

Assessing Regional Differences in Lighting Heat Replacement Effects (HRE) in Residential Buildings across the United States

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Research Question

How much extra heating/cooling do we need when we replace incandescent bulbs at home?

Background

Incandescent bulbs release up to 95 percent of input energy as heat, impacting the overall building energy consumption. Replacing them increases demands for heating service that needs to be provided by the heating systems and decreases demands for cooling service that needs to be provided by the cooling systems. This work investigates the net energy consumption, CO₂e emissions, and savings in energy bills for single-family detached houses across the U.S. as one moves towards more efficient lighting systems.

Method

We compare two scenarios through a series of building energy simulation: *baseline* and *efficiency* scenarios. The simulation is for identically shaped single-family detached houses with natural gas heating located in 105 cities across the U.S.

Baseline Scenario

- Building prototypes compliant with IECC 2009
- Lighting use corresponding to 2010 average household consumption

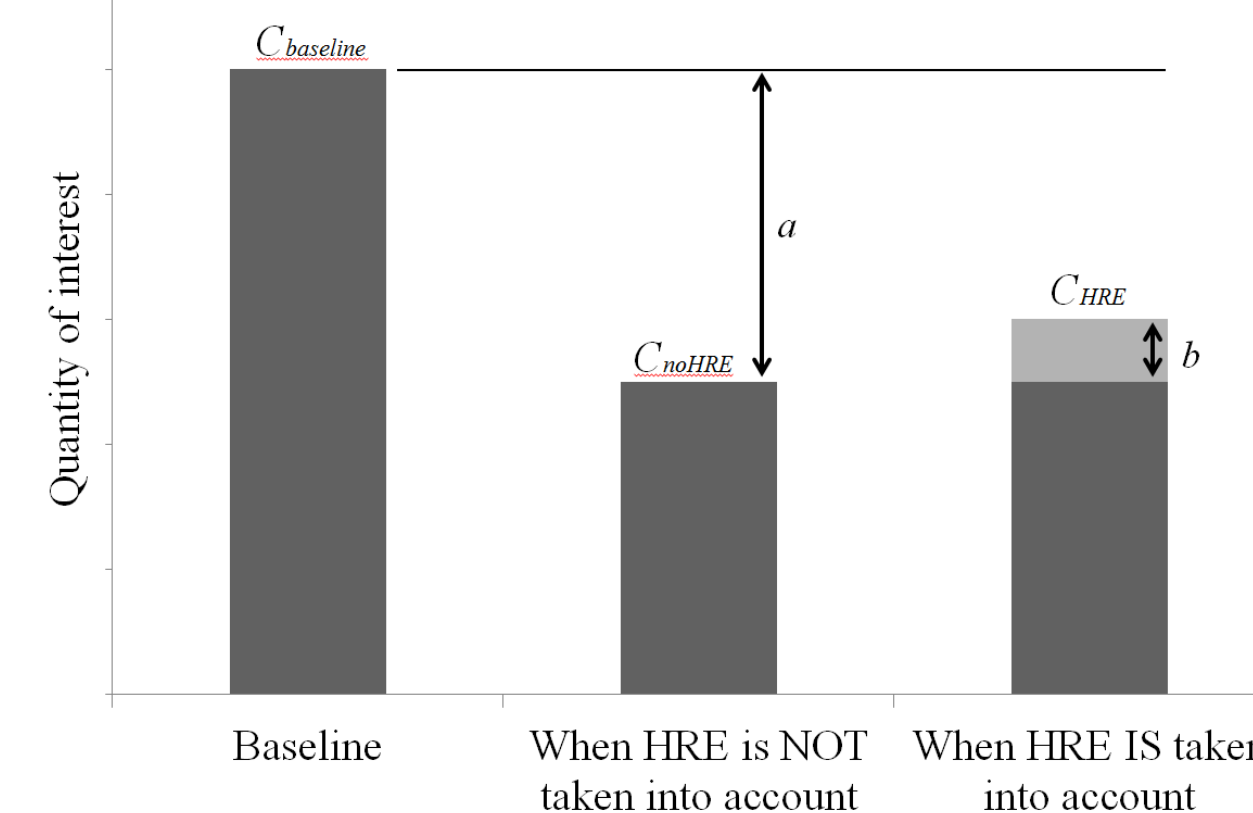
Efficiency Scenario

- Building prototypes compliant with IECC 2009
- Lighting use corresponding to IECC 2012 requirement

