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ResStock

Targeting Energy and Cost Savings for the U.S. Housing Stock

Eric Wilson, National Renewable Energy Laboratory

Webinar for Appalachian Regional Commission
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Acknowledgements

ResStock has been supported by the U.S. Department of Energy Building Technologies Office and the Office of Energy Policy and Systems Analysis, with significant contributions from other external partners.

Context & Motivation

Which energy efficiency (EE) **upgrades are most cost-effective** in each state or county?

How much **utility bill savings** can be achieved with cost-effective EE?

NREL Image 20285

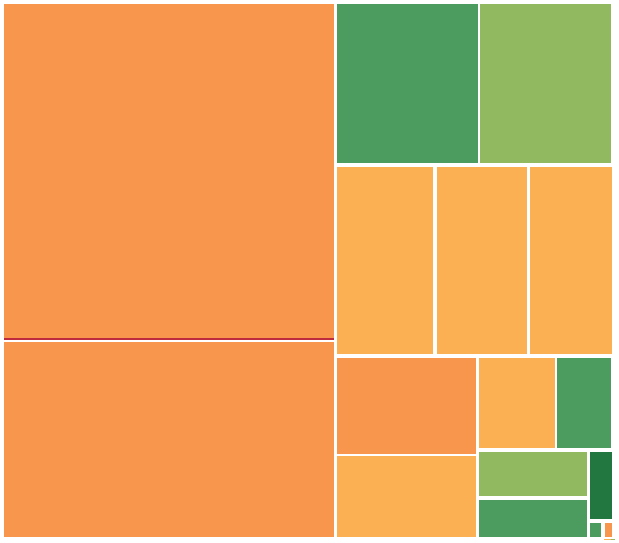
What is the **potential revenue** resulting from cost-effective EE upgrades?

House icon by UNiCORN
from Noun Project (creative commons)

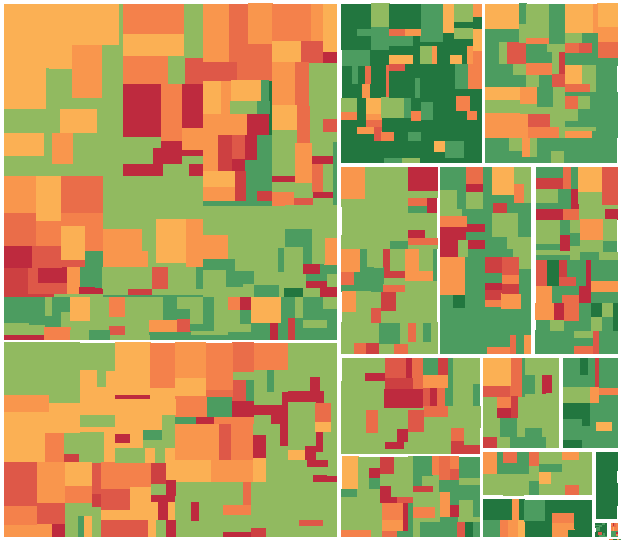
House icons by HAWRAF
via autodraw.com

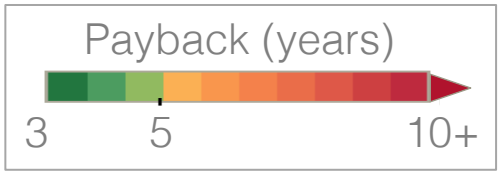
Context & Motivation

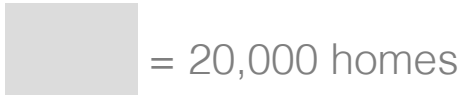
Typical Approach



High-Granularity Approach







Payback, in years, for drill-and-fill wall insulation in Washington and Oregon single-family homes

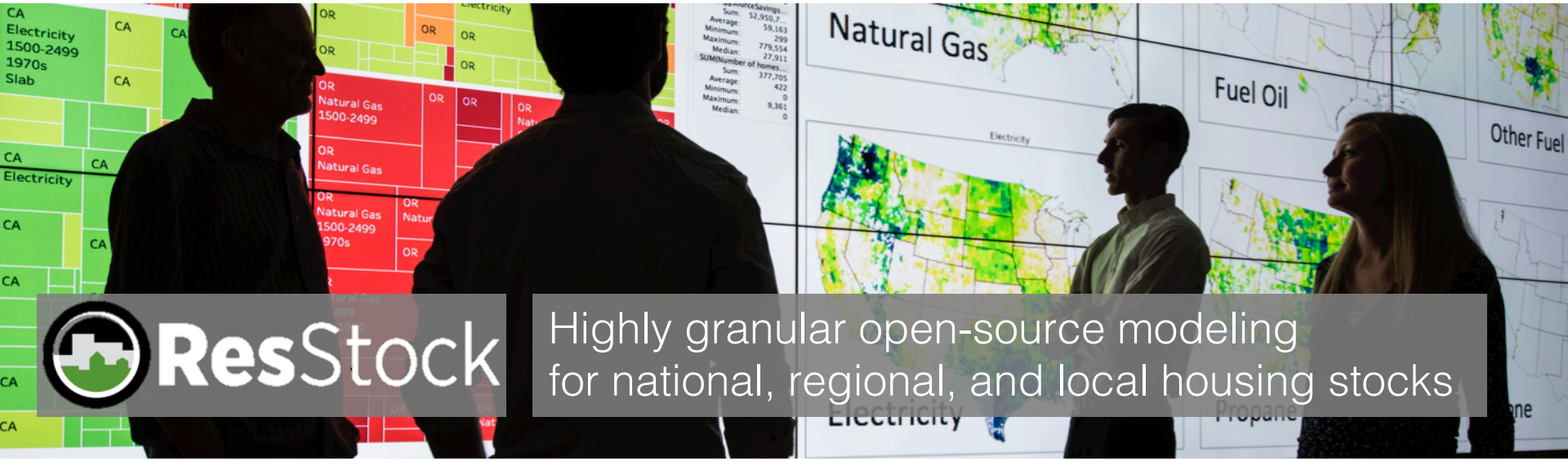
Housing stock characteristics database

+

Physics-based computer modeling

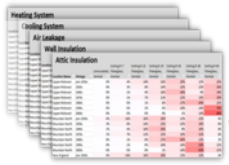
+

High-performance computing

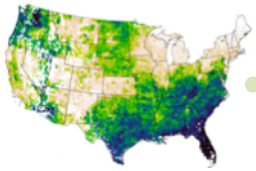


ResStock

Building Characteristics



Census Data



Costs

Climate Locations

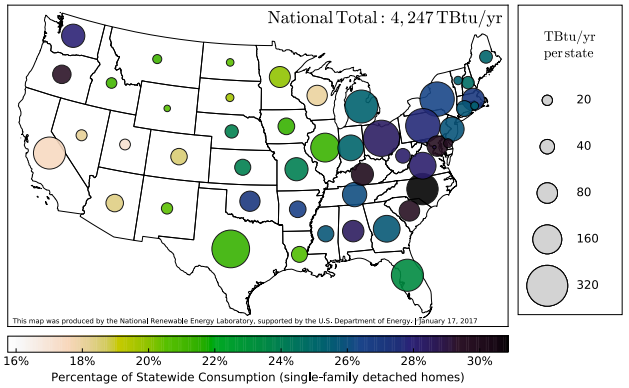
10s–100s of thousands of **statistically representative models**

