Soaking Up the Sun to Squeeze Bills to Zero

By KIRK JOHNSON (From the New York Times)

GOLDEN, Colo. — The west-facing windows by Jim Duffield's desk started automatically tinting blue at 2:50 p.m. on a recent Friday as the midwinter sun settled low over the Rocky Mountain foothills.

Around his plant-strewn work cubicle, low whirring air sounds emanated from speakers in the floor, meant to mimic the whoosh of conventional heating and air-conditioning systems, neither of which his 222,000-square-foot office building has, or needs, even here at 5,300 feet elevation. The generic white noise of pretend ductwork is purely for background and workplace psychology — managers found that workers needed something more than silence.

Meanwhile, the photovoltaic roof array was beating a retreat in the fading, low-angled light. It had until 1:35 p.m. been producing more electricity than the building could use — a three-hour energy budget surplus — interrupted only around noon by a passing cloud formation.

For Mr. Duffield, 62, it was just another day in what was designed, in painstaking detail, to be the largest net-zero energy office building in the nation. He's still adjusting, six months after he and 800 engineers and managers and support staff from the National Renewable Energy Lab moved in to the $64 million building, which the federal agency has offered up as a template for how to do affordable, super-energy-efficient construction.

"It's sort of a wonderland," said Mr. Duffield, an administrative support worker, as the window shading system reached maximum.

Most office buildings are divorced, in a way, from their surroundings. Each day in the mechanical trenches of heating, cooling and data processing is much the same as another but for the cost of paying for the energy used.

The energy lab's Research Support Facility building is more like a mirror, or perhaps a sponge, to its surroundings. From the light-bending window louvers that cast rays up into the interior office spaces, to the giant concrete maze in the sub-basement for holding and storing radiant heat, every day is completely different.

This is the story of one randomly selected day in the still-new building's life: Jan. 28, 2011.

It was mostly sunny, above-average temperatures peaking in the mid-60s, light winds from the west-northwest. The sun rose at 7:12 a.m.

By that moment, the central computer was already hard at work, tracking every watt in and out, seeking, always, the balance of zero net use over 24 hours — a goal that managers say probably won't be attainable until early next year, when the third wing of the project and a parking complex are completed. With daylight, the building's pulse quickened. The photovoltaic panels kicked in with electricity at 7:20 a.m.

As employees began arriving, electricity use — from cellphone chargers to elevators — began to increase. Total demand, including the 65-watt maximum budget per workspace for all uses, lighting to computing, peaked at 9:40 a.m.

Meanwhile, the basement data center, which handles processing needs for the 300-acre campus, was in full swing, peaking in electricity use at 10:10 a.m., as e-mail and research spreadsheets began firing through the circuitry.

For Mr. Duffield and his co-workers, that was a good-news bad-news moment: The data center is by far the biggest energy user in the complex, but also one of its biggest producers of heat, which is captured and used to warm the rest of the building. If there is a secret clubhouse for the world's energy and efficiency geeks, it probably looks and feels just about like this.

"Nothing in this building was built the way it usually is," said Jerry Blocher, a senior project manager at Haselden Construction, the general contractor for the project.

The backdrop to everything here is that office buildings are, to people like Mr. Blocher, the unpicked fruit of energy conservation. Commercial buildings use about 18 percent of the nation's total energy each year, and many of those buildings, especially in years past, were designed with barely a thought to energy savings, let alone zero net use.

The answer at the research energy laboratory, a unit of the federal Department of Energy, is not gee-whiz science. There is no giant, expensive solar array that could mask a multitude of traditional design sins, but rather a rethinking of everything, down to the smallest elements, all aligned in a watt-by-watt march toward a new kind of building.

Managers even pride themselves on the fact that hardly anything in their building, at least in its individual component pieces, is really new.

Off-the-shelf technology, cost-efficient as well as energy-efficient, was the mantra to finding what designers repeatedly call the sweet spot — zero energy that doesn't break a sweat, or the bank. More than 400 tour groups, from government agency planners to corporations to architects, have trouped through since the first employees moved in last summer.

"It's all doable technology," said Jeffrey M. Baker, the director of laboratory operations at the Department of Energy's Golden field office. "It's a living laboratory."

Some of those techniques and tricks are as old as the great cathedrals of Europe (mass holds heat like a battery, which led to the concrete labyrinth in the subbasement). Light, as builders since the pyramids have known, can be bent to suit need, with louvers that fling sunbeams to white panels over the office workers heads' to minimize electricity.