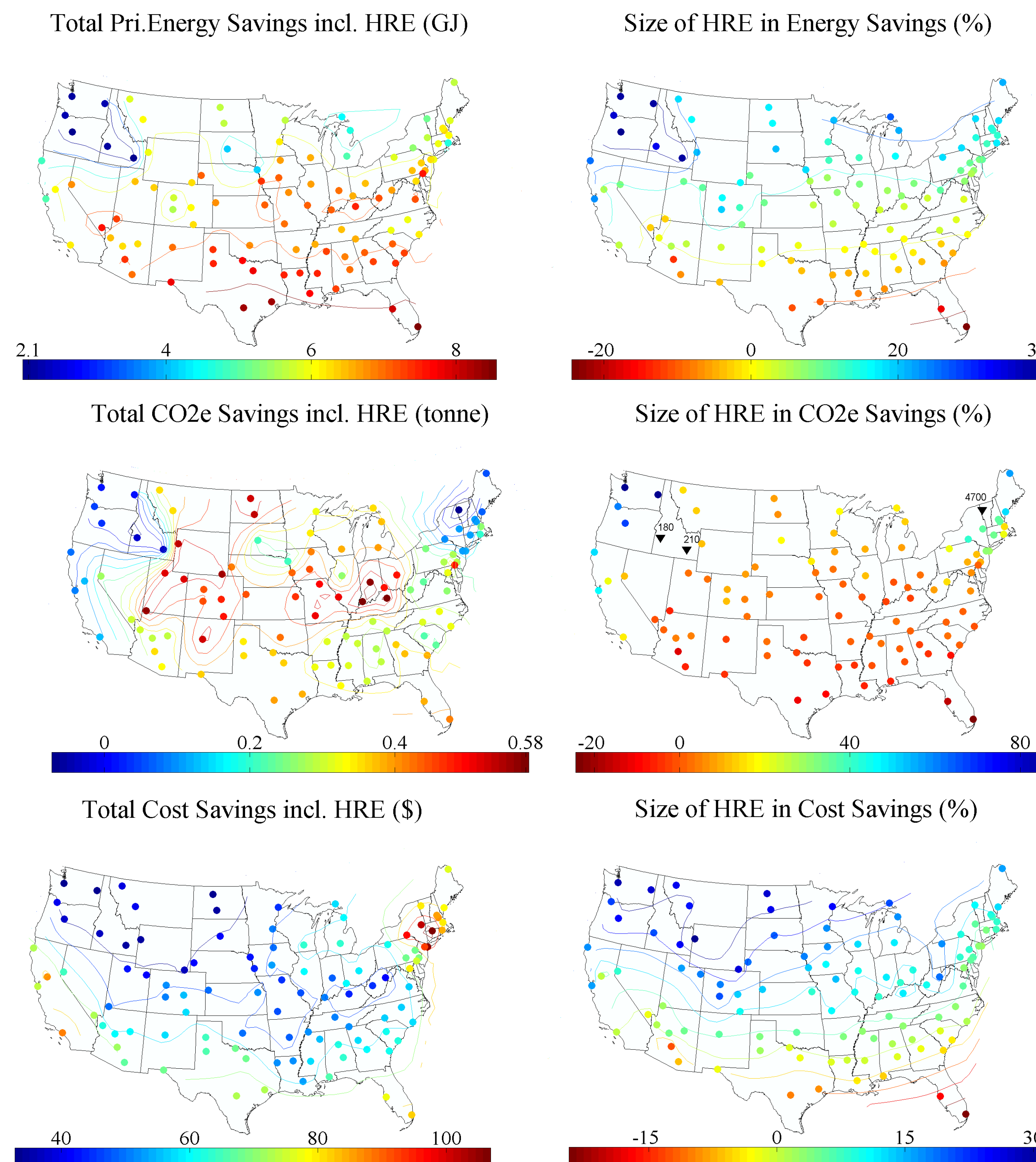
We compute the HRE as follows:

$$HRE [\%] = \frac{\{[C_{baseline} - C_{noHRE}] - [C_{baseline} - C_{HRE}]\}}{[C_{baseline} - C_{noHRE}]} \times 100$$

$$= \frac{[C_{HRE} - C_{noHRE}]}{[C_{baseline} - C_{noHRE}]} \times 100 = \frac{b}{a} \times 100$$

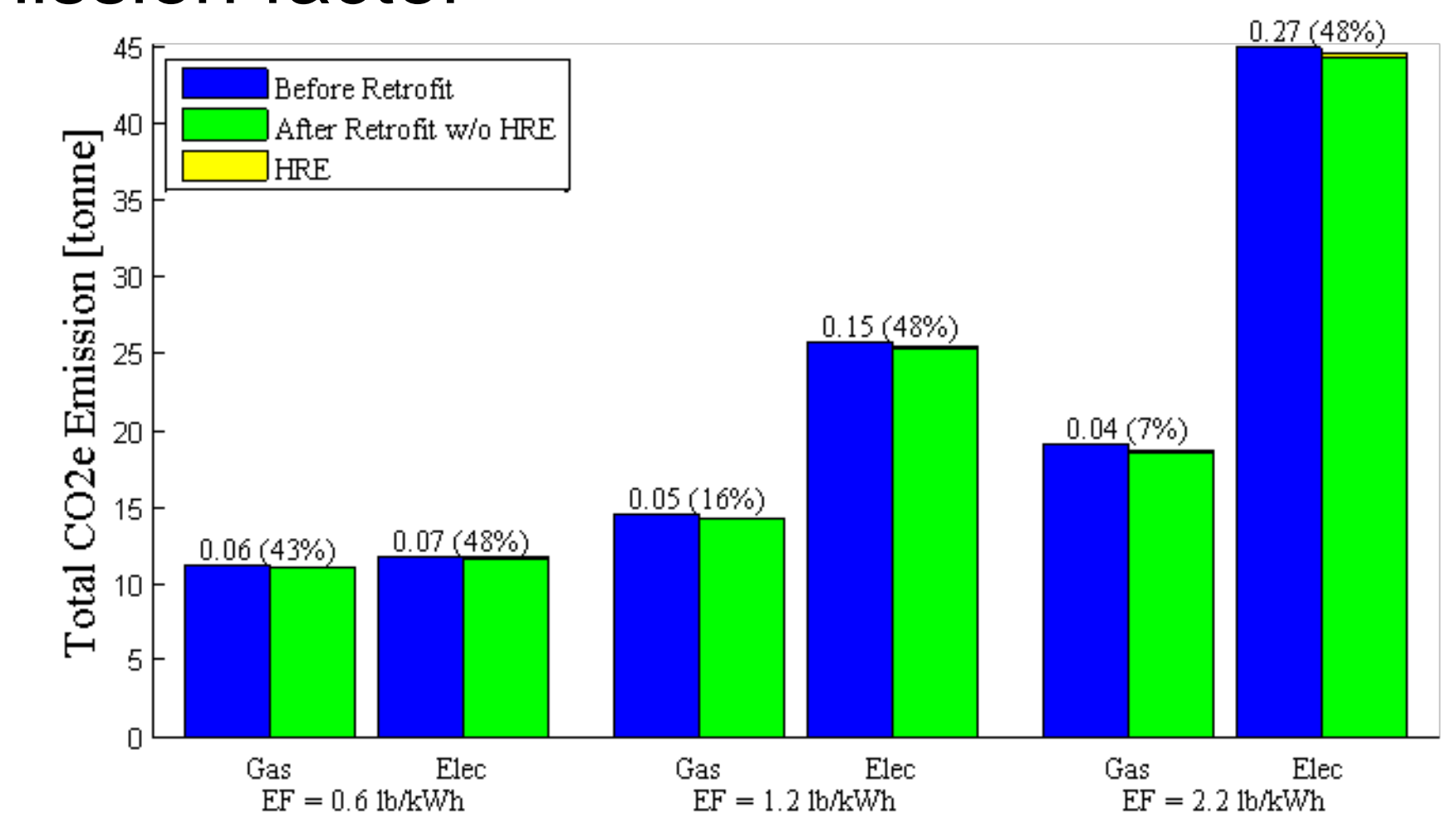


Results

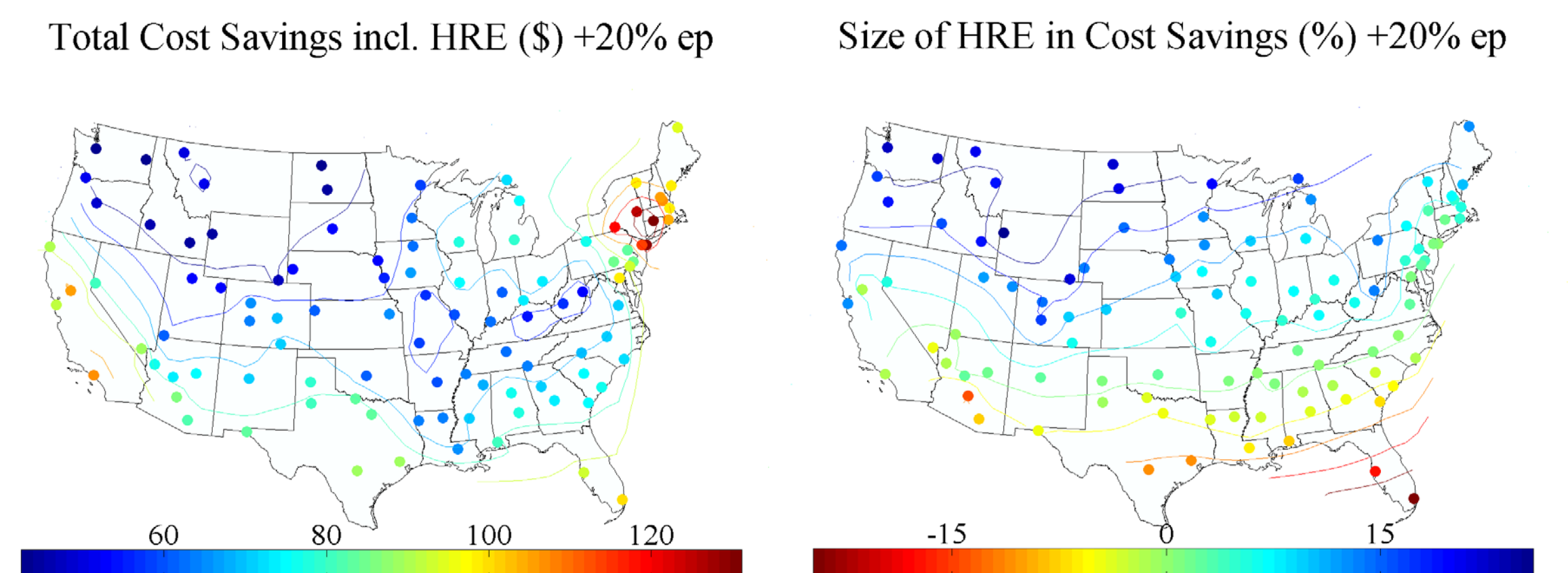


Sensitivity Analyses

Emission factor



Electricity price



Conclusion

- Almost all cities achieve positive savings even when we account for heat replacement effects.
- However, where the emission factors for electricity generation are very low (WA, ID, OR, and VT), the overall emissions associated with the building may not decrease as expected or actually increase.
- Energy prices and emissions factors are crucial factors directly influencing the size of HRE.
- For moderate lighting efficiency interventions, the overall effect is small in magnitude, corresponding at most to around 1 percent of either total emissions or of energy consumption by a house.

