Decoding the Energy Code

Navigating IECC Energy Savings Analysis

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Working on energy codes since 2003
Committees, 2009 IECC, 2021 IECC, 2024 IECC
90.2 subcommittee
Insulation trade association
Now works at a REEO

SWEEP

The Southwest Energy Efficiency Project (SWEEP) promotes greater energy efficiency, clean transportation, and beneficial electrification through Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming economies.
We work with other REEOs across the country to advance efficiency.

IECC Updates

- Adoption occurs at the state and local government level
- Cost and efficiency questions arise with each new code
- Amendments occur

BUILDINGSAFETYJOURNAL

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Upcoming Release of the 2024 International Energy Conservation Code and International Residential Code with Energy Conservation Provisions

The 2024 IECC and 2024 IRC with energy conservation provisions will be available by the end of August, 2024, in both digital and print formats.

AUGUST 1ST, 2024
by International Code Council

QUICK HITS

he 2024 International Energy Conservation Code® (IECC®) and 2024 International Residential Code® (IRC®) with energy conservation provisions will be available by the end of August 2024, in both digital and print formats.

This highly anticipated release marks the culmination of three years and countless hours of dedicated work by volunteers, including consensus members, subcommittee members and other interested parties.

These resources are essential for architects, builders, engineers and code officials who want to stay at the forefront of industry standards and best practices. Be sure to pre-order your copies of the 2024 IRC and 2024 IECC to stay informed and compliant with the latest advancements in energy conservation and residential construction.

Additionally, the International Code Council Board of Directors has developed a draft scope and intent for the 2027 IECC based on feedback from the 2024 IECC appeals process. Accompanying this draft is a commentary provided by the Board of Directors on the revisions made to the scope and intent. The draft scope and commentary can be found at this link.

SUBMISSIONS

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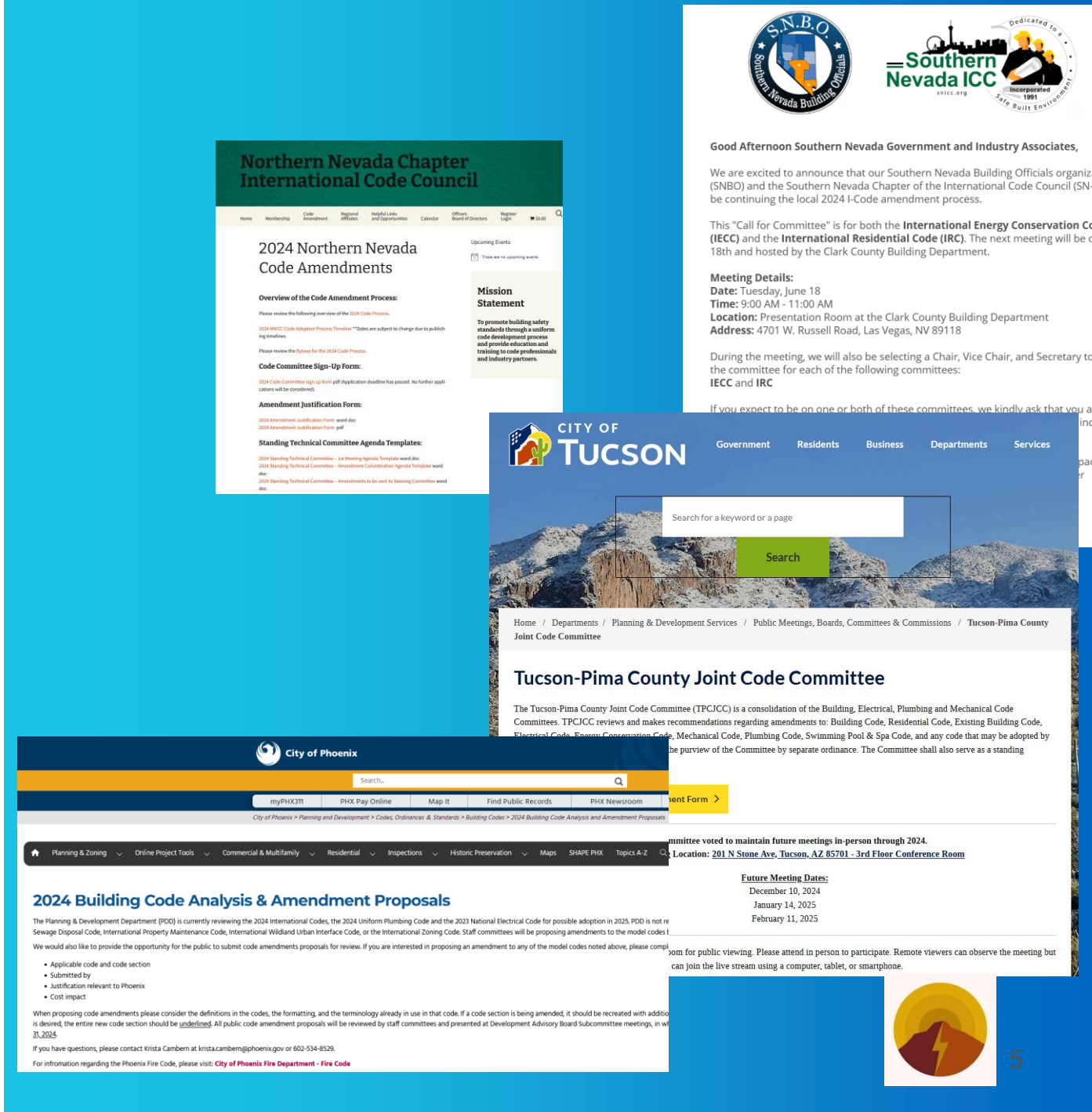
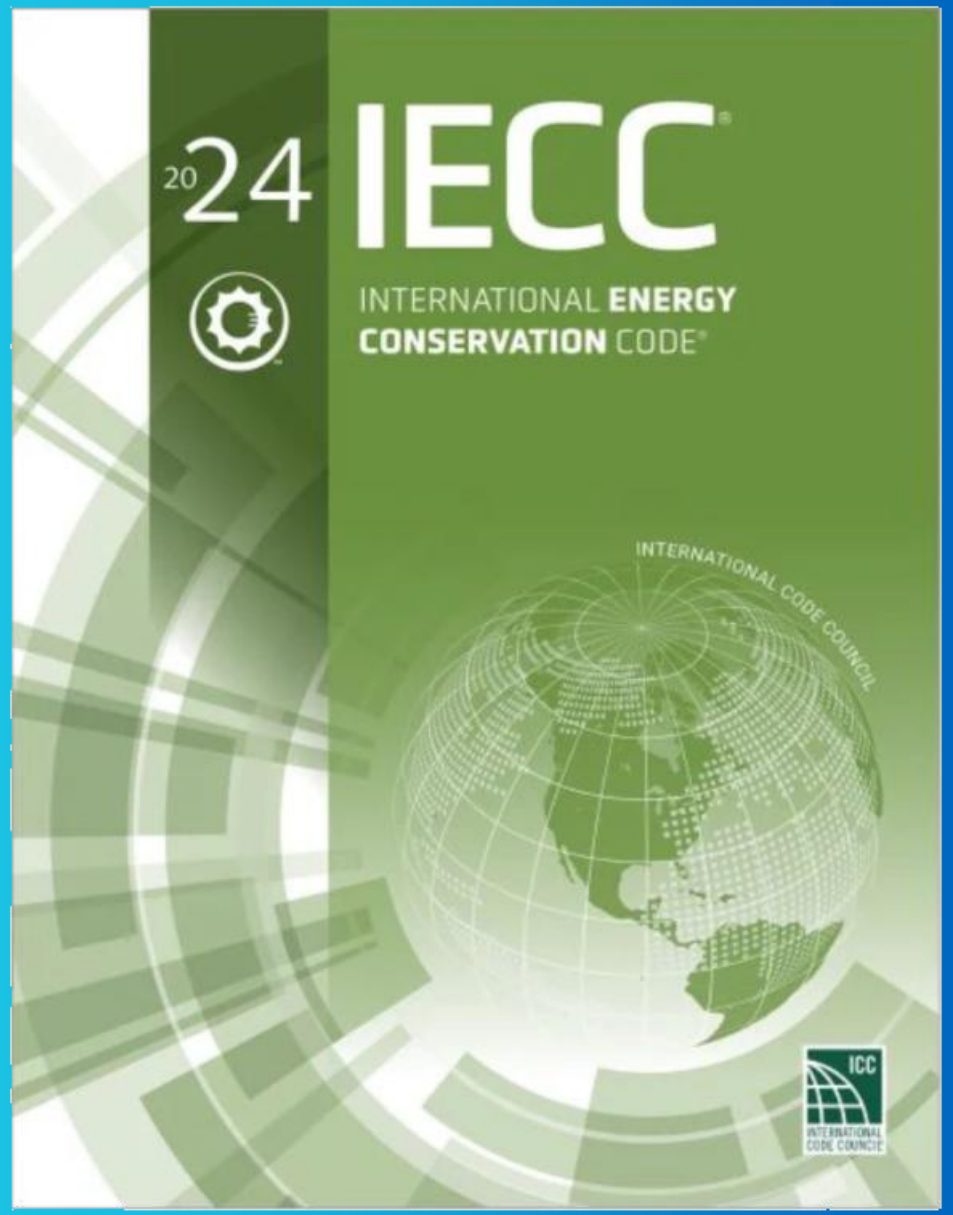
Announcements

- When adoption is at local governments
- Cost and efficiency questions arise with each new code
- Amendments occur



