DOE FACT SHEET: Transition to High Efficiency Space Heating

Overview

The City of Seattle was recognized as a Climate Action Champion (CAC) by The White House and the Department of Energy (DOE) in December 2014. In 2015, DOE released a Notice of Technical Assistance (NOTA) to provide CACs with additional opportunities for financial and technical assistance to support and advance their greenhouse gas emissions reduction and climate resilience objectives. DOE's Office of Energy Efficiency and Renewable Energy (EERE) released this NOTA with the goal of strengthening Champions' resilience to extreme weather and prepare for other effects of climate change. The City of Seattle was a multiple awardee of the NOTA.

Lawrence Berkeley National Laboratory and ARUP conducted an energy study in spring of 2015 of advanced efficient space heating options available for commercial buildings specific to the Seattle area. This study on focused determining how space heating options would affect Seattle's efforts towards becoming a net-zero carbon city and what changes in building code and trades would be necessary to facilitate this transition.

Energy Analysis Results for Representative Building	
Current Use (DOE Reference Building Model)	► Gas-based systems: ~8 kBtu /sq. ft. for heating and hot water ► Electric resistance heating: ~7 kBtu / sq. ft. for heating and hot water
Energy Savings	Estimated savings: ► For heat pumps and VRF, 5.9 kBtu/sq. ft. vs gas systems for heating and hot water ► For heat pumps and VRF, 4.5 kBtu/sq. ft. vs electric resistance heating for heating and hot water
Utility Savings	Estimated operating cost savings: ► Negligible vs gas systems, largely due to increased demand charges ► ~$4,500 per year vs electric resistance heating
Overall Performance	Potential energy savings of 19% for commercial offices city-wide

The Case for Advanced High-Efficiency Space Heating

The City of Seattle is committed to achieving community-wide carbon neutrality for its non-industrial operations by 2050, which also includes intermediate 2030 targets. Seattle's authority to amend its local energy code provides an opportunity to mandate specific energy performance requirements for buildings in the city. A significant portion of heating comes from natural gas-based heating systems with a large portion of the remainder coming from inefficient electric resistance heating. Therefore, there is significant potential to reduce energy use and carbon emissions by switching to efficient electricity-based alternatives.

An assessment of existing space heating system types in Seattle office buildings shows a 50/50 split between gas and electric resistance systems. This trend presents a significant barrier to a move towards net zero carbon buildings for both existing buildings and new construction. This study focuses on what heating system types could support a move towards net zero carbon and also to identify the mechanisms needed to stimulate implementation of these advanced high efficiency heating systems in both new construction and retrofit projects.

Study Objectives

- Assessed potential for advanced high efficiency heating technologies for office buildings in Seattle that reduce energy use and support a transition to a zero-carbon community
- Identified key opportunities and barriers to implementation
- Developed policy and program recommendations for transition of the Seattle space heating market, focusing primarily on commercial buildings for both existing and new construction

Study Design: Developing Progressive Energy Codes

The City of Seattle wants a roadmap for implementation of advanced high efficiency heating technologies in new and existing commercial buildings. The method used in this project was to assess which technologies would be viable now and in the future for installation in typical medium sized commercial office buildings of around 55,000 square feet that meet energy and carbon reduction goals, and to quantify the energy and energy cost savings in this transition.

The analysis also used this knowledge to recommend local energy code, programmatic and policy changes to support this transition.

A technology assessment was conducted for two advanced high efficiency heating alternative systems that were based on electrical source energy – an air source heat pump and a variable refrigerant flow system. An energy savings assessment was done using a DOE reference building in EnergyPlus* for the target building type, with the aim of quantifying environmental and economic performance. It was assumed that although only two technologies were assessed in detail, the technology results would generally be representative of other advanced high efficiency heating systems.

Results

Due to a wide range of system types in existing buildings, there was no single system type that would provide a simple transition to low-carbon, high efficiency heating. However, the two system types identified did provide key insights into potential savings. It was estimated that advanced high efficiency heating systems may deliver between 56-79% of HVAC energy savings depending on the baseline system and their efficiency may also help reduce the winter peak demand despite a transition from gas heating to electric systems.

Both first costs and operating costs are likely to be significant for such systems and should be addressed through appropriate strategic financial analysis, as well as through policy and program improvements.

Conclusions

The potential impact of implementation of advanced heating systems in commercial offices is expected to be a reduction in whole-building energy use of between 18-21% once implemented across the commercial office building stock while at the same time providing a path to eliminate the on-site carbon emissions contribution of these heating systems.

*https://energyplus.net/

Learn More

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

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