



Household Energy Efficiency Analysis for the City of Columbia, South Carolina

Many households in the City of Columbia, South Carolina, could save hundreds of dollars annually on their energy bills, reduce carbon emissions, and improve comfort with energy efficiency retrofits and upgrades in their homes and apartments. As part of the U.S. Department of Energy's (DOE) Communities LEAP (Local Energy Action Program) pilot, the National Renewable Energy Laboratory (NREL) analyzed energy efficiency and electrification upgrades for about 94,000 housing units in Columbia.

For more information about the Communities LEAP effort in Columbia visit <https://www.energy.gov/communitiesLEAP/columbia-south-carolina>

Managing Energy Efficiency Upgrade Costs

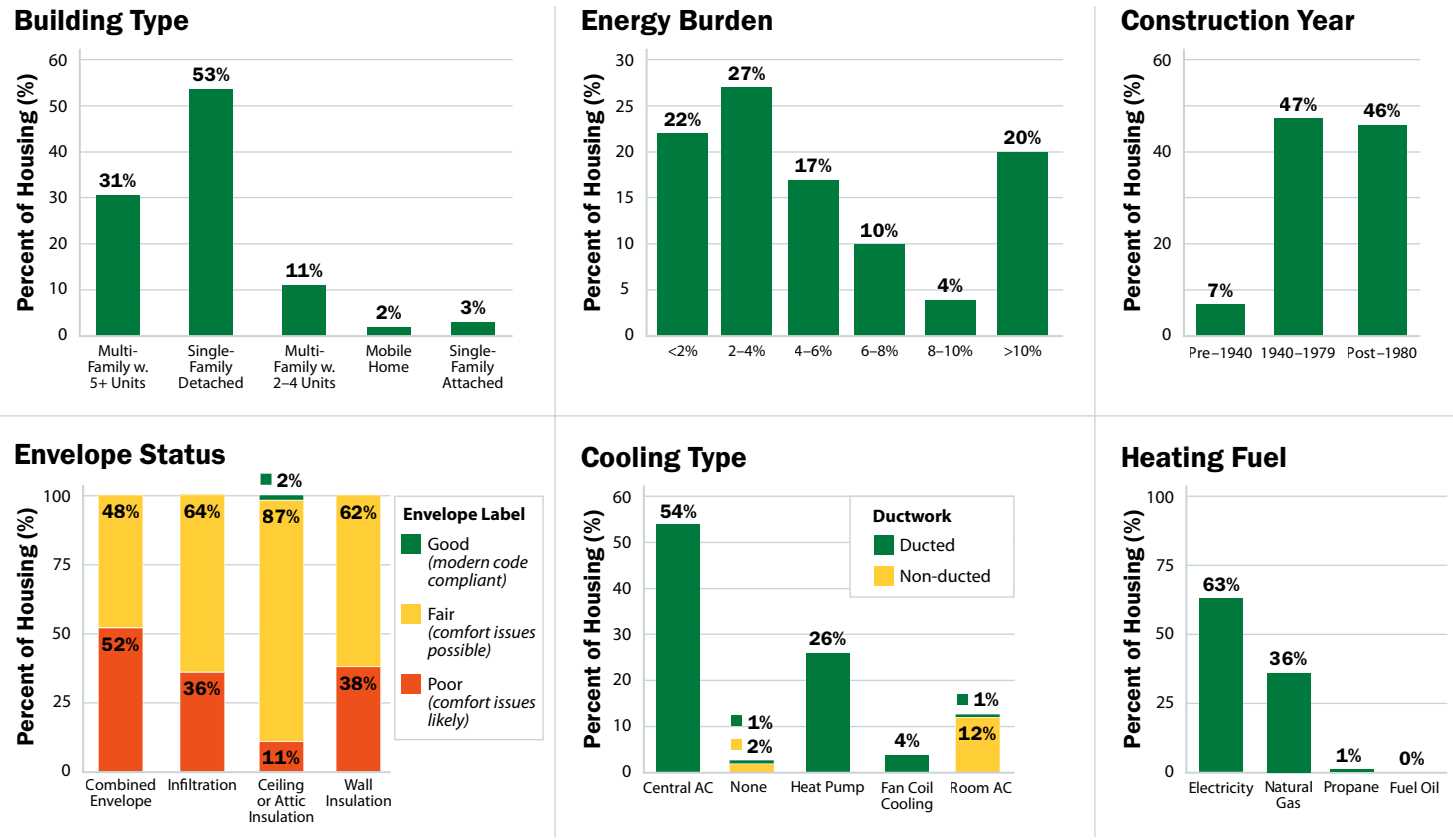
The upfront costs of energy efficiency upgrades can be reduced if they are coordinated with certain home upgrades. For instance, it is worth considering adding insulation when a home's siding requires replacement, or upgrading to a heat pump when the space heating or cooling system needs to be updated.

