MEMORANDUM

Date:	**1/8/2024**		
To:	**Lisa Hennigh, Illinois Capital Development Board**	Information Release #	**PNNL- 35349**
From:	**Rob Salcido, YuLong Xie, Fan Feng**		
Subject:	**Cost-Effectiveness Analysis of the Residential Provisions of the Illinois Stretch Energy Code Update**		

As outlined in the Illinois Clean Energy Jobs Act, Public Act 102-0662, the State of Illinois is in the process of developing a stretch residential energy code. The proposed code is an enhancement of the 2021 International Energy Conservation Code (IECC), incorporating key energy saving and readiness measures from the 2024 IECC development process[1]. The State of Illinois requested that PNNL conduct a cost-effectiveness analysis by assessing the energy and economic impact of the code changes that make up the residential provisions of the Illinois Stretch Energy Code (Stretch Code).

The proposed stretch code reduces energy use and operational costs for the occupant, while also ensuring homes are prepared for future electrified technologies, avoiding costly retrofit scenarios in the future.

The resulting analysis shows that the proposed code is cost-effective, yielding short-term and long-term consumer benefits when homes are built to the stretch code as compared to the 2021 IECC. Over the course of 30 years, a homebuyer will net approximately $2,355 in life-cycle energy cost savings as well as $6,474 in avoided future retrofit costs for the electrified technologies, resulting in a total life-cycle cost savings of $8,829.

As shown in Table 2, when only considering energy cost savings, the average household can expect to save 9.6%, equating to $248 of annual utility bill savings. Over a 30-year period, these energy saving measures, collectively, will save almost $2 billion in energy costs and reduce statewide CO_2 emissions by 14,150,000 metric tons, equivalent to the annual CO_2 emissions of 3,077,000 cars on the road (1 MMT CO_2 = 217,480 cars driven/year) as outlined in Table 3. Adopting the Stretch Code will result in homes that are energy efficient, more affordable to own and operate, and which are designed and constructed to modern standards for health, comfort, and resilience.

[1] IECC RESIDENTIAL PUBLIC COMMENT DRAFT #1, December 2022 https://www.iccsafe.org/wp-content/uploads/IECC-RES-PCD1-UPDATE-122622.pdf

Table 1. Individual Consumer Life-cycle Impact of Illinois Stretch Energy Code

Metric	Illinois Stretch Energy Code
Life-cycle energy cost savings	$2,355
Life-cycle decarbonization cost savings	$6,474
Life-cycle total cost savings	$8,829

Table 2. Individual Consumer Energy Cost Savings Impact of Illinois Stretch Energy Code

Metric	Illinois Stretch Energy Code
Net annual consumer cash flow in year 1	$46
Annual (year 0) energy cost savings	$248
Annual energy cost savings (%)	9.6%

Table 3. Statewide Societal Benefits[2]

Statewide Impact	First Year	30 Years Cumulative
Energy cost savings, $	5,873,000	1,997,000,000
CO_2 emission reduction, Metric tons	30,820	14,150,000
CH_4 emissions reductions, Metric tons	1.1	516
N_2O emissions reductions, Metric tons	0.14	65
NOx emissions reductions, Metric tons	23.3	10,700
SOx emissions reductions, Metric tons	4.7	2,170

The Illinois Stretch Energy Code includes the following provisions:

- Allows Passive House US or Passive House International and Appendix RC compliant homes to be used as alternate compliance paths.
- Prescriptive compliance requires buildings to either install heat pump space heating and water heating with a tight envelope or achieve 29 energy credits from Section R408.
- Additional R408 energy credit measures.
- EV readiness or EV Charger installed.
- Electric readiness home requirements.
- Solar readiness home requirements.

[2] This statewide analysis only accounts for benefits associated with the energy saving measures in the Illinois Stretch Energy Code and does not account for the additional benefits (e.g., avoided future costs) of the readiness measures in the code. Those benefits are accounted for in the LCC analysis at an individual consumer level.

- Demand responsive thermostats and water heaters.
- Performance compliance based on site energy rather than site energy costs.
- Section R406 ERI adjustments for ventilation, envelope efficiency backstop and ERI targets based on combustion equipment.
- Existing home energy credit, duct leakage testing, HVAC load calculation and controls requirements.
- Appendix RD All-Residential Buildings added (Optional).
- Appendix RB for Solar Ready Buildings removed (in lieu of solar readiness home requirements).

