Toward the Most Cost Effective Residential Energy Reduction: A Data-Based Approach

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Introduction/Motivation

Many U.S. utilities incentivize residential energy reduction through rebates, often in response to state mandates relative to energy reduction or from a desire to reduce demand in order to insure mitigate needs to grow generating assets or simply from a desire to provide service to customers. The assumption built into incentive programs is that the least efficient of residences will more likely take advantage of the rebates.

A data based approach which leverages known building and energy characteristics is used to develop a single model to accurately predict energy consumption for a grouping of houses, which collectively can be considered to be representative of all residences within an entire utility district. From this model, the natural gas and cost savings and corresponding implementation cost associated with adoption of the most impactful energy reduction measures for each residence can be estimated. From these savings and cost estimates a sequential energy reduction strategy can be developed, whereby the most cost effective measures from within the entire utility district are addressed first and so on

Objective

Show the potential for prioritized incentivization, e.g., incentivization that delivers the greatest energy savings per investment. The key question addressed in this research is how to prioritize energy reduction measures among all possible measures for all residences in an entire customer base.

Methodology

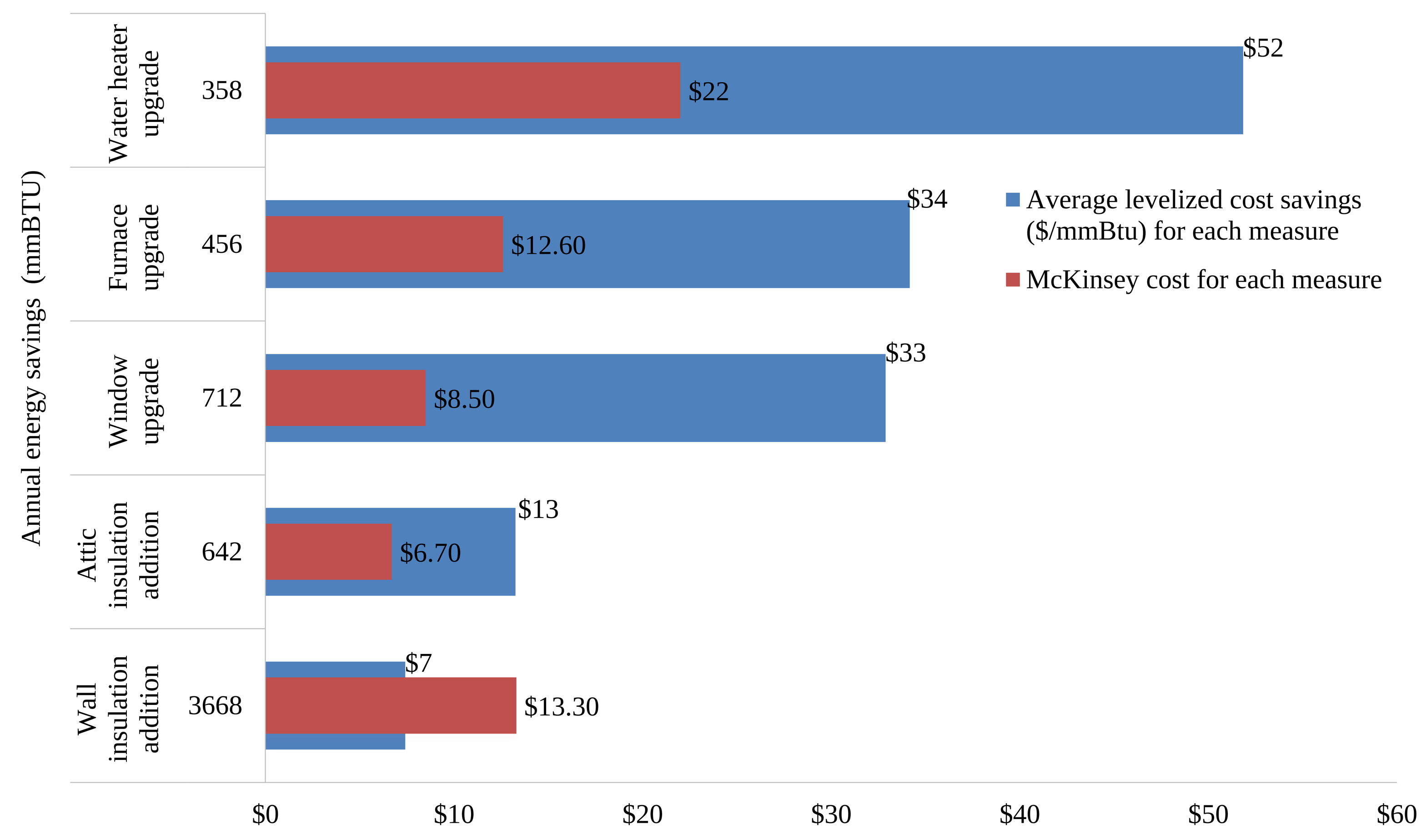
- Description of data collected
- Data mining for developing a predictive model for energy consumption of all residences within a community
- application of model developed to predict savings from specific measures for each house
- A 'worst-to-first' strategy for adoption of energy efficiency measures in order to achieve community-scale energy (and carbon) savings most cost effectively.

