U.S. Department of Energy's National Renewable Energy Laboratory
Operated by Midwest Research Institute, Battelle, and Bechtel

25 Years of Research Excellence 1977–2002

National Renewable Energy Laboratory

NREL

In 1991, President George H. W. Bush elevated the Solar Energy Research Institute to national laboratory status, creating the National Renewable Energy Laboratory.

The National Renewable Energy Laboratory (NREL) was established by the Solar Energy Research Development and Demonstration Act of 1974. Originally called the Solar Energy Research Institute, NREL began operating in July 1977 and was designated a national laboratory of the U.S. Department of Energy (DOE) in September 1991.

A quarter-century of research has yielded remarkable progress in renewable energy technologies. NREL research has been a major contributor to increasing efficiencies and lowering costs. The cost of wind energy has declined from 30¢ per kilowatt-hour (kWh) in 1980 to less than 5¢. Ethanol costs have dropped from $4 per gallon in the early 1980s to $1.20 today. And the cost of electricity from photovoltaics has plummeted from more than $1/kWh in 1980 to nearly 20¢/kWh today. And, through technology transfer mechanisms such as cooperative research and development agreements and technology licensing activities, we also provide a bridge between NREL-developed technologies and the marketplace. And, while we are proud of all that we've accomplished in our short history, we are even more excited about the future. NREL is confident the next 25 years will see further advances in renewable energy and energy efficiency technologies that will help provide a sustainable future for not only the U.S., but the world.

NREL Quick Facts

Mission

NREL develops renewable energy and energy efficiency technologies and practices, advances related science and engineering, and transfers knowledge and innovations to address the nation's energy and environmental goals.

Locations

- Main campus located on 327 acres in Golden, Colorado
- National Wind Technology Center located on 280 acres approximately 20 miles north of the main site
- Offices in Washington, D.C.

Major Facilities

- Solar Energy Research Facility—*houses the National Center for Photovoltaics*
- Field Test Laboratory Building—*houses the National Bioenergy Center and includes the Thermochemical Users Facility*
- Thermal Test Facility—*houses buildings research and includes the Battery Test Facility and the Thermal Conversion Facility*
- Alternative Fuels User Facility—*includes Ethanol Process Development Unit*
- Solar Furnace
- Solar Radiation Research Laboratory
- Photovoltaics Outdoor Test Facility
- National Wind Technology Center—*includes wind blade test facility and turbine dynamometer*
- Distributed Energy Resources Test Facility
- Renewable Fuels and Lubricants (ReFUEL) Research Laboratory

Management/Staffing

- Owned by the U.S. Department of Energy
- Managed by the Midwest Research Institute, Battelle, and Bechtel
- Operating contract administered by the DOE Golden Field Office
- 1100 full-time and contract staff

25 Years of Research Excellence 1977-2002
National Renewable Energy Laboratory

Our Energy Journey

Where are we going on our nation's energy journey?

At NREL, we think it's a destination where cleaner, more reliable, and affordable energy options have strengthened our nation's energy security, reduced pollution and greenhouse gas emissions, enhanced electric grid operations, boosted local economic development, and increased energy and economic efficiency.

Photo courtesy of Ullal, Harin - Central Electronics, Ltd., , PIX 01802

Bringing electricity to the world – a woman in India collects potable water provided by a PV-powered pump.

How do we get there?

The good news is that we're already well on our way. For 25 years, NREL's basic energy science, research, and analytical studies have been crucial to improving energy efficiency and renewable energy technologies. Our tradition of excellence in renewable energy R&D and analysis continues to propel our nation toward its energy goals. Another path leading us toward a brighter energy future is "distributed" energy—or energy systems located near the point of use. Our country's electrical grid and centralized energy infrastructure are aging, overburdened, and susceptible to disruption. Distributed energy systems can keep electricity flowing—even if part of the grid goes down. Renewable energy is one of the major sources of distributed energy available to the nation, and NREL is one of the leading organizations advancing distributed energy technologies.

A global view

Transforming the current energy situation in the United States is only part of our journey. People in developing nations around the world also need clean air and water, adequate food, and good health. All require energy—and, with support from NREL's International and Environmental programs, renewable energy technologies are already helping to power rural communities in places like Africa, South America, and Asia.

How do we communicate progress of our journey, and encourage others to join us?