Baseline Buildings

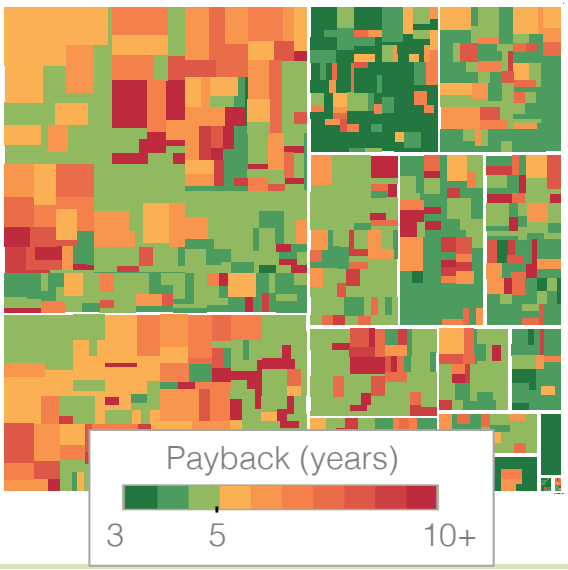
Efficiency Upgrades

NREL supercomputer or Amazon Cloud

National Potential

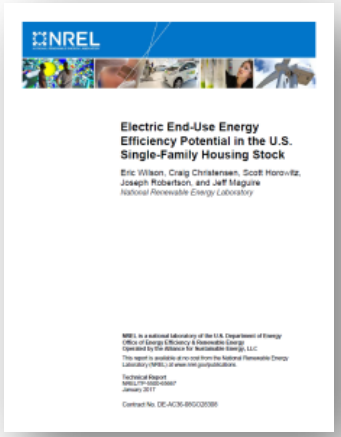


Targeting Cost-effectiveness



Ways to benefit from ResStock

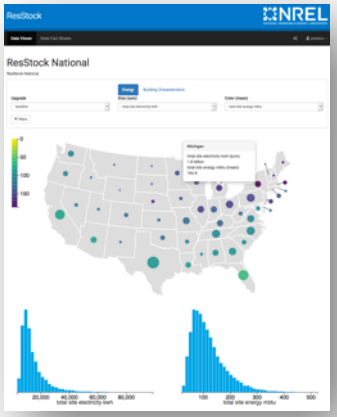
Read the Report



Energy Efficiency Potential in the U.S. Single-Family Housing Stock

Download State Factsheets

Explore Results



Interactive Data Viewer

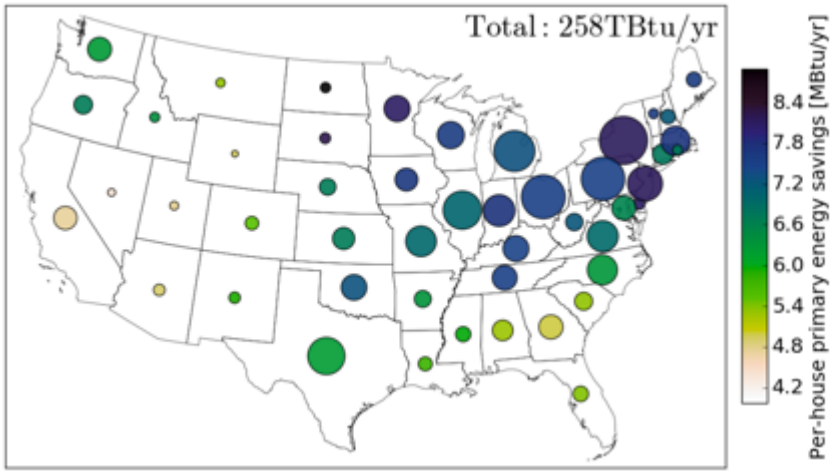
Analyze Your Scenario BETA

Use the open-source software yourself or work with NREL or other trained consultants

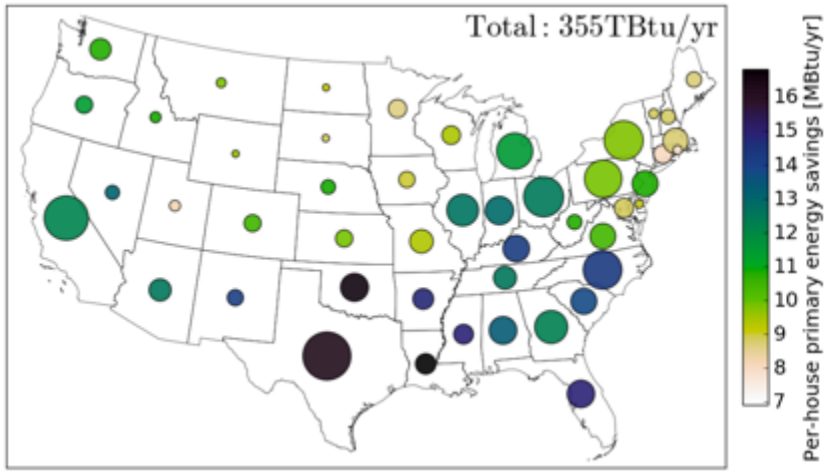
Visit **resstock.nrel.gov** to get started

Existing Results – Economic Potential (NPV > 0)

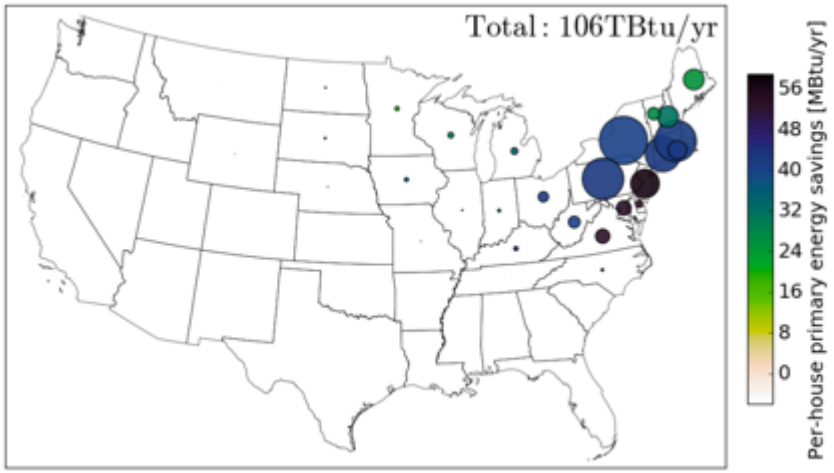
Air Sealing



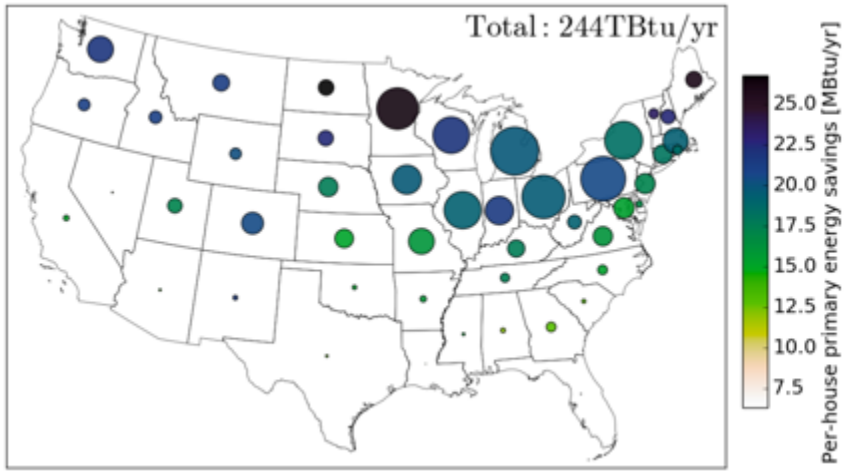
Attic Insulation (R-49)



Replacing Oil Boilers with Ductless Heat Pumps



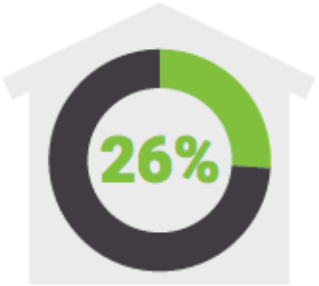
Basement Wall Insulation (R-10)



48 State Factsheets

TENNESSEE

Residential Energy Efficiency Potential



Energy used by Tennessee single-family homes that can be saved through cost-effective improvements

Tennessee existing jobs in energy efficiency (2016)[1]

