Photo courtesy of NASA

Impacts of climate change on energy use

The John C. Stennis Space Center is a NASA rocket testing facility. It is located in Hancock County, Mississippi, on the banks of the Pearl River at the Mississippi–Louisiana border. It is one of ten NASA field centers in the United States.

Today, we design, construct and operate buildings in a world affected by climate change. The potential to curb greenhouse gas emissions by reducing energy use in the built environment is substantial. We believe energy efficiency also has a role to play in mitigating the impacts of climate change on future building energy use and costs. By evaluating future energy impacts due to climate variability, we will be able to take steps to increase the resilience of buildings, campuses and communities.

This study indicates that conventional energy efficiency technologies may be an effective method of mitigating climate change impacts. While we apply efficiency technologies to existing buildings and new construction to meet current energy savings goals, these actions will also contribute to lessening the energy impacts from climate change. By using the research approach we developed for this study, we can target mitigation strategies that are most effective for a given region or building type.

THE STENNIS SPACE CENTER PROJECT

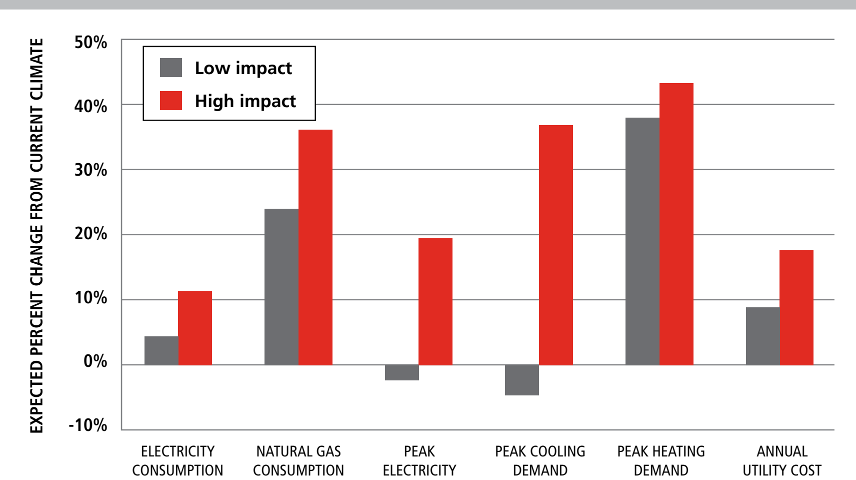
We studied the impacts of future climate variability on energy consumption, demand and operating costs at NASA's John C. Stennis Space Center in southern Mississippi. We also developed potential adaptation approaches through the application of energy efficiency technologies.

Facility property and energy consumption data were collected for 142 buildings to characterize the energy consumption of the entire campus. Using energy models of 32 buildings—constructed and calibrated to measured energy consumption—we developed an aggregate energy model of the campus under current climate conditions. For the climate scenarios we tested, we predict annual electricity consumption will increase 4% to 11%, while natural gas consumption will increase 24% to 36% due to colder winters. Peak annual electric demand decreased almost 4% in one scenario and increased by nearly 20% under the worst-case scenario. In the end, we identified energy efficiency measures to adapt buildings to the projected climate impacts. The study provides direction for long-term facility decisions, allowing staff to plan ahead and make cost-effective decisions today that lessen the effect of future climate variations while increasing the resilience of their buildings.

APPROACH AND FINDINGS

We established a baseline energy consumption profile using utility data and current climate data. Using this data and data gathered about building stock, we developed energy models representing the space center's current energy profile. We then

EXPECTED FUTURE PERCENT CHANGE RELATIVE TO CURRENT CLIMATE CONDITIONS AT STENNIS



Future climate data were inserted into calibrated energy models to estimate energy use for each climate scenario.

KEY OBSERVATIONS

- Utility costs are a large portion of the budget for a typical campus. Climate change will increase demand on overtaxed cooling capacity, driving up energy demand and consumption. This will result in higher operating costs and require greater electricity transmission capacity and larger cooling equipment.
- Capital planning and campus facilities teams can take steps to adapt to climate change by assessing the expected impacts and variability in future energy consumption, peak energy demand and energy costs.
- Standard energy efficiency approaches are effective strategies to adapt to projected energy impacts.
- Annual electricity and natural gas consumption increase at Stennis under each climate scenario tested. Consequently, annual costs are expected to increase.
- The results of this study are specific to this facility and location. However, the approach developed in this study could be replicated at other campuses and communities around the country.

CLIMATE CHANGE ADAPTATION STRATEGIES AT STENNIS

PRIMARY STRATEGIES	DESCRIPTION
Roof insulation	Add additional roof insulation, minimum R-20
Cooling equipment	Upgrade to high-efficiency centrifugal chillers; minimum 0.639 kW/ton, 0.45 kW/ton-IPLV
Energy recovery ventilation	Install enthalpy wheel energy recovery systems on exhaust with bypass and modulation control; 70%+ latent effectiveness, ~0.7" P
SECONDARY STRATEGIES	**DESCRIPTION**
Wall insulation	Add additional wall insulation, 2" continuous insulation
High performance windows	Replace existing windows with low conductivity glass and thermally-broken frames; maximum assembly U-Value of 0.35
Tighter envelope	Install continuous air-vapor barrier using spray on air barrier or spray foam to seal the building envelope, seal all roof penetrations (piping, ductwork, electrical) at both the top and the deck level
Heating equipment	Upgrade to condensing gas-fired boilers; 90%+ thermal efficiency

screened 11 different future climate model data sets provided by the North American Regional Climate Change Assessment Program and chose two data sets representing low impact and high impact climate change scenarios.

The low impact future climate data we used show that Stennis could have cooler minimum annual temperatures and average annual temperatures that are 4 degrees Fahrenheit lower compared to the current climate. In this scenario, only maximum annual temperatures were higher than current conditions, with an increase of 11°F.

The high impact future climate scenarios show only a slight increase in annual average temperature but an increase of as much as 22°F for maximum summer temperature. Winters are expected to be cooler with an increase in heating degree days.

CLIMATE CHANGE ADAPTATION STRATEGIES

We identified the energy efficiency measures designed to mitigate climate change impacts. The three primary strategies include improving roof insulation, upgrading the water-cooled chillers and installing ventilation energy recovery wheels. Additional roof insulation indirectly reduces the cooling and heating loads at Stennis during the more extreme summers and winters by reducing the amount of energy used by the heating and cooling equipment. Upgrading to more efficient chillers directly reduces the amount of cooling energy needed to offset the increased need for cooling during hotter summers. The energy recovery ventilation will recover energy from the exhaust air stream, reducing the wasted energy already used to condition the hotter or colder outside air.

We also identified four secondary strategies. The first three strategies—increasing wall insulation, installing high performance windows and sealing air leaks—indirectly reduce energy use by isolating the conditioned indoor environment from the outdoor climate. The fourth strategy—upgrading to condensing boilers—directly reduces the amount of heating energy needed to offset the increased need for heating during the colder winters. ■

RESOURCES

Full report from the Energy Center of Wisconsin: **www.ecw.org/ecwresults/271-1.pdf**

Learn more about our climate research: **www.ecw.org/climate-resilience**

For information about climate change scenarios: **www.narccap.ucar.edu**

For information about NASA's Stennis Space Center: **www.nasa.gov/centers/stennis/home**

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