NREL
NATIONAL RENEWABLE ENERGY LABORATORY

ENERGY SYSTEMS INTEGRATION

ESI optimizes the design and performance of electrical, thermal, fuel, and water pathways at all scales.

PARTNERSHIPS

NREL + LIQUIDCOOL SOLUTIONS

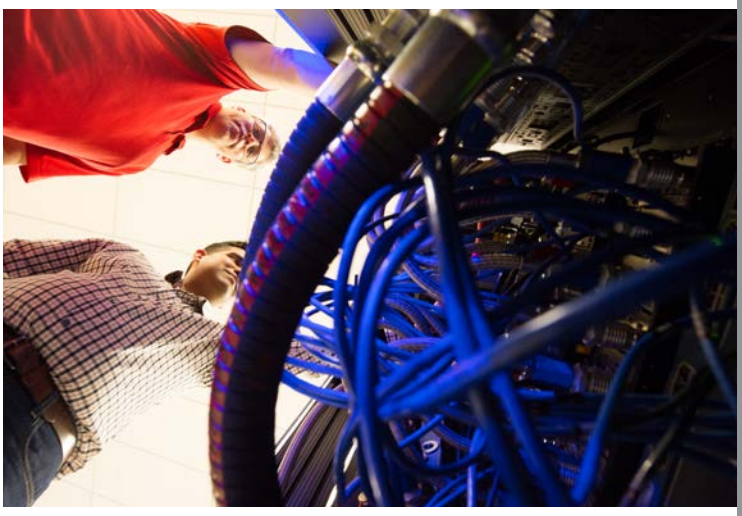
NREL is working with LiquidCool Solutions, Inc. (LCS) to demonstrate and characterize the performance of LCS's liquid-submerged technology for cooling computers and servers. LCS employs a dielectric fluid strategically directed onto electronic components in a liquid tight server enclosure. The fluid's high heat-carrying capacity enables efficient heat removal from temperature-sensitive electronics such as central processing units, graphics processing units, and memory. The dielectric liquid has 1,400 times the heat-carrying capacity of air by volume, making it much more efficient than air at removing heat from electronics.

R&D STRATEGY

An eight-server prototype unit was installed at NREL's Thermal Test Facility to characterize the thermal performance of the system, including parameters such as the dielectric flow rate, inlet and outlet temperatures, and computing power. The experiments characterized the cooling capability of the LCS system to maintain acceptable electronic temperatures. Component temperatures were maintained acceptably cool with up to 140°F exiting dielectric fluid temperature and 90%–95% heat-recovery efficiency (depending on the ambient temperature and server workload). The unit is now undergoing operational testing at NREL's Energy Systems Integration Facility (ESIF) to assess installation and ongoing performance and maintenance in a real data center environment.

IMPACT

Although air cooling currently dominates the computing industry, the approach is reaching its limits as new compute racks become denser and generate more heat. Liquid cooling, including the LCS technology, offers a more energy-efficient solution that also allows for effective reuse of the heat rejected by the computer. Lab results thus far show a minimum outlet water temperature of 120°F, with potential for 140°F water, depending on the coolant temperature and heat exchanger specifications. These water temperatures are suitable for building applications such as forced-air heating, radiant heating, and domestic water heating.



NREL Engineer Eric Kozubal and LiquidCool Solutions Engineer Harsh Patel work on the company's Liquid Submerged Server at the ESIF's high performance computing data center. The server's thick coolant hoses are visible in the foreground. *Photo by Dennis Schroeder, NREL 37352*

Partner with NREL at the ESIF

User facility access to the ESIF is awarded through the review and approval of user proposals, depending on the scientific merit, suitability of the user facilities, and the appropriateness of the work to DOE objectives, and includes a signed user agreement for the facility.

For more information, please visit:
www.nrel.gov/esi/working_with.html
or contact:
Dr. Martha Symko-Davies
martha.symko.davies@nrel.gov
(303) 898-4834

The Energy Systems Integration Facility (ESIF) at the National Renewable Energy Laboratory (NREL) provides the R&D capabilities needed for private industry, academia, government, and public entities to collaborate on utility-scale solutions for integrating renewable energy and other efficiency technologies into our energy systems.

To learn more about the ESIF, visit: ***www.nrel.gov/esif***.

National Renewable Energy Laboratory
15013 Denver West Parkway • Golden, CO 80401 • 303-275-3000 • www.nrel.gov

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