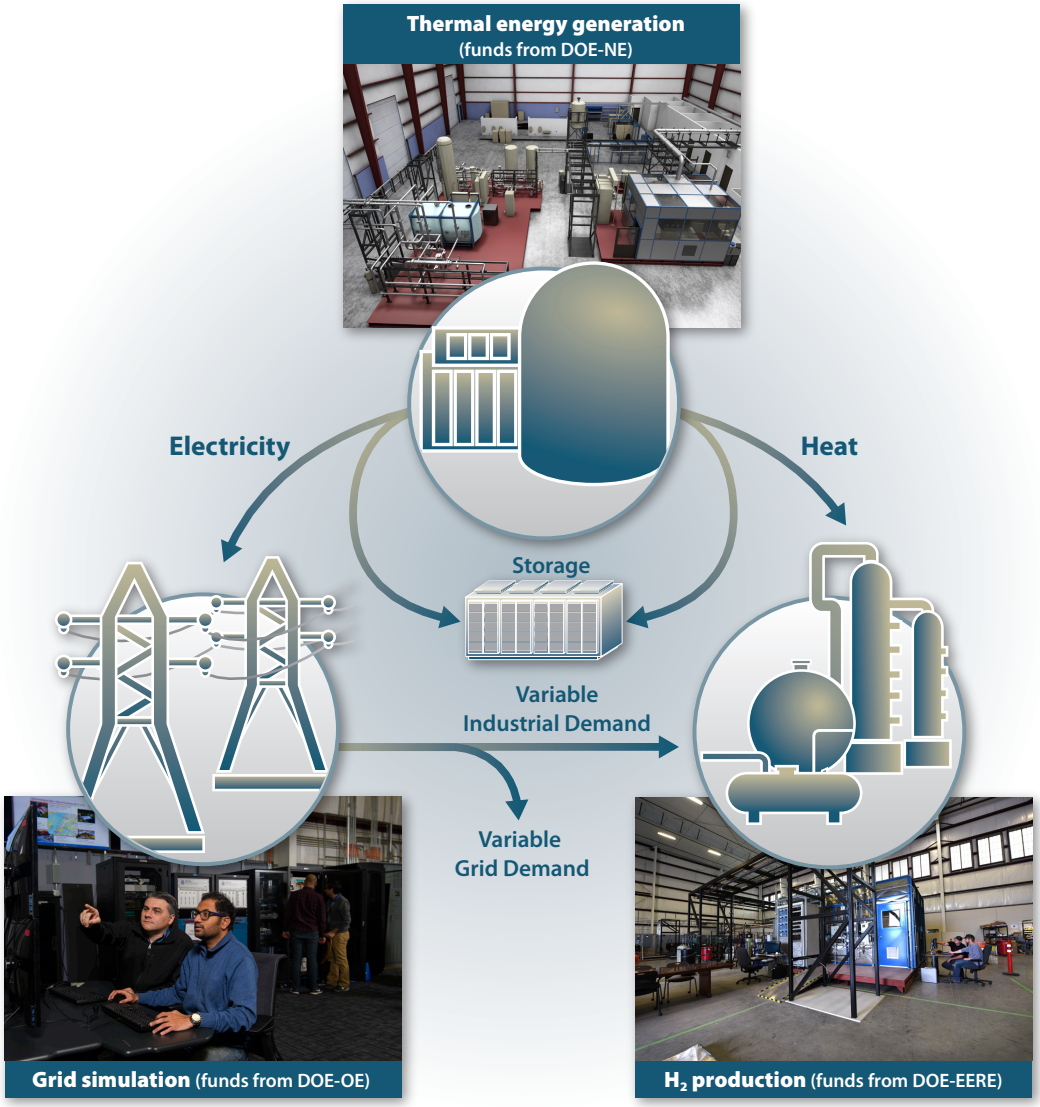
The Dynamic Energy Transport and Integration Laboratory (DETAIL) will integrate a grid simulator with an electrically heated nuclear plant simulator that will generate heat for a steam electrolysis station making hydrogen.



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Integrated Energy Systems Overview

Thermal and electric energy working in synergy

Power plants exist to make electricity, but most also produce a lot of heat. What if they could use that heat for other processes that require thermal energy?

Today, roughly 40% of all energy is wasted. More efficient energy use would be better for the environment and for the plant owner. A power plant being used for both electricity and heat is called an integrated energy system.