Cost-effective package savings potential in Tennessee single-family homes

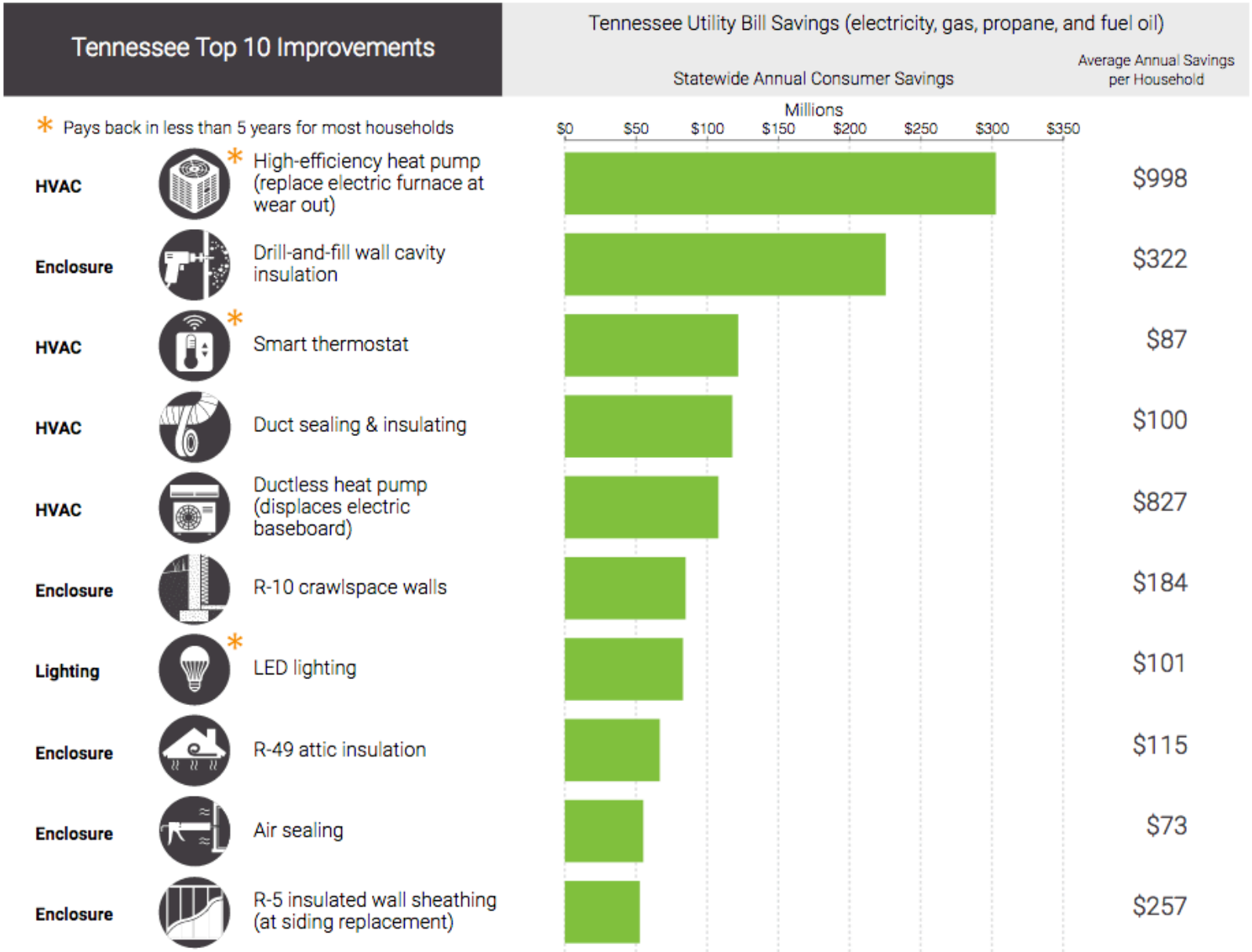
1.1 billion — dollars per year utility bill savings

17.3 trillion — Btu per year gas, propane, and fuel oil savings

8.8 billion — kWh per year electricity savings

1.5 million — cars of pollution reduction

48 State Factsheets



48 State Factsheets

Tennessee Top 10 Improvements

Tennessee Utility Bill Savings (electricity, gas, propane, and fuel oil)

HVAC

Duct sealing & insulating

Applicable to 77% of homes

Cost-effective in 62% of homes

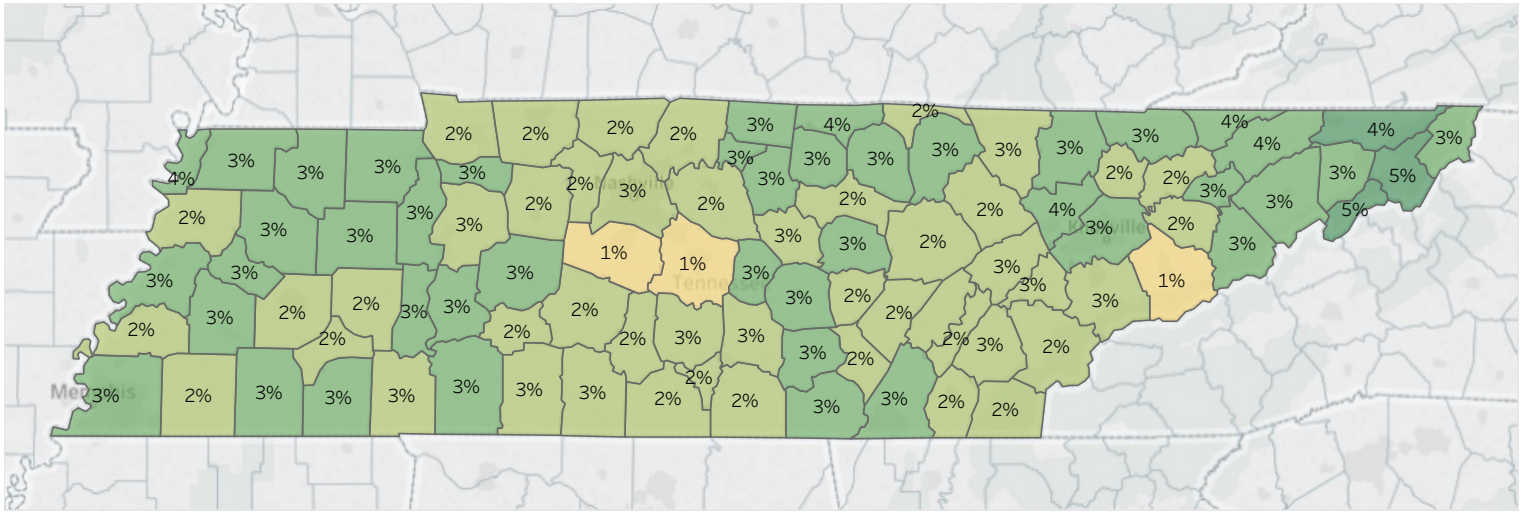
Per House Average (where cost effective)	Statewide (cost-effective savings)
$100 annual savings	$117.7 million annual savings
$931 average cost of improvement	3.6 trillion Btu gas, propane, and fuel oil savings
9 years, 4 months payback	754.3 million kWh electricity savings

[NEW] Example county-level results

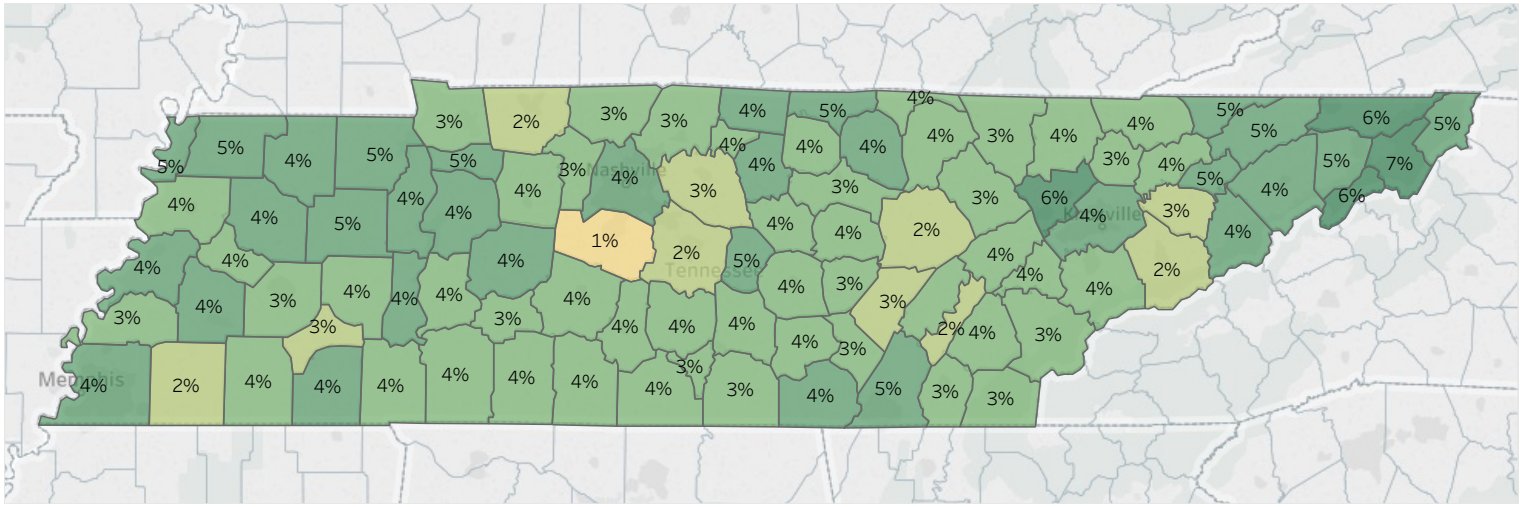
Technical Potential: Adding R-13 Wall Insulation to Empty Wall Cavities

