Three heat recovery chillers in Stanford's central energy facility are used to heat and cool water for space heating and cooling and for hot water use throughout campus.

Building Electrification

Moving Toward 100% Clean, Renewable Energy on Campus

Committing to 100 percent renewable electricity is a great start, but it is critical that universities eliminate the use of fossil fuels for all energy uses – including heating, hot water and cooling in campus buildings. Over half of universities' energy consumption – 53 percent on average – comes from water heating and space heating, which are primarily powered by gas and other fossil fuels. Transitioning these systems away from fossil fuels is therefore key to moving toward 100 percent clean, renewable energy on college campuses – and building electrification is a great way to get there.

Building Electrification Is a Key Step Toward a Clean Energy Future

Replacing fossil fuel-powered systems such as space heating, water heating, cooking and laundry with electricity and other fossil fuel-free, zero-carbon alternatives is a necessary step for campuses to achieve 100 percent clean, renewable energy. Building electrification can also save universities money and provide students with valuable educational opportunities.

Building Electrification Can Benefit Colleges

Building electrification provides colleges and universities with many benefits, including:

- **Increased Efficiency:** Electric heat recovery chillers, or heat pumps, are twice as efficient as natural gas systems in providing heating and hot water.
- **Cost Savings:** Building electrification is becoming more cost-effective as technologies improve and use becomes more widespread and is already economical in some cases. Electric heat pumps, for example, are already cost-competitive with other technologies in some cases because they are highly efficient and can replace both heating and air conditioning units. Building electrification can also protect colleges from unpredictably fluctuating and increasing fossil fuel costs.
- **Environmental Benefits:** Electric heating, hot water and cooling systems make use of electricity increasingly generated by clean, renewable energy – thus generating less air pollution and creating fewer greenhouse gas emissions than oil or gas fired building systems.
- **Safety:** Electric water and space heating does not come with the hazards of some gas and oil-fired systems, including carbon monoxide leaks and explosions.

Building Electrification Can Benefit Colleges

Building electrification provides colleges and universities with many benefits, including:

- **Electrification can be more economical during construction.** Because universities frequently renovate and add buildings to campus, they have ample opportunities to electrify at lower cost.
- **Colleges are hubs for technological development and training.** This makes universities great places to develop new technologies and train students to deploy these technologies on campus.
- **Colleges are heavy energy users.** With so many rooms to cool and showers to heat, buildings consume over 80 percent of colleges' energy use – magnifying the financial and environmental benefits of electrification on college campuses.

Stanford Electrifies its Campus and Cuts Emissions by 65 Percent

In 2015, Stanford University in California swapped out its natural gas-powered energy system with one primarily powered by electricity. The university did this because it recognized that buildings are large energy users and that electrification is a necessary step toward a sustainable energy future. The new system has cut the campus' greenhouse gas emissions by 65 percent due to efficiency improvements and electricity for the system being partially supplied by solar energy. This is a big step toward Stanford meeting its commitment to be 80 percent carbon-free by 2025, which will also involve electrifying all university vehicles and purchasing 100 percent renewable electricity.

In Stanford's system, cold and hot water circulate through pipes around the campus to meet cooling and heating needs. As it travels around campus and through buildings, the cold water is heated. At a central facility, heat recovery chillers transfer the excess heat from the cold water to the hot water – thus cooling the cold water and heating the hot water to the appropriate temperatures, a process that meets 80 percent of the campus' heating needs. These heat recovery chillers are twice as efficient as natural gas heating systems, which leads to significant cost savings – $420 million over 35 years for Stanford's system.

This system also features tanks that can store the hot and cold water for later use. This allows the university to heat and cool the water in the tanks at night when electricity costs are low and circulate it through the buildings during the day when demand is high.

On very hot or cold days, the heat recovery chillers can extract heat from the ground or Stanford's lake water irrigation system to meet the additional demand. The campus retains its old natural gas hot water generators as a last back up. This type of system can even be used in cold climates, where excess heat is generated by cooling and humidity control in certain buildings and can also be tapped from the ground or nearby water bodies.

Green Mountain College utilized a cold climate heat pump in the Two Editors Inn to offset the use of an oil boiler in the building by 40 percent.

Green Mountain College Upgrades an Old Building Using a Cold Climate Heat Pump

Green Mountain College in Vermont is widely recognized as a national sustainability leader thanks to both its curriculum and its campus facilities.

In response to a proposal from a weatherization class, Green Mountain College installed a cold climate air-source heat pump in one of its older buildings – the Two Editors Inn – in 2014. This effort helped offset the use of an oil boiler by 40 percent.

Electric heat pumps are more commonly used in mild climates, but the Green Mountain College project shows that these technologies are already effective in cold climates, and are continuing to improve.

The college's sustainability office hopes to install more heat pumps in campus buildings with the help of future weatherization classes, helping to cut emissions and provide training opportunities for students.

This factsheet is one of an 11-piece series. For citations, and to read the other factsheets, please visit EnvironmentAmericaCenter.org/Campus101

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List of Resources

To help electrify your campus:

- Reference "Use Cases and Case Studies of Successful Approaches to Electrification" in the U.S. DOE report Electrification of Buildings and Industry in the United States by the Lawrence Berkeley National Laboratory
- To learn about the importance of building electrification for tackling climate change, challenges and opportunities, read Decarbonizing U.S. Buildings by the Center for Climate and Energy Solutions
- Look for rebates associated with electrification in your area

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