NREL's public, civic, and international outreach programs convey a compelling message about the benefits of sustainable and secure energy. Working with DOE, we produce more than 200 scientific papers and a broad spectrum of publications annually. And in the past three years, through NREL's Communications programs, we have created comprehensive Web sites to spread the word about efficiency and renewable energy technologies. Our Energy Analysis Office combines NREL's unique knowledge of technologies, markets, and policies to provide a world-class analysis capability. And NREL's Education programs help educate up-and-coming scientists and engineers – ensuring a prosperous and sustainable energy future.

NREL's Pathways to a Clean Energy Future

Hydrogen

Hydrogen can be produced from a wide variety of fossil and renewable resources, including water, making it a flexible and attractive fuel. When hydrogen is used in fuel cells to produce electricity and heat, the only by-product emitted is water—and when used as a fuel for conventional engines, fewer pollutants are emitted than with fossil fuels. As a transportable and storable fuel, hydrogen has greater flexibility than electricity for vehicular use and remote-area power generation. Many experts believe hydrogen and electricity will become the primary energy carriers of the future.

NREL is fostering a transition to a hydrogen-based economy through its leadership and extensive experience in materials development and basic and applied research. NREL is developing a broad portfolio of electrochemical, biological, and thermal hydrogen production technologies. NREL scientists are also developing innovative technologies for storing, sensing, and using hydrogen, and are helping to move today's industrial hydrogen infrastructure to one that can support widespread use of hydrogen energy.

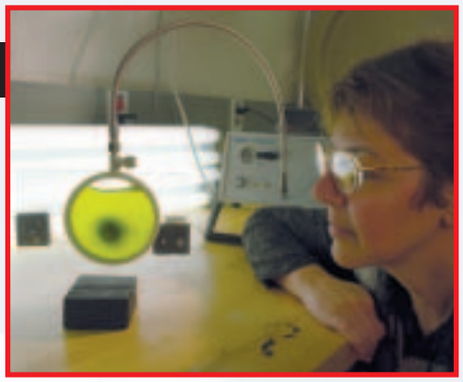

Photo: Warren Gretz, PIX 09839

In the long term, hydrogen will be produced from renewable resources such as sunlight, photoelectrochemical devices, and water as shown in the above hydrogen-from-algae project.

Photo: Warren Gretz, PIX 04746

The McNeil generating station in Burlington, Vermont, is an innovative, high-throughput gasifier that converts biomass into gas for electric power generation.

Bioenergy

Bioenergy—fuels, biobased materials, and power from plants and wastes—represents an important and relatively untapped supply of a potentially enormous indigenous renewable resource. It has the potential to supplement, or displace, imported fossil fuels in many applications—transportation, power production, or as a feedstock for chemicals, fiber, and other products. Biorefineries that produce multiple products—a concept still in its infancy yet with enormous potential—could eventually contribute to the creation of a robust, domestic biobased industry. Broader use of biomass will create new income for farmers and rural economies.

Biofuels research at NREL focuses on conversion technologies for two major biofuels—bioethanol and biodiesel. Developing cost-effective, environmentally friendly technologies for converting biomass into alternative transportation fuels and fuel additives is the aim of NREL's alternative fuel research and development.

In October 2000, DOE created the National Bioenergy Center (NBC), located at NREL. The NBC links DOE-funded biomass energy research programs with the resources and capabilities of the U.S. Departments of Agriculture and Interior, the Environmental Protection Agency, the National Science Foundation, and several other federal agencies, DOE laboratories, and universities. The two-fold strategy for the NBC is to develop multiple products from biomass residues and natural biomass sources, and to genetically engineer more productive biomass sources.

Distributed Energy Resources

Distributed energy resources (DER) can provide on-site electric generation close to where it is needed. These resources can be available for sensitive load applications (such as electronics equipment, critical manufacturing processes, etc.), and can provide a number of energy products and services not readily available from today's electricity grid—such as higher reliability, better power quality, and combined heat and power. NREL coordinates and manages important elements of DOE's DER program. DER R&D activities at NREL are conducted in the areas of electric systems integration, electric reliability, superconductivity, thermal energy storage, desiccant cooling, resource evaluation, environmental analysis, and hydrogen systems.

Wind Energy

Wind power is currently the only non-hydroelectric renewable energy technology that is economically competing for a substantial portion of the U.S. electric power grid. From 30¢ per kWh in 1980, wind electricity costs dropped to less than 5¢ per kWh in 2000. Costs are expected to reach 2 to 3¢ per kWh by 2010. Aggressive advanced technology development has helped to drive the cost down.

