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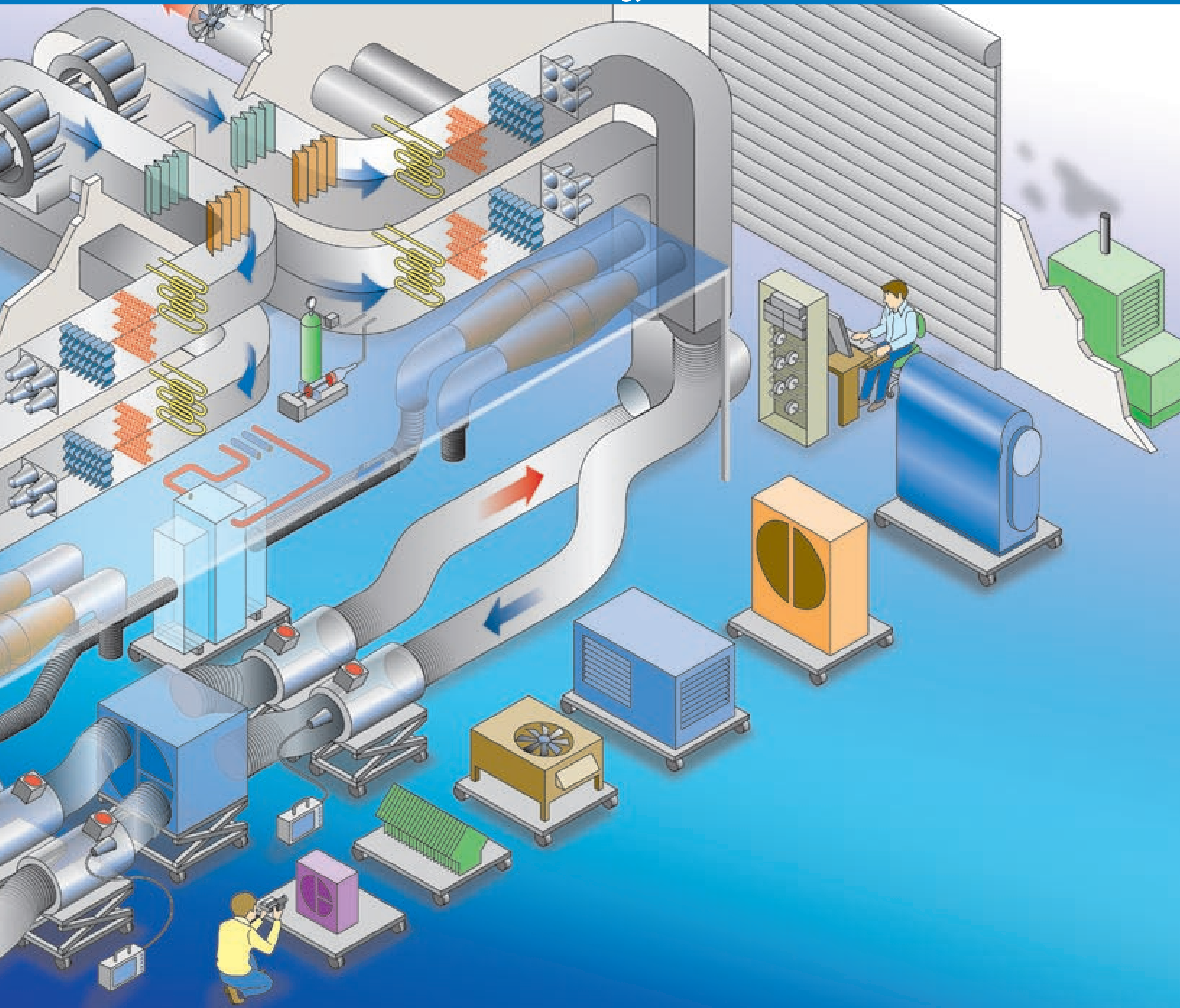
Office of Energy Efficiency & Renewable Energy

National Renewable Energy Laboratory

Innovation for Our Energy Future



NREL's Advanced Thermal Conversion Laboratory

at the Center for Buildings and Thermal Systems:

On the Cutting-Edge of HVAC and CHP Technology

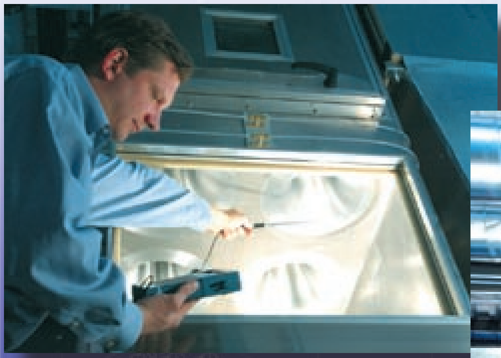
Industry's Challenge

Today's heating, ventilating and air-conditioning (HVAC) industry faces increasingly demanding economic, environmental, and regulatory challenges. These include managing peak demand for greater electric grid reliability, replacing phased-out CFC refrigerants, and meeting new standards for improved ventilation rates and indoor air quality. Another challenge, that offers expanded energy efficiency and security opportunities, is the integration of HVAC and onsite power generation into combined heat and power (CHP) systems.

To help industry rise to these challenges, researchers at the Department of Energy's National Renewable Energy Laboratory (NREL) conduct in-depth experimental studies of new HVAC and CHP concepts to help accelerate their development. For more than 20 years, NREL researchers have brought their expertise to bear in world-class labs such as the Advanced Thermal Conversion Laboratory.

NREL's Advanced Thermal Conversion Lab Meets Industry's Needs

The Advanced Thermal Conversion Laboratory is unsurpassed in the speed, accuracy, and flexibility with which it evaluates full-scale systems and components.



The U.S. Department of Energy calls on its unique capabilities to develop next-generation HVAC and CHP equipment and concepts. The lab addresses industry's needs in areas such as:

- Solid and liquid desiccant dehumidification and cooling
- Waste-heat recovery for CHP and distributed power generation
- Energy recovery and ventilation in buildings
- Sensing and removing indoor air contaminants
- Quantifying the benefits of enhanced ventilation and humidity control.

Using cutting-edge sensors, data acquisition, and diagnostic techniques, NREL's experienced researchers produce test results to the highest standards of data quality.

Fully automated control and measurement equipment produces steady-state results in a fraction of the time required by a test chamber. The result is rapid generation of comprehensive performance maps and accelerated development of prototypes.

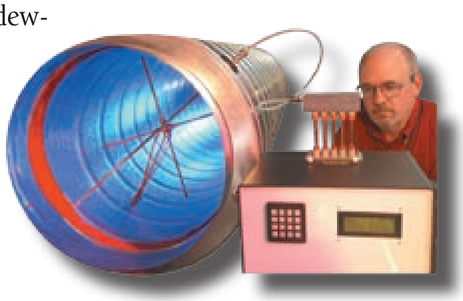
Dual test stations and unique conditioning and control systems seamlessly accommodate fundamentally different technologies, with no downtime for experimental reconfiguration. Technologies under inspection vary from residential to commercial scale and from liquid to air-cooled, and they include conventional as well as not-in-kind devices.

Advanced HVAC R&D Capabilities

The Advanced Thermal Conversion Laboratory, operated by NREL's Center for Buildings and Thermal Systems, houses state-of-the-art temperature, humidity, flow rate and pressure instruments. These provide the highest accuracy available for pyschrometric measurements.

Laboratory specifications include:

- Four independently conditioned air streams (two for each test station) use blower and suction fans to control pressure differentials within the equipment and load cooling prototypes with up to 10 tons capacity.
- A maximum air-flow rate of 4000-6000 scfm for each stream (totaling up to 20,000 scfm) and a minimum air-flow rate of 30 scfm are continuously variable and controlled to within ±1%. Laminar flow elements provide accuracies of ±1% of reading for air flows up to 500 scfm; ASME nozzle arrays measure larger flows within ±2% accuracy.
- Air temperatures are tightly maintained from 30°F to 450°F, and humidity from 10 to 250 grains. Set points are controlled within ±0.3°F and ±2 grains. Type-T thermocouples and 10 chilled mirror hygrometers measure dry-bulb and dew-point temperatures within ±0.3°F accuracy.



- Dozens of data channels are continuously monitored, and all parameters can be graphically compared in real time to investigate the subtlest phenomena; a typical test result contains thousands of readings.
- Dehumidification capacity is determined to within ±4%. Overall mass balance is achieved to within ±5%.
- Advanced diagnostics include:
  - Infrared thermal imaging for instant defect detection and confirmation of air-flow uniformity
  - Tracer-gas leak detection that provides rapid evaluation of heat-exchanger core integrity and seal performance for rotary devices
  - Laser particle counting and sizing that quantifies entrainment from liquid systems and establishes filtration characteristics
  - VOC contaminant measurement techniques that accelerate industrial protocols by a factor of 50, enabling air-cleaner performance testing at the parts-per-billion levels needed for indoor air quality applications.

