A Data-Driven Housing Stock Analysis of Southeast Pennsylvania

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ResStock™ is a well-known and widely used resource

This is a **case study** of a custom, collaborative housing stock analysis conducted using ResStock and led by the **ResStock team**

It's not **the only** way to conduct such an analysis, but it's **a** way to conduct one, and the general methodology is **broadly applicable across the U.S.**

Credible, **comprehensive**, and **accessible** information about an area's housing stock and its technical potential is critical for industry efforts related to:

Utility program design

Energy efficiency planning

IRPs and load forecasts

Rate design

Energy policy analysis

And more

But ResStock is **many terabytes** of information.

Best practices in translating those terabytes into **useful, actionable information** are still being developed. This presentation is part of that conversation.

The Project Context

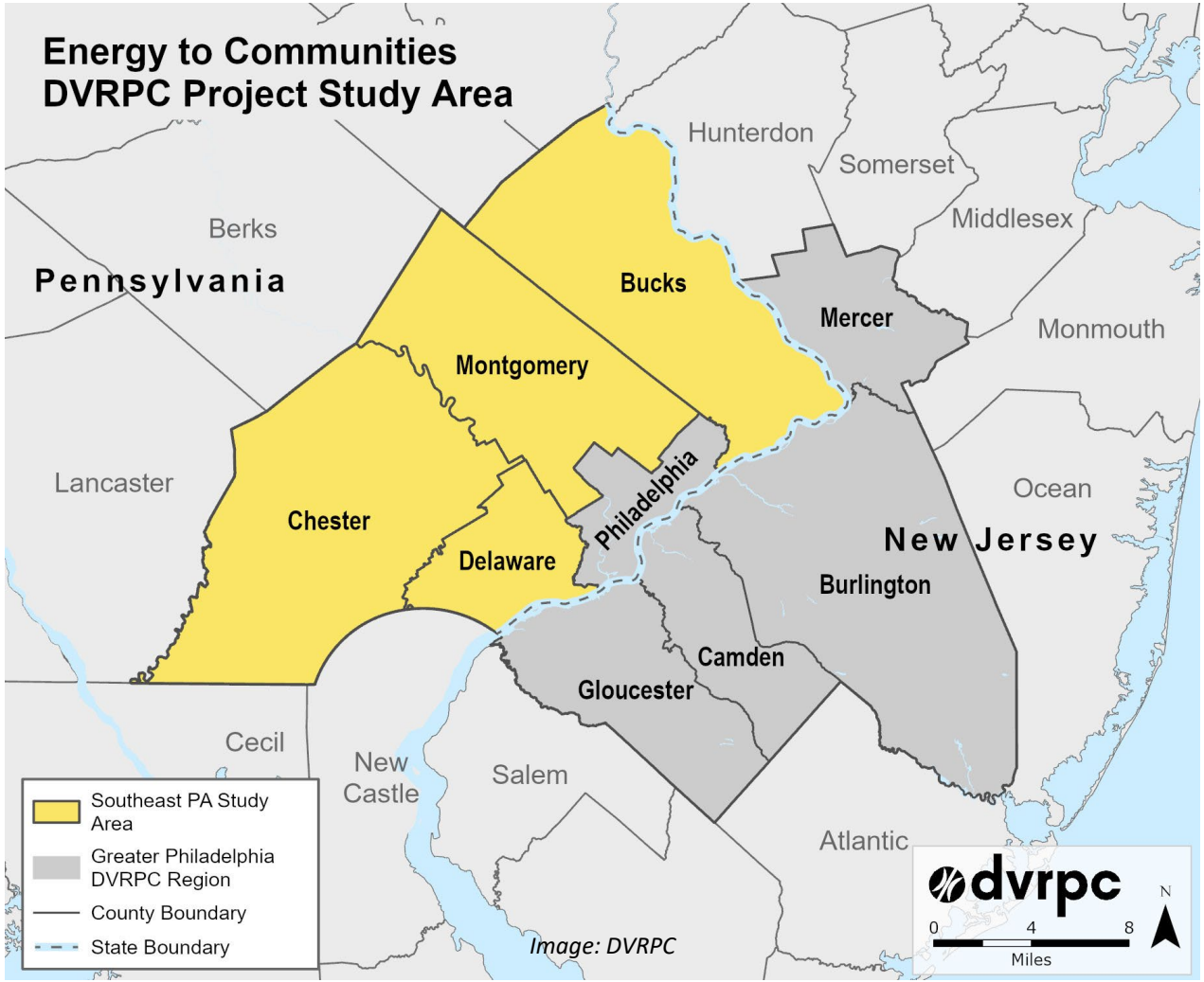
The Project: A DOE Energy to Communities (E2C) In-Depth Partnership supporting Southeast PA with:

- Whole home retrofits
- DVRPC's energy programs
- Expanding Philadelphia's Energy Ecosystem

The Project Team: County staff, Community Action Agencies, U.S. national laboratories, consultants, and others, all led by **DVRPC**

This presentation is on the **housing stock analysis** portion of the larger E2C Delaware Valley project

The Study Area



Housing Stock Analysis Methodology

ResStock is a building energy stock model that represents the U.S. housing stock circa 2018.