As DOE's lead laboratory in wind technology development, NREL operates the National Wind Technology Center, and manages turbine research programs and applied research activities. Market opportunities for wind energy systems exist in both industrialized nations and developing countries. These opportunities include sales of wind power plants, village power systems, wind-electric water pumping systems, wind power support for telecommunications, and stand-alone wind and hybrid-electric systems for homes, cottage industries, health clinics, and community centers. Prospective wind energy markets could generate several billion dollars in sales for the U.S. wind industry by 2005.

Photo: Warren Gretz, PIX 08599

"Green power" programs such as Xcel Energy's Windsource, are increasingly popular – the Colorado wind-generated electricity program has the second-highest utility customer participation in the country.

Solar Energy

Photo courtesy of Live Oak Solar

Mobile, solar-powered, uninterruptible power supplies ensure reliable operation of communications substations and other critical infrastructures during power outages.

Solar technologies use the sun's energy and light to provide heat, light, hot water, electricity, and even cooling for homes, businesses, and industry. Photovoltaic (PV) solar cells, which directly convert sunlight into electricity, provide electricity for pumping water, powering communications equipment, lighting, and running appliances. In many applications, PV is the cheapest source of power for these tasks and is particularly useful in supplying critical electricity during grid outages. PV systems are usually modular—they're flexible and suitable for distributed energy applications. For example, solar-electric systems can be used to provide electricity wherever it is needed in any amount—from watts to megawatts. PV cells and modules are also very reliable in space. Virtually all communications satellites are powered by photovoltaic technology developed at NREL.

NREL is home to the National Center for Photovoltaics (NCPV) and world-class PV research and development. On behalf of DOE, the NCPV also promotes partnering and growth opportunities, and serves as a forum and information source for the PV community. Our comprehensive solar programs include R&D in solar thermal, concentrating solar power, and passive solar technologies.

Concentrating solar power technologies use reflective materials (such as mirrors) to concentrate the sun's energy. Parabolic-trough systems concentrate the sun's energy through long, rectangular, curved (U-shaped) mirrors. Dish systems use a mirrored dish (similar to a very large satellite dish) to concentrate sunlight at the focal point of the dish; this concentrated sunlight is then converted into electricity.

Passive solar technologies incorporate design features in buildings that absorb and slowly release the sun's heat. Solar hot water heaters use the sun to heat either water or a heat-transfer fluid in collectors. A typical system will reduce the need for conventional water heating by about two-thirds. High-temperature solar water heaters can provide energy-efficient hot water and hot water heat for large commercial and industrial facilities.

Geothermal Energy

Geothermal energy is heat that flows continuously from the Earth's core toward the surface. Geological processes concentrate enough of that heat near the surface that a large amount of energy could be extracted and used for electrical power generation and for direct-heat applications—all on a clean, reliable, and sustainable basis. Today's geothermal energy comes from hydrothermal resources, where reservoirs of water or steam have been heated by contact with hot rock. In the future, the hot rock itself may provide enormous energy resources.

NREL supports DOE's geothermal mission—to establish geothermal energy as an economically competitive contributor to the U.S. energy supply—by improving the efficiency of heat transfer, serving as a core laboratory for energy systems research and testing, and through communication, analysis, and outreach activities.

Using Energy Wisely

Using energy more efficiently is almost always easier and cheaper than producing new energy. And in most cases, increased efficiency does not mean decreased convenience to the consumer. NREL's energy efficiency technologies are reducing the demand for energy in residential and commercial buildings, in the transportation and industrial sectors, and in our nation's biggest energy user, the federal government.

Photo courtesy of Keith Gawlik, PIX 04252

NREL works with industry to improve energy efficiency. At this Federal Express facility located in Denver, Colorado, an NREL-developed transpired solar collector on the building's south wall pre-heats incoming ventilation air – reducing the building's heating costs.

Buildings

NREL develops modeling software that helps architects build cost-effective, energy efficient structures. We also develop technologies such as "smart" windows that darken in sunlight to control heat gains, and desiccant–based dehumidification systems that reduce cooling loads. Working with industry, NREL developed the solar wall, an inexpensive use of solar energy to pre-heat ventilation air for large buildings such as hangars and warehouses.

NREL works with the U.S. home-building industry to develop quality homes that use 30 to 70 percent less energy than conventional homes. By using a whole-building design approach that combines energy efficiency with renewable energy technologies, NREL is advancing the concept of "zero-energy buildings"—buildings that actually produce all of, or even more than, the energy they use.

