High Performance Computing Data Center

The high performance computing (HPC) data center in the Energy Systems Integration Facility (ESIF) is designed to be one of the most energy efficient data centers in the world, featuring warm-water liquid cooling and waste heat capture and re-use. Its HPC capabilities support the breadth of research at NREL, leading to increased efficiency and lower costs for important technologies including solar photovoltaics, wind energy, energy storage, electric vehicles, and the large-scale integration of renewables with the grid.

With its state-of-the-art computational modeling and predictive simulation capabilities, the HPC data center will reduce the risks and uncertainty that are often barriers to industry adopting new and innovative technologies, thereby accelerating the transformation of our nation's energy system.

Energy Efficient Supercomputing

The HPC data center houses a petascale computing capability (one million billion calculations per second) and provides room for future systems that enable large-scale modeling and simulation of novel materials, biological and chemical processes, and fully integrated systems that would be too expensive, or even impossible, to study by direct experimentation. Not only does the ESIF data center house the Peregrine supercomputer, the fastest HPC system in the world dedicated to advancing energy efficiency and renewable energy technologies, it is also one of the most energy efficient data centers in the world, operating at a power usage effectiveness (PUE) rating of 1.06 or better.

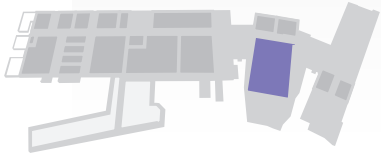
A 2006 study conducted by the U.S. Environmental Protection Agency estimated that data centers account for about 2% of all electricity consumed in the U.S. alone—roughly equivalent to the energy used by the entire airline industry. What's more, the industry is in the midst of the biggest build-out of new data center capacity in its history; therefore, improving energy efficiency in data center designs is critically important. The HPC data center in the ESIF is a showcase data center facility demonstrating best-in-class technologies for a holistic, integrated approach to energy efficient high performance computing.

Innovative Cooling Design

Traditional data centers circulate mechanically cooled air (typically 50°F) under pressurized raised floors up through grated floor tiles in front of the compute racks in an attempt to keep vital computer chips from going above 150°F. The ESIF data center takes advantage of the fact that liquid has approximately 1,000 times the cooling capacity of air and pumps circulating liquid cooling are much more efficient than fans circulating air. The primary means for keeping the HPC systems in the data center from overheating is a liquid-cooled approach—*warm* liquid, that is.

The working fluid starts at approximately 75°F. It circulates through heat exchangers in the HPC system to efficiently capture waste heat from the HPC system. The liquid is heated to 95°F or warmer by the HPC system and utilized as the primary source of heating for laboratory and office spaces in the ESIF. Provisions have been made to export heat beyond the ESIF to the rest of the campus. Data center waste heat is even circulated through piping under walkways to keep pedestrian areas free of dangerous ice and snow in cold months. Data center waste heat not needed by the building can be rejected via efficient evaporative cooling towers serving the HPC data center. Reuse of data center heat reduces the amount of water used by the cooling towers.

The ESIF HPC data center is approximately 10,000 ft^2 of uninterrupted, usable machine room space and is designed to be ultra energy efficient, capturing both the critical bytes of information for scientific research as well as the heat generated by powering multi-megawatts of HPC equipment, which is then used to heat office and laboratory space in the facility.



The Peregrine supercomputer in the HPC data center at the ESIF. *Photo from NREL*

Innovative Building Design

The top floor has approximately 10,000 ft^2 of uninterrupted, usable machine room space to house HPC and related equipment. The data center ceiling height is 11 feet, with return openings as required for any residual data center heat not captured to the hydronic cooling system. Return air chases on the north and south direct warm air from the ceiling plenum above down to the main fan wall air-handling units below. The middle floor is the mechanical space for pumps and power distribution. The lowest level is a pump room that allows the ESIF to connect to central heating and cooling services as needed for backup or to supply heat to other parts of the NREL campus.

Tour corridors with large viewing window areas are on all three floors. All major components of the mechanical and electrical system are color coded to identify the role they play in this energy efficient infrastructure and are viewable from the tour routes. The stacked nature of the data center provides for a very compact design resulting in short run lengths for both electrical and plumbing components. Data center efficiency is highlighted with LED monitors at the viewing windows reporting instantaneous, season, and cumulative values for PUE and energy re-use.

Partner with Us

Work with NREL experts and take advantage of the state-of-the-art capabilities at the ESIF to make progress on your innovative research in computational science, mathematics, and scientific computing.

Partners at the ESIF HPC data center may include:

- Researchers and scientists
- Visualization software developers
- Energy manufacturers and investors
- Utilities
- Government agencies
- Universities
- Other national laboratories

Contact Us

If you are interested in working with the ESIF HPC data center, please contact:

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Top front page photo by Dennis Schroeder, NREL 26198

The Energy Systems Integration Facility (ESIF) is one of the only megawatt-scale test facilities in the United States that integrates electricity, thermal, and fuel systems with high performance modeling and simulation capabilities.

NREL scientists and engineers at the ESIF research and test integrated energy systems, devices, and concepts for electric supply and demand systems.

For more information on the ESIF, visit: www.nrel.gov/esi/esif.html.

Photo by Dennis Schroeder, NREL 26382

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