0% 7%

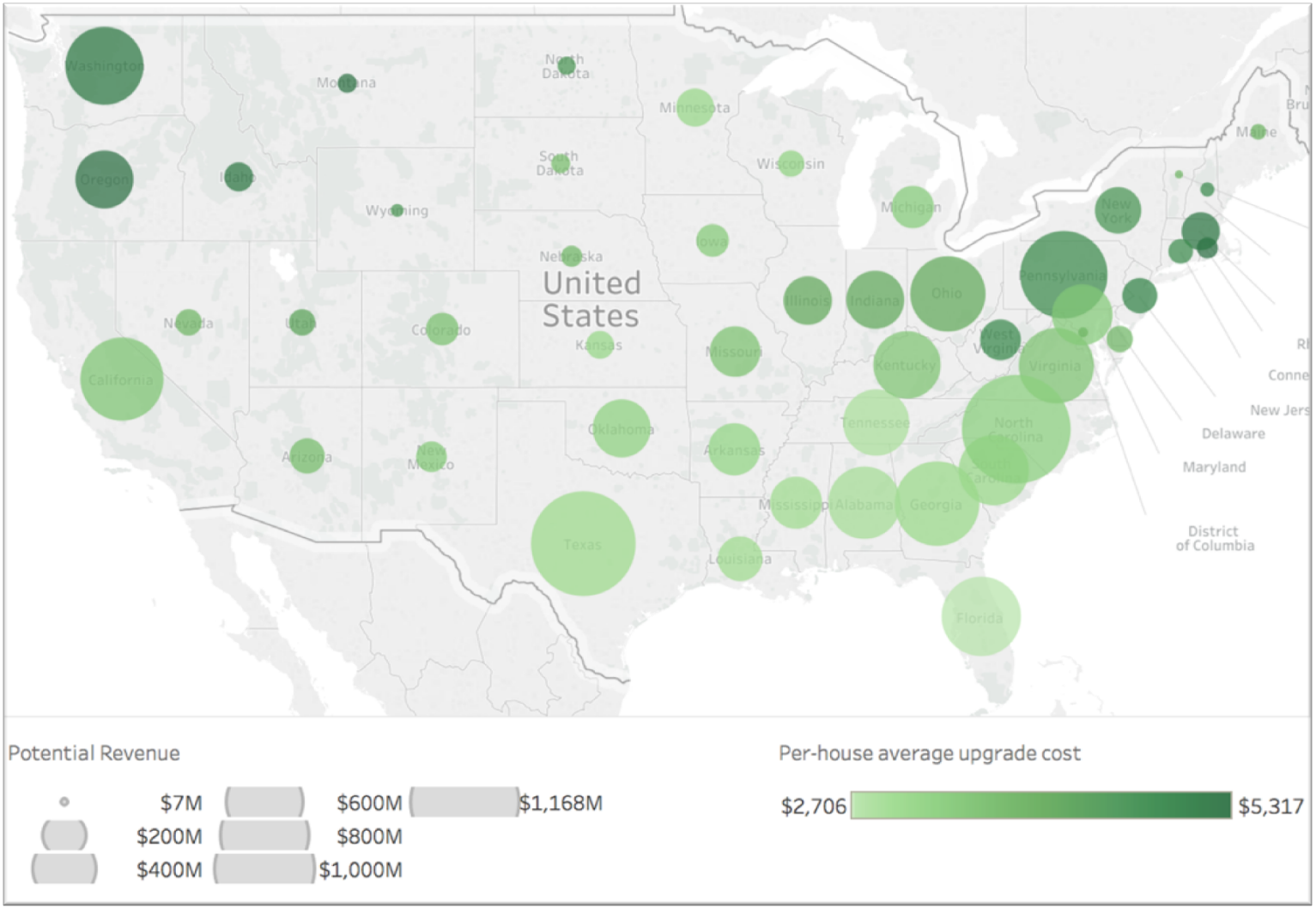
Percentage savings (savings in homes with <200% FPL div. by usage of all homes)



Percentage savings (savings in homes with <300% FPL div. by usage of all homes)



Revenue Potential

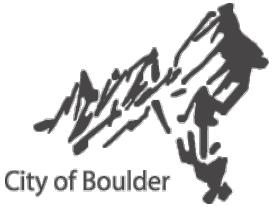


Potential revenue from high-efficiency variable-speed heat pump equipment sales and installation in households where the upgrade has a less than 5 year payback period.

ResStock Strategic Partners

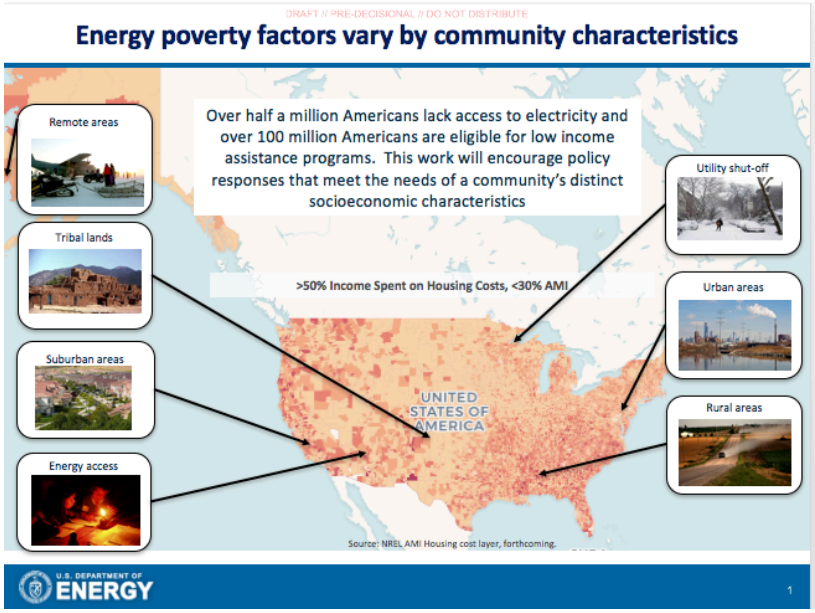
EERE Building Technologies Office
EERE Office of Strategic Programs
Office of Energy Policy and Systems Analysis
Office of Electricity

United States Environmental Protection Agency
Regions 8 & 10



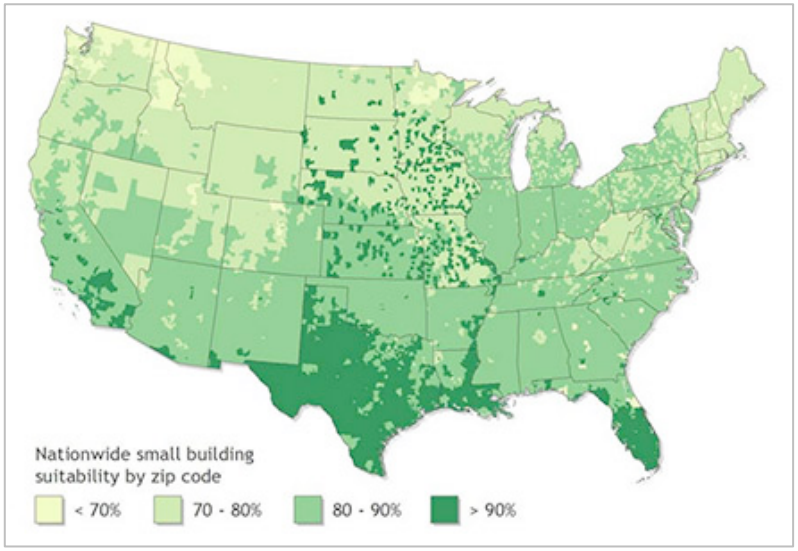
Related DOE/NREL Projects

Energy Affordability and Access Study



Goal: Conduct a data-driven energy poverty analysis to explore and highlight policy tools that could enable affordable, universal energy access

Solar Energy Evolution and Diffusion 2017–2019 Study



Goal: Identify new strategies to dramatically boost solar adoption rates in low and moderate income (LMI) communities

Discussion

What is your potential research question?

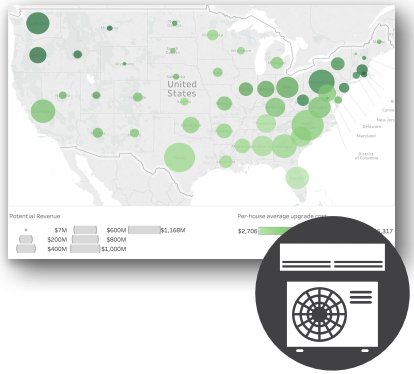
How do you envision a possible project or partnership that would use the ResStock tool?

