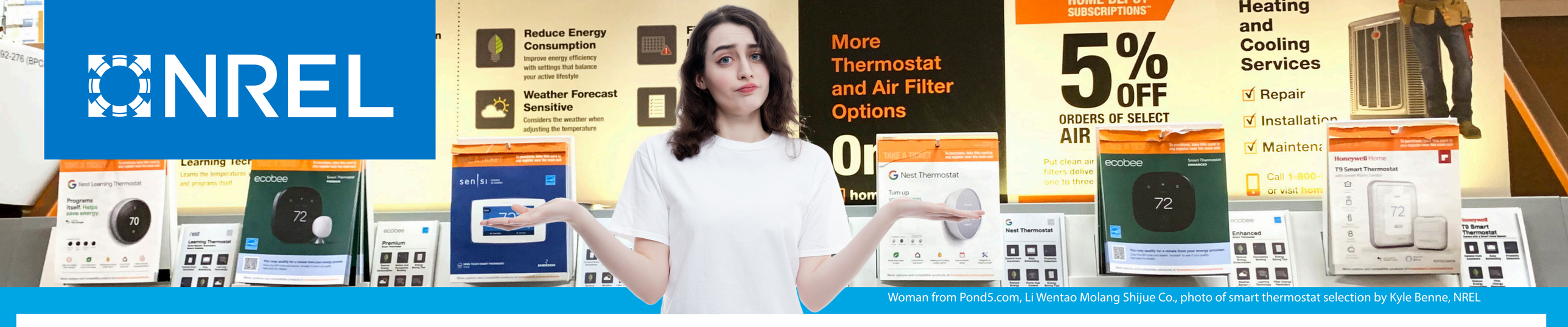


Woman from Pond5.com, Li Wentao Molang Shijue Co., photo of smart thermostat selection by Kyle Benne, NREL

# Benchmarking Smart Thermostats

We are using building energy modeling to evaluate smart thermostat algorithms so that, in the future, rating programs such as EPA ENERGY STAR may be able to evaluate a wider range of new thermostat products before they go to market

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## CONVENTIONAL APPROACH AND CHALLENGES

The EPA currently requires 12 months of field data in order to consider a new thermostat model for the ENERGY STAR label. Their algorithm looks at the amount of time the heating and cooling equipment is running (HVAC runtime) within a large sample of homes to predict energy savings. While the method is reliable, there are still limitations and challenges to overcome.

**Consumers** do not initially have an independent assessment of the energy savings potential associated with new products.

**Manufacturers** must bring new products to market without the ENERGY STAR label. Marketing material and packaging must be changed if the label is added later. The current method favors incumbent products.

**EPA** does not have a methodology to evaluate thermostats that are coupled to variable speed HVAC technology, because the current method assumes a linear relationship between HVAC runtime and indoor/outdoor temperature difference, which does not apply to variable speed equipment.

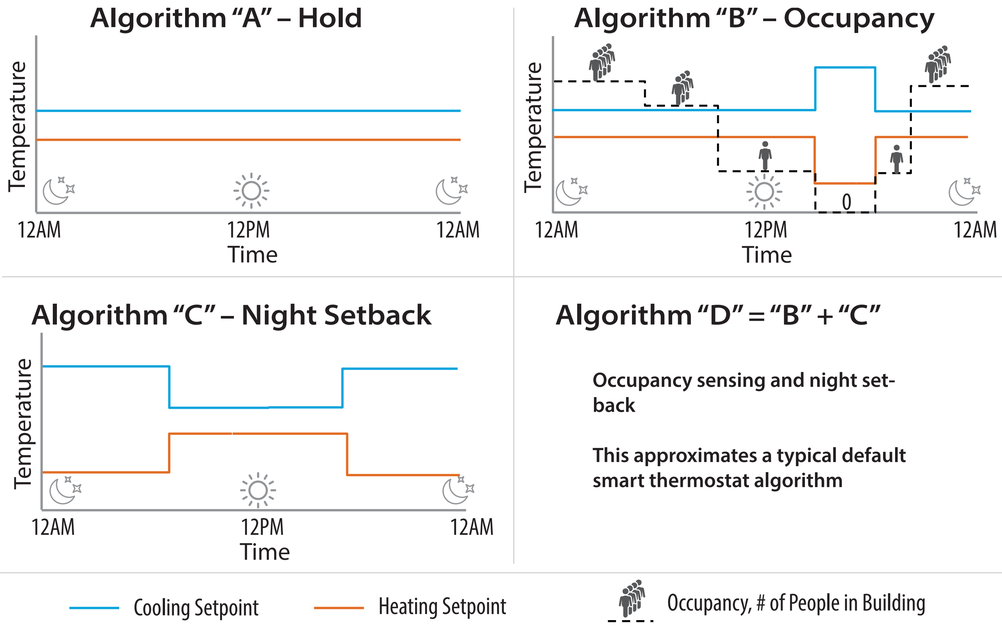
## OUR APPROACH

We are demonstrating a new thermostat evaluation method based on large scale building energy modeling and simulation. If successful, we will make it possible to evaluate a wider range of thermostats earlier in the product lifecycle, thereby bringing significant energy and cost savings to multiple stakeholders.

