NREL NATIONAL RENEWABLE ENERGY LABORATORY | ENERGY SYSTEMS INTEGRATION FACILITY

U.S. DEPARTMENT OF ENERGY

ESIF

The ESIF is expected to be the nation's only megawatt-scale research and development facility.

ESIF Snapshot

- Cost: $135M
- Square feet: 182,500
- Occupants: ~200
- High performance computer: one-half petaflop scale; planned to be expanded to petaflop
- State-of-the-art electric systems simulation and visualization
- Component and systems testing at MW-scale power
- Integration of functioning systems with utility system simulations for real-time, real-power evaluation of high penetration scenarios
- Construction complete: fall 2012

Illustrations courtesy of SmithGroup

Transforming our Nation's Energy System

With all the benefits associated with renewable energy, why hasn't the grid already been modernized to accommodate these clean sources of energy? The short answer is: Megawatt-scale integration is hard to find.

Our nation's existing power grid is crucial to our way of life and cannot be shut down, overhauled, and started back up again. Yet, critical to moving clean energy technologies onto the electrical grid is the ability to carry out research, development, and megawatt-scale testing of the complex integrated systems, devices, and concepts of future electric supply and demand systems.

The Energy Systems Integration Facility (ESIF) on the campus of the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) in Golden, Colorado, will soon be the nation's first facility that can conduct integrated megawatt-scale research and development of the components and strategies needed in order to safely move clean energy technologies onto the electrical grid "in-flight" at the speed and scale required to meet national goals.

A Unique Partnering Facility

This state-of-the-art facility will enable NREL and industry to work together to develop and evaluate their individual technologies on a controlled integrated energy system platform. Testing and optimization at megawatt scale will help reduce risks associated with early market penetration. Participation from utilities, equipment manufacturers, renewable systems integrators, universities, and other national labs and related industries that fully utilize ESIF's capabilities will dramatically accelerate the research required to transform the energy system to one that is cleaner, more secure, and more reliable. Major electric system manufacturers and companies have already demonstrated interest in conducting their own research and development at the ESIF, once the facility is completed.

Energy Integration Research Focus

Research and development conducted in the ESIF will aim to overcome the challenges of integrating renewable energy into the electrical grid. These application and technology challenges span the entire electric power system — from generation to transmission, to distribution, and to end-use applications. Of particular focus are electric systems, buildings and facility systems, community power generation and microgrids, utility generation, thermal and hydrogen systems, energy efficient and advanced grid technologies, electricity system architectures, interoperability, and utility generation and grids that incorporate renewable energy (solar, wind, hydrogen, and advanced vehicles).

Labs and Equipment

To support these areas of research, the 182,500-sq. ft. ESIF will house approximately 200 scientists and engineers and a wide range of fully equipped, state-of-the-art laboratories and outdoor test areas, including:

Laboratories

- Power Systems Integration
- Smart Power
- Energy Storage
- Electrical Characterization
- Energy Systems Integration
- Thermal Storage Process & Components
- Thermal Storage Materials
- Optical Characterization Lab
- Energy Systems Fabrication
- Manufacturing
- Materials Characterization
- Electrochemical Characterization
- Energy Systems Sensor
- Fuel Cell Development and Test
- Energy Systems High Pressure Test

Outdoor test areas

- 13.2 kV - medium voltage
- 480 V - low voltage
- Rooftop test area
- Energy Storage

In addition, the ESIF will include other key service and support features, such as:

- Research Electrical Distribution Bus (REDB)
- High Performance Computing Data Center (HPCDC)
- Hardware-in-the-Loop Prototyping at Megawatt-scale Power
- Collaboration and Visualization Rooms
- High Bay Control Room

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

Uniquely Tied Together

Integrated throughout the ESIF, the Research Electrical Distribution Bus (REDB) will function as the ultimate power integration "circuit" capable of utilizing multiple AC and DC buses that connect multiple sources of energy and interconnecting laboratories and experiments to test and simulate equipment. Running parallel with the REDB is a Supervisory Control and Data Acquisition (SCADA) system that monitors and controls facility-based processes and gathers and disseminates real time data for collaboration and visualization.

Parallel with the REDB are the thermal and fuel infrastructures built into the ESIF that all together provide a variety of electricity, thermal power, and fuel type connections.

Hardware-in-the-Loop at Power

Hardware-in-the-loop simulation is not a new concept, but adding megawatt-scale power takes research to another level. Equipped with hardware-in-the loop simulators, the ESIF's Smart Power Lab is the test lab for research and development of the power electronics components, circuits, and controls used in clean and sustainable energy integration. It will allow researchers and manufacturers to conduct integration tests at full power and actual load levels in real-time simulation, and evaluate component and system performance before going to market.

High Performance Computing Capabilities

In addition to high-tech collaboration and visualization rooms, the ESIF will include a high-performance computing data center (HPCDC) that will serve the breadth of NREL, expanding the laboratory's capabilities in modeling and simulation of renewable energy technologies and their integration into the existing energy infrastructure. The one-half petaflop scale (planned to be expanded to petaflop scale) will enable large-scale modeling and simulation of material properties, processes and fully integrated systems that would be too expensive, or even impossible, to study by direct experimentation.

Not only will the HPCDC house the fastest computing system dedicated to energy efficiency and renewable energy technologies in the world, it will also be one of the most energy efficient data centers in the world, operating at a power usage effectiveness (PUE) rating of 1.06 or better.

Office of the Future

The ESIF will demonstrate NREL's commitment to a sustainable energy future with its energy-saving workplace environment and will include energy efficient features such as natural ventilation through operable windows, daylighting, open air cubicles, and 'chilled beam' technology, to name a few.

Illustrations courtesy of SmithGroup

Walking the Talk

The Energy Systems Integration Facility will not only meet the nation's crucial research objectives for integrating clean and sustainable energy technologies into the grid, but will do it in a way that is safe, efficient, and respectful to its surrounding environment. The ESIF will be built in accordance with the U.S. Green Buildings Council's standards and is expected, at minimum, to achieve LEED Gold Certification.

Energy Conservation Strategies

- Reuse of data center and High Bay laboratory waste energy to maximize building/campus heating
- Transfer of electrical energy (via REDB) from experiments between laboratories for simultaneous use/reuse
- Underfloor air distribution for interior cooling and ventilation; outside air economizer
- Active radiant beams provide for perimeter cooling and heating
- Evaporative-based central cooling meets ASHRAE 55 thermal comfort range
- Natural ventilation mode with operable windows and ventilation shafts
- Daylighting with high efficiency lighting (lights off 10 AM to 2 PM)
- Energy Star rated equipment

For More Information

More information about the ESIF can be found on NREL's Web site: *http://www.nrel.gov/eis/facilities_esif.html* or by calling NREL's Public Affairs Office at (303) 275-4084.

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