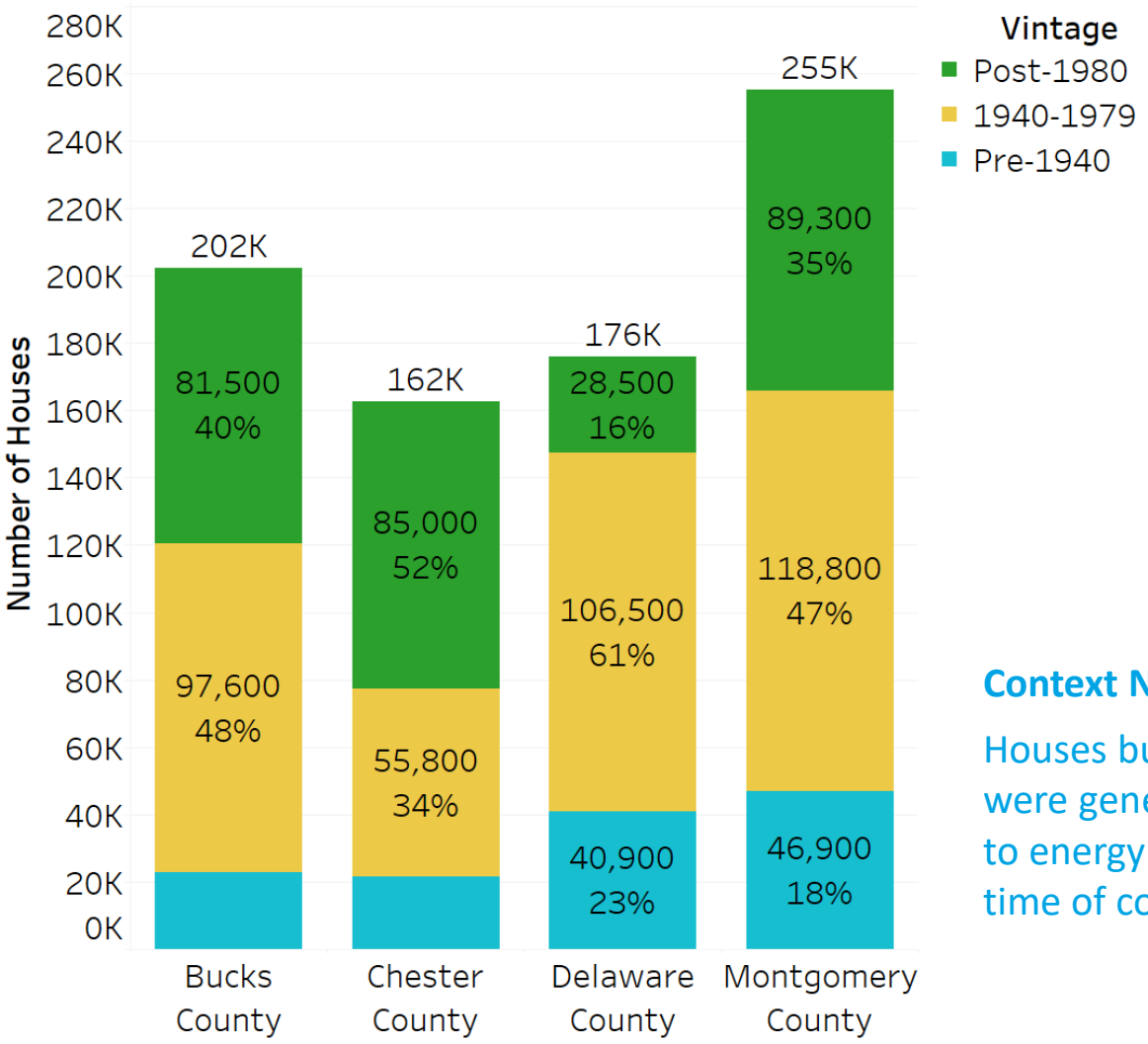
- Datasets of hundreds of thousands of statistically representative housing units based on the best available data
- Housing characteristics, energy consumption, emissions, etc.
- Results for Bucks, Chester, Delaware, and Montgomery counties were taken from a national dataset for this analysis

Where did we source it?

- **Housing characteristics, energy, emissions**: ResStock dataset 2024 Release 2
- **Energy utility bills**: calculated using local utility rates from 2025
- **First costs**: developed specifically for this project by an NREL sub
- **Energy affordability & net present value**: calculated directly from other results