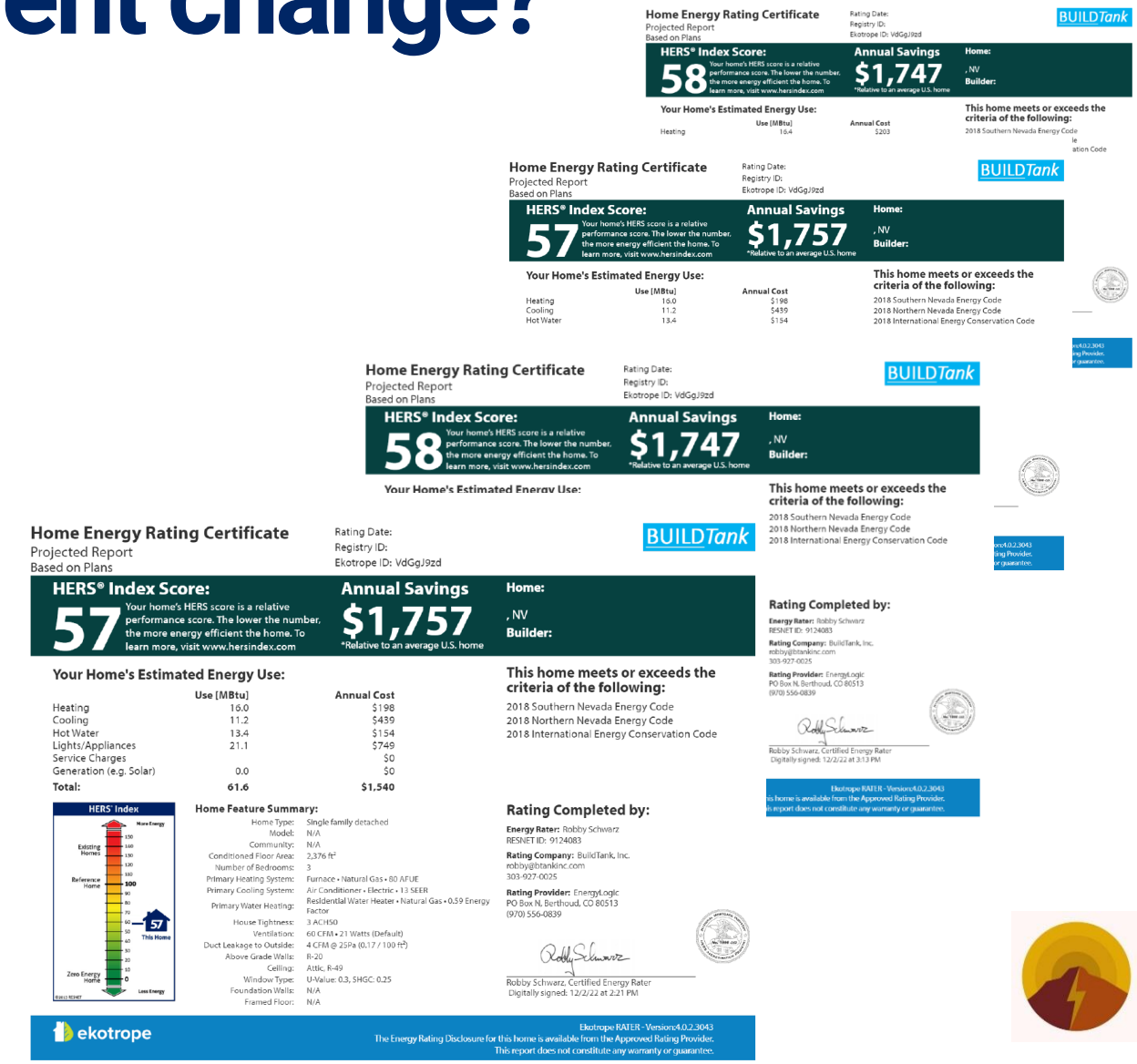


Base Energy Code

- Who typically wants adoption of the base energy code?
  - REEOs, Sustainability Dept, NGOs, industry, DOE
- How can a local building official assess the cost and energy impacts of the new code?

How does a building official understand the impact of one component change?

- Examples:
- Air leakage
- Insulation
- Fenestration
- Duct location



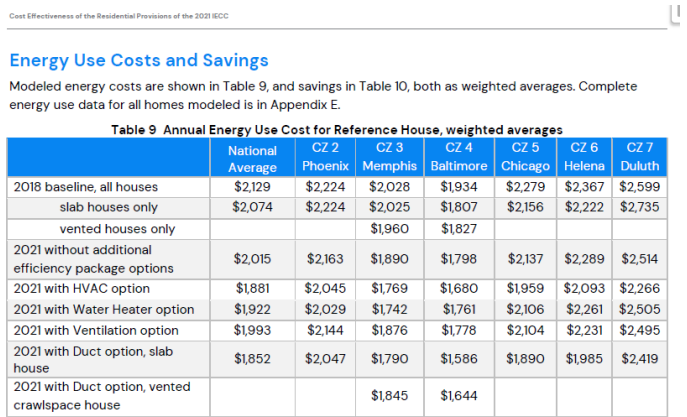
Ekotrope

REM/*Rate*

EnergyGauge

What's available near-term?

- Local code adoption timeline is much shorter than national code development
- DOE Labs
- Other organizations



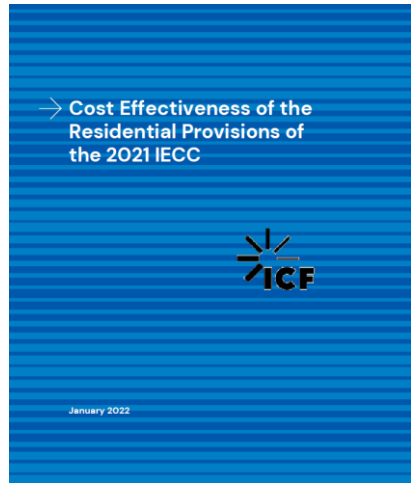
Cost Effectiveness of the Residential Provisions of the 2021 IECC

Energy Use Costs and Savings

Modeled energy costs are shown in Table 9, and savings in Table 10, both as weighted averages. Complete energy use data for all homes modeled is in Appendix E.

Table 9 Annual Energy Use Cost for Reference House, weighted averages

	National Average	CZ 2 Phoenix	CZ 3 Memphis	CZ 4 Baltimore	CZ 5 Chicago	CZ 6 Helena	CZ 7 Duluth
2018 baseline, all houses	$2,129	$2,224	$2,028	$1,934	$2,279	$2,367	$2,599
slab houses only	$2,074	$2,224	$2,025	$1,807	$2,156	$2,222	$2,735
vented houses only			$1,960	$1,827			
2021 without additional efficiency package options	$2,015	$2,163	$1,890	$1,798	$2,137	$2,289	$2,514
2021 with HVAC option	$1,881	$2,045	$1,769	$1,680	$1,959	$2,093	$2,266
2021 with Water Heater option	$1,922	$2,029	$1,742	$1,761	$2,106	$2,261	$2,505
2021 with Ventilation option	$1,993	$2,144	$1,876	$1,778	$2,104	$2,231	$2,495
2021 with Duct option, slab house	$1,852	$2,047	$1,790	$1,586	$1,890	$1,985	$2,419
2021 with Duct option, vented crawlspace house			$1,845	$1,644			



What house is used

- House configuration, what should be used?
- DOE developed a methodology for evaluating residential energy code changes

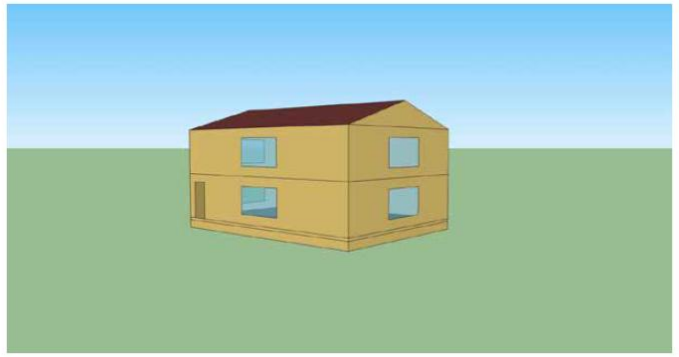
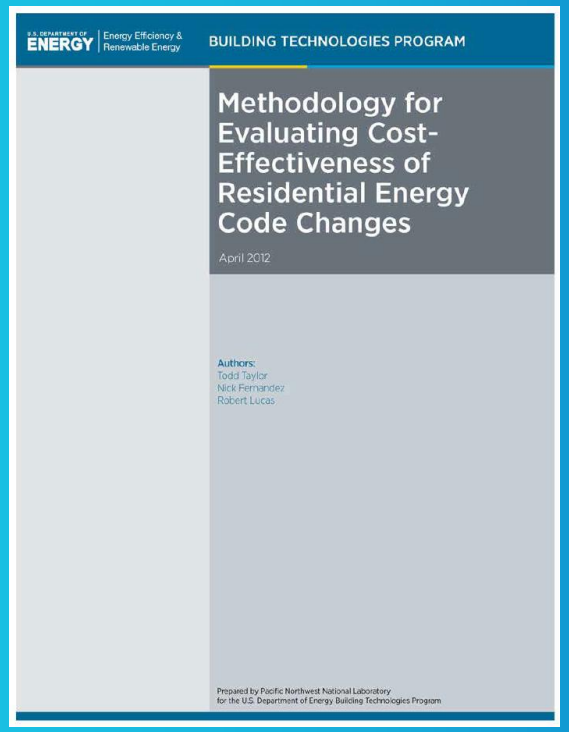


Figure 2.1. Single-Family Prototype

Figure 1 Simulation Model of Standard Reference Hou



U.S. Department of ENERGY | Office of Energy Efficiency & Renewable Energy

Building Technologies Office

December 20, 2024

DOE Issues Updated Model Energy Code Determination for Residential Buildings

The U.S. Department of Energy (DOE) has issued a *determination* that the updated model energy code for residential buildings, the 2024 International Energy Conservation Code (IECC), will increase energy efficiency in residential buildings. DOE technical analysis, performed by Pacific Northwest National Laboratory (PNNL), estimates that buildings meeting the 2024 IECC would result in national *site* energy savings of 7.80%, *source* energy savings of 6.80%, and energy *cost* savings of 6.60%. This action represents DOE's determination for the 2024 IECC as directed under the Energy Conservation and Production Act (ECPA), as amended. (42 USC 6833)

Supporting technical analysis, as well as previous model energy code determinations, are available at: www.energycodes.gov/determinations.