The Stretch Code contains mandatory requirements for EV readiness, electric readiness, solar readiness and demand response thermostats and water heaters. The readiness of these decarbonization and grid flexibility measures during construction allows homeowners to fully implement them at a much lower cost than when homes are retrofitted in the future. While the decarbonization and grid flexibility measures were not part of the energy simulations, the incremental costs were accounted for in a 30-year cash flow analysis. When accounting for avoided retrofit costs, the life-cycle cost savings associated with installing the decarbonization and grid flexibility measures during the time of construction are $6,474. More detail is provided in the methodology section.

Methodology

To assess the impacts of the Illinois Stretch Code, PNNL analyzed the prescriptive requirements of the stretch code and compared the simulated results to the unamended version of the 2021 IECC using the DOE Residential Building Prototype[3] models and DOE's Residential Cost-Effectiveness Methodology.[4]

The DOE-established methodology analyzes the primary prescriptive requirements of model energy codes for new home construction. As a result, the Stretch Code provisions for performance compliance, ERI compliance, existing buildings or the all-electric appendix are not considered in the analysis. The EV charging, electric readiness, solar readiness and demand response requirements are outside the scope of the traditional simulation analysis as they do not have direct energy use impacts on building energy efficiency. However, the construction costs to implement these measures, along with the avoided future retrofit costs, are included in the cost-effectiveness analysis and described in more detail in the Decarbonization and Grid Flexibility Measures section.

DOE's cost-effectiveness methodology evaluates 32 residential prototypes comprising two building types, four foundation types, and four HVAC system types. Simulations are conducted for single-family and multifamily buildings. The prototypes used in the simulations are intended to represent a typical new one- or two-family home or townhouse and a low-rise (3-story) multifamily building, such as an apartment, cooperative, or condominium. All buildings are

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[3] https://www.energycodes.gov/prototype-building-models
[4] https://www.energycodes.gov/sites/default/files/2021-07/residential_methodology_2015.pdf

evaluated with central air conditioning and each of four heating system types: gas furnace, oil furnace, heat pump, and electric furnace. The multifamily prototypes are simulated with a central oil-fired boiler instead of individual oil furnaces. Four foundation types are examined for all buildings: vented crawlspace, slab-on-grade, and a finished heated basement with basement wall insulation. Table 3 contains the Illinois-specific foundation type weights based on current construction practices found in the field based on a recent state residential energy code field study.[5]

Table 3. Weighting Factors by Foundation Type

Parameter	Weight (%)
Heated Basement	93.4%
Slab-on-Grade	3.8%
Unheated Basement	1.9%
Crawlspace	0.9%

The Stretch Code enables compliance flexibility by providing both separate compliance pathways and an additional efficiency measure table with 25 options. This analysis is based on the prescriptive compliance option (R401.2.1) with additional efficiency measures achieving as close to the minimum number of credits required (29) as possible. This approach represents just one option to comply with the energy code, selecting measures deemed to be relatively common, but it does not necessarily represent the most cost-effective approach. The compliance flexibility embedded within the code allows for optimization in terms of incremental construction costs, energy cost savings, and emissions reduction which should be considered on a case-by-case basis. Table 4 shows the selected energy credits used in this analysis to meet the R408 additional efficiency requirements (29 energy credits) by fuel type.

Table 4 - Energy Credit Selections for Compliance with Illinois Stretch Energy Code Analysis

Energy Credit Measure	CZ 4A	CZ4A (gas)*	CZ 5A	CZ 5A (gas)*
R408.3.1.1 (1): ≥ 2.5% reduction in total UA	NA	NA	1	1
R408.3.1.2: 0.22 U-factor Windows	3	3	NA	NA
R408.3.2 (4) High performance gas furnace 92 AFUE	NA	4	NA	5
R408.3.3 (1): Fossil fuel water heating (0.82 UEF)	NA	3	NA	2
R408.3.3 (2): HPWH option-1 (2.9 UEF)	8	NA	6	NA
R408.3.3 (5): Compact hot water distribution	2	2	2	2
R408.3.4 (2): 100% of ducts in conditioned space	12	12	15	15
R408.3.5 (2): 2 ACH50 air leakage w balanced vent	4	4	5	5
R408.3.6: Energy Efficient Appliances	1	1	1	1
Total Credits	**30**	**29**	**30**	**31**

**Gas furnace prototypes only*

[5] The field study was conducted by the Midwest Energy Efficiency Alliance (MEEA) in 2019.