ResStock
resstock.nrel.gov

Existing Housing Stock: **Vintage**

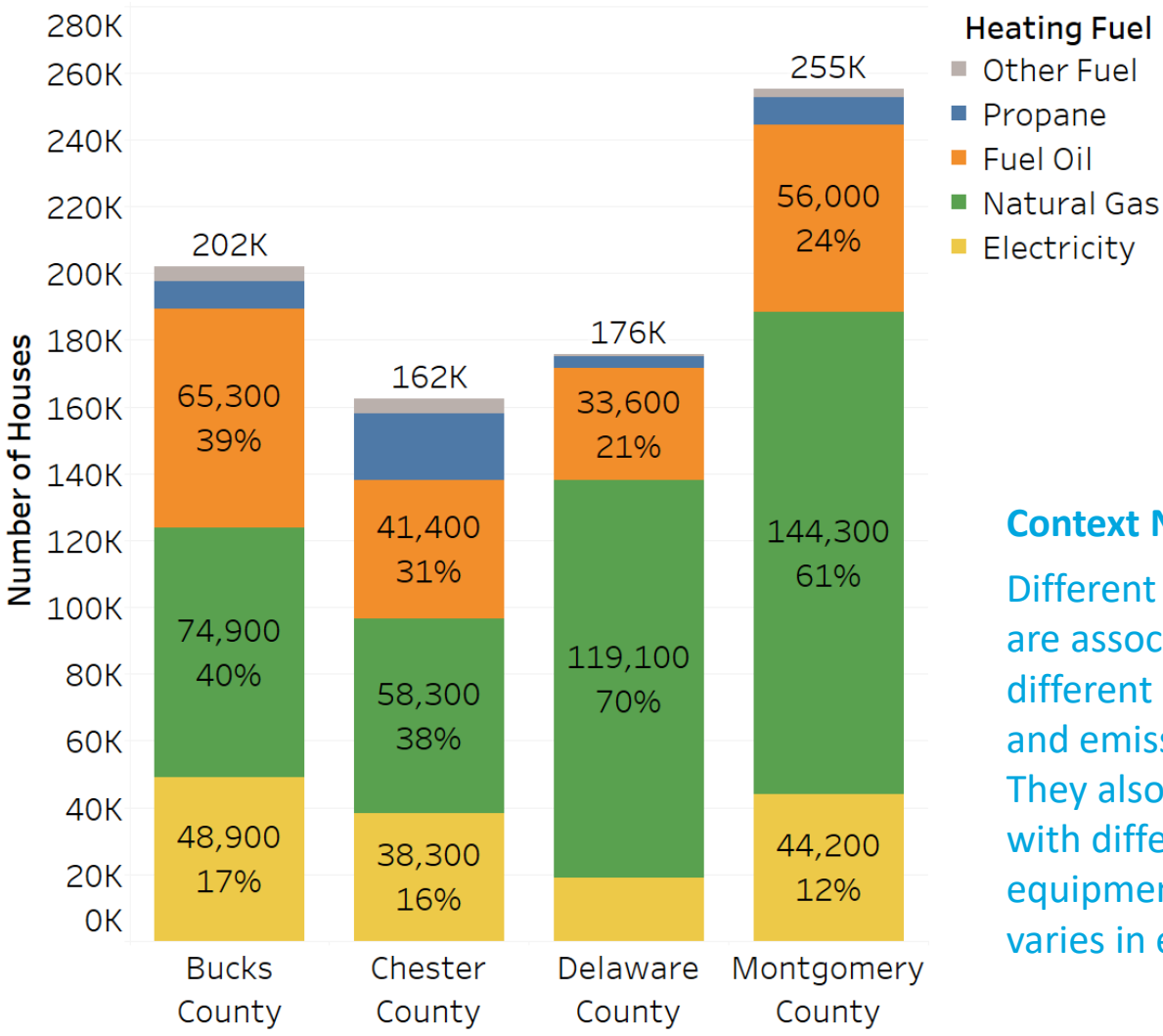


Modeled results for single-family houses in Bucks, Chester, Delaware, and Montgomery Counties, PA

Context Note

Houses built before 1980 were generally not subject to energy codes at the time of construction.

Existing Housing Stock: **Heating Fuel**



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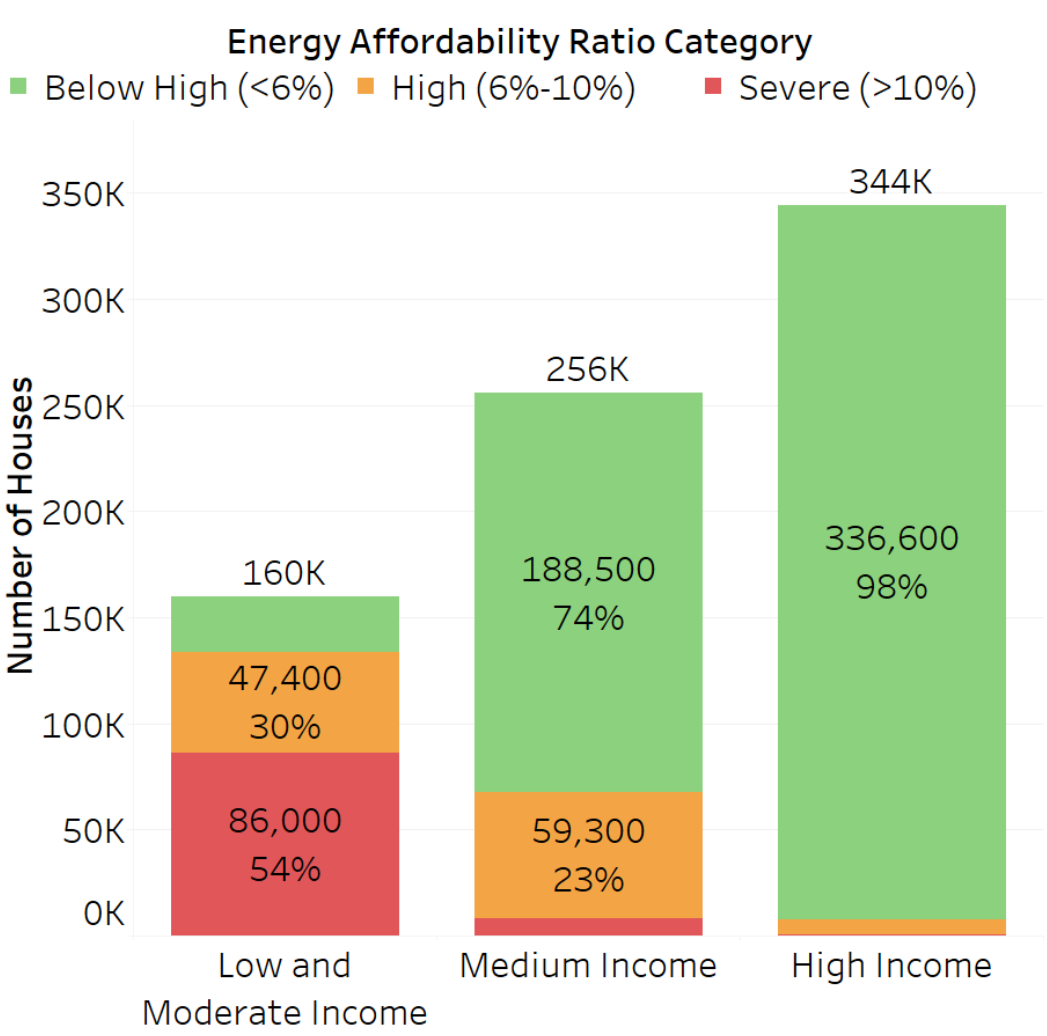
Context Note

Different heating fuels are associated with different utility rates and emissions impacts. They also can be used with different heating equipment, which varies in efficiency.