Supplemental slides

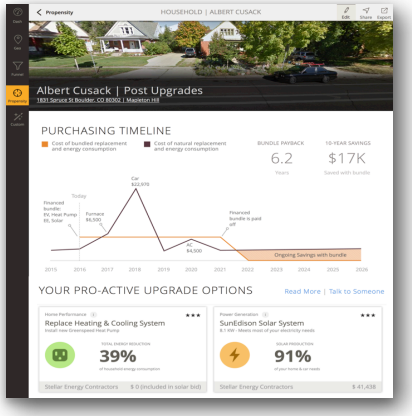
ResStock Applications

National/state policy

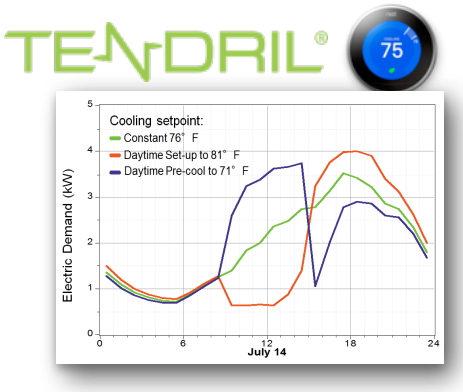
R&D prioritization



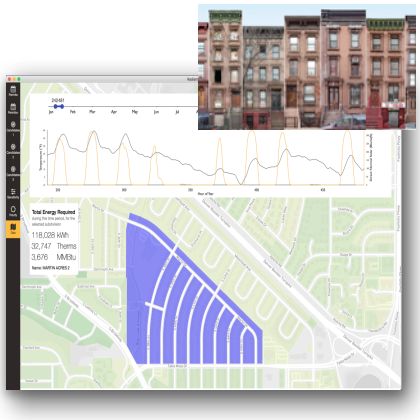
Utility programs



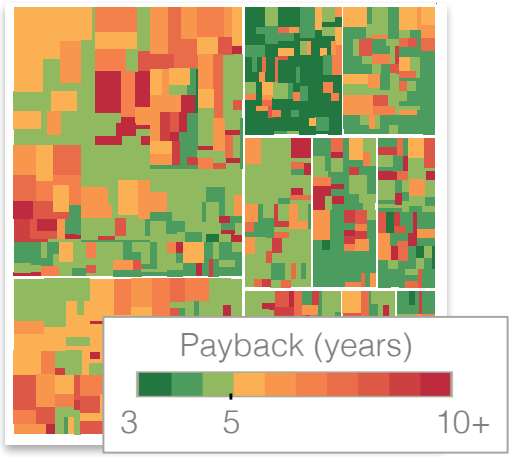
Load flexibility & DR aggregation



City planning/market engagement



Targeted programs



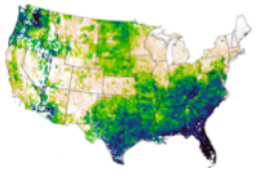
Approach – Data Sources

Building Characteristics

EIA	**Res. Energy Consumption Survey (RECS)**
NAHB	**Homebuilder Surveys**
IECC	**Historical Energy Codes**

Other national, regional, and local audit databases

Census Data



Census	**American Community Survey (ACS)**

Costs

EIA	**Electricity and fuel costs**
NREL	**OpenEI.org Utility Rate Database**
NREL/Navigant	**Measure Cost Database**

Climate Locations

NREL	**TMY3 weather data**

Application: Market engagement

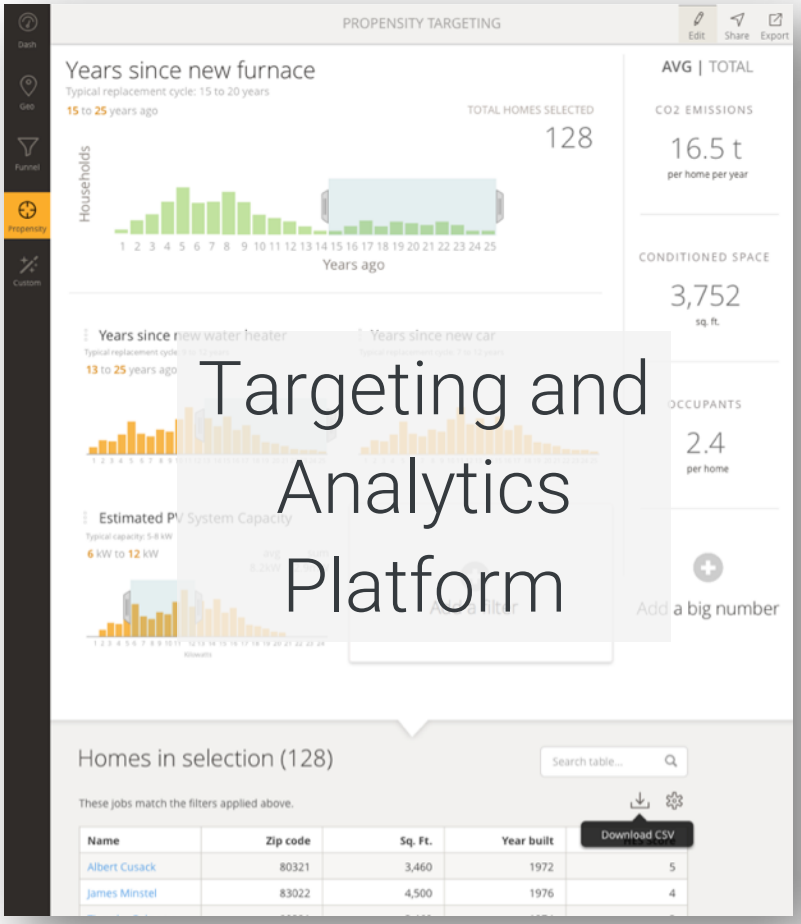
Hyperlocal data
e.g., assessors' databases, utility bills