Determination

- Follows the methodology
- Released after each IECC (and 90.1 std) are released
- Only from a national and climate region perspective

Building Energy Codes Program

Mission

To support building **energy code development, adoption, and implementation processes** to achieve the maximum practicable, cost-effective improvements in energy efficiency while providing safe, healthy buildings for occupants.

Directive

The Building Energy Codes Program is statutorily directed to:

- **Participate in industry processes** to develop model building energy codes
- **Issue determinations** as to whether updated codes result in energy savings
- **Promulgate standards** for federal buildings
- **Provide technical assistance** to states to implement their energy codes

Building Energy Codes Program

Participate in industry processes

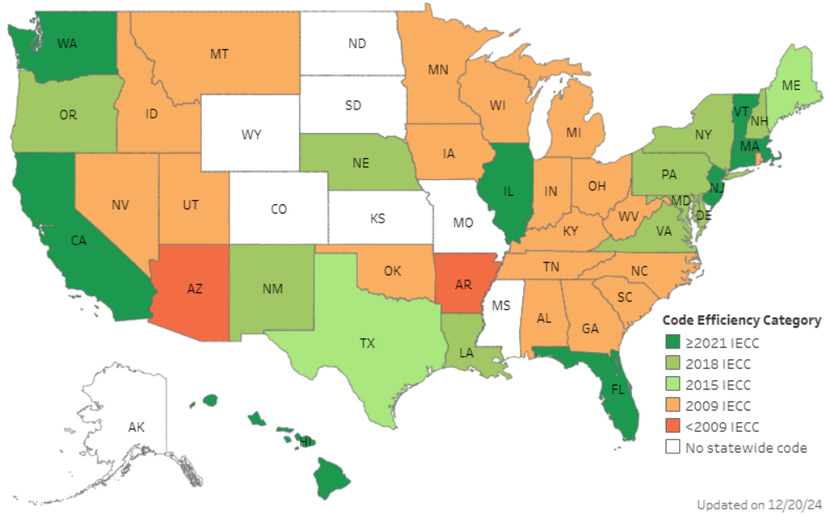
- Code/Standard development committees
- State code adoption maps
- Develop analysis methodologies
- Technical analysis of energy codes and code changes

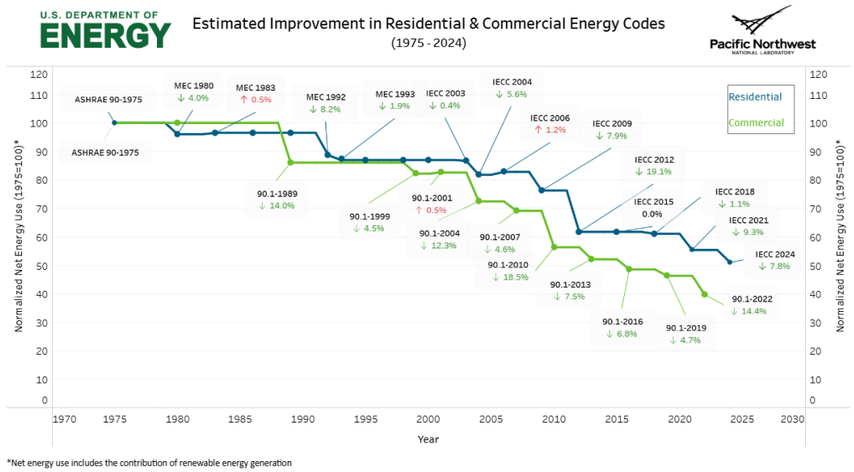
Issue determinations

- DOE is required by the Energy Conservation and Production Act (ECPA) to review published editions of the national model energy codes and issue a determination as to whether the updated edition will improve energy efficiency in residential and commercial buildings.

Supporting implementation and compliance with technical analysis and software tools

- REScheck/COMcheck, Home Energy Score, Asset Score, Total System Performance Review (TSPR)





Residential Analysis Examples

National Level

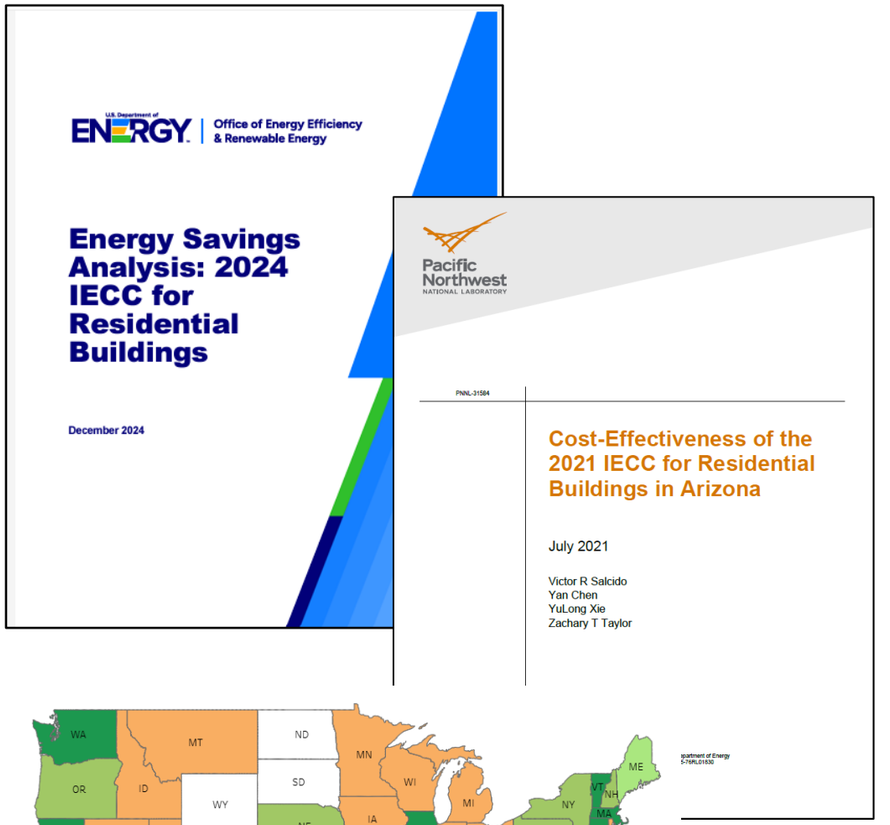
- National Model Code Determinations & Cost-Effectiveness
- Historical Model Code Improvement
- Code Change Proposals
- Technical Briefs and Code Modules

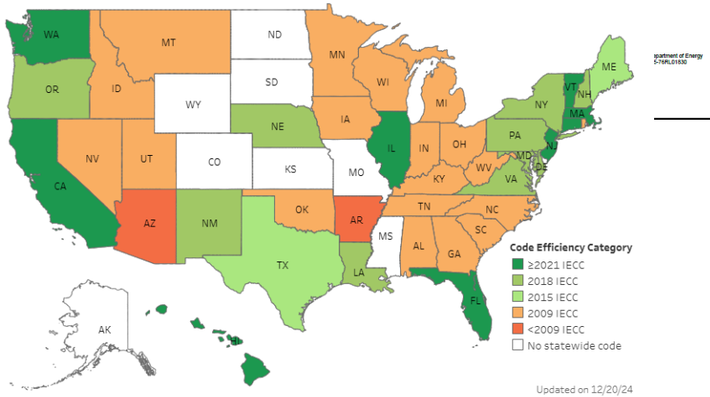
State Level

- State Code Adoption Status – comparison to other model codes
- Energy Impact & Cost-effectiveness
- Custom Impacts Assessment of Amended Codes
- Assessing Resilience Impacts of Energy Codes
- Field Studies - evaluation of code compliance

Local Level

- Establishing code targets and helping to achieve goals
- Evaluation of Energy Credits or other specific amendments