Existing Housing Stock: **Energy Affordability by Income**



Results shown for occupied houses only

Income groups

- Low & Moderate
  - <80% area median income (AMI)
- Medium
  - 80%-150% AMI
- High
  - >150% AMI

Energy affordability ratio

$$= \frac{energy\ utility\ bills}{income}$$

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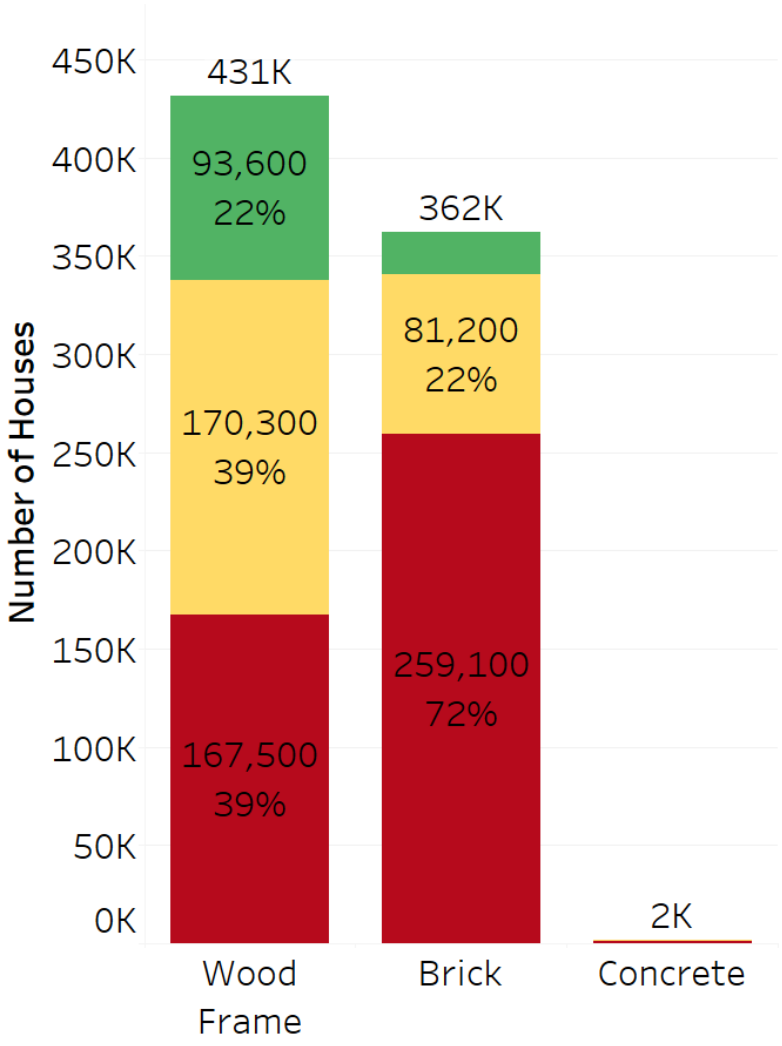
Existing Housing Stock: **Wall Type and Insulation**



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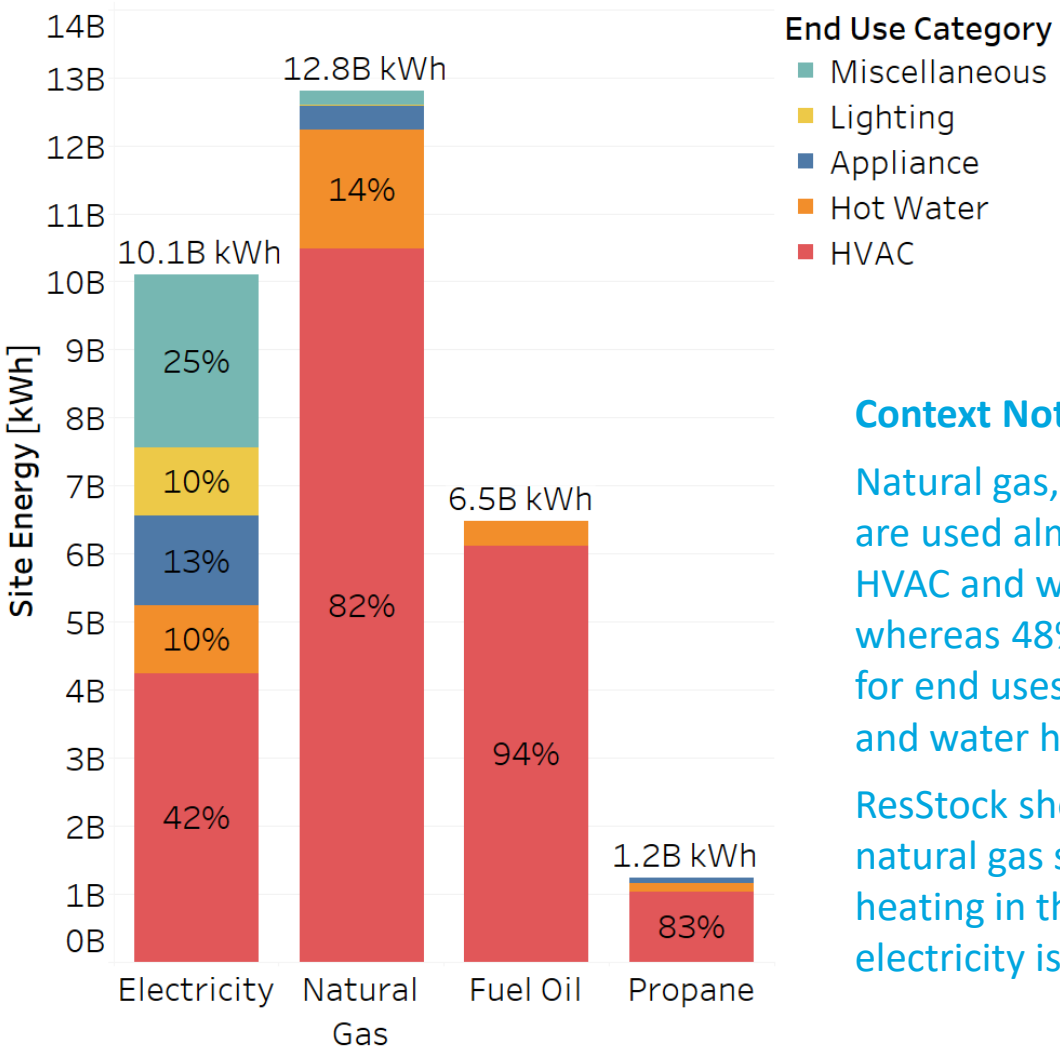
Context Notes