ResStock workflow and regional characteristics

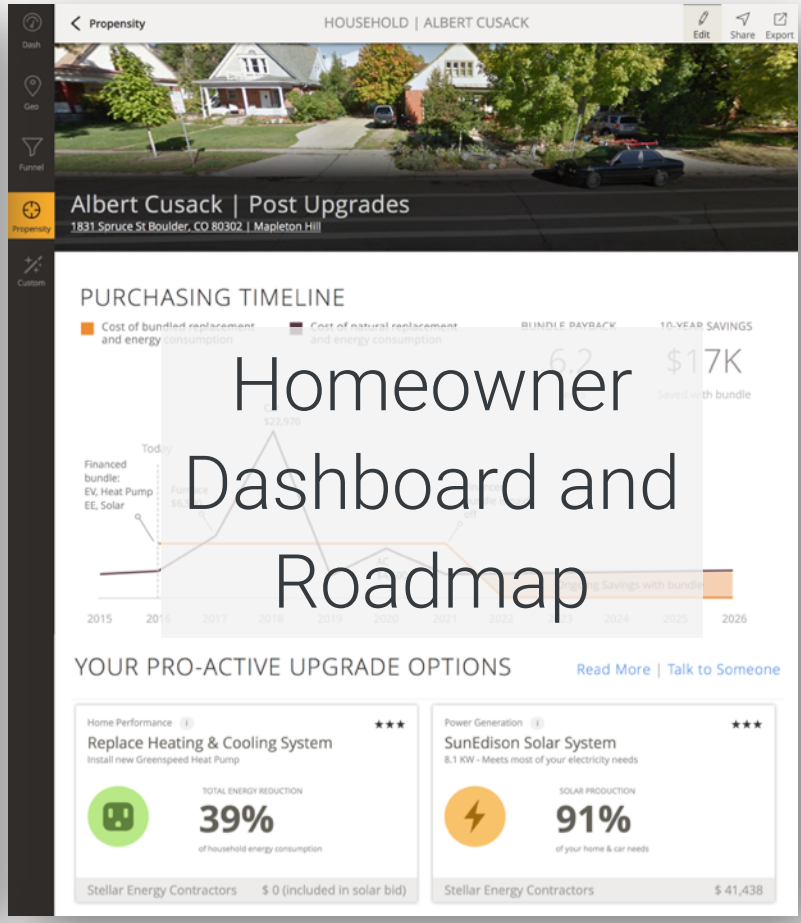
Market engagement tools & analytics

City of Boulder

Radiant Labs



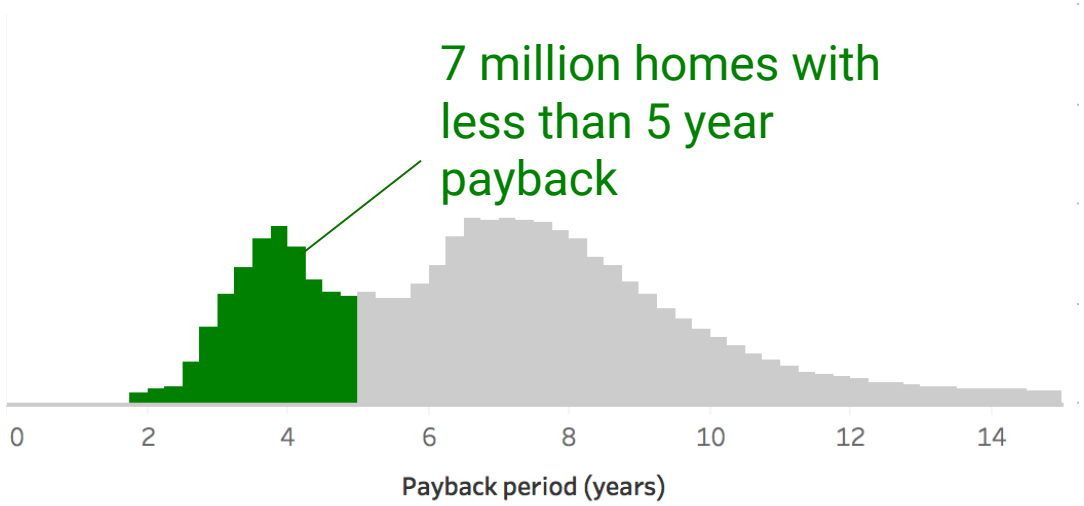
Targeting and Analytics Platform



Homeowner Dashboard and Roadmap

Evaluate incentives – Drill-and-Fill Wall Insulation

With no rebate



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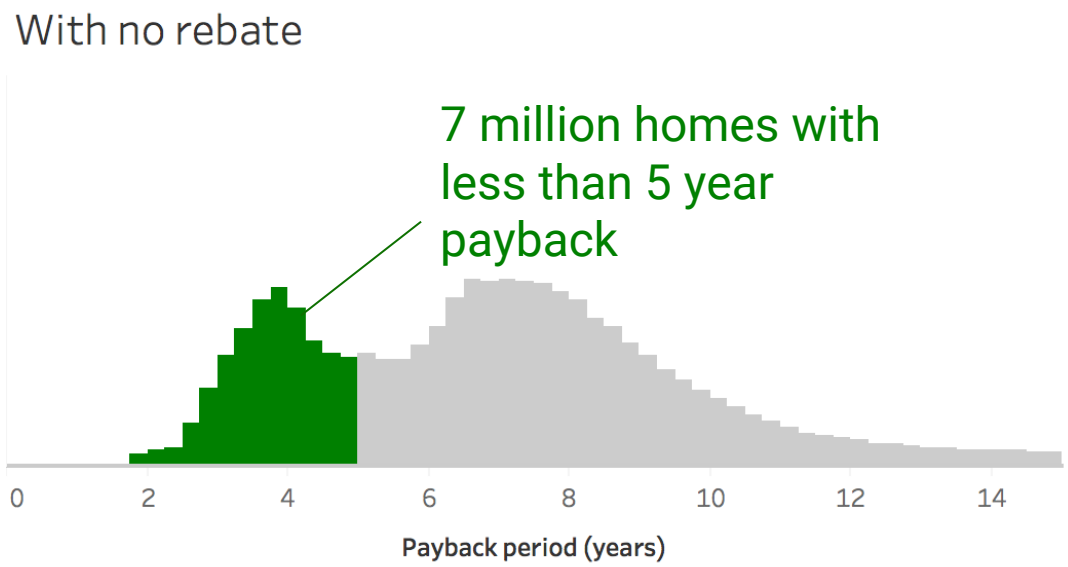

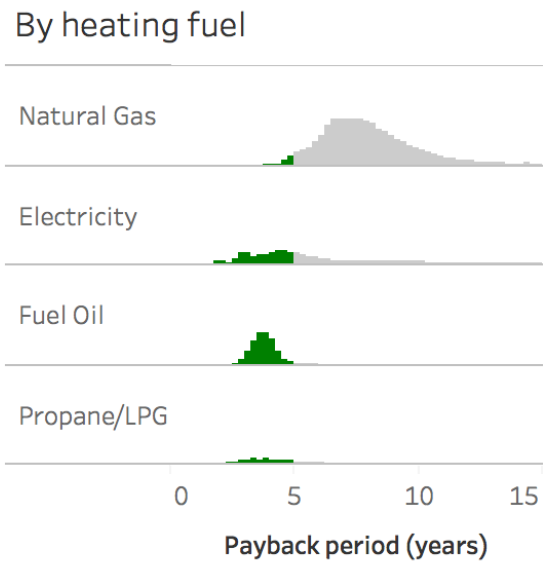

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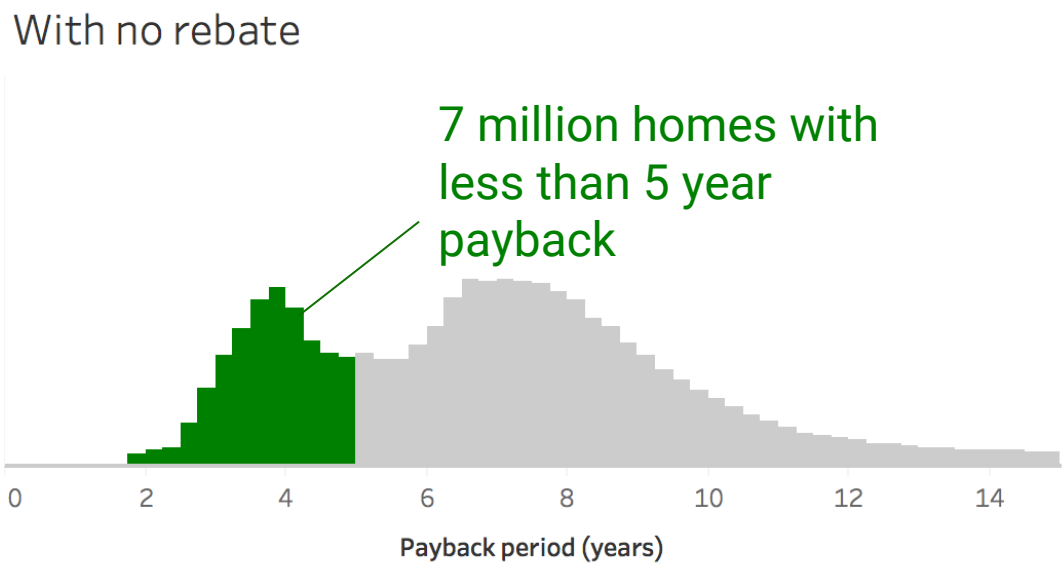
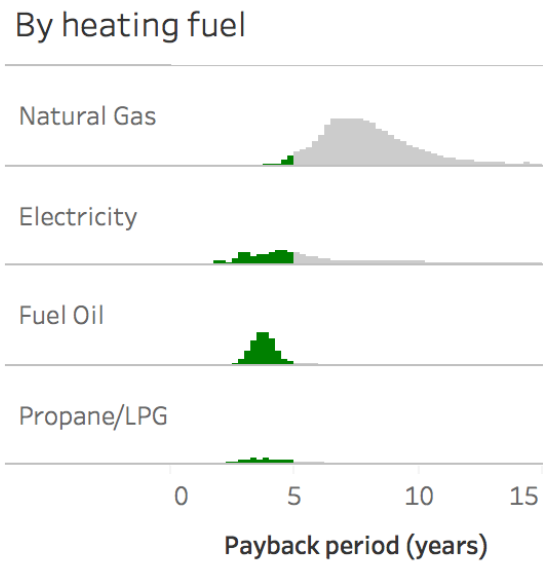
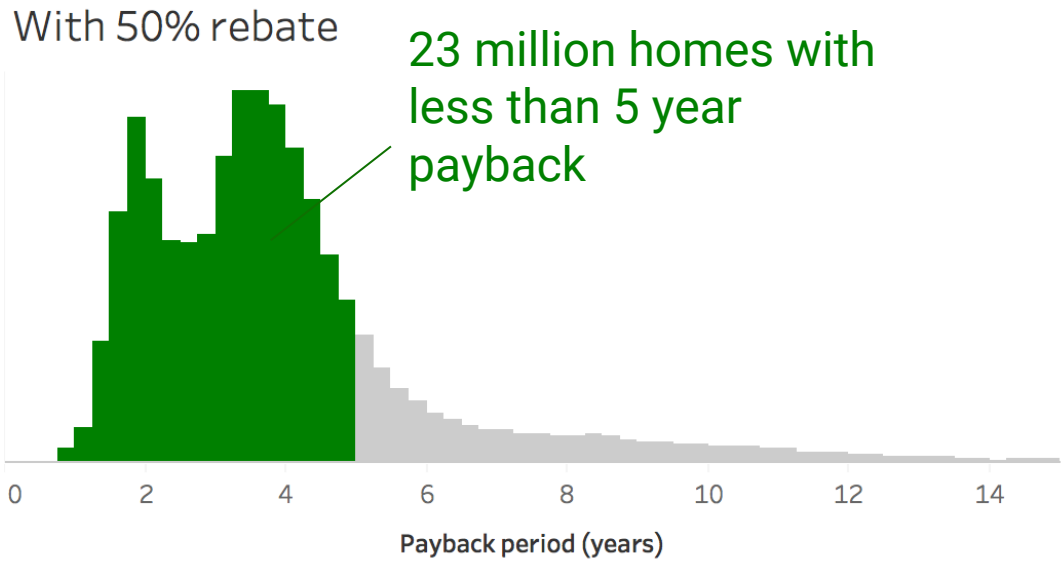
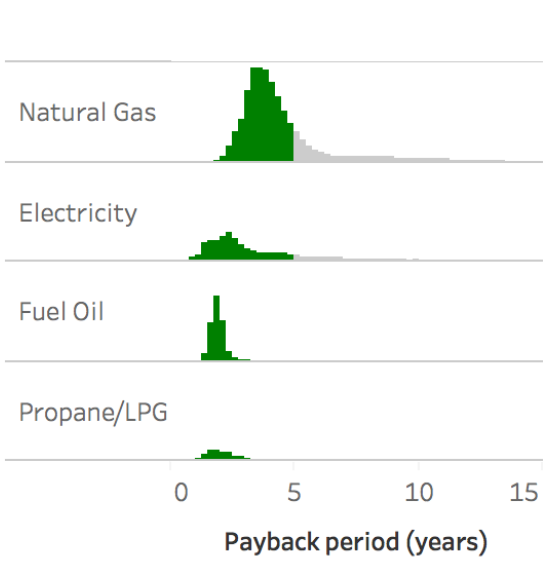


