Nation could double energy productivity

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Researchers at the U.S. Department of Energy's (DOE) National Renewable Energy Laboratory (NREL) have long understood that using energy more efficiently can be just as beneficial as finding new ways to produce energy more efficiently.

On Feb. 7, NREL Director Dan Arvizu and a blue-ribbon panel of 20 energy experts drove that message home, declaring that the United States can double its energy productivity by 2030—and do so in ways that bolster the nation's economy.

Unveiling their recommendations at the National Press Club in Washington, D.C., Arvizu and other members of the Alliance to Save Energy (ASE) Commission on National Energy Efficiency Policy said that doubling energy productivity could create a million new jobs, while saving the average household $1,000 a year and reducing carbon-dioxide emissions by one-third.

"Serving on the Commission on National Energy Efficiency Policy over the past year has been a unique and rewarding experience," Arvizu said. "The commission's recommendations provide a bold yet attainable roadmap for revolutionizing our nation's use of energy, and boosting our economy and improving our environment along the way." The commission was organized and sponsored by the ASE, and the full report is available on the ASE website.

The commission said its ambitious goals can be accomplished by unleashing investments in energy efficiency concepts and technologies

throughout the economy, modernizing our energy infrastructure, reforming regulatory measures to promote efficiency, and educating consumers and business leaders on ways to reduce energy waste.

In December, Arvizu testified on the importance of greater energy efficiency before the U.S. Senate Finance Subcommittee on Energy, Natural Resources, and Infrastructure. You can read that testimony here.

"Perhaps the most compelling evidence that energy efficiency measures can have dramatic effects in the future is the often-overlooked fact that they already have produced so many benefits for our nation," Arvizu noted in his testimony. To the same point, a report by the commission showed that the nation would be using fully 50% more energy than we currently use today had we not taken advantage of all the energy efficiency opportunities we have developed and deployed over the past three decades.

The NREL director's work on the commission and his testimony before Congress are but two illustrations of how NREL has been a leader in cutting-edge energy efficiency solutions.

A wealth of NREL experience and research knowledge was included in Arvizu's contribution to the commission's report. Dick DeBlasio, NREL's chief engineer for renewable electricity ande use applications, Austin Brown, a Washington, D.C., analyst in NREL's Strategic Energy Analysis Center, and Gary Schmitz, NREL senior manager for government relations, worked closely with Arvizu and ASE staff to ensure the recommendations reflected the latest in energy efficiency analysis and R&D concepts from NREL programs.

In addition to NREL's R&D on renewable energy generation technologies such as solar and wind, the laboratory has major programs to improve energy efficiency in the nation's two largest sectors of energy

use: buildings and transportation.

More Efficient Buildings

Forty percent of the nation's energy is used in buildings—from hospitals to factories, restaurants to office complexes.

NREL is helping the nation's architects and engineers find ways to reduce by 50% the energy intensity of large hospitals, schools, and retail buildings. NREL created the modeling and optimized the software for the Advanced Energy Design Guidelines (AEDGs) that spearhead the effort.

U.S. hospitals spend more than $5 billion annually on energy, equaling about 2% of a typical hospital's operating budget. NREL Senior Research Engineer and AEDG Project Chairman Shanti Pless said: "Our job is to develop those best practices, along with the professionals in the industry, and put them together in an easy-to-implement guide."

Schools Finding Big Energy Savings

NREL researchers helped New Orleans build 40 new schools and renovate 38 others in the wake of Hurricane Katrina's devastation—demonstrating an average energy savings of 30%. Among cost-saving measures, the blueprints called for pretreatment of humid air rather than overcooling the entire airflow; aligning the new schools on an east-west axis, with large, efficient, south-facing windows; and smart monitors to assure that only the lights that are needed are turned on.

The potential savings are monumental, amounting to some $75,000 per year, per school. In the United States there are about 100,000 public schools. This year, $14 billion will be spent constructing about 750 new

schools and renovating others, according to School Planning & Management magazine. If all the new and renovated schools followed green-school designs, the savings would be more than $50 million the first year, compounded each succeeding year. And the average school is built to endure 50 to 100 years.

Green Is the Color of Disaster Relief

In the aftermath of Katrina, NREL researchers helped city officials develop the Energy Smart New Orleans Plan, which includes residential energy audits, incentives for energy efficiency, low-income weatherization, commercial and industrial programs, pilot programs for photovoltaic arrays, solar domestic hot water systems, and education outreach. In a city in which 55,000 houses were abandoned, NREL worked with builders to achieve 15% to 30% energy savings on homes for middle-class and lower-income residents.

In 2007, a tornado leveled nearly the entire town of Greensburg, Kansas. Town leaders invited NREL scientists, and together they rebuilt a town that achieved 50% energy savings. The farm-supply town formerly tried to attract tourist dollars with the largest hand-dug well in the country. Now, it is a mecca for architects, planners, and vacationers who want to see how wind and solar energy can combine with energy efficiency to create a vibrant, attractive community.

NREL's Living Laboratory of Energy Efficiency

Last year, Construction Digital, a monthly online magazine, named NREL's Research Support Facility (RSF)—a 326,000-square-foot building housing 1,300 employees—the top net-zero energy building in the world. A net-zero building uses no more fossil-fuel-based energy than it produces via renewables. In all, the RSF has received more than

30 awards for sustainable design and construction.

The "SolarWall" transpired collector, light louvers, electrochromic and thermochromic windows, thermal storage walls, and NREL's Open Studio software tools that simplify optimal energy design, are getting friendly receptions in the marketplace.