Predictors used in ANN model to predict energy consumption in all houses

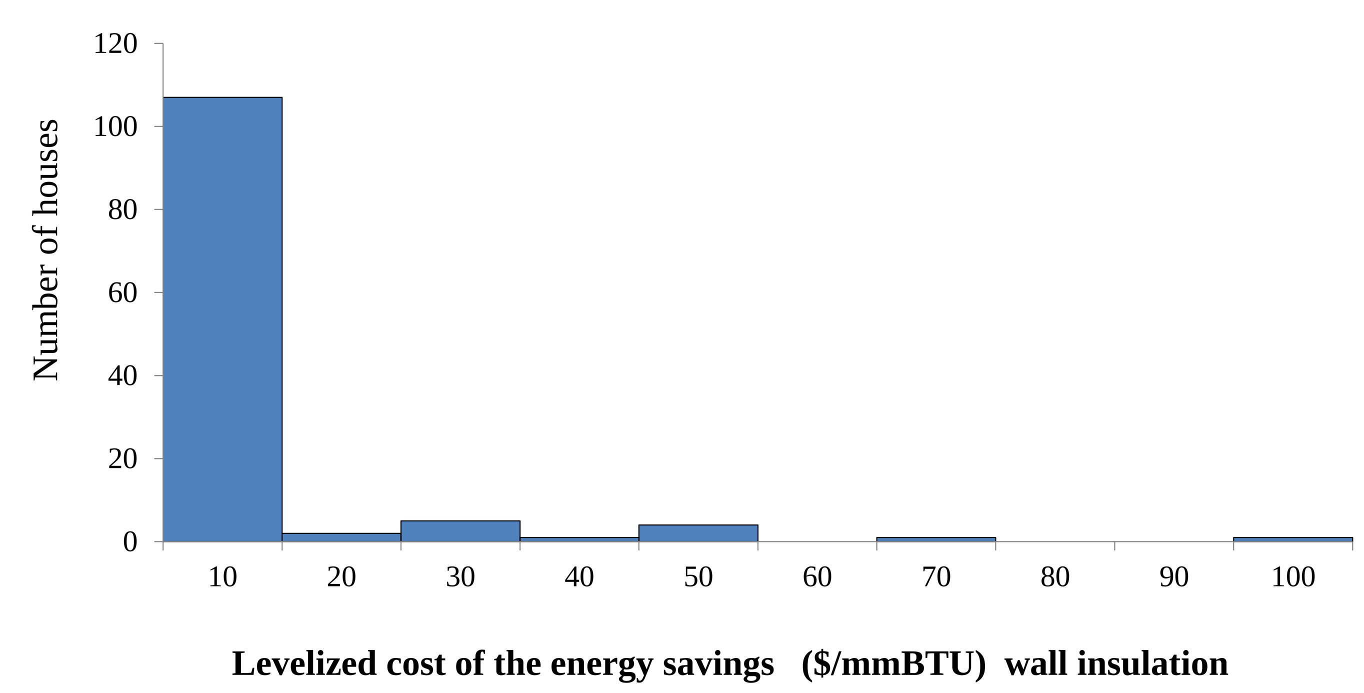
Variable	Input	Output
Floor area (ft^2)	X	
Attic area/ R_{attic} (BTU/hr-^{o}F)	X	
Window area/ R_{win} (BTU/hr-^{o}F)	X	
Wall area/ R_{wall} (BTU/hr-^{o}F)	X	
Furnace efficiency (%)	X	
Energy factor for water heater	X	
Baseline electric intensity (kWh/ft^2)	X	
Number of occupants	X	
Heating slope gas (BTU/hr-^{o}F-ft^2)	X	
Heating balance point temperature (^{o}F)	X	
Average monthly outdoor temperature (^{o}F)	X	
Monthly natural gas usage (ccf/month)		X

