DOE Fact Sheet: Cost-Effectiveness of Deep Green Alterations of Multi-family Buildings in Seattle

Overview

The City of Seattle was a multiple awardee of the Climate Action Champions (CAC) Notice of Technical Assistance (NOTA). The U.S. Department of Energy (DOE)'s Office of Energy Efficiency and Renewable Energy offered technical assistance from its Commercial Building Partnerships (CBP) Program to provide CACs with additional opportunities for technical assistance to support and advance their greenhouse gas emissions reduction and climate resilience objectives.

In spring 2015, Lawrence Berkeley National Laboratory and Arup conducted a physical study and energy modeling of a representative multi-family residential building in Seattle. The objective was to identify energy savings opportunities and potential approaches for on-site generation, with the aim of replication across the city's numerous housing blocks. The approach involved a detailed site inspection, review of the utility bills, development of computational models for energy performance assessment and selection of a preferred set of energy conservation measures and renewable energy supply options.

Why focus on multi-family housing units?

The City of Seattle is committed to achieving carbon neutrality for its non-industrial operations by 2050, which includes intermediate 2030 targets. Seattle administers its own local energy code which is developed in part to help achieve the City's carbon goals. Multi-family housing is one of the market sectors with a significant energy footprint in Seattle; as such energy reduction strategies applicable to this market will help meet these challenging targets.

Multi-family blocks are considered especially difficult to address for energy efficiency upgrades, as responsibility for payment of utility services falls to both landlord and tenants – landlords for the common spaces and tenants for the living units.

Any investment in energy efficiency improvements to the living units, though often paid for by the landlord, is likely to return savings largely to the tenants, and the return on investment is not seen by the owner.

However, the potential benefits of tapping into this market are significant. Data from Seattle's benchmarking program suggest that potential energy savings range from 22% - 71%. Transitioning to lower energy use intensity for these buildings offers an opportunity to make significant strides toward carbon neutrality through energy system upgrades and installation of on-site renewable energy.

The Boyston-Howell multi-family residential building that was the City of Seattle test subject building for the energy study.

Energy Study Results	
Current Use	Total building energy use is estimated as 286,000 kWh of electricity and 464051kBTU of natural gas, for a building floor area of ~ 38,600ft2. The combined energy cost was ~$24,800.
Energy Savings	The set of recommended measures provide ~ 98,000 kWh of electricity and ~426,000 kBtu of natural gas savings per year.
Utility Savings	The set of recommended measures provides ~$11,700 in annual utility savings.
Overall Performance	The recommended set of measures focused significantly on reducing fossil fuel dependence via use of heat pumps, envelope and lighting upgrades and installation of on-site solar PV.

Study Objectives

- Characterize existing energy performance of the representative multi-family residential block
- Using energy model simulations, identify approaches to improve overall energy-efficiency and explore future opportunities for renewable energy
- Develop a roadmap for transition towards non-fossil fuel-based systems to take fuller advantage of locally generated low-carbon electricity.

Study Design: Broad Deployment Potential

An objective for this energy study was to evaluate energy efficiency and renewable energy options in an appropriately selected building and to develop a strategy for energy system upgrades appropriate across the city's multi-family residential building stock.

By creating a computational simulation model from the utility bill data, it was possible to test each of the proposed energy options individually and in combination, leading to a targeted energy measures set.

The deployment of energy efficient strategies and influencing future energy code iterations can result in installation and operating cost reductions, volume energy savings, and a significant reduction in carbon emissions.

Results

The energy audit and modeling resulted in an evaluation of sixteen energy efficiency and renewable energy measures.

Seven of the measures represent the core set of recommendations:

- Air Source Heat Pump Domestic Water Heating
- Lighting Upgrade to LEDs (Common Areas)
- Air Source Heat Pumps for Space Heating
- Ventilation Heat Recovery
- Envelope Upgrade
- Setback Thermostat Control
- Roof-mounted PV

The ECM set resulted in an energy use reduction of 39% and an on-site generation offset of 14%.

For the study building, nearly one third of energy use was associated with natural gas use, most of which was for domestic hot water.

Of the remaining two thirds that relates to electricity use, priority was given to tackling lighting, space heating and ventilation energy use.

Finally, available roof space provides the potential for offsetting energy use through application of solar PV or solar thermal hot water panels. As the installed cost of solar PV continues to fall and renewable electricity may be utilized by the majority of building systems, it was selected as the cost effective option and provides the greatest flexibility for end use.

Conclusions

Implementing a move to low carbon building energy systems often cannot be justified from just a cost effectiveness standpoint. The proposed options within the set of measures incur long payback periods due to the current low cost of energy in Seattle, as such other potential approaches that would help stimulate adoption were identified and assessed.

The push from codes and standards will be crucial in stimulating such a transition, along with further benefits as the market shifts, and installation costs decrease. For instance, a move to heat pumps for space heating should result in greater systems durability than that of physically exposed systems such as electric resistance heaters that have often been inadvertently damaged by tenants.

It is important to note that the measure set developed for the test building may not apply universally across the target building stock. Options other than those proposed for the test building will be preferred options at other sites.

The study also identified clear guidelines on how to effectively implement proposed upgrades under a variety of ownership and billing models Building upgrade program managers must keep in mind that energy efficiency updates identified as "low hanging fruit" are not always able to be implemented because tenants do not have the incentive, or authority, to make equipment changes. Implementation of a variety of programmatic and city level planning activities can ensure that Seattle's carbon neutrality goals may be realized.

Learn More

Climate Action Champions Initiative:
http://energy.gov/epsa/climate-action-champions

City of Seattle: http://www.seattle.gov/environment