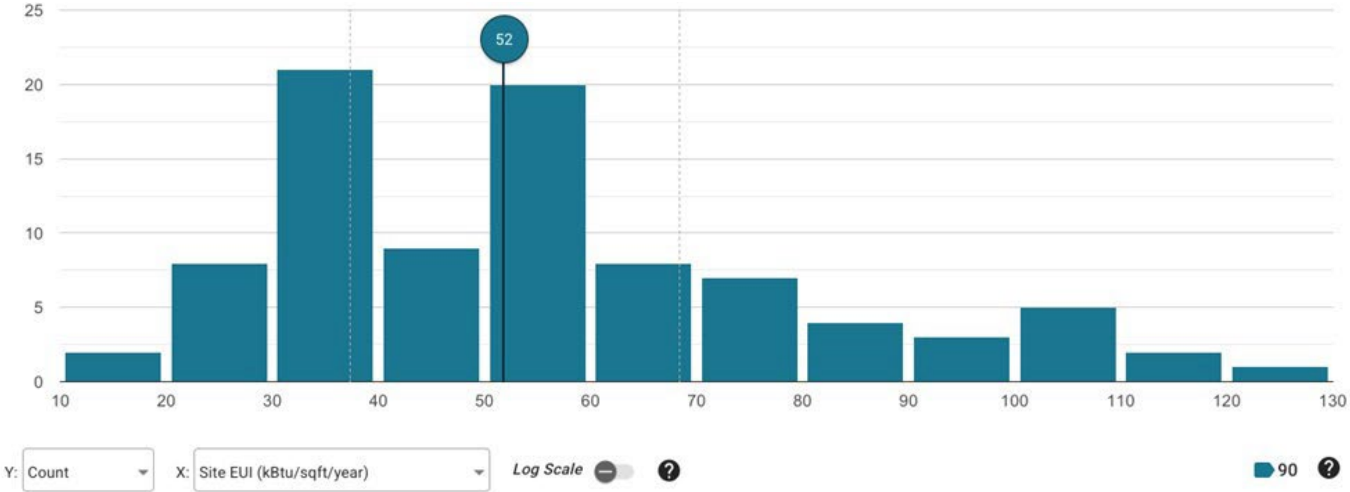

Figure 4
Median site EUI values for Multifamily buildings in climate 6A built after 2000
Source: Building Performance Database, bpd.lbl.gov

The predicted EUI for "The Villages" based on the IECC 2018 code was 47.26 kBtu/ft2 and the EUI for the same building under the IECC 2024 code was 38.87 kBtu/ft2, a savings of 8.39 kBtu/ft2 or 17.8%. The dominant parameter in the analysis is air infiltration as the lower 2.5 ACH @50 Pa reduces the heat leakage significantly. Assuming the cost of LP gas to be $3.40/gallon and the cost of electricity to be $.23/kWh, the annual cost to operate the building declines by $13,205 per year or 15%. A summary of the modeling output results can be seen in Table 4 below:

	IECC 2018	IECC 2024
EUI (Total) (kBtu/ft²)	47.26	38.87
EUI (Electricity) (kWh/ft²)	5.61	5.21
EUI (Gas) (kBtu/ft²)	28.13	21.08
Interior Lighting (kBtu/ft²)	6.96	6.96
Space heating (gas) (kBtu/ft²)	28.13	21.08
Space heating (elec) (kBtu/ft²)	3.79	2.62
Space cooling (kBtu/ft²)	1.14	1.26
Pumps (kBtu/ft²)	0.35	0.36
Fans interior (kBtu/ft²)	3.66	3.34
Heat Rejection (kBtu/ft²)	0.07	0.08
Receptacle equipment (kBtu/ft²)	3.15	3.15
Volume L Propane (US gal)	11,491	8,610
Propane Cost @$3.4/gal	$39,069.4	$29,274.0
Electricity Cons (kWh)	209,520	194,693
Electricity Cost @$0.23/kWh	$48,189.6	$44,779.4
Total Cost of Operation	$87,259.0	$74,053.4
Annual Operational Cost Savings		$13,205.6

Table 4
Model output of energy parameters and cost savings comparing the IECC 2018 to the IECC 2024 energy codes
A reduction of approximately 15% in energy consumption

Financial Analysis

Synthesizing the estimates for the increased cost of compliance and annual energy savings, the financial impacts of more efficient energy building codes can be assessed. Assuming the initial cost of the building was approximately $10M (owner verified), an additional investment of $22,537 would be required to comply with the 2024 IECC. In every realistic financing scenario considered, the more efficient building leads to decreased cost of ownership, among the many other benefits associated with energy-efficient buildings.