Selected prototypes are simulated in EnergyPlus with TMY3 weather data for climate zones 4A and 5A. National cost estimates for all stretch code amendments were adjusted by an Illinois-specific construction cost multiplier[6] and appropriate Consumer Price Index (CPI) multipliers[7] to bring costs into 2023 dollars.

Life-Cycle Cost (LCC) 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 30 years 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 (Illinois Stretch Code) is positive the updated code is considered cost-effective. This LCC analysis also considers the upfront costs, and avoided retrofit costs of readiness measures included in the Illinois Stretch Code.

The energy savings from the simulation analysis are converted to energy cost savings using Illinois' latest average fuel prices. Fuel prices are escalated over the analysis period based on an escalation factor of 4.05% for all fuel types.

Data updated and published monthly by the U.S. Energy Information Administration (EIA) are used to determine Illinois' latest average fuel prices for the three fuel types considered in this analysis—electricity, natural gas, and fuel oil. To avoid seasonal fluctuations and regional variations in the price of electricity, the analysis used the average annual residential electricity price of 16.40 ¢/kWh[8] through July 2023. The EIA reports a cost of \$11.906/1,000 ft^3, from an average of winter months from November 2022 to March 2023 and average heat content of 1,043 Btu/ft^3 for natural gas delivered to consumers in Illinois in 2022[9]. The resulting national average price of \$1.142/therm for natural gas was used in this analysis. In addition, the EIA reports a national annual average cost of \$4.266/gallon for No. 2 fuel oil.[10]

Table 5. Fuel Prices Used in the Analysis

Electricity ($/kWh)	**Gas ($/Therm)**	**Fuel Oil ($/gal)**
0.164	1.142	4.266

The financial and economic parameters used in calculating LCC and annual consumer cash flow are based on the latest DOE cost-effectiveness methodology with Illinois-specific economic scenarios. This analysis assumed the average middle-income buyer makes a 13% down

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[6] Utilizing 2020 RSMeans only for state level cost multipliers. https://www.rsmeans.com
[7] https://www.usinflationcalculator.com/inflation/consumer-price-index-and-annual-percent-changes-from-1913-to-2008/
[8] Table 5.6.B. Average Price of Electricity to Ultimate Customers by End-Use Sector. https://www.eia.gov/electricity/monthly/
[9] http://www.eia.gov/oil_gas/natural_gas/data_publications/natural_gas_monthly/ngm.html
[10] https://www.eia.gov/dnav/pet/pet_pri_wfr_dcus_SMI_w.htm

payment[11] on a loan with a mortgage interest rate of 5% for home purchases. The mortgage interest rate is a weighted average of the average mortgage rates using the 5-year average (4.59%) and 1 year average (6.69%) rates.[12] The economic parameters are summarized in Table 6 for reference.

The 30-year mortgage time frame is used as it is the most common loan product; 90 percent of homeowners choose a 30-year mortgage.[13]

Table 6. Economic Parameters Used in the Analysis

Parameter	Average Income Homebuyer
Mortgage interest rate (fixed rate)	5.0%
Loan fees	1.0%
Loan term	30 years
Down payment	13%
Nominal discount rate (equal to mortgage rate)	5.0%
Inflation rate	3.0%[14]
Marginal federal income tax	12%
Marginal state income tax	4.95%
Property tax	2.27%

To evaluate the cost-effectiveness, PNNL estimated the incremental construction costs associated with building to the stretch code when compared to the 2021 IECC. For this analysis, the following cost data sources were converted to 2023 dollars and consulted by PNNL:

- Building Component Cost Community (BC3) data repository
- 2020 RSMeans Residential Cost Data
- 2018 ENERGY STAR Cost & Savings Estimates[15]
- An Overview of Implementation Practices, NREL[16]
- Price data from nationally recognized home supply stores

The incremental costs are calculated separately for each code change and then added together to obtain a total incremental cost by climate zone, building type, and foundation type. Tables 7

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[11] https://cdn.nar.realtor/sites/default/files/documents/2022-home-buyers-and-sellers-generational-trends-03-23-2022.pdf
[12] https://www.freddiemac.com/pmms
[13] https://sf.freddiemac.com/articles/insights/why-americas-homebuyers-communities-rely-on-the-30-year-fixed-rate-mortgage
[14] https://www.usinflationcalculator.com/inflation/current-inflation-rates/
[15] https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Version%203%20Cost%20%20Savings%20Summary.pdf
[16] www.nrel.gov/docs/fy12osti/51296.pdf

and 8 show the climate zone-specific construction costs when updating to the Stretch Code based on the single-family and multifamily prototypes used in this analysis. Costs are separated by energy efficiency measures and decarbonization and grid flexibility (readiness) measures as outlined in the proposed code. Costs have been adjusted using a construction cost multiplier of 1.069 to reflect local Illinois construction costs based on location factors provided by 2020 RS Means and converted to 2023 dollars. The total average incremental costs vary by building type and climate zone but range from ~$5,400 to $7,700 to build to the Stretch Code, when compared to the 2021 IECC.