IECC 2009, a widely used energy code for residential buildings, specifies an insulation R-value of R-13 or higher for wood-frame walls in the relevant climate zone (4A).

ResStock's envelope data is not as high resolution as other data, such as vintage and heating fuel. Conclusions carry this caveat, and results are not broken out by county.

Existing Housing Stock: **Total Site Energy Consumption** in Single-Family Houses in the Study Area



Modeled results for single-family houses in Bucks, Chester, Delaware, and Montgomery Counties, PA

Context Notes

Natural gas, fuel oil, and propane are used almost exclusively for HVAC and water heating, whereas 48% of electricity use is for end uses other than HVAC and water heating.

ResStock shows that more natural gas site energy is used for heating in this study area than electricity is used in total.

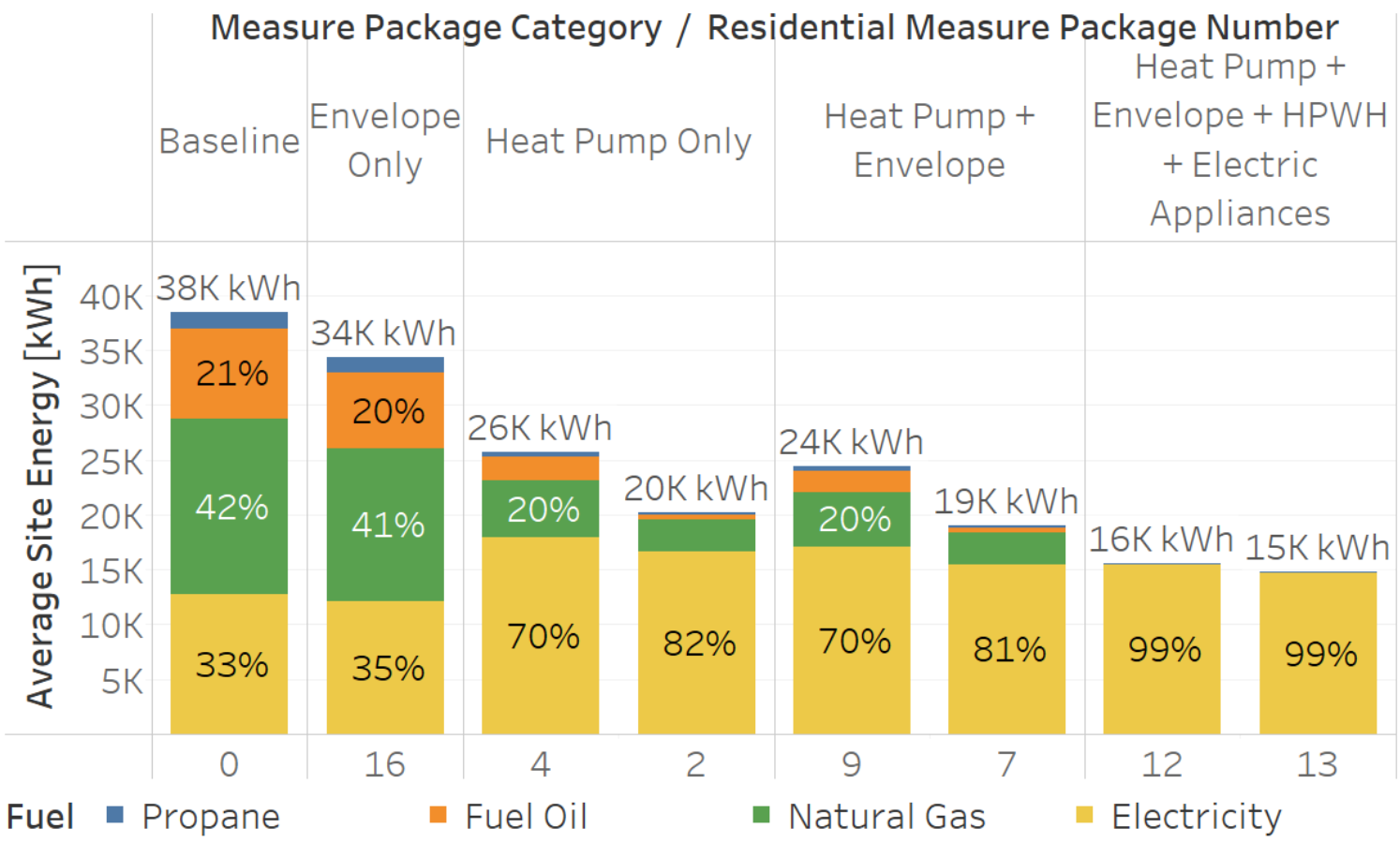
Housing Stock Analysis Methodology **Retrofit Measures Analysis**