A method that is often used for initial assessment is Simple Payback. Simple Payback refers to the time it takes to recover the initial investment and does not consider the time value of money, the increase in energy unit cost over the period of recovery, or the accumulated savings over the life of the building. Assuming this method is used, the “Simple Payback” occurs within two years on this multifamily building. This means that by year 2, the building improvements have already paid for themselves through lower energy bills.

Simple Payback:

Cost of upgrades:	$22,537
Annual energy savings:	$13,205
Time to positive cash flow:	***1 year and 8 months***

However, Simple Payback is a poor method for analyzing a project with a long product life, such as a building, because it does not convey how savings continue to accrue after the payback period. A better method recommended by the US Department of Energy for financial analysis is Life Cycle Cost (LCC). The LCC analysis balances upfront costs with longer term consumer costs and savings It is therefore the primary economic metric by which DOE evaluates the cost-effectiveness of building energy codes. Assuming a discount rate of 6% and a 3% rise in the cost of energy per year, the LCC of the savings grows to $202,264 over the assumed 30-year life of the building. A visual representation of this can be seen in Figure 5 below (see middle line):

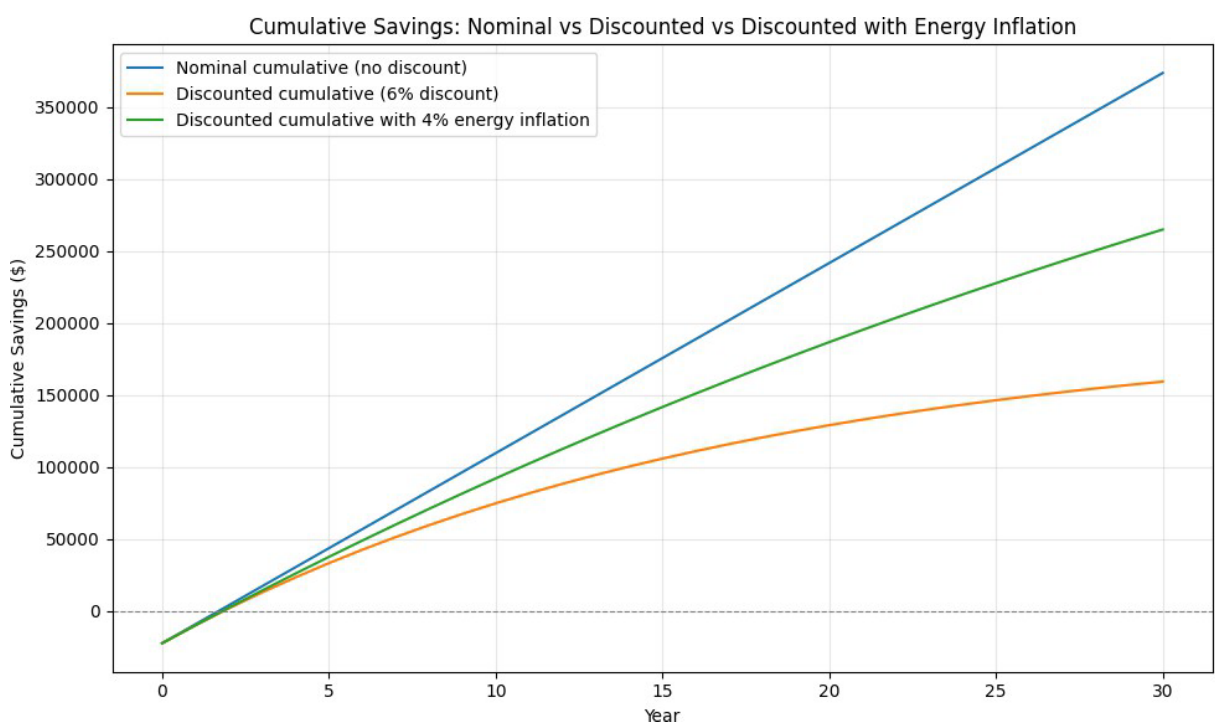

Figure 5
Net Present Value calculation assuming cost of capital of 6% and energy inflation of 4%/year
LCC and cashflow scenarios assume 3% annual inflation

Loan Considerations

When financing a new home or building, financing methods and products can have a significant impact on the overall viability of the project. For commercial buildings, it is typical to require a 25% down payment on the loan and to finance the remaining amount. Often, preferential terms on the interest rate or a longer term on the loan can be obtained for energy-efficient buildings, reflecting the lower risk of default on high efficiency buildings. In the following scenarios, we consider various options: the assumption of no advantage from the improved energy efficiency of the building (scenario 1), a modest interest rate reduction (scenario 2), and a longer term of the loan (scenario 3). Scenarios 2 and 3 illustrate the impact of improved terms for energy-efficient buildings.