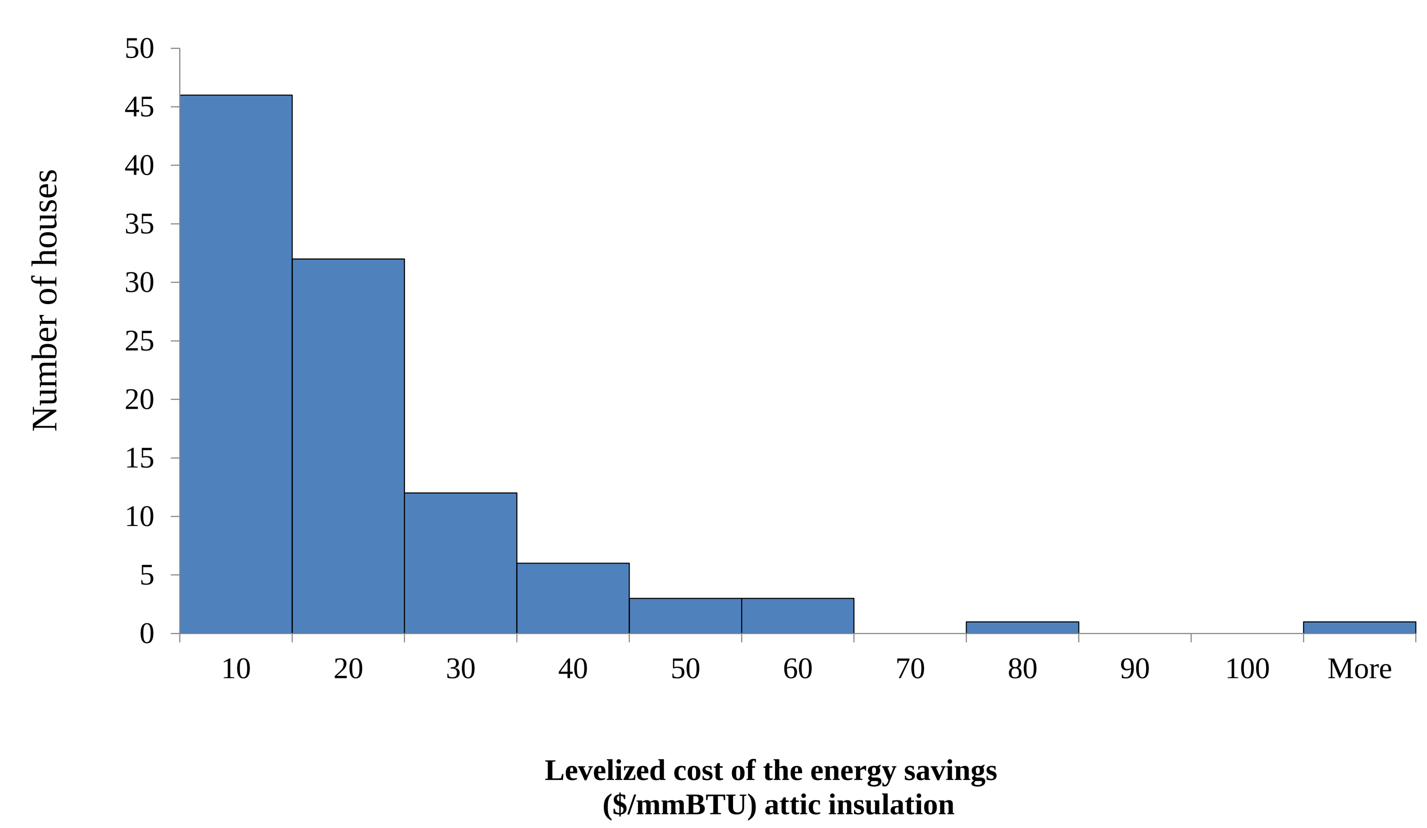
Economic Analysis of Sequential Adoption of Most Cost Effective EE Measures