Integrated energy systems could couple nuclear, renewable and fossil energy sources. Such systems offer efficiencies that can lead to energy independence, economic competitiveness, job creation and smarter use of resources.

With support from three different Department of Energy offices, Idaho National Laboratory is tackling the technology challenges to making this vision a reality. A new test bed at INL will do this.

The Dynamic Energy Transport and Integration Laboratory (DETAIL) will link a grid simulator with a simulated

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nuclear plant. The mock plant's heat will come from electric heaters. A real steam electrolysis unit will use that heat to make hydrogen. DETAIL will be linked to INL's Human Systems Simulation Lab to fully represent a tightly-coupled integrated energy system.

Industry Benefits

By using heat as an energy currency, nuclear plants can adjust their output according to demand and market price.

To balance electricity and heat users, utilities could sell grid electricity when its value is high or they could produce heat to make hydrogen or commodity chemicals when electricity prices are low. In this way, baseload power plants could operate at max capacities to support the grid while also making an alternative market product. That heat could be sold to industrial customers at a lower cost and environmental impact than today's alternatives.

Today, industrial processes such as some advanced water treatment and the production of chemicals, fuels, and steel all require heat or steam. Using the thermal energy already produced at power plants would allow those industries to avoid burning fuels for heat alone.

In short, nuclear-renewable integrated energy systems could use energy resources more efficiently and economically to reduce industrial emissions while increasing investor profitability.

The Idaho Test Bed

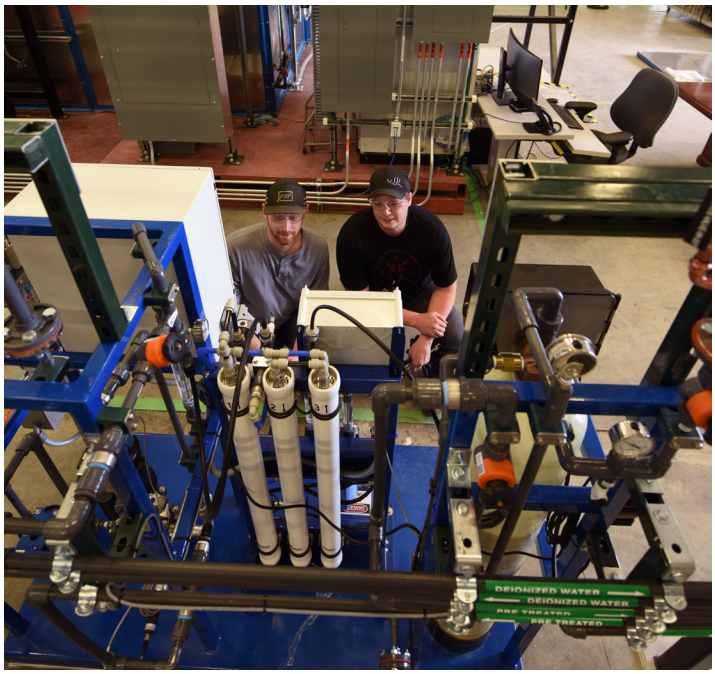
To understand and solve technical challenges associated with integrating complex systems, INL will link two energy distribution networks (electric and thermal) and one heat consumer. Each component will be semi-autonomous and able to operate independently as well as in a response mode to thermal and/or electrical grid needs.

Grid needs and responses will be anticipated by a Digital Real Time Simulator. It confers the ability to integrate power systems hardware and software into simulations (hardware- and controller-in-the-loop), allowing researchers to co-simulate electrical, thermal and mechanical systems. This portion of the test bed is funded by DOE's offices of Electricity (OE) and Energy Efficiency & Renewable Energy (EERE).

The hybrid system's heat will be supplied by the Thermal Energy Distribution System (TEDS). TEDS will transport a working fluid from electrically-simulated heat sources to thermal energy storage components, energy users and simulated users. Plus, it can be expanded to represent advanced nuclear reactors that deliver higher temperature heat. DOE's Office of Nuclear Energy (DOE-NE) is funding this portion of the test bed.

Finally, an industrial heat customer will be represented via hydrogen production. A high-temperature electrolysis test station will produce hydrogen using electricity and heat. This portion of the test bed is funded by DOE's Fuel Cell Technologies Office (within EERE).

By tying together capabilities and funding from a variety of energy research areas, INL's integrated energy system test bed is a truly innovative energy integration endeavor.



DETAIL includes a high-temperature electrolysis test station that will produce hydrogen using electricity and heat.

For more information

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