Advanced Vehicle and Fuel Technologies

The world's transportation systems are 96 percent dependent on petroleum products and, not surprisingly, the United States uses more oil than any other country in the world. At NREL, we are paving the way for world-class transportation solutions that reduce vehicle emissions, improve air quality, and decrease our nation's dependence on foreign oil.

Working with industry, NREL develops innovative technologies that encourage use of alternative fuels and expand the market for advanced vehicle systems. Our diverse team of scientists and engineers focuses on many aspects of advanced transportation systems, including fuel and vehicle assessment, vehicle simulation modeling, battery thermal management, advanced passenger heating and cooling systems, air quality and emissions testing, and fuel cell design.

Photo courtesy of the Wieck Photo Database

NREL's partnership with industry has led to manufacturing prototype hybrid electric vehicles that get up to 80 miles per gallon, which is three times the fuel economy of today's average mid-size car.

Federal Energy Management

The federal government is the largest energy consumer in the nation. DOE's Federal Energy Management Program (FEMP) strives to reduce government costs through energy and water efficiency, encourage use of renewable energy, and provide overall utility management for all federal facilities. NREL works with FEMP staff, the private sector, and other national laboratory partners to assist government agencies in supporting the FEMP mission.

Advanced Industrial Technologies

NREL works in partnership with DOE and U.S. industry to develop and deliver advanced technologies that increase energy efficiency, improve environmental performance, and boost productivity in the industrial sector. We also work directly with industry to carry out research and technology development, to provide technical assistance, and to serve in an advisory capacity.

NREL's Solar Energy Research Facility was designed to be efficient yet still meet the exacting requirements of a cutting-edge laboratory facility. Architecture, site orientation, daylighting, passive solar features, lighting occupancy and photo-sensors, evaporative cooling, ventilation air heat recovery, variable frequency drives, high efficiency motors, automated controls, photovoltaics, and other energy efficiency measures result in a utility bill savings of about 45 percent of a comparable, code-compliant facility.

NREL's R&D Areas

Alternative transportation technologies
Advanced fuel technologies • Advanced industrial technologies
Analytical studies • Basic science • Bioenergy • Biofuels
Biological sciences • Biomass power • Biotechnology
Buildings research • Electrocatalysis
Electric markets analysis and applications
Chemical science • Climate change • Computational science
Concentrating solar power • Distributed power
Energy conversion and storage
Energy storage assessment/battery thermal management
Environmental programs • Federal energy management
Geographic information systems • Geothermal power research
Green power programs • High-performance PV
High-temperature superconductivity • Hydrogen energy
Information and outreach • International programs
Life-cycle assessment • Measurements and characterization
Ocean energy • Optoelectronic technologies • Photovoltaics
PV manufacturing technologies • PV silicon materials research
Resource assessment • Solar energy • Solid-state spectroscopy
Solid-state theory • Turbine research • Vehicle climate control
Vehicle evaluation and assessment • Wind energy

Walking the Talk

At NREL, we apply technologies and practices to our own facilities to derive maximum value while minimizing the use of energy, materials, water, and other resources. For more information, please visit ***www.nrel.gov/sustainable_nrel/***

This aerial photo shows NREL's primary research facilities at the South Table Mountain site. In cooperation with the state and county, the mountain's sides and top were put into open space easement.

National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, CO 80401-3393
(303) 275-3000

Stakeholder Liaison
(303) 275-3166

Media inquiries
(303) 275-4096

Visitors Center
(303) 384-6565

Technology transfer, licensing, and cooperative R&D opportunities
(303) 275-3008

Information on job opportunities at NREL can be found at
http://www.nrel.gov/hr/employment/

For more information on NREL, energy efficiency, and renewable energy, visit the NREL Web site at
www.nrel.gov

For the U.S. Department of Energy's gateway to Energy Efficiency and Renewable Energy, visit
www.eren.doe.gov

To talk to an Energy Expert, call the Energy Efficiency and Renewable Energy Clearinghouse at 800-DOE-EREC

National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, Colorado 80401-3393

NREL is a national laboratory of the U.S. Department of Energy (DOE).

NREL is managed for DOE by Midwest Research Institute • Battelle • Bechtel

NREL/BR-30845 • July 2002

Printed with renewable-source ink on paper containing at least 50% wastepaper, including 20% postconsumer waste.