7 Measures, selected from ResStock 2024.2: weatherization through full equipment changeouts

**LT envelope* is air sealing and attic insulation

ResStock 2024.2 Measure Package #	HVAC Component	Envelope Component	Water Heating Component	Appliance Component
16	NA	LT Envelope*	NA	NA
4	ENERGY STAR HP	NA	NA	NA
2	High Eff. CCHP	NA	NA	NA
9	ENERGY STAR HP	LT Envelope	NA	NA
7	High Eff. CCHP	LT Envelope	NA	NA
12	High Eff. CCHP	LT Envelope	HPWH	Electric Appliances
13	Ultra-High Eff. CCHP	LT Envelope	HPWH	Electric Appliances

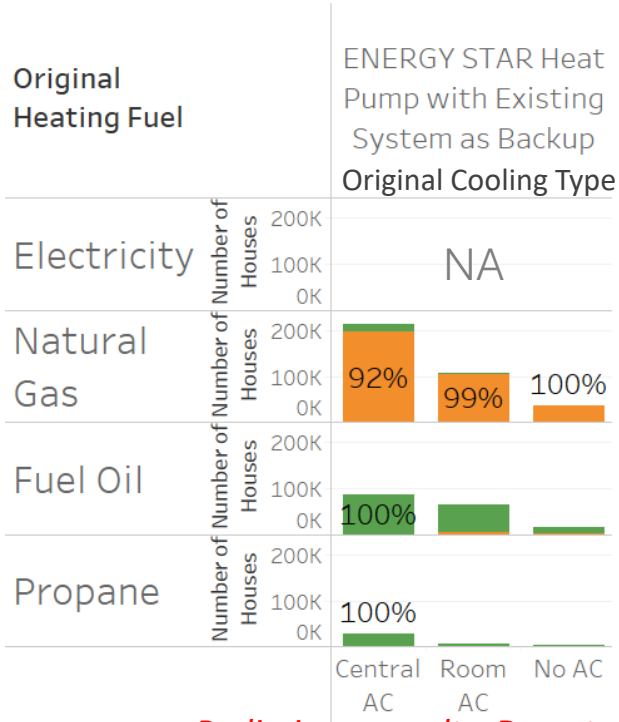
Residential Retrofit Measure Analysis: **Average Site Energy Consumption**



Modeled results for single-family houses in Bucks, Chester, Delaware, and Montgomery Counties, PA

Context Notes The average site energy consumption across all houses before and after the measure package is applied. Houses that did not have the measure package applied are included.

Residential Retrofit Measure Analysis: **Energy Utility Bill Changes**



Preliminary results. Do not cite. Utility rate assumptions under revision.

Energy Utility Bill Impact

- Reduction or No Change
- Increase

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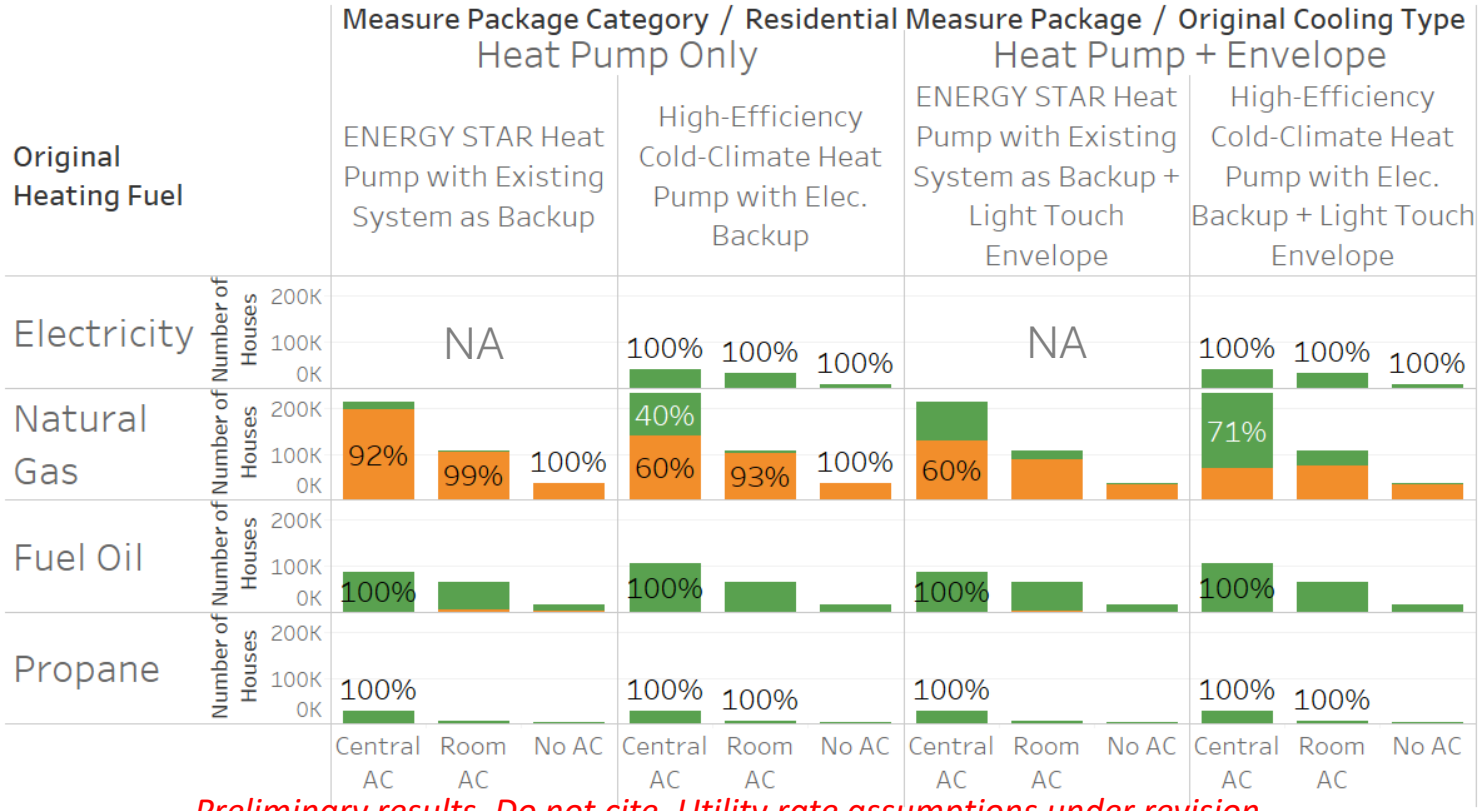