Table 7. Total Single-Family Construction Cost Increase for the Illinois Stretch Energy Code

Single-family Prototype House					
Climate Zone	**Measure Type**	**Crawlspace**	**Heated Basement**	**Unheated Basement**	**Slab**
4A	Efficiency	$4,841	$4,289	$4,841	$5,112
	Readiness	$3,350	$3,350	$3,350	$3,350
5A	Efficiency	$3,917	$3,366	$3,918	$4,188
	Readiness	$3,350	$3,350	$3,350	$3,350
Average	Combined	$7,375	$6,823	$7,375	$7,646

Table 8. Multifamily Construction Cost Increase for the Illinois Stretch Energy Code[17]

Multifamily Prototype Apartment/Condo		
Climate Zone	**Measure Type**	**All Foundation Types**
4A	Efficiency	$2,319
	Readiness	$3,350
5A	Efficiency	$2,008
	Readiness	$3,350
Average	Combined	$5,395

Decarbonization and Grid Flexibility Measures

The Illinois Stretch Code requires that all new homes contain four measures impacting building decarbonization and grid flexibility – EV readiness, electric readiness (for mixed-fuel homes), solar readiness and demand responsive thermostats and water heaters. Each decarbonization/grid flexibility measure has a direct impact on new construction costs and provides benefits to society (e.g., emissions reductions, enhanced grid stability) and to building occupants (e.g., improved indoor air quality). Although these measures do not have immediate

[17] 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.

energy or energy cost savings that can be analyzed as part of the traditional DOE cost-effectiveness methodology, they do still provide long-term consumer savings. PNNL quantified these savings by considering the avoided cost of installing these measures during new construction versus the higher cost of implementation as a future retrofit.

Table 9 compares costs associated with installing these measures during the time of construction vs. in a retrofit scenario and shows an average consumer saving of approximately $6,500 over the 30-year analysis period. The inclusion of the decarbonization and grid flexibility measures as part of the energy code helps homeowners avoid $8,468 in future retrofit costs.

Table 9. Decarbonization and Grid Flexibility Feature Installation and Avoided Costs

Measure	New Construction Cost	Retrofit Cost	Avoided Cost
EV Readiness[18]	$920	$3,710	$2,790
Electric Readiness**[19]	$1,200	$2,400	$1,200
Solar Readiness[20]	$1,059	$3,637	$2,578
Demand Response[21]	$200	$2,100	$1,900
Total Costs	**$3,379**	**$11,847**	**$8,468**
Life Cycle Costs (Present Value)	**$3,350**	**$9,824**	**$6,474**

*** Mixed fuel prototypes only*

To verify the cost-effectiveness of the decarbonization and grid flexibility measures in the Stretch Code, PNNL utilized a strategy to compare the present value of the additional mortgage costs from these measures (new construction) to the present value of the costs for future installation of the same measures (retrofit).

The additional mortgage costs were calculated using a fixed loan payment function based on the mortgage interest rate (5%) and the downpayment percentage (13%) over a 30-year analysis period. Every mortgage payment was converted to a present value based on the discount rate (5%) and which year the payment occurred using a simple present value calculator. The present values of all mortgage payments over the analysis period were summed together into a cumulative present value. The cumulative present value represents the present value of the new construction costs for the decarbonization/grid flexibility measures.

The future retrofit costs were calculated for each year of the analysis period by multiplying the total retrofit cost by the probability of implementation (100% probability divided by 30) and converted to a future value and inflation rate of 3%. The decarbonization/grid flexibility measures were assumed to have linear growth to eventually achieve 100% probability of

[18] https://www.energycodes.gov/sites/default/files/2021-07/TechBrief_EV_Charging_July2021.pdf
[19] https://www.energycodes.gov/sites/default/files/2022-02/TechBrief_Electric_Readiness_Oct2021_v3.pdf
[20] www.nrel.gov/docs/fy12osti/51296.pdf
[21] Demand response costs contain only the smart thermostat with DR control. The new construction already contains heat pump water heaters with DR control as an energy credit.

implementation over the 30-year period, which is supported by an Illinois' law to achieve 100% clean energy by 2050[22]. Every future retrofit cost was converted to a present value (based on 3% inflation and analysis year) and summed over the 30-year analysis period. This summation represents the present value of the retrofit costs for the decarbonization/grid flexibility measures.