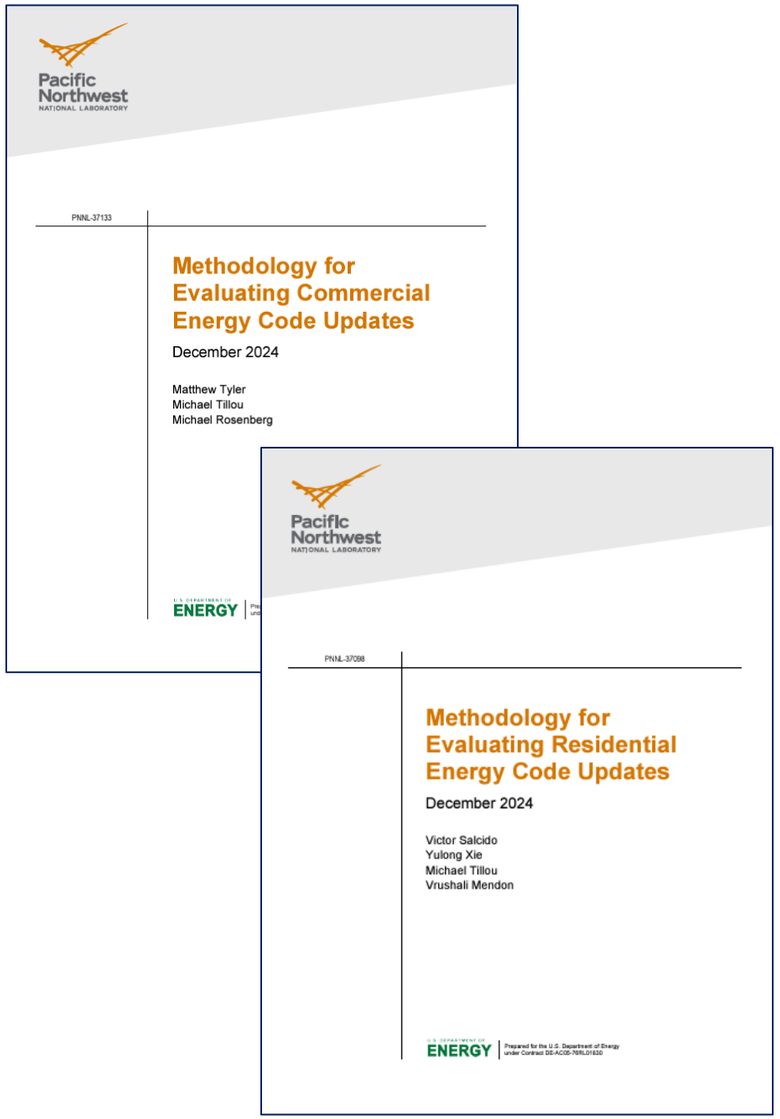




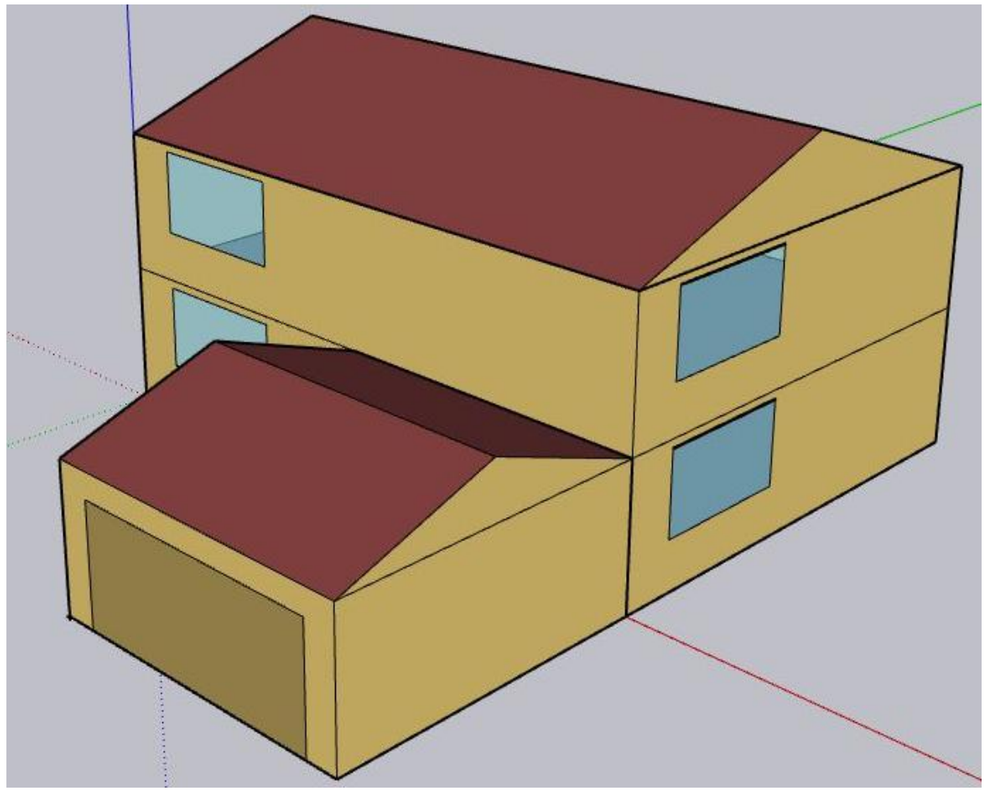
Methodology for Evaluating Residential Energy Code Updates

BECP has an established methodology for evaluating the energy and economic performance of residential energy codes:

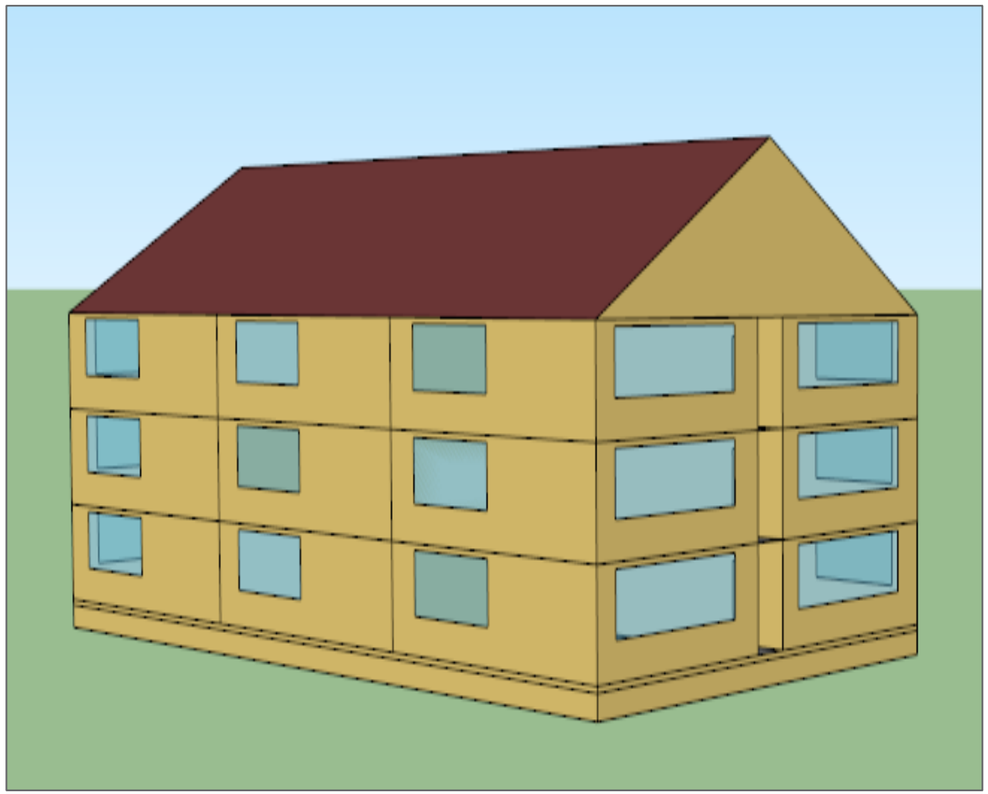
- Estimating energy savings of code changes
- Estimating the cost-effectiveness of code changes
- Aggregation of energy and economic results
  - At State, Climate Zone, County, City-level and Variable Type
- Estimating broader benefits and impacts of code changes
  - State code adoption analysis
  - Cost-effectiveness of readiness code provisions



Residential Prototypes



Single Family Prototype

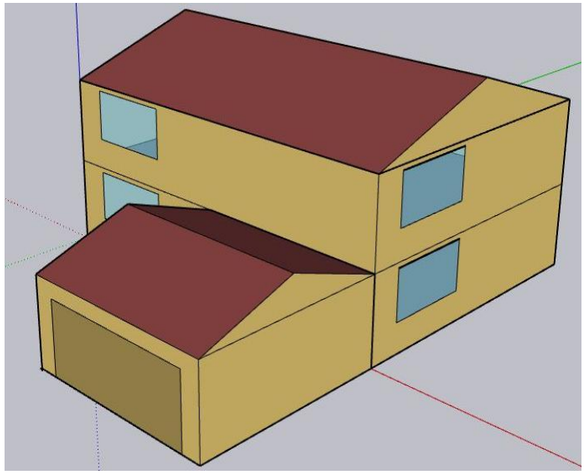


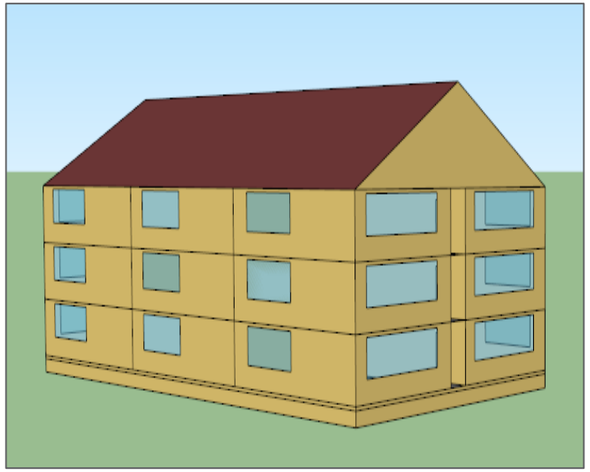
Multifamily Prototype

Residential Prototypes

Prototype Operation

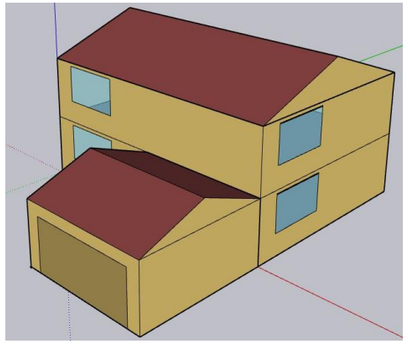
- Can be built equivalent to any prescriptive energy code edition level
- Code amendments are set in infrastructure parameter scripts
- Can adjust size and number of floors if necessary
- Uses EnergyPlus airflow network for air and duct leakage
- Scheduling and unregulated settings based on Building America modeling guidelines
- Energy credits (Additional Efficiency) are selected based on common construction-practices and costs