Scenario 1: No advantage

This scenario assumes there is no financial advantage derived from the improved energy efficiency except for the lower energy costs related to the improved building envelope. The incremental costs associated with the energy improvements have been added to the building costs and compared to the base 2018 case. As can be seen in Table 5 below, the additional energy savings result in a net decline of $941 in the monthly operating expense due to the improved energy efficiency of the building.

	Base Case	Scenario 1
Base Cost	$10,000,000	$10,000,000
Additional Cost IECC 2018 - 2024		$22,537
Total Cost	$10,000,000	$10,022,573
Down Payment (25%)	$2,500,000	$2,505,643
Loan amount (75%)	$7,500,000	$7,516,930
Interest Rate	7%	7%
Loan Term (yrs)	25	25
Monthly Payment	($70,678)	($70,837)
Energy Savings/month	0	$1,100.4
Net monthly cost	($70,678)	($69,737)
Net monthly cash savings	0	941
Energy Cost Inflation/year	3.0%	3.0%
Total Savings over Loan Term	0	$202,246.48

Table 5
Monthly Cash Flow Analysis

Assuming the life of the building is only 25 years, the accumulated net present value of the savings is $202,246, assuming an average energy cost inflation rate of 3%. From a cash flow point of view, the improvements immediately drive down the operating costs of the building.

Scenario 2: Modest reduction in interest rate.

In this scenario, a modest reduction in interest rate was assumed of 0.2% over the term of the 25-year loan. It is difficult to predict exactly what these amounts will be, and each financing package is different. For example, if we assume the CPACER program, it may be that only a portion of the loan is provided with a longer term or interest rate reduction. However, for purposes of simplicity, a small 0.2% advantage was applied to the loan over the 25-year term. The result of this change has a significant impact on the monthly cash flow, as can be seen in Table 6 below:

	Base Case	Scenario 2
Base Cost	$10,000,000	$10,000,000
Additional Cost IECC 2018 - 2024		$22,537
Total Cost	$10,000,000	$10,022,573
Down Payment (25%)	$2,500,000	$2,505,643
Loan amount (75%)	$7,500,000	$7,516,930
Interest Rate	7%	6.8%
Loan Term (yrs)	25	25
Monthly Payment	($70,678)	($69,564)
Energy Savings/month	0	$1,100.4
Net monthly cost	($70,678)	($68,463)
Net monthly cash savings	0	2,214
Energy Cost Inflation/year	3.0%	3.0%
Total Savings over Loan Term	0	$468,370.51

Table 6
Monthly Cash Flow Analysis

Assuming a modest interest rate reduction of just 0.2%, the monthly cash flow expense declines by $1,100 per month and accumulates $468,370 over the 25-year life of the loan. This analysis is conservative, considering the building's life will likely be much longer than the 25-year term of the loan. By combining the benefits resulting from energy savings with improved financing, the choice to invest in additional energy savings is compelling.

Scenario 3: Longer Term Financing

This scenario assumes the original interest rate of the base 2018 design but allows for a longer term of the loan. In this scenario, the loan term is extended an extra 5 years to a 30-year amortization period. The interest rate and other related costs are assumed to be the same. As can be seen in Table 7 below, increasing the term by just 5 years reduces the monthly cash flow requirement by $5,098 per month, a 7.2% reduction in monthly cash when compared to the 2018 base case. However, the total amount paid increases due to the longer term of the loan.