For more information on energy efficiency improvements, including smaller do-it-yourself projects, visit DOE's Office of Energy Efficiency and Renewable Energy's Energy Saver webpage: <https://www.energy.gov/energysaver/energy-saver>

Energy Challenges of Columbia's Housing Stock

An estimated 52% of the homes and apartments analyzed in Columbia have below average building envelopes, meaning inadequate insulation and sealing allows air in and out of homes. Inadequate building envelopes increase the cost of heating and cooling homes, which requires residents to spend a higher share of their income on energy. Updating the building envelope could help lower the share of income residents must spend on energy, known as energy burden, and provide a more comfortable and safe indoor environment.

Columbia, South Carolina Residential Housing Stock Summary



Source: ResStock-modeled data and results, <https://data.nrel.gov/submissions/224>

Annual Community-Wide Savings by Upgrade

The results below are the estimated average annual savings for all modeled household types located in Columbia.



Energy Bill Reductions

Million \$



Emissions Reductions

Equivalent to number of cars taken off the road



Energy Savings

Equivalent number of homes



Upgrade Cost

\$-\$\$\$

Basic enclosure*

27

17,700

17,160

\$

Enhanced enclosure**

32

20,900

20,075

\$

Heat pump water heater

11

6,700

7,100

\$

Enhanced enclosure and high-efficiency whole home electrification***

89

54,700

52,950

\$\$\$

Minimum-efficiency heat pump with existing backup

26

19,100

17,970

\$\$

* Basic enclosure includes attic floor insulation, general air sealing, duct sealing, duct insulation, and wall insulation.

** Enhanced enclosure includes basic enclosure with insulating foundation walls and rim joists, sealing crawlspace vent, and insulating finished attics and cathedral ceilings.

*** Enhanced enclosure with high-efficiency whole home electrification includes an enhanced enclosure, high-efficiency heat pump, heat pump water heater, ventless heat pump dryer, electric oven, and induction range.

Average Annual Home Savings from Basic Enclosure Upgrade

Housing Type	Area Median Income	Estimated Annual Energy Bill Reductions	Impact of Energy Bill Reductions on Energy Burden (pre -> post)	Estimated Upgrade Cost
Single-family detached homes built between 1940-1979	all	\$603	11.1% → 8.8%	\$7,660
	0%–80%	\$527	20.4% → 16.3%	\$6,620
Single-family detached homes built 1980 or after	all	\$237	8.9% → 8.2%	\$4,370
	0%–80%	\$189	23.7% → 22.0%	\$3,950
Multifamily building with 5+ units built between 1940 and 1979*	all	\$103	12.8% → 11.8%	\$1,430
	0%–80%	\$104	15.4% → 14.2%	\$1,460
Multifamily building with 5+ units built 1980 or after*	all	\$56	9.5% → 9.0%	\$1,230
	0%–80%	\$60	12.3% → 11.6%	\$1,210

Actual site energy reductions, energy bill reductions, and changes to energy burden for any individual household will vary.

* Results are per unit for multifamily buildings with 5+ units. Buildings built after 1980 generally require fewer or smaller upgrades than older buildings.

Basic Enclosure Upgrade

NREL’s analysis for Columbia showed that on average, the most cost-effective option for upgrading energy efficiency is the basic enclosure upgrade, which includes adding insulation to exterior walls, the attic, and sealing openings around vents, doors, windows, and crawlspaces. Actual costs will vary depending on many factors, including the price of materials, contractor, size of the project, current incentive programs, and more.

Approach Details

Information on Upgrade Packages

NREL analyzed a total of 16 energy efficiency upgrades for Columbia. The most cost-effective upgrade was defined as the energy efficiency and retrofit package that resulted in the most energy bill reductions per upgrade cost. All four housing types identified in this fact sheet had the same most cost-effective package. Modeled energy burden and energy bill reductions vary by ownership (resident-owned or rented), housing type, and other factors. This analysis does not account for

federal, state, and local rebates or programs that may further lower energy burden, upgrade costs, and payback periods.

Modeling Assumptions

- Vacant housing was not included as part of this analysis per the community’s request.
- Local equipment, labor costs, and utility costs were taken from a mixture of local and national data sources from 2023 or the most recently available data.
- The envelope status figure was based on 2023 International Energy Conservation Code (IECC) requirements for wall insulation, attic insulation, infiltration rates, and wall construction type.
- Upgrades did not consider new electric panel requirements.

To learn more about the modeled packages and upgrades in all building types, please visit <https://data.nrel.gov/submissions/224>.



This work presents energy efficiency and electrification modeling results for dwelling units using ResStock EUSS 2022.1, which is a statistical representation based on modeling predictions of energy use and savings, and actual results may vary. Scan the QR code to access the methodology document at <https://www.nrel.gov/docs/fy24osti/88058.pdf>.