MEMORANDUM

Pacific Northwest NATIONAL LABORATORY

Date:	**12/12/2022**		
To:	**Bridget Herring, North Carolina Building Code Council**	Information Release #	**PNNL-180509**
From:	**Vrushali Mendon, Rob Salcido, and YuLong Xie**		
Subject:	**Cost-Effectiveness Analysis of the 2024 North Carolina Energy Conservation Code**		

The State of North Carolina is in the process of updating their current residential energy code, the 2018 North Carolina Energy Conservation Code (NCECC) which is an amended version of the 2015 International Energy Conservation Code (IECC), to the 2024 NCECC, which is an amended version of the 2021 IECC. The Building Code Council of North Carolina requested an analysis on the energy, environmental, and economic impacts of the proposed code. To assess these impacts, PNNL analyzed the cost-effectiveness of adopting the 2024 NCECC compared to the 2018 NCECC.

Moving to the 2024 NCECC is cost-effective for both single-family and low-rise multifamily residential buildings when compared to the 2018 NCECC in North Carolina. The new code will provide energy cost savings of 18.7%. This equates to $399 of annual utility bill savings for the average North Carolina household as detailed in Table 1. Adopting the 2024 NCECC will also result in societal benefits such as cost savings and reduced greenhouse gas emissions. During the first year alone, North Carolina residents could expect to save over $15,372,000in energy costs and reduce CO_2 emissions by 130,700 metric tons, equivalent to the annual CO_2 emissions of nearly 29,000 cars on the road. Adopting the 2024 NCECC in North Carolina is expected to result in homes that are energy efficient, more affordable to own and operate, and based on newer industry standards for health, comfort, and resilience.

Table 1. Individual Consumer Impact[1]

Metric	Compared to the 2018 NCECC
Life-cycle cost savings of the 2024 NCECC	$4,347
Net annual consumer cash flow in year 1 of the 2024 NCECC [2]	$144
Annual (year 0) energy cost savings of the 2024 NCECC ($)[3]	$399
Annual energy cost savings of the 2024 NCECC (%)[4]	18.7%

Table 2. Societal Benefits

Statewide Impact	First Year	30 Years Cumulative
Energy cost savings, $	15,372,000	5,331,440,000
CO_2 emission reduction, Metric tons	130,700	65,815,000
CH_4 emissions reductions, Metric tons	9.4	4,700
N_2O emissions reductions, Metric tons	1.310	660
NOx emissions reductions, Metric tons	78.5	39,500
SOx emissions reductions, Metric tons	50.3	25,300

Table 3. Statewide Jobs Impact

Statewide Impact	First Year	30 Years Cumulative
Jobs Created Reduction in Utility Bills	755	22,500
Jobs Created Construction Related Activities	1,270	37,900
Total Jobs Created	2,025	60,400

Methodology

DOE's cost-effectiveness methodology evaluates 32 residential prototypes comprising two building types, four foundation types, and four HVAC types. The entire set is simulated with TMY3 weather data representing climate zone 3A, 3AWH, 4A and 5A in this analysis.

Construction cost differences between the 2024 NCECC and the 2018 NCECC were taken directly from DOE/PNNL reports on the cost-effectiveness of new code editions. National cost

[1] A weighted average is calculated across building configurations and climate zones.
[2] The annual cash flow is defined as the net difference between annual energy savings and annual cash outlays (mortgage payments, etc.), including all tax effects but excluding up-front costs (mortgage down payment, loan fees, etc.). First-year net cash flow is reported; subsequent years' cash flow will differ due to the effects of inflation and fuel price escalation, changing income tax effects as the mortgage interest payments decline, etc.
[3] Annual energy savings is reported at time zero, before any inflation or price escalations are considered.
[4] Annual energy savings is reported as a percentage of whole building energy use.

estimates were adjusted by a North Carolina-specific construction cost multiplier[5] and appropriate Consumer Price Index (CPI) multipliers[6] to bring costs into 2022 dollars.

Life Cycle Cost (LCC) savings is the primary measure DOE uses to assess the economic impact of building energy codes. LCC is the calculation of the present value of costs over a 30-year period including initial equipment and construction costs, energy savings, maintenance and replacement costs, and residual value of components at the end of the 30-year period. When the LCC of the updated code (e.g., the 2024 NCECC) is lower than that of the previous code (the 2018 NCECC), the updated code is considered cost-effective.

The energy savings from the simulation analysis are converted to energy cost savings using fuel prices found in Table 3. Fuel prices are escalated over the analysis period based on an escalation factor of 1.6% for all fuel types.