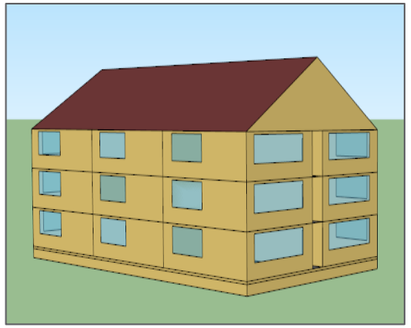




Residential Prototypes - Specifications

	Single Family	Multifamily
Floor Area	2,376 sq ft	Whole Building - 23,400 sq ft Dwelling Unit - 1,200 sq ft
Dimensions	29.8 ft by 39.8 ft	Whole Building - 120 ft by 65 ft Dwelling Unit - 40 ft by 30 ft
Aspect Ratio	1.33	Whole Building - 1.85 Dwelling Unit - 1.33
Number of Units	1	18 (6 per floor)
Number of Floors	2	3
Number of Bedrooms	3	2 per dwelling unit
Window Area	15% Window to Floor Ratio (WFR)	23% Window to Wall Ratio (WWR)
Zoning	3 zones - attic, living, foundation	breezeway in the center. Each dwelling unit is modeled as a separate zone. The other thermal zones are: attic, breezeway and foundation
Floor to Ceiling Height	8.5 ft	8.5 ft
Roof Construction	Low slope gable roof with asphalt shingles	Low slope gable roof with asphalt shingles
Ceiling Insulation	IECC edition requirements	IECC edition requirements
Wall Construction	Wood frame assembly (2 x 4 or 2 x 6)	Wood frame assembly (2 x 4 or 2 x 6)
Wall Insulation R-value/U-factor	IECC edition requirements	IECC edition requirements

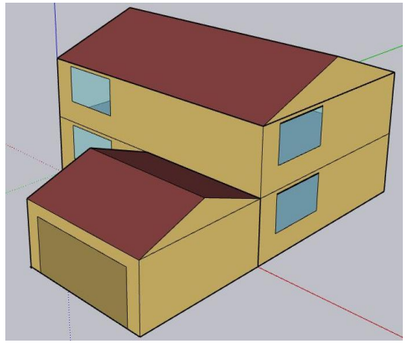


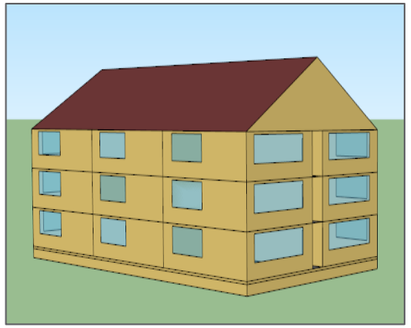


https://www.energycodes.gov/sites/default/files/2025-01/2024_IECC_CostEffectiveness_Residential_Final.pdf

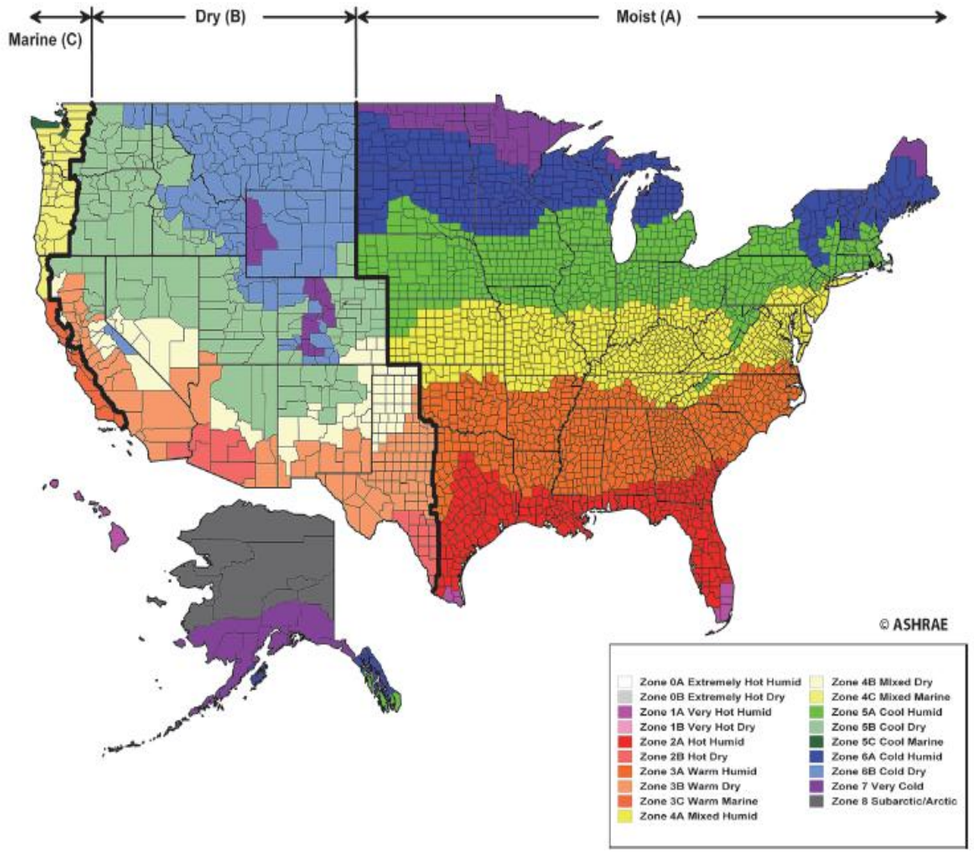
Residential Prototypes - Specifications

	Single Family	Multifamily
Fenestration Dimensions	Based on window fraction, location, floor area and aspect ratio	Based on window fraction, location, floor area and aspect ratio
Fenestration U-factor/SHGC	IECC edition requirements	IECC edition requirements
Fenestration Operable Area	100%	200%
Foundation Types	Slab, Crawl, Unheated Basement, Heated Basement	Slab, Crawl, Unheated Basement, Heated Basement
Foundation Insulation Levels	IECC edition requirements	IECC edition requirements
Infiltration ACH50	Based on climate zone and IECC edition requirements	Based on climate zone and IECC edition requirements
Heating System Types	Gas Furnace, Electric Furnace, Oil Furnace, Heat Pump	Gas Furnace, Electric Furnace, Oil Furnace, Heat Pump
Cooling System Types	Central DX AC/Heat Pump	Central DX AC/Heat Pump
HVAC efficiency	Federal Minimum Standards	Federal Minimum Standards
HVAC control	75°F Cooling/72°F Heating - No Setback	75°F Cooling/72°F Heating - No Setback
HVAC capacity	Autosized	Autosized
Ventilation	Exhaust Fan at 60 CFM continuous	Exhaust Fan at 45 CFM continuous
DHW Type	Storage	Storage
DHW Fuel Type	Same fuel as heating system	Same fuel as heating system
DHW Efficiency	Federal Minimum Standards	Federal Minimum Standards
DHW Tank Volume	Electric - 40 gallon / Fuel - 52 gallon	Electric - 40 gallon / Fuel - 52 gallon
DHW Temperature Setpoint	120F	120F
Lighting Power Density	0.68 W/sq ft adjusted by percent of high efficacy lighting	0.82 W/sq ft adjusted by percent of high efficacy lighting
Internal Gains	17,900 + 23.8 x CFA + 4104 x Nbr (Btu/day)	17,900 + 23.8 x CFA + 4104 x Nbr (Btu/day)
Operational Schedules	Based on Building America guidelines	Based on Building America guidelines





Climate Zones and Representative Cities



Climate Zone	Climate Zone Name	Representative City
1A*	Very Hot Humid	Honolulu, HI (tropical)
1A	Very Hot Humid	Miam, FL
2A	Hot Humid	Tampa, FL
2B	Hot Dry	Tucson, AZ
3A	Warm Humid	Atlanta, GA
3A, WH	Warm Humid	Montgomery, AL
3B	Warm Dry	El Paso, TX
3C	Warm Marine	San Diego, CA
4A	Mixed Humid	New York, NY
4B	Mixed Dry	Albuquerque, NM
4C	Mixed Marine	Seattle, WA
5A	Cool Humid	Buffalo, NY
5B	Cool Dry	Denver, CO
5C	Cool Marine	Port Angeles, WA
6A	Cold Humid	Rochester, MN
6B	Cold Dry	Great Falls, MT
7	Very Cold	International Falls, MN
8	Subarctic/Arctic	Fairbanks, AK