NREL's Golden, Colorado, campus now has several buildings that have achieved lofty LEED (Leadership in Energy and Environmental Design) status, and it hosts visitors from around the country and the world who want to replicate the energy efficiencies on display at NREL.

Don't Forget the Parking Garage

Parking garages are opportunities to save a lot of energy because, while they are often an afterthought, they typically use 15% of the energy used by the buildings they are designed to support.

NREL's new parking garage attracts builders and architects because it is mostly daylit, performs 90% above code, and has enough solar panels on its roof to help the 1,300-employee RSF achieve net-zero energy. For every watt saved in the building or garage, that's $33 worth of photovoltaics a company doesn't have to buy to achieve net-zero energy.

Cooling Efficiently in All Climates

Nothing runs up the energy bill like air conditioning. Air conditioning currently accounts for 15% of all electricity use in the United States, and can be as much as 70% of use during hot summer days.

NREL researchers borrowed ancient cooling ideas and combined them with outside-the-box thinking to come up with a radically new kind of

air conditioning. NREL's Desiccant-Enhanced Evaporative (DEVAP) system first dehumidifies the air, and then sends it through an evaporative cooler to produce cool, dry air in any climate. The keys are paper membranes that separate the air from the water and the liquid desiccant, and a re-routing mechanism that uses a thermal cycle to refresh the desiccant and vent moisture away. The technology has the chance to lower air-conditioning energy bills by 40% to 80%, because it uses water rather than electricity to perform most of the process.

"The idea is to revolutionize cooling, while removing millions of metric tons of carbon from the air," said NREL mechanical engineer Eric Kozubal, principal investigator of the DEVAP cooling system. DEVAP uses no environmentally damaging working fluids, such as the chlorofluorocarbons used in vapor compression systems.

Energy Efficiency Starts at Home

TV blasting, air conditioner humming—that's no time to start the dishwasher, do laundry, or bake a cake.

NREL's Automated Home Energy Management (AHEM) Laboratory uses real plugs, panels, and appliances to study how consumers can save energy by running their appliances at the optimal time of the day—or have smart monitors do it for them. The "smart" home of the near future will communicate with the electricity grid to know when power is cheap, tell appliances when to turn on or off, and even alert when renewable energy resources are available to offset peak demand.

"We are very cognizant of the fact that every home is part of a larger energy system," NREL Senior Engineer Dane Christensen said. "We've modeled the AHEM Lab around a real home. The idea is that eventually our appliances and homes are going to be able to 'talk' to the grid."

The goal of the DOE Building America program is to reach 50% energy savings for new construction and 40% savings for building retrofits.

Energy Efficiency Spreads to the Grid

NREL's new Energy Systems Integration Laboratory (ESIF) helps optimize energy efficiency by hosting companies and utilities large and small that want to test how their products can integrate renewables onto the grid in a seamless way.

In its electrically interconnected laboratories, research partners can literally plug in and test new energy technologies on real and simulated power systems before hooking them up to the grid.

"We help utilities and companies that want to design new equipment that will increase the penetration of renewables into the energy grid," Acting Group Manager for Distributed Energy Systems Integration Bill Kramer said. "We can also test natural gas field generators. If you don't take into consideration the overall system and only work on a component at a time, you will never come up with the optimal solution."

Testing the Energy Efficiency of Battery-Powered Cars

NREL's Large-Volume Battery Calorimeter (LVBC) is helping put more energy-efficient automobiles on the road. It precisely measures the heat generated by batteries for electric drive vehicles, analyzes temperature's effects on systems, and helps pinpoint ways to manage battery temperatures for the best performance and maximum life.

Affordable, long-lasting, high-performing batteries are keys to consumer acceptance of automobiles that can get the equivalent of 100-plus miles

per gallon.

The Military Reaches for Energy Efficiency

NREL teamed with the U.S. Army on the Army Vision for Net Zero program, an ambitious effort to increase energy productivity and to get 25% of energy from renewables by 2025. Army bases responded enthusiastically, dozens accepting the challenge to reach net-zero energy, or to reduce water use and waste by 30% to 50%. Strategies include solar daylighting, photovoltaics, and turning waste into energy.

NREL is helping in war zones, too, where Army bases are replacing bottled water and barrels of diesel with solar systems that purify water and heat barracks. The changes don't just boost energy productivity; they mean fewer dangerous truck rides to forward bases—and that saves lives.

Converting Waste Gas into Usable Energy

The amount of natural gas simply flared or vented from oil wells globally is enormous—equal to one-third of the amount of petroleum used in the United States each year. And every molecule of methane vented to the atmosphere in that process has the global-warming capacity of 12 molecules of carbon dioxide.

NREL biofuels scientists working with industrial and university partners are developing microbes that convert methane found in natural gas into liquid diesel fuel. The novel approach could reduce greenhouse gas emissions and lower dependence on foreign oil.

Their proposal—to develop a microbe that eats the methane in the gas—won a $4.8 million Advanced Research Projects Agency—Energy

(ARPA-E) award from DOE. If the wasted gas can be turned into a liquid, then it can be piped along with the petroleum to refineries, where it can be turned into diesel suitable for trucks and cars, or even jet fuel for use in planes.

"The direct conversion of methane to diesel has the potential to dramatically increase energy supply while mitigating greenhouse gas impact," said Dr. Jennifer Holmgren, CEO at LanzaTech, NREL's manufacturing partner in the consortium.

Provided by National Renewable Energy Laboratory