Table 3. Fuel Prices used in the Analysis

Electricity ($/kWh)	Gas ($/Therm)	Fuel Oil ($/MBtu)
0.116	1.253	2.422

The financial and economic parameters used in calculating the LCC and annual consumer cash flow are based on the latest DOE cost-effectiveness methodology to represent the current economic scenario.[7] The parameters are summarized in Table 4 for reference.

Table 4. Economic Parameters Used in the Analysis

Parameter	Value
Mortgage interest rate (fixed rate)	5%
Loan fees	0.6% of mortgage amount
Loan term	30 years
Down payment	10% of home value
Nominal discount rate (equal to mortgage rate)	5%
Inflation rate	1.6%
Marginal federal income tax	15%
Marginal state income tax	5.25%
Property tax	1.1%

[5] https://www.energycodes.gov/sites/default/files/2021-11/Location_Factors_Report.pdf
[6] https://www.usinflationcalculator.com/inflation/consumer-price-index-and-annual-percent-changes-from-1913-to-2008/
[7] https://www.energycodes.gov/sites/default/files/2021-07/residential_methodology_2015.pdf

Consumer Impacts

Moving to the 2024 NCECC is cost-effective for households living in single-family and low-rise multifamily units in North Carolina. Based on a 30-year life-cycle cost analysis, the average consumer can expect to save nearly $4,347 and see a positive cashflow in 3 years.

Table 5 through Table 7 display typical cost-effectiveness metrics analyzed in DOE national and state energy code analyses. These metrics include climate zone specific life-cycle cost savings, consumer cash flow timeframe,[8] and annual energy cost savings. Tables 8 and 9 show the climate zone specific incremental construction costs when updating to the 2018 IECC based on the single-family and multifamily prototypes used in this analysis.

[8]Consumer Cash Flow: Net annual cost outlay (i.e., difference between annual energy cost savings and increased annual costs for mortgage payments, etc.)

Table 5. Life-Cycle Cost Savings of the 2024 NCECC compared to the 2018 NCECC

Climate Zone	Life-Cycle Cost Savings ($)
3A	3,918
3AWH	3,596
4A	8,005
5A	6,079

Table 6. Consumer Cash Flow from Compliance with the 2024 NCECC compared to the 2018 NCECC

	Cost/Benefit	3A	3AWH	4A	5A
A	Incremental down payment and other first costs	$429	$429	$421	$534
B	Annual energy savings (year one) [9]	$395	$381	$545	$523
C	Annual mortgage increase	$236	$236	$231	$294
D	Net annual cost of mortgage interest deductions, mortgage insurance, and property taxes (year one)	$31	$31	$30	$38
E = [B-(C+D)]	Net annual cash flow savings (year one)	$129	$114	$283	$191
F = [A/E]	Years to positive savings, including up-front cost impacts	4	4	2	3

[9] Annual energy savings as reported at year 1, after considering discount rate, inflation, and price escalations.

Table 7. Simple Payback Period for the 2024 NCECC Compared to the 2018 NCECC

Climate Zone	Simple Payback (Years)
3A	11
3AWH	11
4A	8
5A	10

Table 8. Total Single-Family Construction Cost Increase for the 2024 NCECC Compared to the 2018 NCECC

Single-family Prototype House			
Climate Zone	**Crawlspace**	**Slab**	**Unheated Basement**
3A	$4,763	$5,194	$4,763
3AWH	$4,763	$5,194	$4,763
4A	$4,755	$5,186	$4,755
5A	$6,057	$6,487	$6,057

Table 9. Multifamily Construction Cost Increase for the 2024 NCECC Compared to the 2018 NCECC per Dwelling Unit[10]

Multifamily Prototype Apartment/Condo			
Climate Zone	**Crawlspace**	**Slab**	**Unheated Basement**
3A	$1,803	$1,867	$1,803
3AWH	$1,803	$1,867	$1,803
4A	$1,552	$1,616	$1,552
5A	$2,029	$2,092	$2,029

[10] In the multifamily prototype model, the heated basement is added to the building, and not to the individual apartments. The incremental cost associated with heated basements is divided among all apartments equally.

For a more detailed description of the approach PNNL uses to evaluate residential energy code cost-effectiveness, including building prototypes, energy and economic assumptions, and other considerations, please review the latest DOE Residential Cost-Effectiveness Methodology.[11]

[11] https://www.energycodes.gov/sites/default/files/2021-07/residential_methodology_2015.pdf