

Mechanical Engineering Doctoral Defense

Kuwait Residential Energy Outlook: Modeling the Diffusion of Energy Conservation Measures

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abstract

The residential building sector accounts for more than 26% of the global energy consumption and 17% of global CO₂ emissions. Due to the low cost of electricity in Kuwait and increase of population, Kuwaiti electricity consumption tripled during the past 30 years and is expected to increase by 20% by 2027. In this dissertation, a framework is developed to assess energy savings techniques to help policy-makers make educated decisions. The Kuwait residential energy outlook is studied by modeling the baseline energy consumption and the diffusion of energy conservation measures (ECMs) to identify the impacts on household energy consumption and CO₂ emissions.

The energy resources and power generation in Kuwait were studied. The characteristics of the residential buildings along with energy codes of practice were investigated and four building archetypes were developed. Moreover, a baseline of end-use electricity consumption and demand was developed. Furthermore, the baseline energy consumption and demand were projected till 2040. It was found that by 2040, energy consumption would double with most of the usage being from AC. While with lighting, there is a negligible increase in consumption due to a projected shift towards more efficient lighting. Peak demand loads are expected to increase by an average growth rate of 2.9% per year. Moreover, the diffusion of different ECMs in the residential sector was modeled through four diffusion scenarios to estimate ECM adoption rates. ECMs' impact on CO₂ emissions and energy consumption of residential buildings in Kuwait was evaluated and the cost of conserved energy (CCE) and annual energy savings for each measure was calculated. AC ECMs exhibited the highest cumulative savings, whereas lighting ECMs showed an immediate energy impact. None of the ECMs in the study were cost effective due to the high subsidy rate (95%), therefore, the impact of ECMs at different subsidy and rebate rates was studied. At 75% subsidized utility price and 40% rebate only on appliances, most of ECMs will be cost effective with high energy savings. Moreover, by imposing charges of \$35/ton of CO₂, most ECMs will be cost effective.

December 3, 2018; 3 PM; ERC 593