The life-cycle decarbonization and grid flexibility measure cost savings were calculated as the present value of the retrofit costs minus the present value of the added mortgage costs. As shown in Table 9, the present value of the avoided retrofit costs of these measures were $9,824 while the present value of the higher mortgage costs was $3,350 for a life-cycle cost savings of $6,474.

Consumer and Societal Impacts

Moving to the Illinois Stretch Code provides myriad benefits, including direct savings to consumers, environmental benefits from long term emissions reductions, and a more resilient and responsive grid through enhanced demand response in buildings. Over a 30-year period, collectively, Illinois residents could expect to save almost $2 billion in energy costs and reduce statewide CO_2 emissions by 8,075,000 metric tons, equivalent to the annual CO_2 emissions of 3,077,000 cars on the road (1 MMT CO_2 = 217,480 cars driven/year) as outlined in Table 10.

Table 10. Statewide Societal Benefits

Statewide Impact	First Year	30 Years Cumulative
Energy cost savings, $	5,873,000	1,997,000,000
CO_2 emission reduction, Metric tons	30,820	14,150,000
CH_4 emissions reductions, Metric tons	1.1	516
N_2O emissions reductions, Metric tons	0.14	65
NOx emissions reductions, Metric tons	23.3	10,700
Sox emissions reductions, Metric tons	4.7	2,170

The proposed stretch code reduces energy use and operational costs for the occupant, while also ensuring homes are prepared for future electrified technologies, avoiding costly retrofit scenarios in the future.

In addition to statewide societal and environmental benefits, building to the stretch code is cost-effective across all new single-family and low-rise multifamily units in Illinois and will prepare homes for future electrified technologies, avoiding costly retrofit scenarios and creating a healthier and more resilient home for occupants. When amortizing costs and benefits over a typical 30-year mortgage, a homebuyer will net approximately $2,355 in life-cycle energy cost

[22] https://www2.illinois.gov/IISNews/23893-Climate_and_Equitable_Jobs_Act.pdf

savings, and an additional $6,474 in avoided future retrofit costs. This results in a total life cycle cost savings of $8,829 to the average homeowner when building to the Stretch Code.

Table 11. Individual Consumer Life-cycle Impact of Illinois Stretch Energy Code

Metric	Illinois Stretch Energy Code
Life-cycle energy cost savings	$2,355
Life-cycle decarbonization cost savings	$6,474
Life-cycle total cost savings	$8,829

Tables 11 through 13 display typical cost-effectiveness metrics analyzed in DOE national and state energy code analyses. These metrics include life-cycle cost savings, consumer cash flow timeframe,[23] and annual energy cost savings. Benefits associated with decarbonization and grid flexibility measures are only accounted for in the life-cycle consumer savings analysis as outlined in Table 11. The remaining tables and associated analyses are specific to the energy saving measures in the Stretch Code.

When building to the Stretch Code, Illinois households can expect to save 9.6% in energy costs, equating to $248 of annual utility bill savings. When amortizing annual energy savings and the upfront construction costs of energy saving measures (i.e., often referenced as first costs) – ranging from approximately $3,400 to $5,100 per single-family home and $2,000 to $2,200 per multifamily unit – over a typical 30-year mortgage, homeowners will see a cumulative positive cashflow in the first five to 14 years, depending on building type and climate zone, as shown in Table 13. This means the cumulative annual energy cost savings are greater than the cumulative costs (initial downpayment cost and increased loan payment) by this time.