IECC 2024 / ASHRAE Standard 169-2013

*For tropical climate region determination

Residential Prototype Building Models - IECC

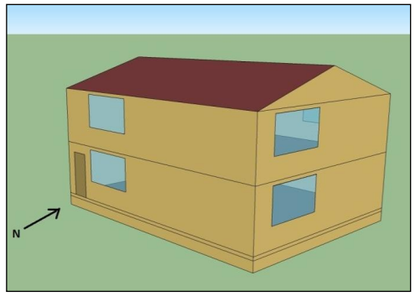
Zone/Regime	Complete Set	2018 IECC	2021-IECC	2024-IECC
1A	resstd_CZ1A.zip	resstd_CZ1A_IECC_2018.zip	resstd_CZ1A_IECC_2021.zip	resstd_CZ1A_IECC_2024.zip
2A	resstd_CZ2A.zip	resstd_CZ2A_IECC_2018.zip	resstd_CZ2A_IECC_2021.zip	resstd_CZ2A_IECC_2024.zip
2B	resstd_CZ2B.zip	resstd_CZ2B_IECC_2018.zip	resstd_CZ2B_IECC_2021.zip	resstd_CZ2B_IECC_2024.zip
3A	resstd_CZ3A.zip	resstd_CZ3A_IECC_2018.zip	resstd_CZ3A_IECC_2021.zip	resstd_CZ3A_IECC_2024.zip
3B	resstd_CZ3B.zip	resstd_CZ3B_IECC_2018.zip	resstd_CZ3B_IECC_2021.zip	resstd_CZ3B_IECC_2024.zip
3C	resstd_CZ3C.zip	resstd_CZ3C_IECC_2018.zip	resstd_CZ3C_IECC_2021.zip	resstd_CZ3C_IECC_2024.zip
4A	resstd_CZ4A.zip	resstd_CZ4A_IECC_2018.zip	resstd_CZ4A_IECC_2021.zip	resstd_CZ4A_IECC_2024.zip
4B	resstd_CZ4B.zip	resstd_CZ4B_IECC_2018.zip	resstd_CZ4B_IECC_2021.zip	resstd_CZ4B_IECC_2024.zip
4C	resstd_CZ4C.zip	resstd_CZ4C_IECC_2018.zip	resstd_CZ4C_IECC_2021.zip	resstd_CZ4C_IECC_2024.zip
5A	resstd_CZ5A.zip	resstd_CZ5A_IECC_2018.zip	resstd_CZ5A_IECC_2021.zip	resstd_CZ5A_IECC_2024.zip
5B	resstd_CZ5B.zip	resstd_CZ5B_IECC_2018.zip	resstd_CZ5B_IECC_2021.zip	resstd_CZ5B_IECC_2024.zip
5C	resstd_CZ5C.zip	resstd_CZ5C_IECC_2018.zip	resstd_CZ5C_IECC_2021.zip	resstd_CZ5C_IECC_2024.zip
6A	resstd_CZ6A.zip	resstd_CZ6A_IECC_2018.zip	resstd_CZ6A_IECC_2021.zip	resstd_CZ6A_IECC_2024.zip
6B	resstd_CZ6B.zip	resstd_CZ6B_IECC_2018.zip	resstd_CZ6B_IECC_2021.zip	resstd_CZ6B_IECC_2024.zip
7	resstd_CZ7.zip	resstd_CZ7_IECC_2018.zip	resstd_CZ7_IECC_2021.zip	resstd_CZ7_IECC_2024.zip
8	resstd_CZ8.zip	resstd_CZ8_IECC_2018.zip	resstd_CZ8_IECC_2021.zip	resstd_CZ8_IECC_2024.zip
Total	resstd_AllCodes.zip	resstd_IECC_2018.zip	resstd_IECC_2021.zip	resstd_IECC_2024.zip

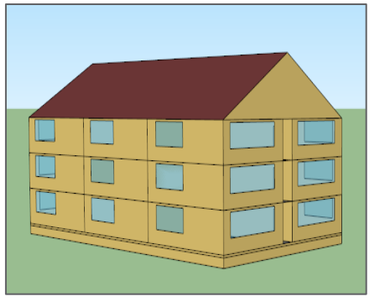
https://www.energycodes.gov/prototype-building-models
https://www.energycodes.gov/sites/default/files/2024-12/2024_IECC_Determination_TSD.pdf

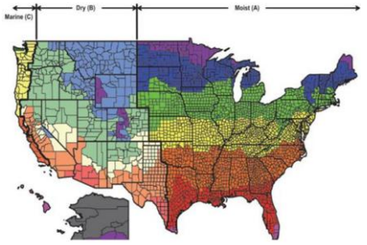
Large Scale Building Energy Simulation

- **2 building types:** single-family (sf) & multi-family (mf)
- **4 foundation types:** heated basement, unheated basement, slab on grade, vented crawlspace
- **4 heating Systems:** gas, oil, electric furnace all with split central air conditioner, and heat pump
- **Weather locations:** 19 (sf) & 18 (mf) represent all U.S. climate zones, moisture regime, humidity and tropical designation defined by the IECC. 129 weather locations for state analyses.
- **Weights:** Assign new building construction weighting factor to each building type in each representative climate location for each Climate Zone
- **Simulations:** 4,128 simulations for national analysis and 32,224 simulations for state analyses

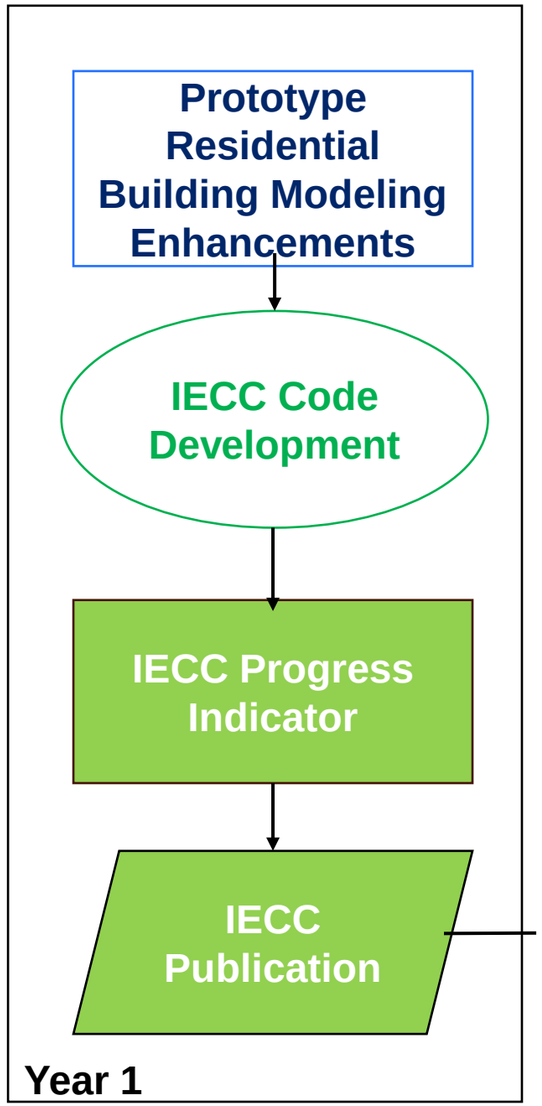
Calculate the national weighted energy use intensity, energy costs, and savings by climate zone