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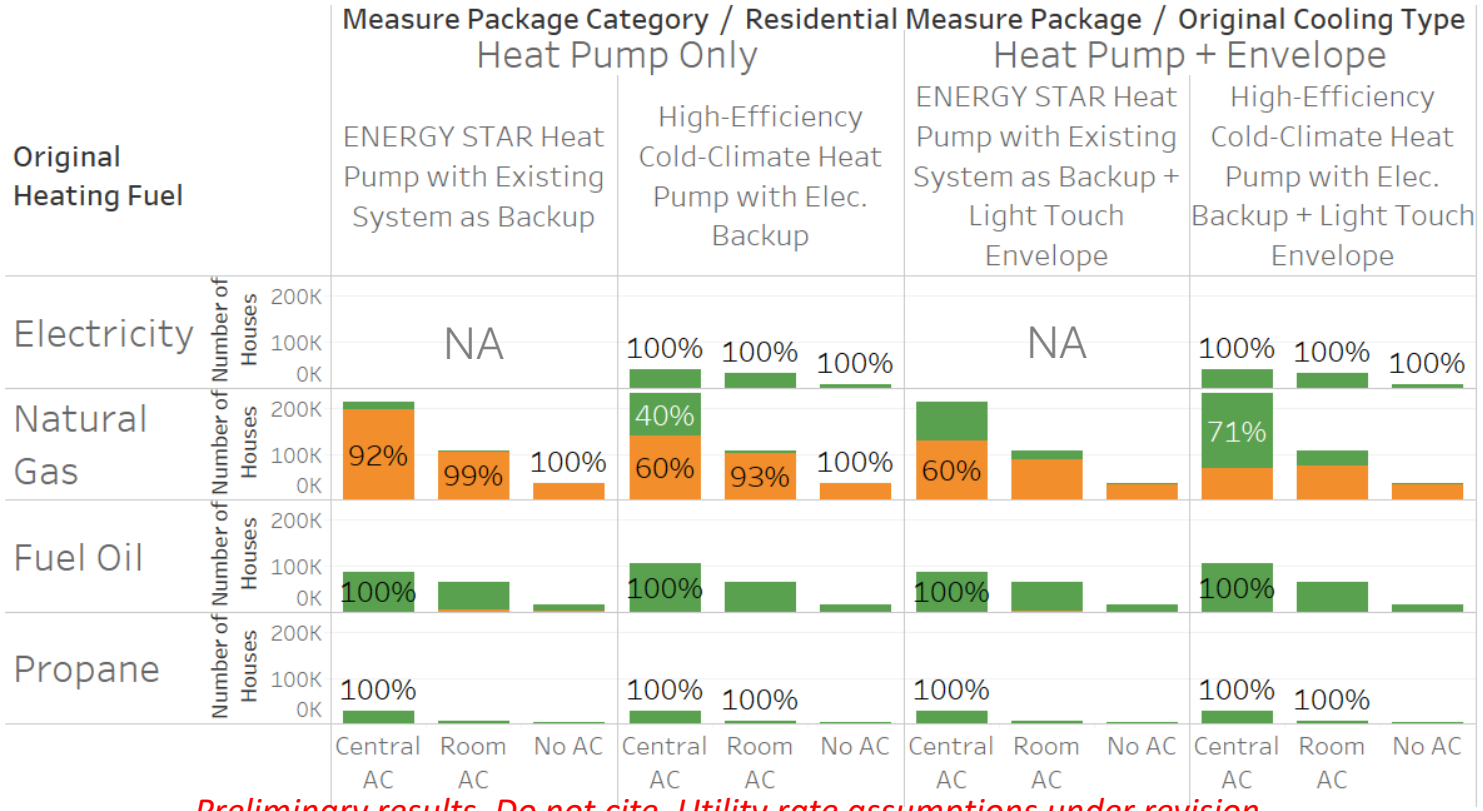

