Smart Home Energy Services

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Abstract

Working with the I Heart my Home Program from NHS New Haven, we are helping with software to improve the energy efficiency of homes in the New Haven area. Our goal for the project is to adapt existing source code and data to monitor, validate and control a residential building, based on common home improvements. The three improvements can be categorized into: 1) capital projects that change the physical building systems, 2) service selections that change providers of retail energy supply and/or onsite generation, and 3) product or occupant changes that modify the timing of equipment operation. The adaptations shall optimize for lowest cost and/or lowest carbon energy use at any time interval of the day and the system shall be operable on a Raspberry Pi 2, 3, or higher device and will also use Amazon Web Services (AWS).

Objectives

- Build upon and interact with Open Studio ResStock software in order to simulate energy efficiency in homes for the New Haven area.
- Tweak software to meet specific needs of NHS
- Make the tool portables to be used in a variety of locations.

Technology
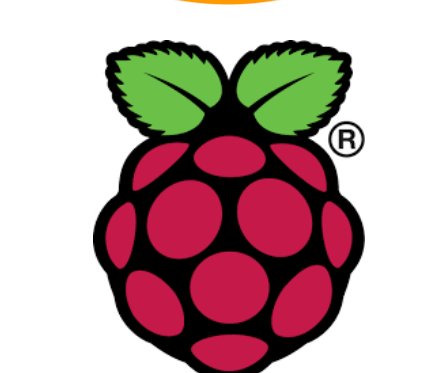
- Open Studio: modeling software home and building data.
- ResStock: open-source code that builds upon Open Studio software for energy efficiency in homes.
- Parametric Analysis Tool (PAT): software to apply changes to a home and run simulations to test energy efficiency changes.
- Amazon Web Services: used by PAT for large scale simulations.
- Raspberry Pi: makes the software more portable for commercial use by the NHS New Haven.

Results

Able to cut energy consumption costs. The design alternative for changing the water heater from electric to natural gas, was able to save energy costs. The peak electric demand is down 9% from before and the electricity savings had a 3% decrease as well. The natural gas consumption went up because we are now using natural gas instead of electricity for water heating. .
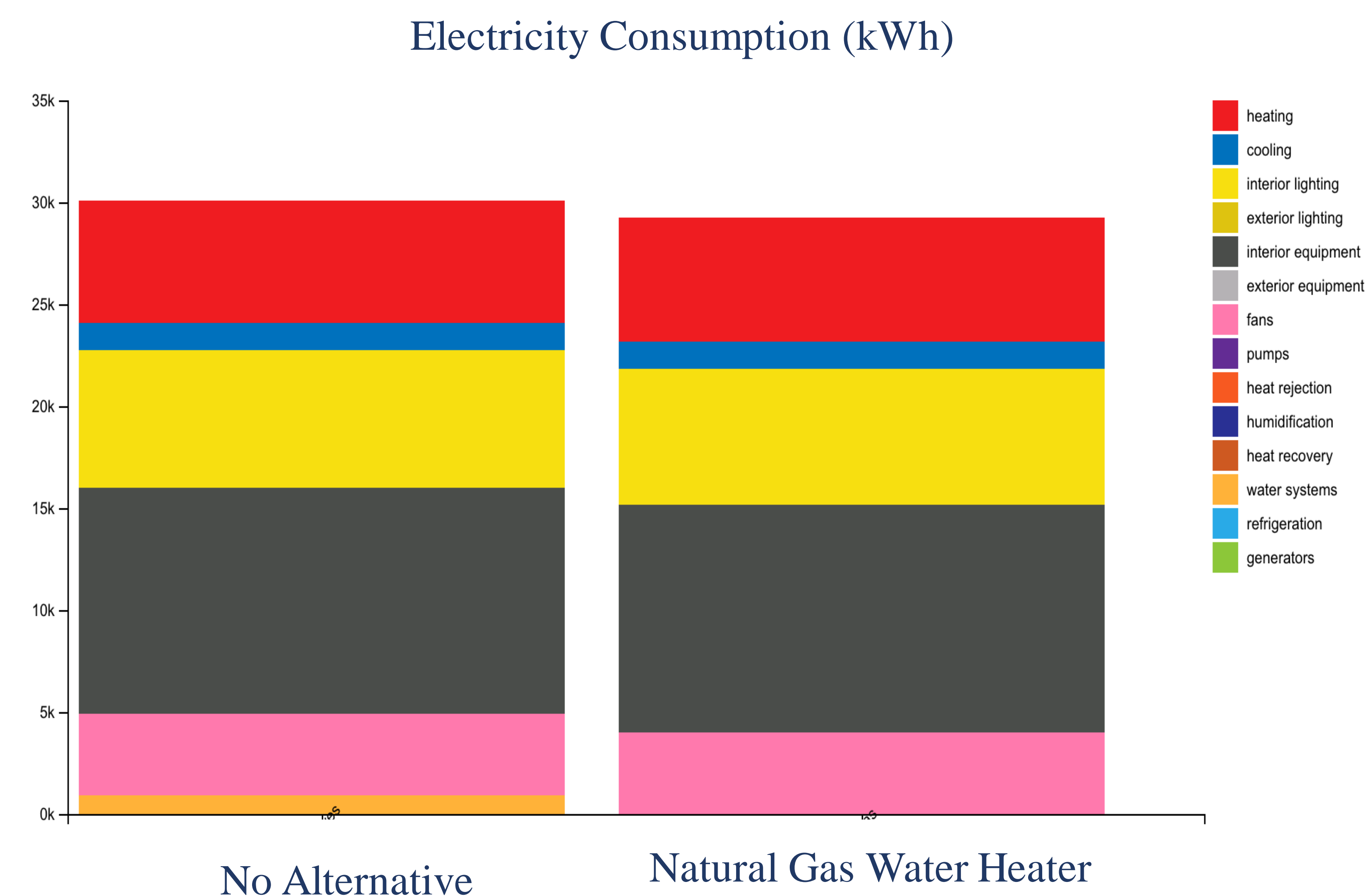
Electricity Consumption (kWh)