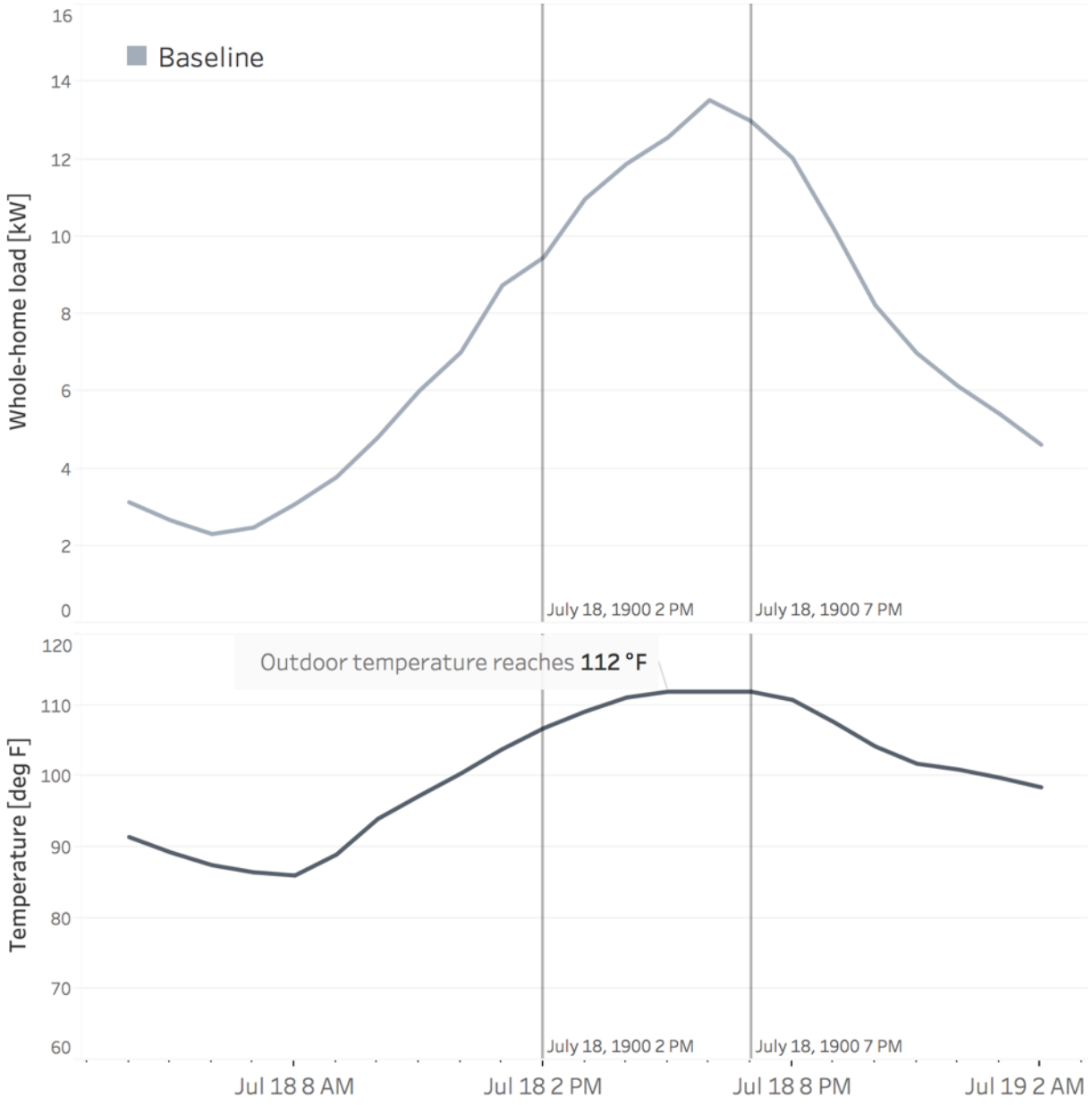






Application: Buildings-to-Grid Analysis

Simulated **peak shifting potential** across a segment of housing stock (1950s homes in Phoenix)



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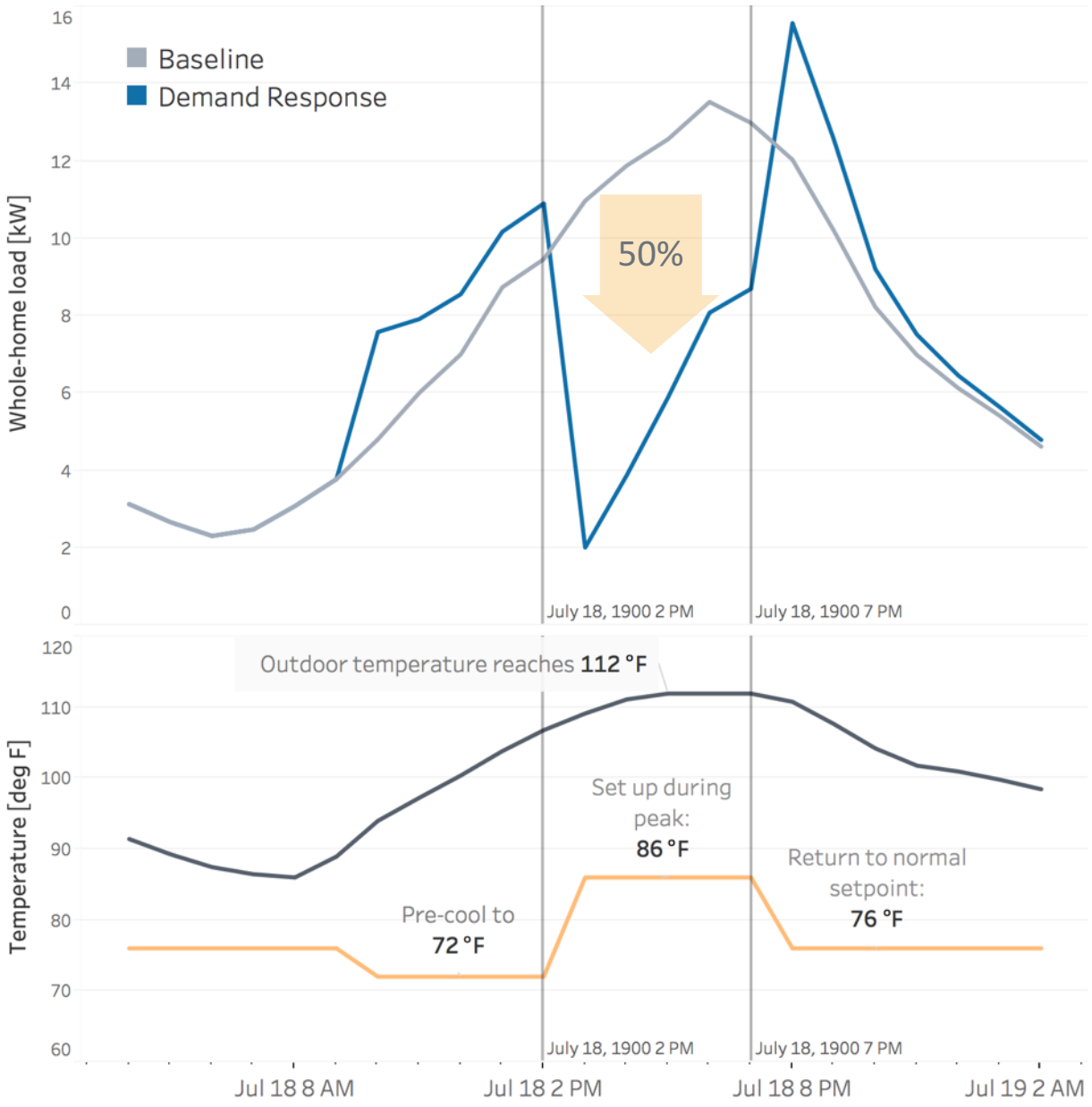

