OPTIMAL DECARBONIZATION PATHWAYS FOR URBAN RESIDENTIAL BUILDING ENERGY SERVICES

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ABSTRACT

Climate change and its associated threats to societal welfare are largely attributable to energy consumption and greenhouse gas emissions. As a major consumer, the residential buildings sector accounts for a significant portion of GHG emissions, and both consumption and emissions are projected to increase throughout the coming decades. Energy in residential buildings is demanded in several major service categories including space heating, space cooling, water heating, lighting, refrigeration, cooking, and miscellaneous plug loads. Drivers of household demand in each service category include factors related to climate, income, demographics, and urban form. Strategies for decarbonizing building energy services can broadly be divided into three classes: (1) switching to lower-carbon fuels in the energy supply mix; (2) adopting more efficient energy end-use appliances within residential buildings; and (3) improving the thermal energy efficiency of the buildings themselves. While the demand-side interventions belonging to (2) and (3) are thought to be the lowest-cost decarbonization options, they tend to be underrepresented in energy system models relative to supply-side strategies.

This study evaluates energy system transformation pathways under climate policy and building stock scenarios for the residential sector in Austin, Texas through 2050. The objective is to evaluate the economic cost of a climate policy given assumptions about building stock efficiency while assessing how technology mixes should shift over time to most cost-effectively achieve a predetermined decarbonization goal. Four building efficiency scenarios are considered under both a no policy scenario and a climate policy. The model optimizes investments and operations of supply and end-use technologies under the various building stock and climate policy scenarios to meet annual and daily demand requirements in each service demand category at least cost. Model outputs include technology capacity mix by demand category, energy and carbon intensity of service demands, and net present values of optimal system transformations.

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