	Base Case	Scenario 3
Base Cost	$10,000,000	$10,000,000
Additional Cost IECC 2018 - 2024		$22,537
Total Cost	$10,000,000	$10,022,537
Down Payment (25%)	$2,500,000	$2,505,643
Loan amount (75%)	$7,500,000	$7,516,930
Interest Rate	7%	7.0%
Loan Term (yrs)	25	30
Monthly Payment	($70,678)	($66,680)
Energy Savings/month	0	$1,100.4
Net monthly cost	($70,678)	($65,580)
Net monthly cash savings	0	5,098
Energy Cost Inflation/year	3.0%	3.0%
Total Savings over Loan Term	0	($650,363.21)

Table 7
Monthly Cash Flow Analysis Scenario 3

The financial analysis illustrates that even without preferred financing from lending institutions related to energy-efficient building design, the additional energy improvements made to the building drive down the monthly operating cost of the building, and if there are any financial incentives to build according to the IECC 2024 building code, the cost of ownership on a monthly basis is lower.

Analysis Results for "Pray Street" Single Family

The Residential building analyzed using this methodology was provided by a member of the local chapter of the American Institute of Architecture. The building is a 2-story wood framed structure with approximately 2,100 square feet gross area. An overview of the building, along with related assumptions, is shown in Figure 6 below:

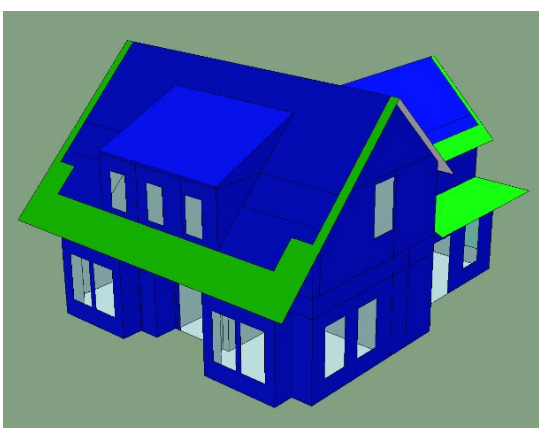

Figure 6

General Building Assumptions

- Building type: Residential Single Family
- Areas:
    - Conditioned ~ 2,230 ft^2,
    - Exterior Wall ~ 3,123 ft^2,
    - Windows/Doors ~ 504 ft^2
- Location: Portsmouth NH, Climate Zone 5A
- Weather file for energy model: USA_NH_Pease.Intl.Tradeport.726055_TMY3.epw
- Software version: IESVE 2025

HVAC Systems Description

Identical for IECC 2018 and IECC 2024 model cases:

- Single zone AHUs with DX cooling, gas furnace and energy recovery ventilator.
- Setpoints: 71˚F heating, 76˚F cooling, no setbacks.
- 75 cfm of mechanical ventilation.
- Internal gains, interior shading, vacation periods per Building America House Simulation Protocols.
- Two (2) systems. One (1) for the 1st floor and one (1) for the 2nd floor.
- DWH production, laundry makeup air and exhaust are not modeled. They would not be a differentiating factor between the 2 models. All HVAC equipment is auto-sized per ASHRAE 90.1 requirements, based on Portsmouth's design conditions. No natural ventilation modeled.

Cost Estimates

An independent organization was contracted by NH ASHRAE to perform the cost analysis for this study. Project Resources Group, under the leadership of John Pietroniro, performed the analysis utilizing cost data specific to New Hampshire. Material costs for the building were calculated based on the average from the following sources:

- Hamshaw Lumber
- Jackson Lumber
- Belletete's Lumber
- Home Depot
- Lowe's
- Lansing Building Products
- Hancock Lumber
- New England Air Barrier

Labor rates were derived from prevailing wage rates in Belknap County and included a 40% markup for payroll burden and 25% for overhead for billing. Air sealing was reduced from the 2018 IECC specification of 5 ACH to the 2024 specification of 3 ACH and assumed additional labor at an average of one worker for a day at $75/MH. This equates to $75 x 8 MH, or $600. At a conditioned space of 2730 SF, the cost per SF is $600/2730 square feet, or $0.22/SF.