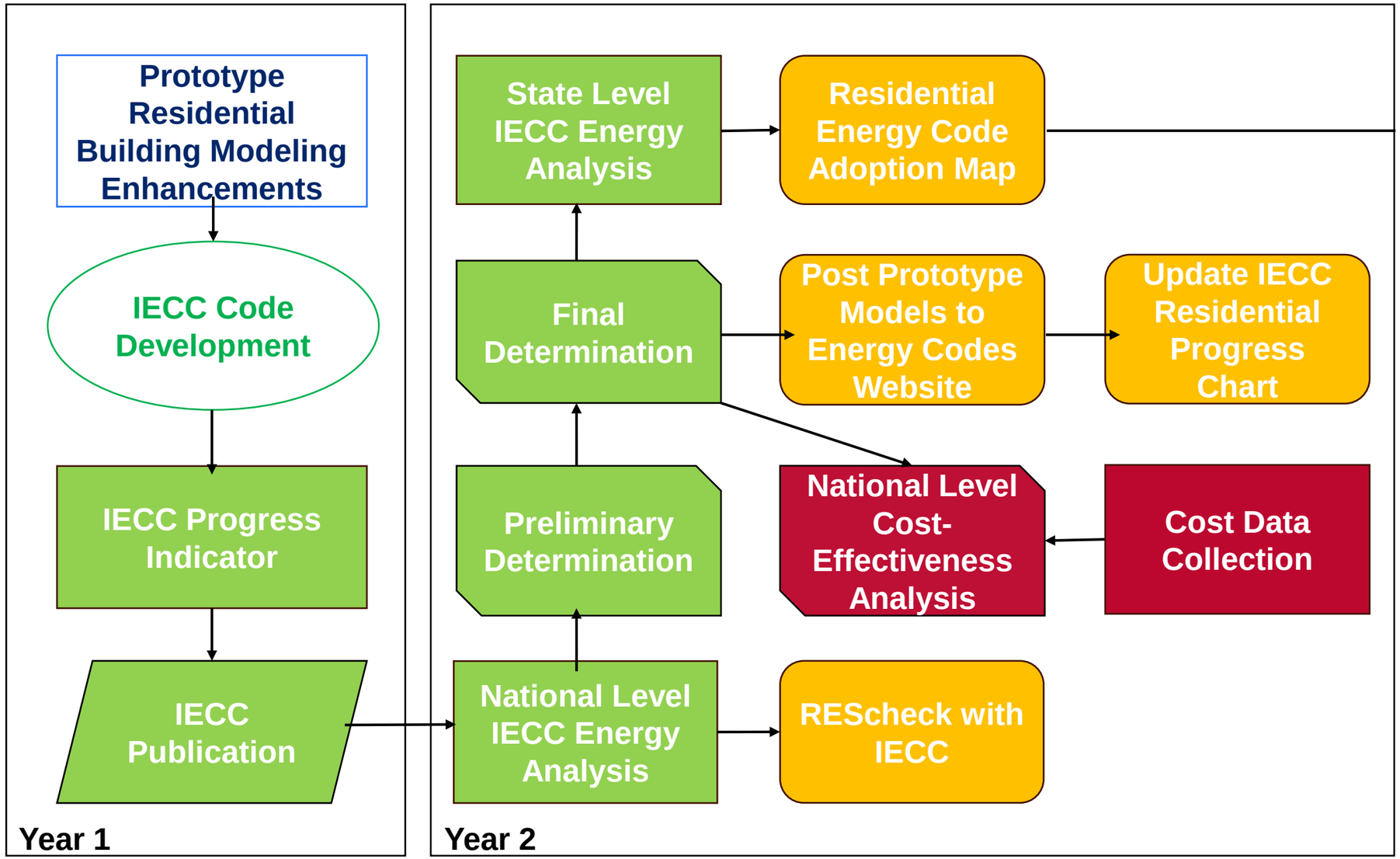




Residential Codes 3-Year Cycle of Analysis



Residential Codes 3-Year Cycle of Analysis



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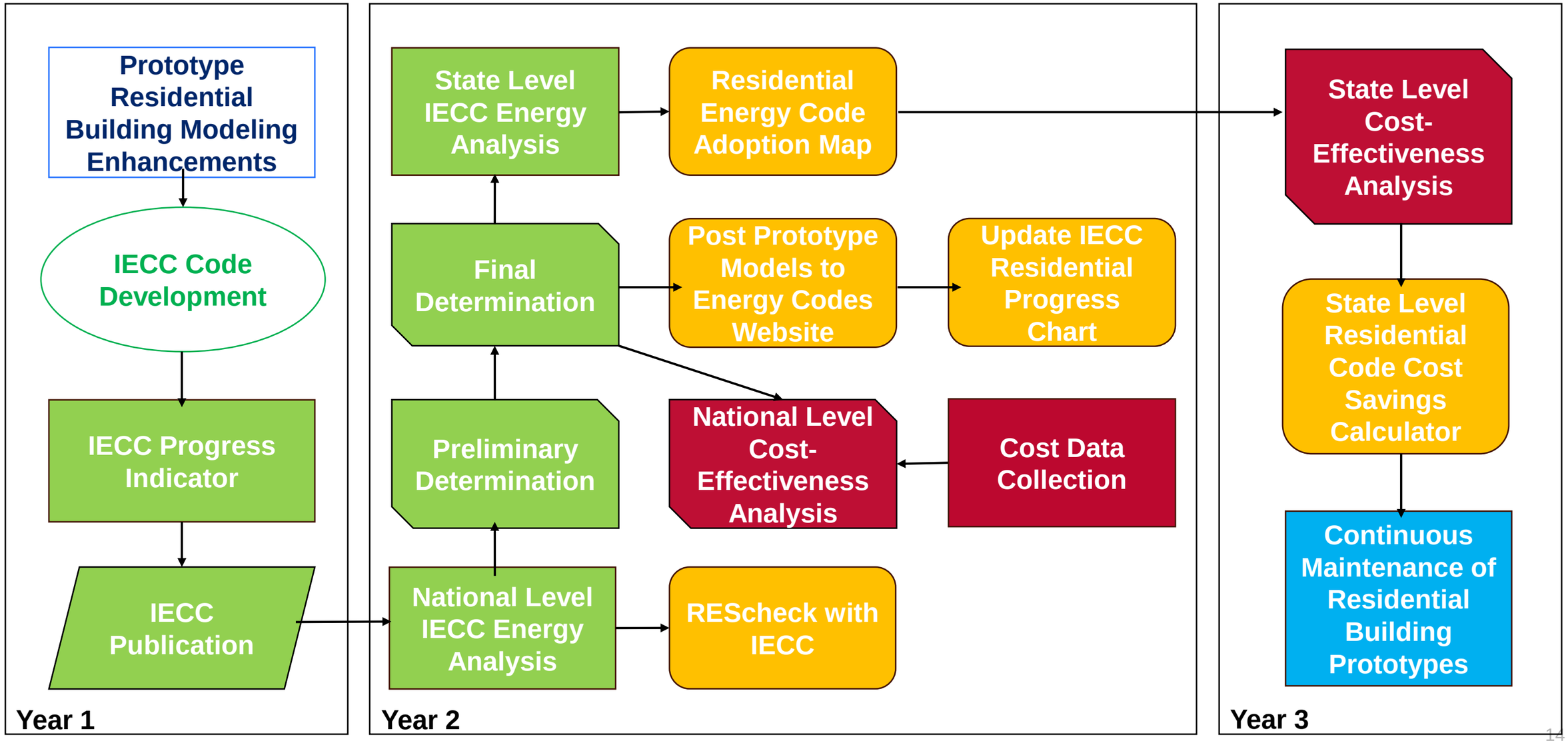
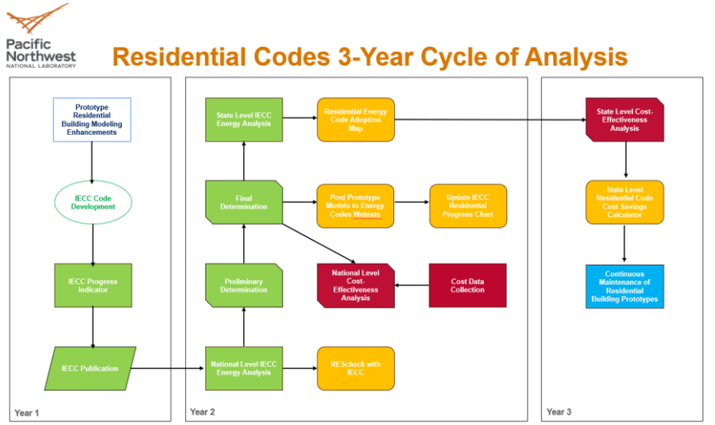


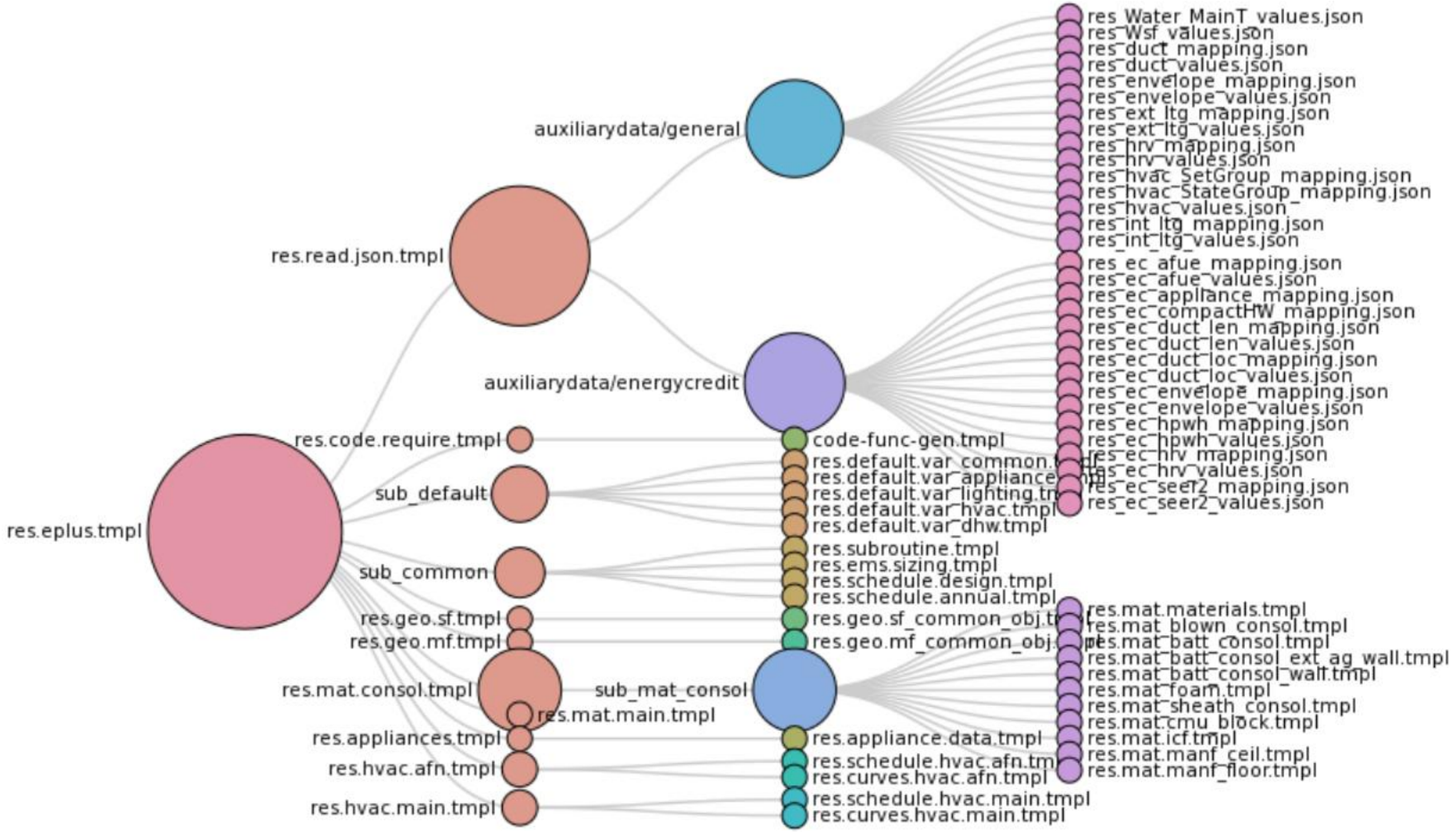
Residential Infrastructure

Residential Infrastructure

- Combines json files, parameter files and template files through GPARM to quickly generate the EnergyPlus input files
- Simulate 2006 IECC – 2024 IECC editions for all analyses on PNNL High Performance Computing (HPC)
- Each simulation file represents an individual building type, foundation type, system type, climate zone and moisture regime and code edition.
- Amended energy codes are analyzed as an additional set of simulations
- Must specify the baseline code and proposed/adopted code
- Infrastructure can compare an amended energy code to any unamended code edition
- Infrastructure post processing will aggregate all energy results to any system variable.
- Automatically provides life cycle cost calculations and cashflow analyses