The annual energy savings in million BTU for various measures vs. Average levelized cost savings ($/mmBTU)

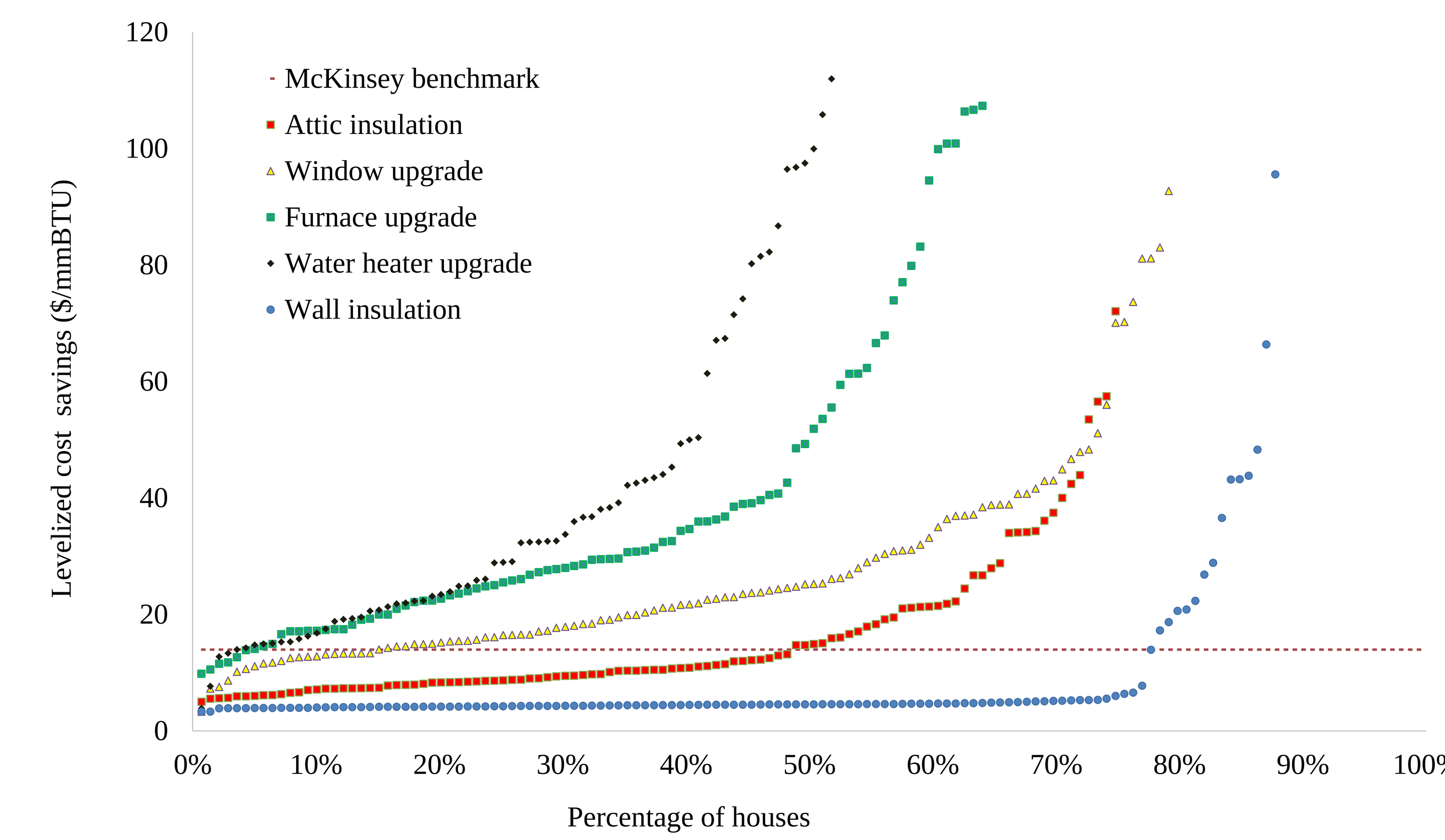


Levelized Cost of Prioritized Investment

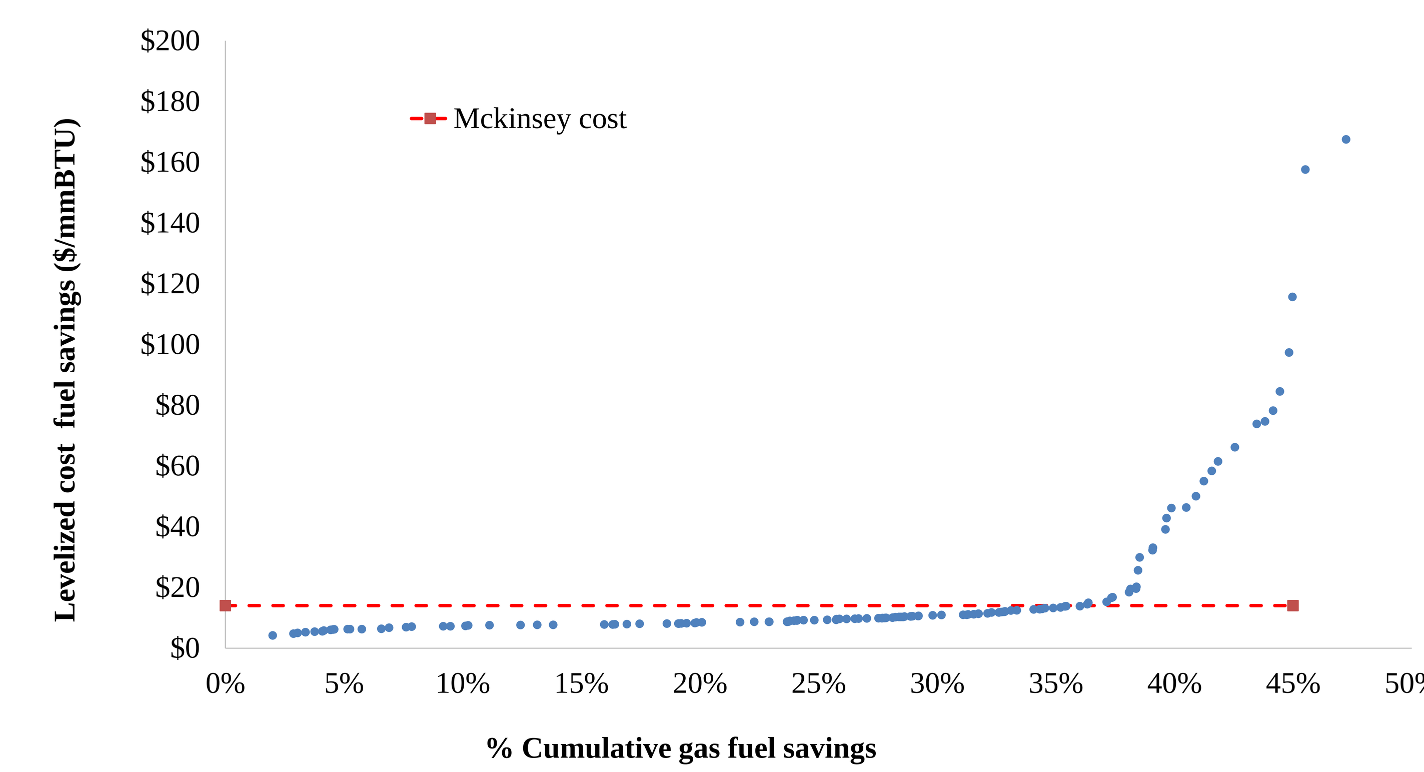




Levelized cost of fuel savings for houses presented in ascending order of cost effectiveness for the houses during winter season



Collective levelized cost of fuel saving (LCFS) as a function of percentage energy reduction for improvements for all measures considered



Conclusion

- A data mining approach is used for developing a single model to estimate natural gas savings and costs from a majority of all possible savings measures after that we use a worst to first energy reduction strategy.
- The results show that an energy reduction of 70% by adding wall insulation and 36% by Collective improvements can be achieved.
- These results show the potential for establishing larger public databases of building energy characteristics in order to strategically implement energy reduction strategies with the greatest energy savings per cost to implement . Will add more conclusion after this revision.