| No Alternative | Natural Gas Water Heater |

Figure 1: Graph shows the change in electricity consumption after applying a change to the water heater.

Name	Measures	Energy Use Intensity (kBtu/ft2-yr)	Peak Electric Demand (kW)	Electricity Consumption (kWh)	Natural Gas Consumption (Million Btu)
No Alternatives		182.4	6.9	30,113.0	58.7
Name	**Measures**	**Energy Use Intensity Reduction (kBtu/ft2-yr)**	**Peak Electric Demand Reduction (kW)**	**Electricity Savings (kWh)**	**Natural Gas Savings (Million Btu)**
1xNaturalGas	• NaturalGas1x	0.0 0%	0.6 9%	895.7 3%	-3.1 -5%

Table 1: Quantity assessment in energy savings with water heater type changed from electric to natural gas.

Conclusions

We were able to promote some energy savings in a duplex style home with the use of the Parametric Analysis Tool. This home model represents some homes in the New Haven Area and allows us to scale these home improvements to them. Some of the improvements are changing from electricity to natural gas where possible, installation of solar panels for a more sustainable and clean energy source, and changes in HVAC systems in order to help make the home more efficient. These changes will help the duplex style homes in the New Haven area because the upgrades can be applied to almost every home.

Benefits

Our work will help make changes to homes in the New Haven area. The changes will help improve the energy efficiency in these New Haven homes and will allow for cheaper electricity costs for homeowners, as well as a healthier carbon footprint. This work will eventually be used by our sponsor in order to help 1.5 million homes in Connecticut

Acknowledgements

Future Work

Our work focused on running simulations in a local environment. Future work on the project could develop algorithmic simulations using cloud-based software. This will make the simulations scalable to include many houses and a larger number of upgrade scenarios.

References

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- https://resstock.readthedocs.io/en/v2.2.5/
- https://energyplus.net/weather
- https://neep.org/home-energy-labeling-information-exchange-helix
- https://www.openstudio.net/