A summary of the incremental cost estimate for increasing the building from the IECC 2018 code base to the IECC 2024 code base can be seen in Table 8 below:

ITEM	SPECIFICATION	CODE YEAR	QTY	Unit	$/Unit	TOTAL	DELTA FROM 2018
SLAB EDGE INSULATION	R-10 @ 2 FT	2018	320	SF	$2	$646	
	R-10 @ 3 FT	2024	480	SF	$2	$970	$324
BASEMENT WALL INSULATION	R-15 c.i.	2018	0	SF			
	R-15 c.i.	2024	0	SF			
SLAB VAPOR BARRIER	6 MIL	2018	1400	SF	$0	$126	
	10 MIL	2024	1400	SF	$0	$182	$56
Windows	U 0.30	2018	25	EA	$3,575	$36,850	
	U 0.28	2024	25	EA	$3,842	$39,601	$2,751
Doors	U0.30	2018	3	EA	$6,400	$9,300	
	U0.28	2024	3	EA	$8,388	$11,776	$2,476
EXTERIOR WALLS	R-13 + 5 ci	2018	2730	SF	$2	$4,941	
	R-13 + 10 ci	2024	2730	SF	$3	$7,671	$2,730
AIR-SEALING	ACH50<5.0	2018	2227	SF			
	ACH50<3.0	2024	2227	SF	$0	$490	$490
ROOF/ATTIC	R-49	2018	1274	SF			
	R-49	2024	1274	SF			
FLOOR	R-30	2018	1274	SF			
	R-30	2024	1274	SF			
BLOWER DOOR TEST	REQUIRED	2018	1	LS	$300	$300	
	3RD PARTY QA/QC	2024	1	LS	$500	$500	$200
	SUBTOTAL ALL						$9,027

Table 8

Cost analysis of assuming the IECC 2024 Building Code Specifications as compared to the IECC 2018 specifications.
Specific to Climate Zone 5A

Energy Model Output

Figure 7 below is a prediction of the heating (red) and electricity (blue) energy consumption by MBTU for each month of last year. Weather data for temperature was provided by the Laconia Airport Weather Station. As can be seen in the figure, the dominant energy parameter is the heating load over the 12-month period.

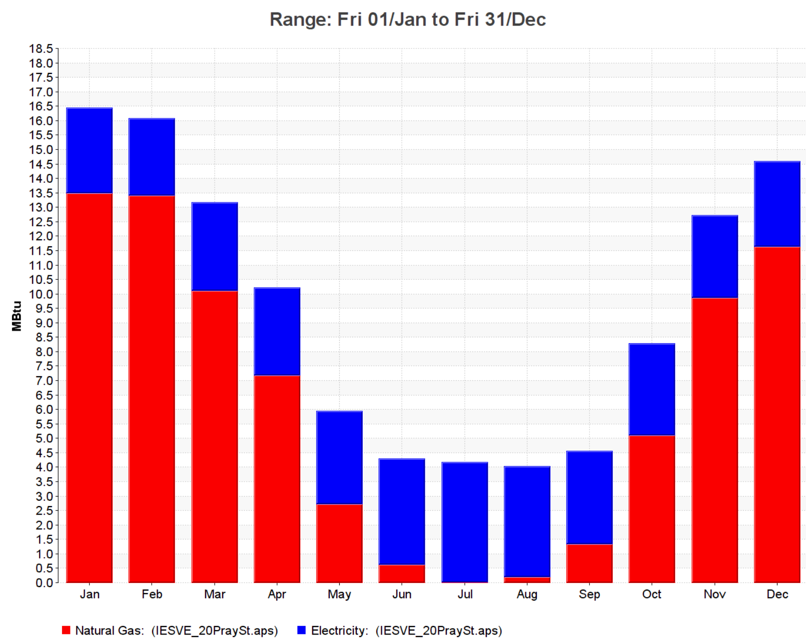

Figure 7
LP Gas consumption in red, Electrical Energy consumption in blue, for each month of a 12-month period

A breakdown of the overall energy consumption is shown in Figure 8 below. Consumption is dominated by heating and cooling requirements. Energy-efficient lights represent approximately 18% of the overall electrical energy consumption and are the same specification in both the IECC 2018 and 2024 building codes.