In our approach, several pieces of the DOE toolchain are combined to bring simulation to bear.

| ResStock | Spawn of EnergyPlus | BOPTEST Building Optimization Performance Test | KPIs |
|---|---|---|---|
| • Large sample of homes based on OpenStudio/ EnergyPlus | • Realistic HVAC equipment<br>• Realistic controls | • Thermostat interface<br>• Large scale simulation<br>• KPIs | • Equipment runtime<br>• Energy consumption<br>• Peak power<br>• And others |

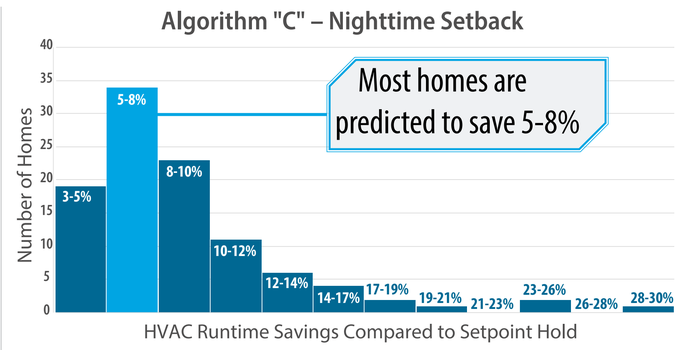
### We Evaluated Four Generic Thermostat Algorithms

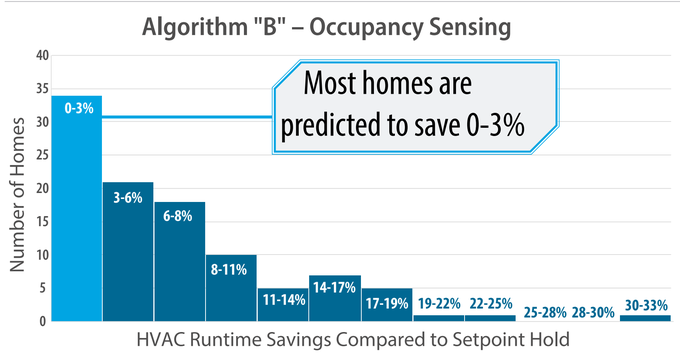


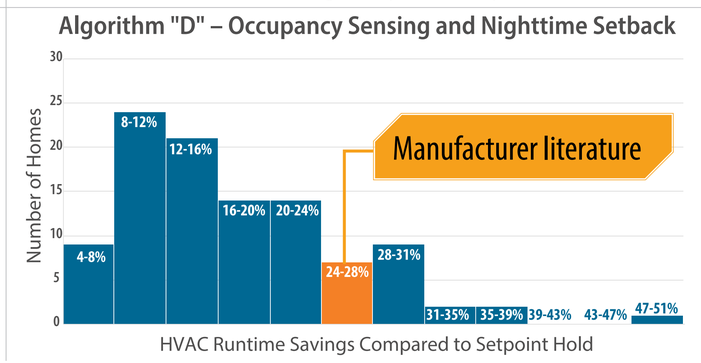

## INITIAL SIMULATION RESULTS

**Results align with manufacturers' literature, but add depth.**

- More advanced algorithms combine savings.
- Algorithm "D" combines the savings from occupancy sensing and nighttime setback.




**A custom dashboard enables analysis of the simulation output**


## OPPORTUNITY IS ENTICING

**Single Family Home Energy Use**




\+ **Smart Thermostat**


**Based on the typical energy savings estimates, most smart thermostats would payback in under 2 years.**

X **74 million single family homes in U.S.**



* Source: U.S. Energy Information Administration, Office of Energy Consumption and Efficiency Statistics, Forms EIA-457A and EIA-457C of the 2015 Residential Energy Consumption Survey.

## WHAT'S NEXT?

- Further establish simulation credibility by aligning simulation data to ecobee's **D**onate **Y**our **D**ata program.
- **Expand the range of HVAC equipment types** to include variable speed technologies.
- **Establish pilot tests with manufacturer**s.




NREL is a national laboratory of the U. S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.



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