There are certainly some things that workers here are still getting used to. In nudging the building toward zero net electricity over 24 hours, lighting was a main target. That forced designers to lower the partition walls between work cubicles to only 42 or 54 inches (height decided by compass, or perhaps sundial, in maximizing the flow of natural light and ventilation), which raised privacy concerns among workers. Even the managers' offices have no ceilings — again to allow the flow of natural light, as cast from the ceiling.

"The open office is different," said Andrew Parker, an engineer. "You want to be next to someone quiet." Getting to the highest certification level in green building technology at reasonable cost also required an armada of creative decisions, large and small. The round steel structural columns that hold the building up? They came from 3,000 feet of natural gas pipe — built for the old energy economy and never used. The wood trim in the lobby? Lodgepole pine trees — 310 of them — killed by a bark beetle that has infested millions of acres of forest in the West.

Ultimately, construction costs were brought in at only $259 a square foot, nearly $77 below the average cost of a new super-efficient commercial office building, according to figures from Haselden Construction, the builder. Other components of the design are based on observation of human nature. People print less paper when they share a central printer that requires a walk to the copy room. People also use less energy, managers say, when they know how much they're using. A monitor in the lobby offers real-time feedback on eight different measures.

The feedback comes right down to a worker's computer screen, where a little icon pops up when the building's central computer says conditions are optimal to crank the hand-opened windows. (Other windows, harder to reach, open by computer command.)

Rethinking work shifts can also contribute. Here, the custodial staff comes in at 5 p.m., two or three hours earlier than in most traditional office buildings, saving on the use of lights.

The management of energy behavior, like the technology, is an experiment in progress.
"Right now people are on their best behavior," said Ron Judkoff, a lab program manager. "Time will answer the question of whether you can really train people, or whether a coffee maker or something starts showing up."

If Anthony Castellano is a measure, the training regimen has clearly taken root. Mr. Castellano, who joined the research laboratory last year as a Web designer after years in private industry, said the immersion in energy consciousness goes home with him at night.

"My kids are yelling at me because I'm turning off all the lights," Mr. Castellano said.
At 5:05 p.m., the solar cells stopped producing. Declining daylight in turn produced a brief spike in lighting use, at 5:55 p.m. Five minutes later, the building management system began shutting off lights in a rolling two-hour cycle (the computer gives a few friendly blinks, as a signal in case a late-working employee wants to leave the lights on.)

Mr. Duffield, whose work space is surrounded by a miniature greenhouse of plants he has brought, said his desk has become a regular stop on the group tours. If the building is a living experiment, he said, then his garden is the experiment within the experiment. Co-workers stop by, joking in geek-speak about his plants, but also seriously checking up on them as a measure of building health.

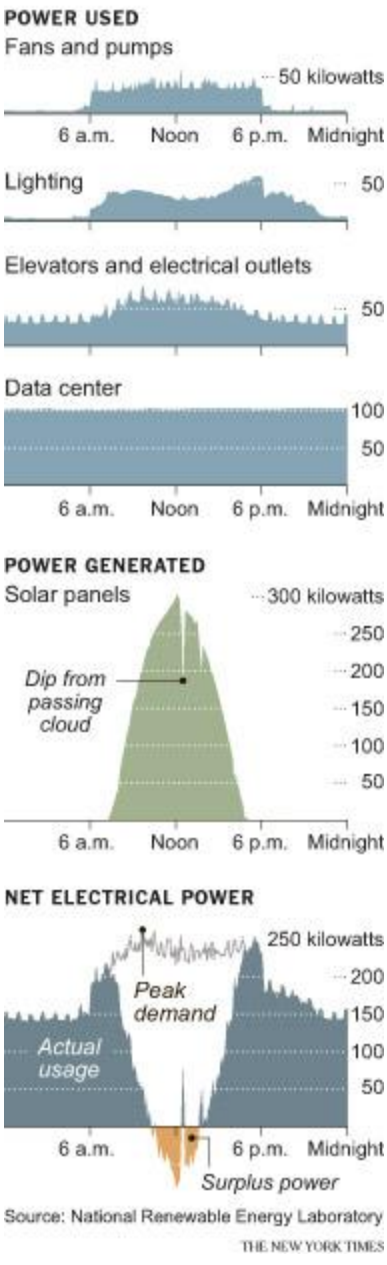
"They refer to this as the building's carbon sink," he said.

And Mr. Duffield's babies — amaryllis, African violet, a pink trumpet vine — are very happy with all the refracted, reflected light they get, he said.

"The tropical trumpet vine in my house stops growing for the winter," he said. "Here it has continued to grow, and when the days starting getting longer it might even bloom."

Office Efficiency

Below, charts show energy usage on January 28 at the Research Support Facility, a federal office building designed to use zero net energy when construction is complete.



Source: National Renewable Energy Laboratory

THE NEW YORK TIMES