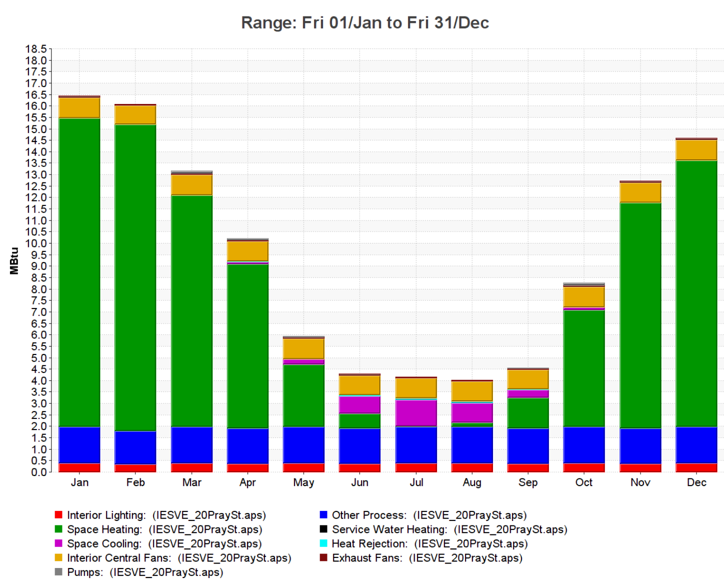

Figure 8
Breakdown of total energy use for “The Villages at Province Street”

In the late 1980’s ASHRAE and the US Department of Energy (DOE) began promoting the Energy Utilization Index through research and modeling tools. EUI (Energy Utilization Intensity) is a metric used to measure a building's energy efficiency related to the conditioned space in the building. Institutions, including the US Green Building Council, ENERGY STAR, and the DOE's Energy/Plus simulation programs, incorporated EUI as a key metric to enable performance ratings for buildings of differing types. A chart of median EUI values for Single Family Buildings in climate 5A can be seen in Figure 9 below. The single-family home modeled in this study results in an EUI of 42.68 based on the 2024 IECC energy code, a 17% reduction as compared to the IECC 2018 energy code.

Typical Energy Use Intensity by Building Type

(Based on LBNL Building Performance Database — Median Performance)

Building Type	Typical Site EUI ($kBtu/ft^2$-yr)	Typical Source EUI ($kBtu/ft^2$-yr)
Office	~50 – 60	~75 – 90
School (K-12)	~40 – 50	~60 – 70
Retail	~40 – 60	~60 – 85
Hospital	~200 – 250	~300 – 350
Lodging (Hotel)	~80 – 100	~120 – 150
Data Center	~300+	~400+
Single-Family Home	**~30 – 45**	**~70 – 95**

* *Typical Energy Use Intensity ranges represent* median values derived from the Lawrence Berkeley National Laboratory Building Performance Database.

Table 8

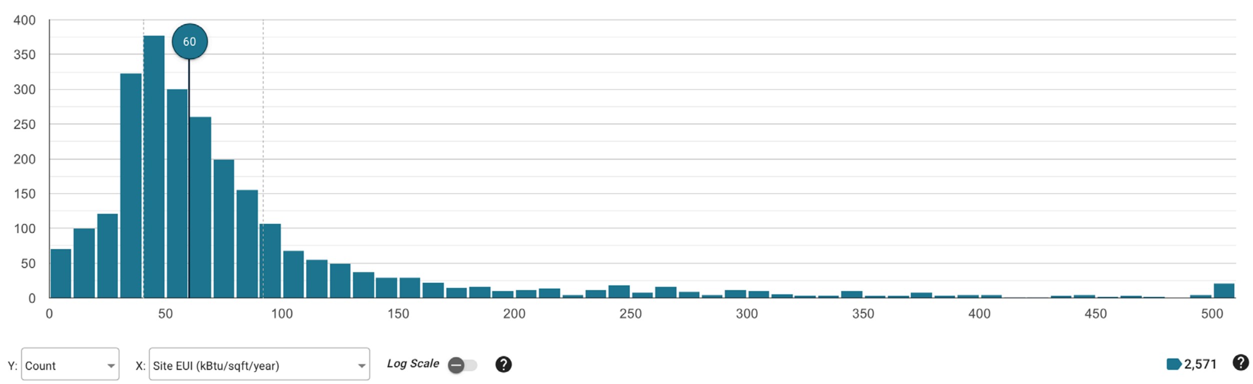

Figure 9
BENCHMARK (Median Site EUI for Single Family buildings, in Climate 5A, built after 2000)
From the Building Performance Database

The predicted EUI for the single-family home based on the IECC 2018 code is 51.33 kBtu/ft2 and the EUI for the same building under the IECC 2024 code is 42.68 kBtu/ft2, a savings of 8.65 kBtu/ft2 or 16.8%. The dominant parameter in the analysis is air infiltration as the lower 3 ACH @50 Pa reduces the heat leakage significantly. Assuming the cost of LP gas to be $3.40/gallon and the cost of electricity to be $.23/kWh, the annual cost to operate the building declines by $764 per year or 14%. A summary of the modeling output results can be seen in Table 9 below:

	IECC 2018	IECC 2024
EUI (Total) (kBtu/ft²)	51.3	42.7
EUI (Electricity) (kWh/ft²)	17.4	16.7
EUI (Gas) (kBtu/ft²)	33.9	26
Interior Lighting (kBtu/ft²)	2.1	2.1
Space heating (gas) (kBtu/ft²)	34	26
Space heating (elec) (kBtu/ft²)	0	0
Space cooling (kBtu/ft²)	1.6	1.6
Pumps (kBtu/ft²)	0.2	0.3
Fans interior (kBtu/ft²)	5	4.3
Heat Rejection (kBtu/ft²)	0.1	0.1
Receptacle equipment (kBtu/ft²)	8.4	8.4
Volume L Propane (US gal)	827	634
Propane Cost @$3.4/gal	$2,813.38	$2,155.04
Electricity Cons (kWh)	11,358	10,896
Electricity Cost @$0.23/kWh	$2,612.31	$2,506.00
Total Cost of Operation	$5,425.69	$4,661.04
Annual Operational Cost Savings		$764.64

Financial Analysis

Synthesizing the estimates for the increased cost of compliance and annual energy savings, the financial impacts of more efficient energy building codes can be assessed. Assuming the initial cost of the building was approximately $780,000 an additional investment of $9,000 would be required to comply with the 2024 IECC. In every realistic financing scenario considered, the more efficient building leads to decreased cost of ownership, among the many other benefits associated with energy-efficient buildings.

A method that is often used for initial assessment is Simple Payback. Simple Payback refers to the time it takes to recover the initial investment and does not consider the time value of money, the increase in energy unit cost over the period of recovery, or the accumulated savings over the life of the building. Assuming this method is used, the “Simple Payback” occurs within 12 years on this single-family building.

Simple Payback:

Cost of upgrades: $9000

Annual energy savings: $765

Time to positive cash flow: ***12 years***

However, Simple Payback is a poor method for analyzing a project with a long product life, such as a building, because it does not convey how savings continue to accrue after the payback period. A better method recommended by the US Department of Energy for financial analysis is Life Cycle Cost (LCC). The LCC analysis balances upfront costs with longer term consumer costs and savings It is therefore the primary economic metric by which DOE evaluates the cost-effectiveness of building energy codes.
Assuming a discount rate of 6% and a 3% rise in the cost of energy per year, the LCC of the savings grows to $14,700 over the assumed 30-year life of the building.

Financing Considerations

When financing a new home or building, financing methods and products can have a significant impact on the overall viability of the project. For residential buildings, it is typical to require a 10% down payment on the loan and to finance the remaining amount. Often, preferential terms on the interest rate or a longer term on the loan can be obtained for energy-efficient buildings, reflecting the lower risk of default on high efficiency buildings. In the following scenarios, we consider two options: the assumption of no advantage from the improved energy efficiency of the building (scenario 1), and a modest interest rate reduction (scenario 2). Scenario 2 illustrates the impact of improved terms for energy-efficient buildings.

Scenario 1: No advantage

This scenario assumes there is no financial advantage derived from the improved energy efficiency except for the lower energy costs related to the improved building envelope. The incremental costs associated with the energy improvements have been added to the building costs and compared to the base 2018 case. As can be seen in Table 10 below, the additional energy savings results in a modest decrease in the monthly operating expense due to the improved energy efficiency of the building.

	Base Case	Scenario 1
Base Cost	$780,000	$780,000
Additional cost for energy improvements		$9,000
Total Cost	$780,000	$789,000
Down Payment (10%)	$78,000	$78,900
Loan amount (90%)	$702,000	$710,100
Interest Rate	7%	7%
Loan Term (yrs)	30	30
Monthly Payment	($5,189)	($5,249)
Energy Savings/month	0	$63.8
Net monthly cost	($5,189)	($5,185)
Net monthly cash savings	0	4
Energy Cost Inflation/year	3.0%	3.0%
Total Savings over Loan Term	0	$1,810.90

Table 10

Monthly Cash Flow Analysis with no incentive

Assuming the life of the building is only 30 years, the accumulated net present value of the savings is approximately $2000, assuming an average energy cost inflation rate of 3%. From a cash flow point of view, the improvements immediately lower the operating costs of the building.

Scenario 2: Modest interest rate reduction.