Combined Heat and Power Puts Waste Heat to Work

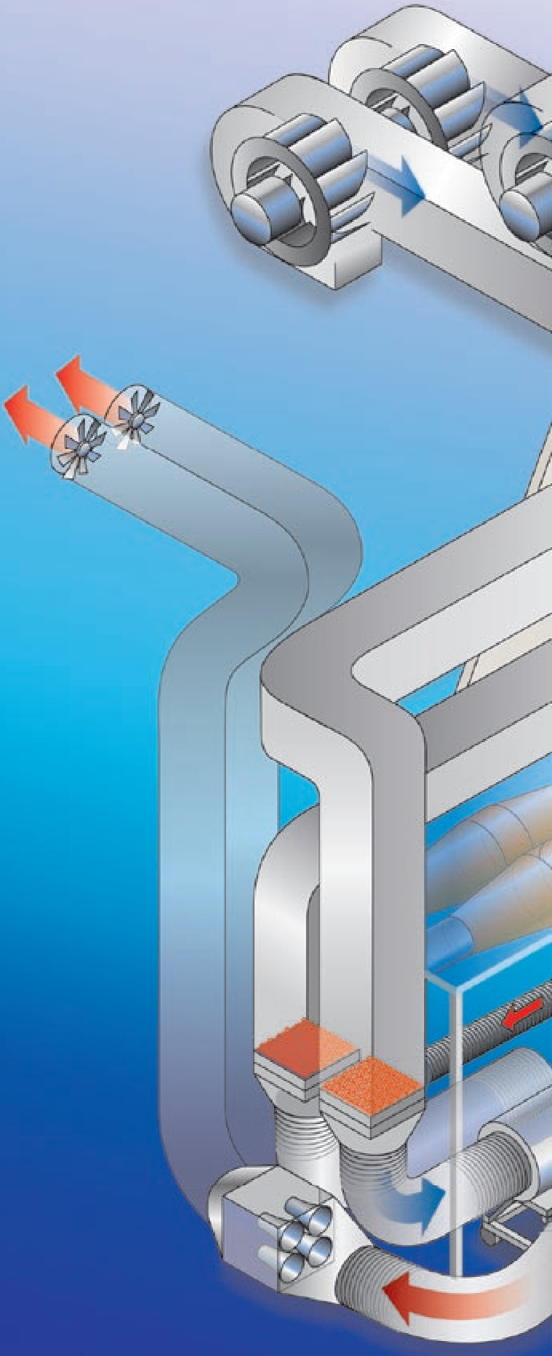
Today's electric power-generation technologies lose substantial quantities of heat to the environment. The heat loss can be 50% to 70% or more of the energy embodied in their fuels. Therefore, the Department of Energy (DOE) is helping to develop combined heat and power technologies (CHP) to recycle that heat energy and achieve 80% resource utilization. DOE's Distributed Energy Program funds the development of the next generation of thermally activated technologies to enable CHP capability in all HVAC markets. This class of HVAC devices runs on waste heat from on-site power generators like microturbines, engine generator sets, and fuel cells, converting the heat into useful heating, cooling, and dehumidification for buildings.

The Advanced Thermal Conversion Lab powers thermally activated HVAC equipment with waste heat streams from highly efficient on-site electric generators. Grid- and site-level analyses based on first-hand experience with state-of-the-art components select the system configurations used to optimize heat recovery and power production. An experimental thermal load module monitors and controls the CHP cooling loop of the 5-kW PEM fuel cell shown here.

Advanced Thermal Conversion Lab Supports Technology Transfer

The Center for Buildings and Thermal Systems' Advanced Thermal Conversion Lab supports NREL's technology transfer efforts by:

- Working with industry groups like the Gas Technology Institute and the Air-conditioning and Refrigeration Institute
- Assisting in the development of cost-effective, high-quality HVAC/CHP testing and certification standards
- Collaborating with certification labs to accelerate their assimilation of new standards and technologies
- Participating in researcher exchanges with manufacturers to enhance their internal testing activities and overcome hurdles facing cutting-edge efficiency advances
- Producing reports and test guides
- Holding technical workshops with industry partners.



For more information

If you are interested in working with NREL's Advanced Thermal Conversion Laboratory to develop the next generation of HVAC/CHP equipment, contact:

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