

## Innovative Evaporative and Thermally Activated Technologies Improve Air Conditioning

Researchers at the National Renewable Energy Laboratory (NREL) invented a breakthrough technology that improves air conditioning in a novel way—with heat. NREL combined desiccant materials, which remove moisture from the air using heat, and advanced evaporative technologies to develop a cooling unit that uses 90% less electricity and up to 80% less total energy than traditional air conditioning (AC). This solution, called the desiccant enhanced evaporative air conditioner (DEVap), also controls humidity more effectively to improve the comfort of people in buildings.

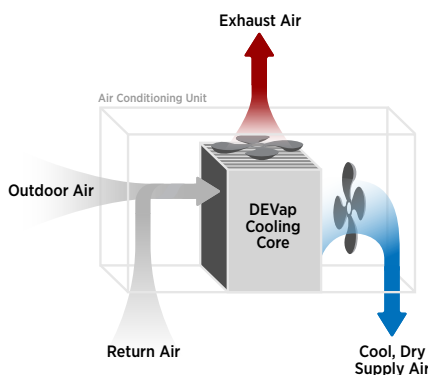
Desiccants are an example of a thermally activated technology (TAT) that relies on heat instead of electricity. Desiccant materials absorb water from the air and are then dried by thermal heat. Many thermal sources, such as natural gas, combined heat and power systems, and renewable energy, can be used to dry desiccants.

### NREL's Expertise Brings Solutions to Market

NREL researchers are leaders in using TATs to condition air. They have extensive analytical and modeling expertise in TATs and evaporative technologies, which work well together to cool buildings. They have also created best-in-class test facilities that helped them develop DEVap and enable them to assist private companies in bringing their products to market.

### DEVap—NREL's Revolutionary Development

The AC industry has been working to reduce energy use, improve comfort, and provide better control to users. One idea has been to combine the benefits of indirect evaporative cooling with liquid desiccant dehumidification. Until now, though, these technologies have not been successfully joined into a single unit. NREL researchers, actively working on this concept since 2005, discovered an innovative solution that merges these critical functions in a single cooling core—DEVap. NREL is currently applying for a patent on this groundbreaking technology.



*NREL's DEVap cooling core, which uses water and liquid desiccant, includes an integrated evaporative component and a desiccant drying process. DEVap's crucial advantage is improved dehumidification, enabling the use of less expensive desiccants and a smaller design.*

*Through deep technical expertise and an unmatched breadth of capabilities, NREL leads an integrated approach across the spectrum of renewable energy innovation. From scientific discovery to accelerating market deployment, NREL works in partnership with private industry to drive the transformation of our nation's energy systems.*

*This case study illustrates NREL's contributions in Market-Relevant Research through Testing and Validation.*



**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.**

The benefits of DEVap are many:

- **Significantly lower energy requirements**—Modeling shows DEVap requires 30% to 80% less thermal and electrical energy compared with state-of-the-art traditional AC, based on climate conditions.
- **Improved comfort and air quality**—With DEVap, users control temperature and humidity independently, providing more comfort. It also manages humidity better than traditional AC, mitigating problems such as mold.
- **Reduced electrical peak load demand**—Most cooling occurs at peak temperatures when power systems are least efficient, straining the electrical grid. DEVap addresses this by using thermal energy to offload this demand.
- **Decreased greenhouse gases**—DEVap eliminates the use of chlorofluorocarbons, which, according to the U.S. Environmental Protection Agency, have a much higher global warming potential than carbon dioxide (CO<sub>2</sub>). Additionally, based on estimates of a 50% market penetration, DEVap's lower electricity and energy use could save more than 60 million metric tons of CO<sub>2</sub> annually.

## State-of-the-Art Heating, Ventilating, and Air Conditioning (HVAC) Test Facility

Effective and efficient testing is key to NREL's success in improving air conditioning. The Advanced HVAC Test Facility is the fifth generation of such facilities at NREL. Its world-class capabilities allow for very quick, thorough, and accurate evaluations of systems and components. Through innovative test design, NREL researchers can provide full performance maps of equipment in a fraction of the time required by traditional methods. This allows researchers to quickly iterate their designs and improve the energy savings of their products.

NREL researchers are revolutionizing the way in which buildings are conditioned through their expertise and the benefits of the Advanced HVAC Test Facility. The products that result from these efforts promise to reduce energy demands, decrease greenhouse gas emissions, and improve the comfort of occupants in buildings.



NREL's Advanced HVAC Test Facility allows for quick, thorough, and accurate evaluations of systems and components. PIX:13234

## NREL Works to Improve Other Solutions

NREL partners with companies to improve products and get them to market. Some use TATs, others integrate well with TATs. NREL develops promising technologies through analysis, field-testing, and evaluation.

- **Sonoma Cool Liquid Desiccant Air Conditioner**—NREL and AIL Research (AILR) began researching liquid desiccant air conditioning (LDAC) in 1997. NREL helped to make LDAC market-ready by evaluating prototypes and resolving product issues. In 2008, AILR licensed the technology to PAX Streamline, a company backed by Khosla Ventures. Today, Whole Foods and Sprouts supermarkets are testing Sonoma systems for retrofit and new stores. A demonstration project is underway at Tyndall Air Force Base.
- **ConsERV Membrane Energy Recovery Ventilator**—NREL worked with Dais Analytic Corporation on an accelerated R&D schedule to bring ConsERV to market. ConsERV reduces cooling loads in humid climates by recovering energy from exhaust. Dais has won awards at the Air Conditioning, Heating, and Refrigerating Exposition and from ASHRAE for this product. ConsERV is now saving energy in U.S. residential and commercial buildings. Dais also recently signed a \$200 million agreement to install these units in China.
- **Coolerado Cooler**—NREL tested and evaluated this product, developed by Idalex Technologies. In 2004, Coolerado Cooler won a prestigious R&D 100 award. In 2007, DOE and NREL tests indicated that the system was 1.5 to 4 times more efficient than traditional AC. On behalf of the Western Cooling Efficiency Center at the University of California, Davis, NREL developed a protocol and tested the Coolerado H-80 system, showing an 80% reduction in energy use and 60% peak-demand reduction. Coolerado became the first winner of The Western Cooling Challenge. Today, the Coolerado Cooler is being installed in commercial buildings and homes and being demonstrated at Fort Carson Army Base.

## National Renewable Energy Laboratory

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