Table 12. Individual Consumer Energy Cost Savings Impact of Illinois Stretch Energy Code

Metric	Illinois Stretch Energy Code
Net annual consumer cash flow in year 1	$46
Annual (year 0) energy cost savings	$248
Annual energy cost savings (%)	9.6%

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

Table 13. Consumer Cash Flow from Compliance with the Illinois Stretch Energy Code

	Cost/Benefit	4A	5A	Average
A	Incremental down payment and other first costs	$458	$373	$383
B	Annual energy savings (year one)[23]	$220	$267	$262
C	Annual mortgage increase	$181	$148	$151
D	Net annual cost of mortgage interest deductions, mortgage insurance, and property taxes (year one)	$73	$60	$61
E = [B-(C+D)]	Net annual cash flow savings (year one)	$33	$60	$49
F = [A/E]	Years to cumulative positive savings, including up-front cost impacts	14	5	6

On a statewide average, the cost-effectiveness analysis shows that adopting the Illinois Stretch Energy Code over the 2021 IECC will have a simple payback in 11.1 years, as shown in Table 14. The simple payback calculation includes measures which increase energy efficiency, balancing upfront costs of those measures against longer term savings, typically in the form of energy cost savings (utility bill savings) experienced by the consumer. Simple payback is a common metric often used to assess the reasonableness of an energy efficiency investment, defined as the number of years required for the sum of the annual returns on investment to equal the original investment. However, simple payback does not consider the full range of costs experienced by the consumer, such as the effects of financing, taxes or costs of maintaining or replacing equipment, and other important factors. It is simply the ratio of the incremental construction cost and the first-year energy cost savings. The simple payback calculation also does not account for the benefits of many new technologies, particularly decarbonization measures which provide benefits in the form of demand response or avoided costs retrofits in the future, such as pre-wiring for EV charging, solar and electric equipment.

Table 14. Simple Payback Period for the Illinois Stretch Energy Code

Climate Zone	Simple Payback (Years)
4A	15.8
5A	10.6
Average	11.1

Simple payback calculations may be helpful to determine how long it takes the annual returns on investment to equal to the original investment. However, this often oversimplifies the financial evaluation to exclude the best financial performance options and does not present a complete picture of the range of costs and benefits faced by the consumer. Given the limitations of the simple payback analysis, LCC is the preferred metric to determine the cost-effectiveness of the code or specific code changes because it comprehensively examines all homeowner costs and savings attributable to the efficiency investment over a 30-year period.

In addition to the economic benefits outlined in this analysis, energy-efficient homes built to the latest energy-efficient codes are more durable, resilient, and help lower mortgage default rates, nationally, on average, by 32 percent.[24] While mortgage costs are typically static month over month, energy costs can vary at different times of the year. In less efficient homes, these cost swings are more volatile, disproportionately impacting first-time and less affluent homebuyers. Illinois has one of the highest mortgage foreclosures nationally, 1 out of every 2,279 units.[25] By updating to the Illinois Stretch Code, homeowners are expected to see more stable energy bills month over month, reducing the financial strain that can lead to foreclosure. Furthermore, states adopting the latest model energy codes are provided more favorable insurance underwriting as they rank higher on the ISO's Building Code Effectiveness Grading Schedule (BCEGS®). This national program rates communities on a scale of one (exemplary commitment to code enforcement) to ten. Currently, Illinois' score is six[26] based energy expenditures in the state. Lastly, homes built to the latest codes are more resilient, enabling occupants to safely shelter in place longer during power outages and extreme weather events.[27] In December of 2022, a blizzard across the Great Lakes region and two-thirds of the eastern US caused a weeklong power outage leaving 250,000 people without power during record low temperatures. At least 35 deaths were attributed to this storm which emphasizes the importance of home resilience to improve survivability of sheltering in the home.[28]

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[24] *Home Energy Efficiency and Mortgage Risks*. UNC Center for Community Capital and Institute for Market Transformation. 2013. https://www.imt.org/wp-content/uploads/2018/02/IMT_UNC_HomeEEMortgageRisksfinal.pdf
[25] https://www.attomdata.com/news/market-trends/foreclosures/attom-january-2023-u-s-foreclosure-market-report/
[26] National Building Code Assessment Report Building Code Effectiveness Grading Schedule. ISO /Verisk. 2019 Edition. https://www.verisk.com/siteassets/media/downloads/underwriting/location/2019-bcegs-schedule.pdf
[27] *Enhancing Resilience in Buildings Through Energy Efficiency*. PNNL. 2023. https://www.energycodes.gov/sites/default/files/2023-07/Efficiency_for_Building_Resilience_PNNL-32727_Rev1.pdf
[28] https://abc7chicago.com/winter-storm-weather-forecast-power-outages-travel/12613253/

More information on the Residential Cost-Effectiveness Methodology, including a detailed description of the approach PNNL uses to evaluate residential energy code cost-effectiveness, building prototypes, energy and economic assumptions, and other considerations are available at www.energycodes.gov.[29]

[29] https://www.energycodes.gov/energy-and-economic-analysis