Laboratory facilities, like the National Renewable Energy Laboratory’s Solar Energy Research Facility, are energy intensive. So the main challenge for the design team was to find efficient ways to heat, cool, light, and ventilate to meet the exacting requirements of the laboratory settings while still maintaining comfort and pleasant conditions in the office spaces.

Designers used a whole-building approach — looking at the way the building’s site, windows, walls, floors, and electrical and mechanical systems could work together most efficiently. Blending architecture and energy efficiency, designers took advantage of the south-sloping site by situating the offices to the south and partly earth-sheltering the labs to the north. A stair-step configuration for the building allows daylight and heat into the office areas, while the laboratories in the back of the building are in a more controlled environment where tight levels of ventilation, humidity, temperature, and light are critical. A unique mechanical system makes the most of the natural environment and the building’s design to efficiently heat and cool the building at an annual utility bill savings of almost $200,000 per year.

With innovation and dedication to the tenets of renewable energy and energy efficiency, the Solar Energy Research Facility has become not only a laboratory to explore ways to turn the sun’s light into electricity and power, but also a building that puts the laboratory’s research into action.
Exhaust air

Loads

heats up, its radiant energy is transmitted

covered with glass. The coating absorbs

cooling systems that consume more energy.

minimizing cooling.

and daylighting while

This captured energy is used to condition

use of sunlight for heating

segments to make good

design incorporates three contiguous

throughout the year. A flexible, modular

shade in the summer, and diffuse daylight

The design provides solar heat in winter,

blending architecture with energy efficiency.

step design of the Solar Energy Research

features that work together to improve the

efficient building is designed with many

walks into a laboratory and turn off when the last

them. Lights turn on automatically when someone

on-demand lighting,

including T-8, compact temperature and increase humidity. The

Low-energy design and renewable energy

at the Solar Energy Research Facility

Building Envelope

Using whole-building design, an energy-

efficient building is designed with many

features that work together to improve the

quality and efficiency of lighting, heating, cooling, and ventilation. The unique, stair-

step design of the Solar Energy Research Facility (SERF) is a feature of the building—

blending architecture with energy efficiency.

The design provides solar heat in winter,

shade in the summer, and diffuse daylight

The primary cooling for the SERF

takes advantage of the semi-arid

climate using indirect/direct evapora-

tive cooling. Oversized cooling towers

provides the indirect portion while an evaporative

gail provides the direct evaporaive cooling.

Cooling

In a conventional building, mechanical

chillers cool the water that is used to cool

the air and equipment. But the SERF uses

indirect evaporative cooling to help the

water cooling process and save energy.

In addition, the SERF uses direct

evaporative cooling to lower air

temperature and increase humidity. The

cool air is distributed throughout

the building, limiting the need for conventional

cooling systems that consume more energy.

Automatic window shades and

overhangs help keep offices cool by shading

Lighting

Stepped clerestory

to illuminate office

areas and brighten the corridors that divide

offices from laboratories. The recessed

clerestories scatter the sunlight to reduce glare,

creating a light that is softer than electric light

and results in a pleasant environment. Because of the

windows’ exterior overhang and inside light

“shelves,” indirect sunlight enters the building to

provide quality light year-round.

“shelves,” indirect sunlight enters the building to

provide quality light year-round.

Sunlight is shared with interior hallways and

offices through strategically placed windows and
curved awnings that reflect light into the space.

Daylighting minimizes the need for electric

lighting, decreases the amount of power used, and

reduces cooling costs that would be incurred to

manage the heat produced by electric lights.

Very efficient lights including T-8, compact

fluorescents, and metal halide save an additional

50,000 a year.

Designers saved even more electricity by using

on-demand lighting, where the motion sensors

automatically turn lights off when nobody is using

them. Lights turn on automatically when someone

walks into a laboratory and turn off when the last

person leaves.

Heating

To help heat part of the building, the

SERF’s design includes a Trombe wall

along the south face of the building. This

16-inch-thick, concrete wall is coated with a

dark, heat-absorbing material, and is covered with glass. The coating absorbs

heat from the sun. When the massive wall

heats up, its radiant energy is transmitted

to the inside of the building in winter. The

radiative effect provides comfort without

heating the environment. A hot water

boiler provides heat for the offices and laboratories.

Ventilation

As a safety precaution, the SERF’s

ventilation system completely exchanges

the air in the laboratories as many as 12

times an hour. This requirement causes

large heating and cooling loads to

condition outside air. Rather than just

exhaust the warm air from the building,

the SERF’s exhaust heat recovery system

uses a heat exchanger to capture the

energy exhausted from the laboratories.

This captured energy is used to condition

fresh, incoming air. The system displaces

about 50% of the energy that would have to

be used to heat and cool the incoming air.

Variable-speed fans carefully maintain

building pressure and temperature while

saving energy.

Photovoltaics

Two 6-kilowatt arrays of photovoltaic

panels are installed on south-facing roof
areas on the SERF. The photovoltaic system

is tied directly to the building’s electrical

supply. The solar panels are integrated with

the building design.
Preparation, talent, and teamwork contribute to high performance. Designing high-performance, energy-saving buildings is no different. Designers use computers to simulate energy use throughout the design process, finding the most energy-efficient design. Whole-building design examines how a building interacts with its systems, activities, and surrounding environment. By optimizing the building's standard components — site, windows, walls, floors, and mechanical/electric systems — building owners can substantially reduce energy use without increasing construction costs.

More Information
The following table shows some of the energy-efficient features of the building.

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<th>Key Energy-Efficiency Features</th>
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Contacts
U.S. Department of Energy
Energy Efficiency and Renewable Energy Clearinghouse (EREC)
1-800-DOE-3732
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Office of Building Technology, State and Community Programs
www.eren.doe.gov/buildings/highperformance
National Renewable Energy Laboratory
Center for Buildings and Thermal Systems
www.nrel.gov/buildings/highperformance

Left: Front office areas are daylit and open for comfort using ventilation towers to circulate heated or cold air. Right: Laboratories in the back of the building have a more controlled environment to meet precise ventilation, temperature, humidity, and lighting needs.

Front cover photos: The Solar Energy Research Facility's stair-step design provides shade in summer, solar heat in winter, and diffuse daylight throughout the year.