OAK RIDGE NATIONAL LABORATORY

Carbon Capture and Utilization

Oak Ridge National Laboratory (ORNL) is leading decarbonization efforts in support of the nation's transition to a clean energy future. From energy generation to distribution, storage, and end use, ORNL delivers scientific solutions to help reduce carbon emissions to net zero by 2050.

Drawing on the Laboratory's world-class capabilities and user facilities, scientists work with industry to provide breakthroughs in decarbonization across several sectors including manufacturing, buildings, transportation, the power grid, and energy storage. ORNL develops, demonstrates, and deploys innovations to accelerate the rapid adoption of clean, prosperous, and secure energy.

Capabilities

Direct-air carbon capture and advanced equipment novel designs—Developing and demonstrating methods to utilize building air systems for direct-air carbon capture; efficient, low- and high-temperature heat pumps, climate-friendly refrigerants, and other equipment innovations

Modernizing and democratizing weatherization technologies—Increasing development and demonstration of the newest technologies for building retrofits to achieve decarbonization, with a focus on equitable distribution and relieving high energy stress in frontline communities. Piloting advanced tools for decision-making and retrofitting best practices

New materials and techniques for advanced building construction—Developing and demonstrating new materials, processes, and assembly techniques for advanced, ultra-efficient building construction

Electrification—Developing and accelerating the deployment of more renewable and low-emission electricity sources

Grid-interactive controls—Expanding home and neighborhood energy controls to the grid scale using distributed artificial intelligence and hardware for automated load sensing and dispatch, promoting a more efficient, resilient, and clean energy–sourced power grid

Thermal storage innovation—Controlling and utilizing the thermal energy storage capacity of homes and businesses to reduce energy consumption and provide grid stability, including the development and deployment of associated advanced materials

Conversion technologies—Developing novel hybrid material designs for one-step energy-efficient capture and conversion of carbon dioxide into valuable, fine chemical products that avoid current toxic approaches

Modeling—Developing models to predict the long-term security of carbon dioxide storage sites

Additive manufacturing—Using additive manufacturing to design and develop novel devices to enhance carbon capture from industrial processes

ENHANCING carbon capture

DEMONSTRATING conversion methods

DEPLOYING novel technologies

ACCELERATING clean energy

ACHIEVING net zero

"We're applying new materials science and leveraging something that already exists to solve a global problem by extracting carbon from the air through the retrofitting of rooftop air conditioning units with carbon capture capabilities."

Kashif Nawaz, ***Group Leader, Multifunctional Equipment Integration***

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Recent Impacts

Additively manufactured carbon capture technology—Creating a first-of-its-kind aluminum device that significantly enhances the capture of carbon dioxide emitted from fossil fuel plants and other industrial processes. By using additive manufacturing, researchers custom-designed a multifunctional device that resolves the challenge of heat produced when solvents are used to absorb carbon in smokestack flue gas treatments.

Reducing cement carbon emissions—Working with industry to develop a breakthrough carbon capture process that will close the loop on carbon emissions released from cement plants. By developing, optimizing, and scaling up carbon capture process components that can be integrated into cement plant production, the carbon footprint is reduced through technological upgrades.

Net-zero carbon fuels—Developing synthetic liquid fuels from renewable electricity, carbon dioxide, and biofeedstocks to decarbonize the transportation sector and advance mobility for clean energy, sustainability, and national security. This is accomplished by directly converting carbon dioxide to ethanol in a high-yield process using a nanotechnology-designed catalyst.

Retrofitting equipment for carbon capture—Integrating a multifunctional cooling tower to complement existing rooftop heating, ventilation, and air conditioning equipment that deploys system controls to optimize the performance of both cooling and carbon capture functions. The cooling tower integration allows for the direct-air capture of carbon from the atmosphere.

Buildings, Industrial Decarbonization

ORNL's vision for decarbonization supports the US Department of Energy's (DOE's) Building Technologies Office goal of an overall 50% reduction in energy consumption by the building sector over the next 10 years. The energy-efficient technologies developed at ORNL and ready to be deployed in retrofits and new builds represent a key approach for limiting the carbon emissions profile of buildings. Working with the DOE's Better Plants program, ORNL is developing strategies to accelerate decarbonization solutions for homes, businesses, and energy-intensive industrial processes through a variety of innovations.

Unique Facilities

DOE Manufacturing Demonstration Facility *houses integrated capabilities to drive the development of new materials, software, and systems for advanced manufacturing technologies that support the secure production of clean energy products.*

DOE Building Technologies Research and Integration Center *improves the energy efficiency and environmental compatibility of residential buildings with research focused on envelopes, multifunctional equipment integration, sensors, and controls.*

ORNL Grid Research Integration and Deployment Center *provides solutions to support the decarbonized utility, buildings, and vehicle sectors while advancing an integrated, secure, and resilient power grid.*

DOE National Transportation Research Center *develops and helps industry deploy efficient and secure transportation technologies focusing on advanced energy storage, electric drive systems, alternative fuels, and intelligent mobility systems.*

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