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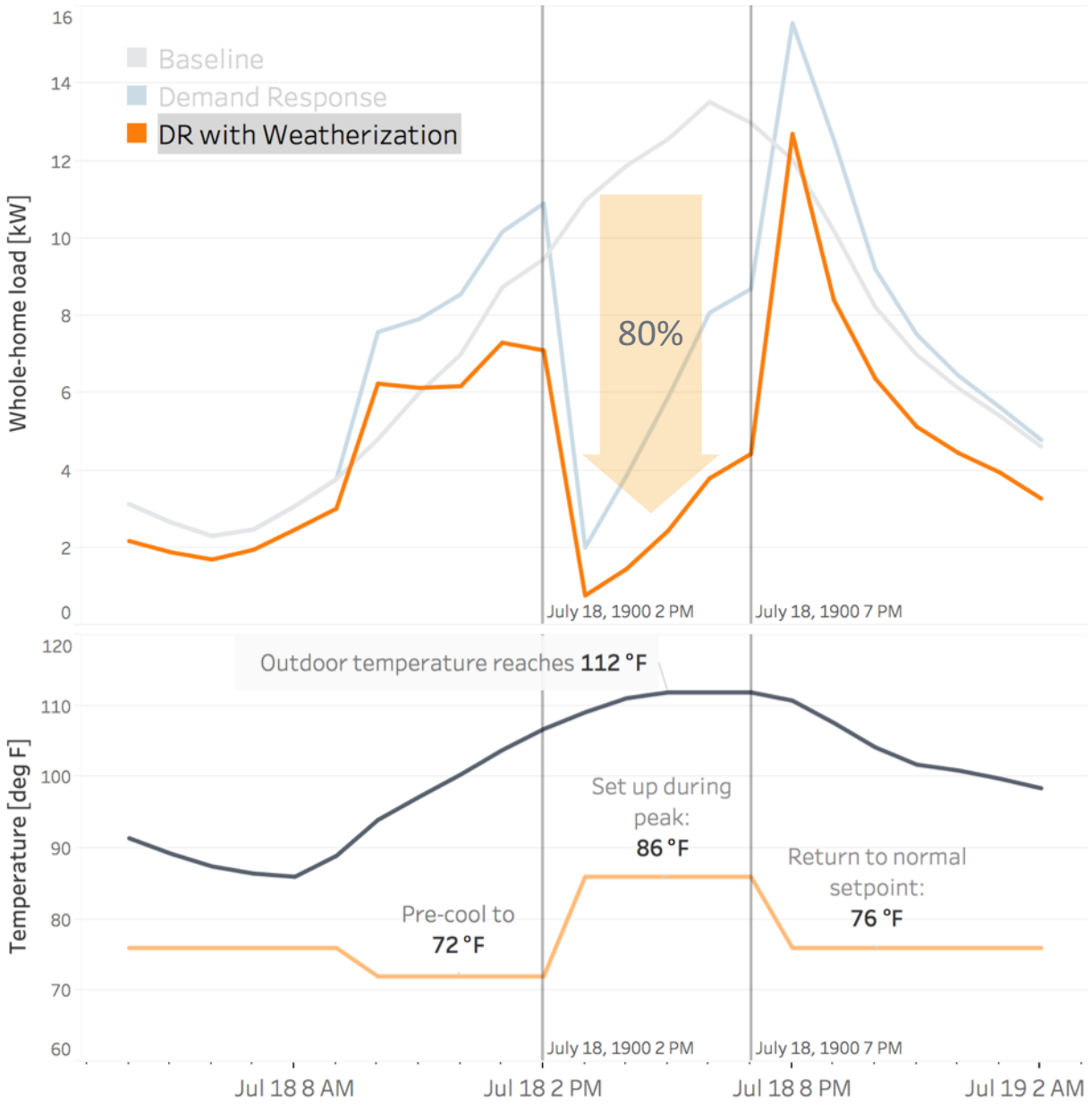

Package algorithm

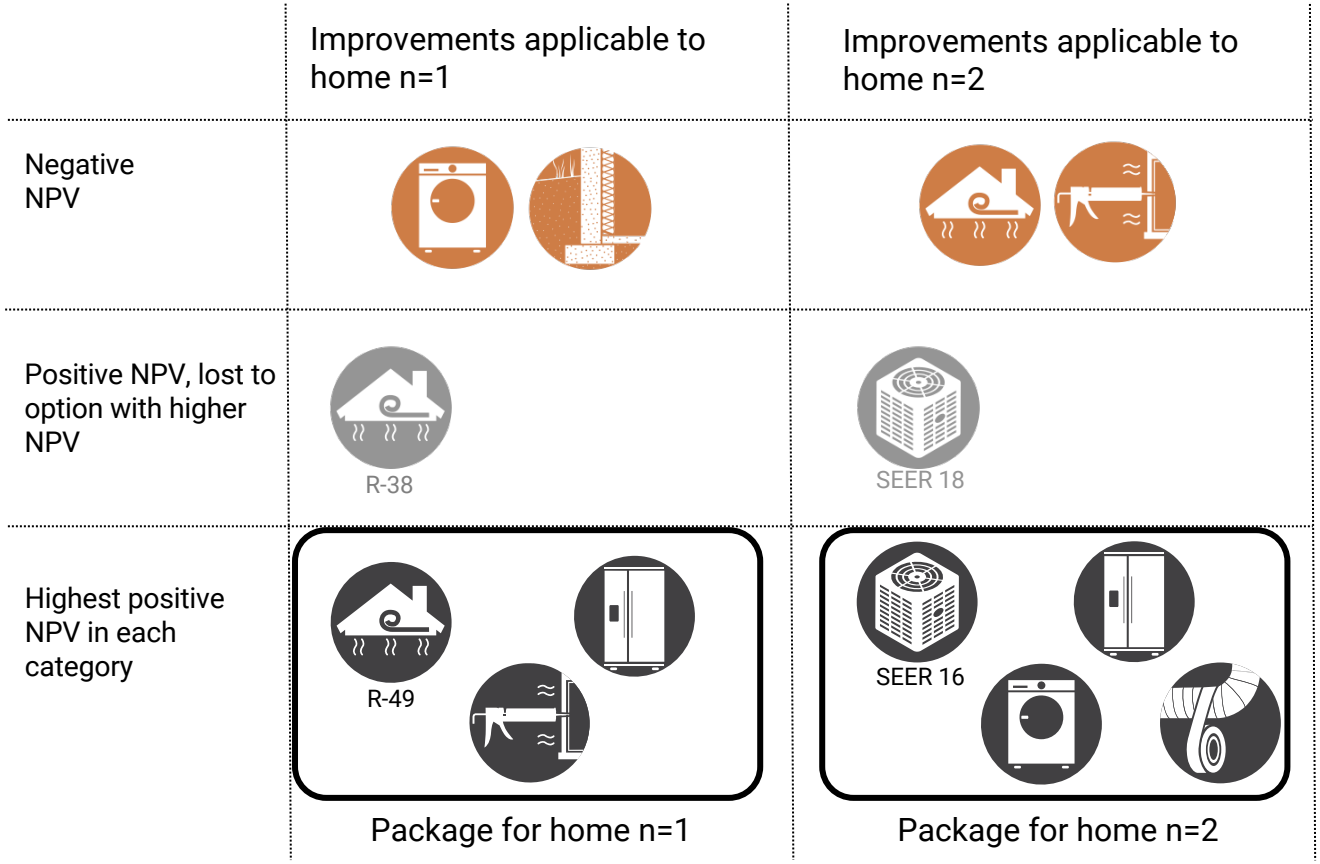

Figure 2: This diagram illustrates the automated process used to develop tailored packages of efficiency upgrades for each of the representative 350,000 homes.

Use Levels and Required Skills

Use Level	Example Inquiry	Required Skills
1) Explore existing results via publications and web-based interfaces	*Which regions of the U.S. have the greatest economic potential for variable-speed heat pumps replacing electric furnaces?*	General knowledge of EE
2) Apply custom metrics, filters, and queries to existing results and plot/map	*What is the potential revenue for variable-speed heat pump installations that pay back in less than 2 years?*	Working with databases (SQL); Python scripting
3) Run new simulations with local data (e.g., tax assessors' data)	*What technologies are best for NYC homes, and which buildings are the best targets for market engagement?*	Working with databases (SQL); Python scripting; Running OpenStudio on Amazon
4) Run new simulations to evaluate an emerging technology	*What is the economic potential of multifunction heat pumps nationally and by-state?*	Building energy modeling (EnergyPlus & OpenStudio); Ruby scripting; Running OpenStudio on Amazon