In this scenario, a modest reduction in interest rate was assumed to be 0.2% over the term of the 30-year loan. The result of this change has a significant impact on the monthly cash flow, as can be seen in Table 11 below:

	Base Case	**Scenario 2**
Base Cost	$780,000	$780,000
Additional cost for energy improvements		$9,000
Total Cost	$780,000	$789,000
Down Payment (10%)	$78,000	$78,900
Loan amount (90%)	$702,000	$710,100
Interest Rate	7%	6.8%
Loan Term (yrs)	30	30
Monthly Payment	($5,189)	($5,144)
Energy Savings/month	0	$63.8
Net monthly cost	($5,189)	($5,080)
Net monthly cash savings	0	109
Energy Cost Inflation/year	3.0%	3.0%
Total Savings over Loan Term	0	$26,636.10

Table 11
Monthly Cash Flow Analysis

Assuming a modest interest rate reduction of just 0.2%, the monthly cash flow expense declines by $63 per month and accumulates $26,636 over the 30-year life of the loan. This analysis is conservative, considering the building's life will likely be much longer than the 30-year term of the loan. By combining the benefits resulting from energy savings with improved financing, the choice to invest in additional energy savings is compelling.

The financial analysis illustrates that even without preferred financing from lending institutions related to energy-efficient building design, the additional energy improvements made to the building drive down the monthly operating cost of the building, and if there are any financial incentives to build according to the IECC 2024 building code, the cost of ownership on a monthly basis is lower.

Conclusion and Recommendations

The purpose of this analysis is to compare the IECC 2018 energy code with New Hampshire amendments to the IECC 2024 version in support of the New Hampshire Building Code Review Board by analyzing a specific building design in New Hampshire using local material and labor costs. The analysis was performed by building professionals from New Hampshire with many years of experience in the building science field, and careful attention was paid to ensure the analysis was fair and complete.

The first building provided by the BCRB for analysis was a 30-unit multi-family design near completion in the town of Laconia, NH. The study found that moving from the current New Hampshire IECC 2018 building code to the IECC 2024 code would have a minor (.2%) impact on the "upfront" cost to build the structure but would immediately reduce the monthly operating costs of the building. These operational savings offset the upfront investment by reducing energy consumption by approximately 15% and return the investment within the first two years of operation under any of the scenarios considered (a simple payback of 1.7 years). Moreover, the benefits would continue to accrue over the life of the building with a net present value of $202,264 over the assumed 30-year life of the building. The energy efficiency savings predicted is consistent with a recent study performed in Massachusetts on the effectiveness of energy modeling to predict energy savings and the resulting measured savings. [11]

The second building in this study is a single-family home located in the town of Portsmouth NH. The study found that moving from the current New Hampshire IECC 2018 building code to the IECC 2024 code would have a minor (1%) impact on the "upfront" cost to build the structure but would immediately reduce the monthly operating costs of the building. These operational savings offset the upfront investment by reducing energy consumption by approximately 14% and return the investment within 12 years of operation when assuming no financial incentives apply, and 4.3 years under the assumption of a .2% reduction in the interest rate attributed to an energy efficient design compliant with the latest IECC energy efficiency building code. Moreover, the benefits would continue to accrue over the life of the building with a net present value of $26.636 over the assumed 30-year life of the building. The energy efficiency savings predicted is consistent with a recent study performed in Massachusetts on the effectiveness of energy modeling to predict energy savings and the resulting measured savings. 11

There are several national FHA secured energy efficient mortgage programs offered through local lenders in NH. They allow for energy efficiency upgrades and/or new construction costs to be financed within the primary mortgage and typically yield more favorable underwriting than standard mortgages due to the projected energy savings. Both Fannie Mae and Freddie Mac also offer programs including the "HomeStyle Energy", and "GreenChoice Mortgage" that allow energy efficiency design to be considered during the construction or energy retrofit of a home.

It is therefore the recommendation of the authors of this study to adopt the 2024 IECC Building Code and recommend that the BCRB pass the same recommendation on to the New Hampshire Legislature.
Updating the energy building code will reduce energy consumption, lower utility costs for owners and renters, improve the resilience of our buildings, improve the health and comfort of building occupants, and contribute to a more sustainable environment by reducing fossil fuel pollution and greenhouse gas emissions while helping the state achieve its Priority Climate Action Plan.

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[11] Scaling Up Passive House Multifamily: The Massachusetts Story. 2022 Summer Study on Energy Efficiency in Buildings