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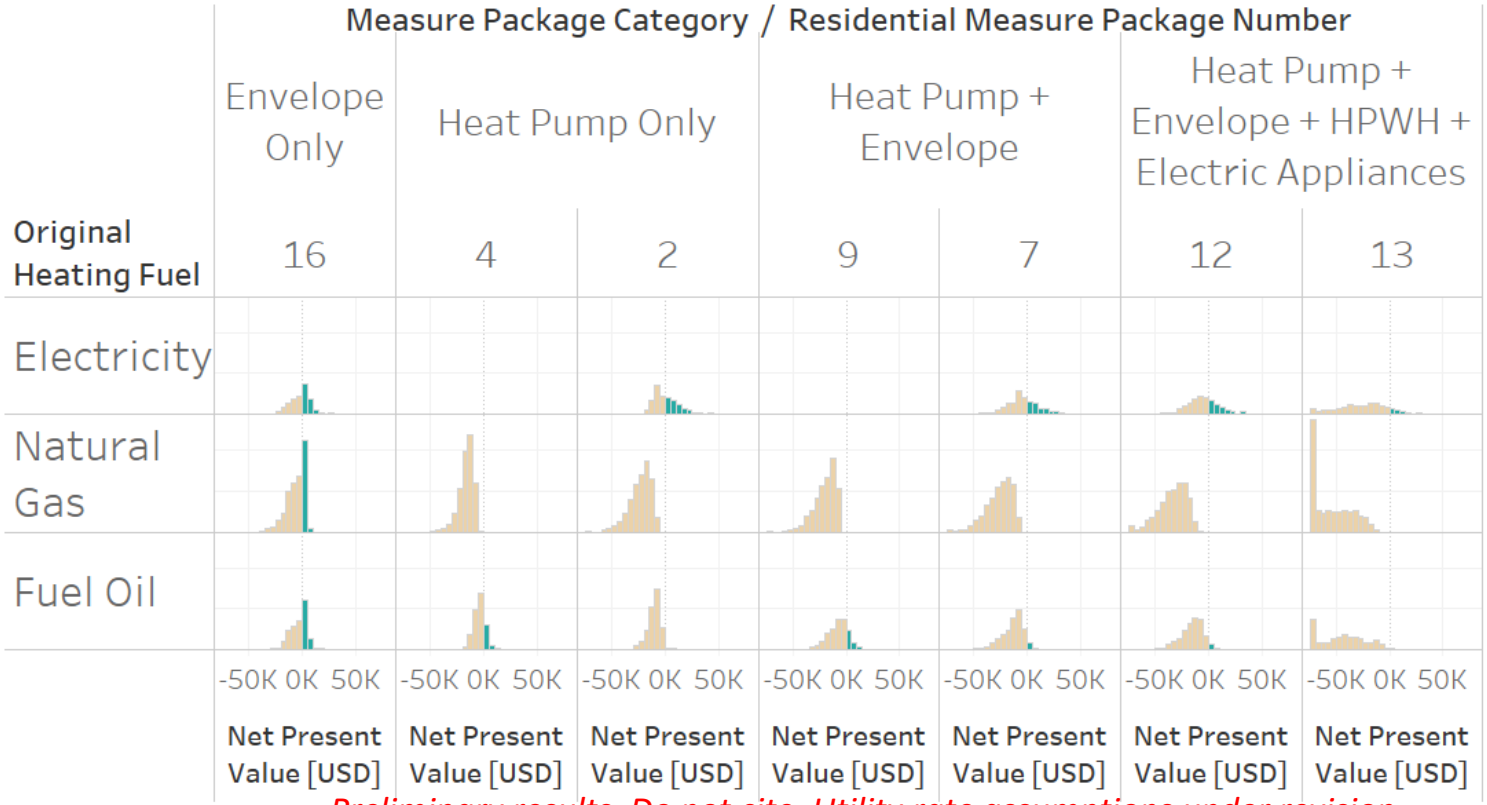
Context Notes The original heating fuel, the original type of cooling, and the work on the building envelope are all highly influential factors in whether household utility bills increase.

Modeled results for single-family houses in Bucks, Chester, Delaware, and Montgomery Counties, PA

Residential Retrofit Measure Analysis: **Histogram of NPV**

Cost ranges are due to house-to-house variations only (such as size of heating system or attic size). They do not reflect other real-world cost variations such as cost differences between contractors or quarter-to-quarter differences in material costs. They also do not include any rebates, incentives, or tax credits. Modeled results for single-family houses in Bucks, Chester, Delaware, and Montgomery Counties, PA.



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Sign of NPV

Negative or Zero Positive

Context Notes Histograms have a $5,000 bin size, an overflow bin for values $75,000+, and an underflow bin for values below -$75,000.

Case Study of Collaborative Housing Stock Analysis Using ResStock **Takeaways**

Different parties see **different key findings in the same results.** Examples:

- 25%-40% of households use delivered fuels
- Approximately 12 times more site energy use for heating than cooling
- Prevalence of lower-performing envelopes.

Multiple **layers of results—**

- Three-slide key takeaways
- Dozens of graphs with summary text
- GBs of data

allowed every team member to see something useful.

Everyone **brings something different** to the table.

Custom, collaborative analyses **take time.**

Further Reading

The Paper! A Data-Driven Housing Stock Analysis of Southeast Pennsylvania, IEPEC 2025

The final report, expected January-February 2026

ResStock, resstock.nrel.gov

Further questions? resstock@nrel.gov

Thank You

Q&A after all speakers

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