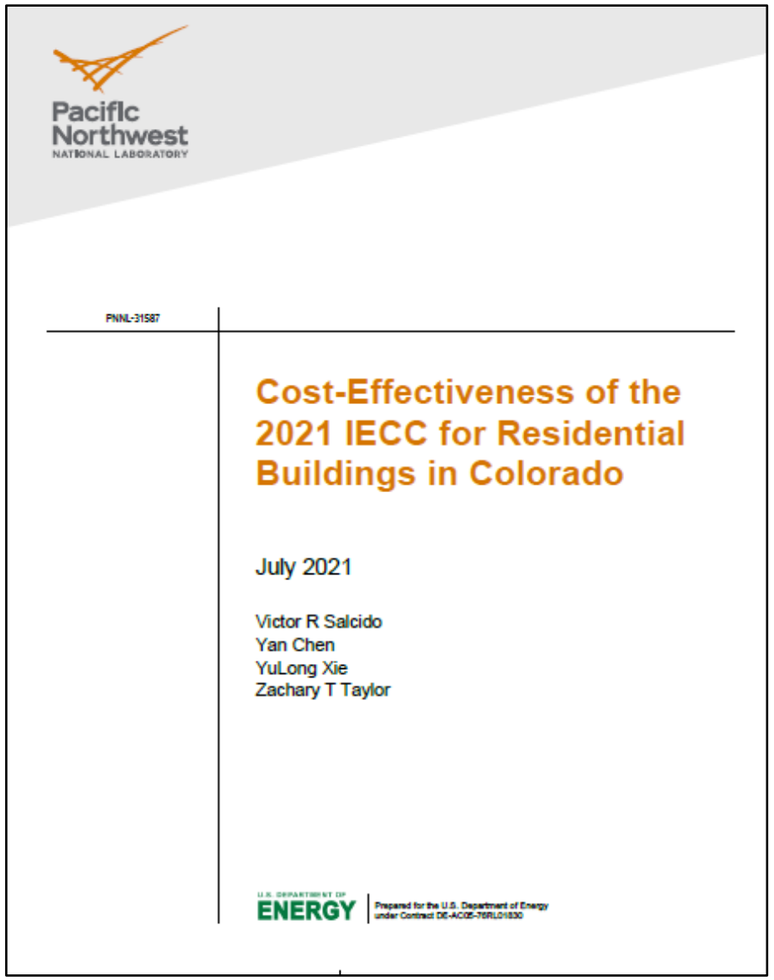


Residential Infrastructure



Residential Infrastructure - Post Processing

- Generates energy, energy costs and emissions
- Results are aggregated to the building type, foundation type, system type, state, climate zone, moisture regime and energy code edition.
- Analyses compare the baseline energy code to the adopted/proposed energy code as well as all code editions.
- Shows benefits/weaknesses of any code changes
- Can view what affects are at national, state, local, climate zone or building parameter level
- Calculate Life Cycle Cost and Simple Payback of code changes
  - Construction Costs
  - Utility Rates
  - Location multipliers
  - Economic Parameters
  - Cashflow analysis



Residential Infrastructure – Process

- Residential Prototypes
  - Templates
  - JSON files
  - Scripts
- GPARM creates EnergyPlus files based on analysis type
- SLURM to run simulations

Simulations

Post Processing

- Aggregated simulation results
- Utility rates
- Construction costs
- Economic parameters
- Carbon emissions
- Societal impact data

- Aggregated energy files
- Aggregated cashflow files
- Aggregated construction cost files
- Aggregated by state, climate zone, building, system and foundation type

Aggregated Results

Cost-Effectiveness of the 2021 IECC for Residential Buildings in Arizona

Consumer Impact

Metric	Compared to the 2015 IECC with amendments
Life-cycle cost savings of the 2021 IECC	$8,043
Net annual consumer cash flow in year 1 of the 2021 IECC[2]	$250
Annual (first year) energy cost savings of the 2021 IECC ($)[3]	$433
Annual (first year) energy cost savings of the 2021 IECC (%)[4]	18.1%

Statewide Impact – Jobs Created

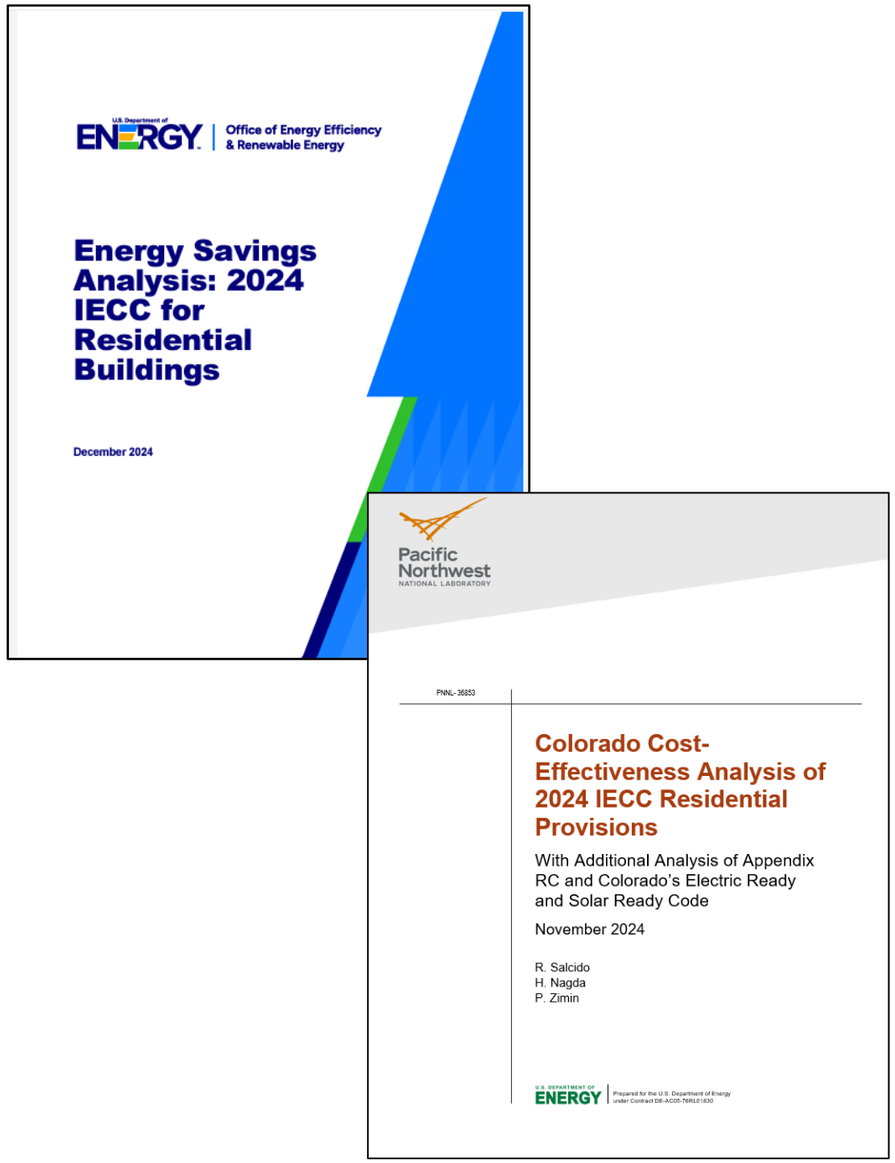
Statewide Impact	First Year	30 Years Cumulative
Jobs Created -- Reduction in Utility Bills	376	10,680
Jobs Created -- Construction Related Activities	1,088	30,920

https://www.energycodes.gov/sites/default/files/2021-07/ArizonaResidentialCostEffectiveness_2021_0.pdf

Summary

Closing

- Methodology for Evaluating Residential Energy Code Updates provides a consistent approach to energy, cost and societal impact of energy code changes
- Lots of use-cases at the national, state and local levels related to adoption and compliance
- Ability to demonstrate energy, economic, and other impacts of energy codes (e.g., jobs, resilience, comfort)
- Analysis capabilities are being expanded to account for new measures and customized codes
- States and localities rely on these technical analyses
- Support-improvement and adoption of model energy codes across the country



Thank you