Cost-Competitive Solar Electric Power Imminent

Solar concentrators using highly efficient photovoltaic solar cells will reduce the cost of electricity from sunlight to competitive levels soon, attendees were told at a recent international conference on the subject. Herb Hayden of Arizona Public Service (APS) and Robert McConnell and Martha Symko-Davies of the US Department of Energy's National Renewable Energy Laboratory (NREL) organized the conference held May 1-5 in Scottsdale, Ariz.

"Concentrating solar electric power is on the cusp of delivering on its promise of low-cost, reliable, solar-generated electricity at a cost that is competitive with mainstream electric generation systems," said Vahan Garboushian, president of Amonix, Inc. of Torrance, Calif. "With the advent of multijunction solar cells, PV concentrator power generation at $3 per watt is imminent in the coming few years," he added.

This solar dish-engine system is an electric generator that "burns" sunlight instead of gas or coal to produce electricity.

"We have seen steady progress in photovoltaic concentrator technology. We are working with advanced multijunction PV cells that are approaching 38% efficiency, and even higher is possible over time. Our goal is to install PV concentrator systems at $3 per watt, which can happen soon at production rates of 10 megawatts per year. Once that happens, higher volumes are readily achieved," Hayden, Solar Program Coordinator at APS, said, evworld.com said.

Growth in the photovoltaic (PV) concentrator business was reflected in the conference attendance, three times that of the 2003 version. This rapid growth was attributed to recent PV concentrator installations and sales forecasts along with excitement created by new solar cell efficiencies approaching 40%. At the conference, NREL announced a new record efficiency of 37.9 percent at 10 suns, a measure of concentrated sunlight. Soon thereafter Boeing-Spectrolab, under contract to NREL and the Department of Energy, surpassed the NREL record with 39.0 percent at 236 suns announced at the European photovoltaic conference in Barcelona, Spain. The efficiency of a solar cell is the percentage of the sun's energy the device converts to electricity.

Photovoltaic (PV) concentrator units are much different than the flat photovoltaic modules sold around the world; almost 1,200 megawatts of flat PV modules were sold last year. PV concentrators come in larger module sizes, typically 20 kilowatts to 35 kilowatts each, they track the sun during the day and they are more suitable for large utility installations.

Another highlight of the conference was the announcement by Amonix Inc. of a joint venture with Spain's Guascor which will build a 10-megawatt per year assembly plant in Spain by the end of 2005. Amonix also plans to install 3 megawatts of PV concentrator systems in the southwestern US while Guascor plans to install 10 megawatts of concentrator PV systems in Spain in 2006.

Solar Systems of Australia announced plans to install more than 5 megawatts of PV concentrator systems in 2006. "Solar Systems' experience gained from installing and operating reliable PV concentrator systems over the last decade combined with its strong relationship with Spectrolab Inc., a leading manufacturer of multijunction solar cells, is poised to make a major step towards being a mainstream power producer," said Dave Holland, CEO of Solar Systems Australia. "The new solar cell technology from Spectrolab will enable us to upgrade our systems from 24 kilowatts to 35 kilowatts, a 46 percent increase in output," he added.

The ultra-high efficiency solar cell technology, initially discovered at NREL and successfully developed for space satellites in the 1990s by Boeing-Spectrolab Inc., in Sylmar, Calif., proves to be enabling for low-cost terrestrial SEC systems. "Today, we are capitalizing on the major investments made by the space satellite industry and reducing the cost of the semiconductor solar cell by two to three orders of magnitude by operating the cells under high sun concentrations, typically 300 to 1000 times. Boeing-Spectrolab and NREL have demonstrated over 37 percent efficient concentrator solar cells and field testing of Spectrolab's cells for over one year with no degradation promise a bright future. We expect concentrator solar cell performance to reach or exceed 40 percent by 2006 and anticipate continued enhancement in performance and reliability," said Dr. Nasser Karam, vice president of Advanced Technology Products at Spectrolab Inc. "We are working closely with PV concentrator manufacturers to ensure their success and expedient deployment of the multijunction PV concentrator cells" said Dr. Raed Sherif, director of PV concentrator products, at Spectrolab.

Worldwide Energy Crunch

We live in a truly magical time. With the flick of a finger, the power of 10 horses flows from a small wire in the wall of our homes to clean our carpets. We go to the local market under the pull of hundreds of horses and fly across our continent with tens of thousands of them. Our homes are warm in the winter, cool in the summer and lit at night. We have the technology and the economic possibility to elevate the living conditions of much of humanity to heights well beyond the dreams of Roman emperors. We never had it so good.

Enjoying life as energy users has been made possible by our increasing ability to exploit abundant sources of energy. The worldwide consumption of energy has nearly doubled between 1970 and 2001. By 2025, it is expected to triple. The extraction of oil, our most precious energy source, is predicted to peak sometime in 10 to 30 years, and most of it will be gone by the end of this century. What took hundreds of millions of years for nature to make will have been consumed in 200 years. Natural gas will follow a similar fate. Other forms of fossil fuel (coal, shale oil, tar sands and methane hydrides) could last for another several hundreds of years, sfgate.com said.

There is, however, a catch. The cost of keeping the equivalent of a billion horses working for the world 365 days a year has a modern-day equivalent of cleaning the stables. The overwhelming consensus among scientists is that the Earth is warming, and the mostly likely cause is our emission of greenhouse gases such as carbon dioxide. Global warming has thus made new investments in conventional coal-burning plants questionable, sfgate.com said.

There appear to be no magic bullets to solve the energy problem. While efficiencies play a huge role in defining how much energy we consume, we must also have a diversified portfolio of investments to develop sustainable sources of energy that, in their creation and use, will result in no net emission of carbon dioxide.

What, then, should be our best investments for our nation's energy future? Fusion research must continue, but commercially viable fusion is not a certainty. Fission energy has significant issues: long-term waste storage and the potential proliferation of nuclear weapons materials. Despite these issues, it needs a second look, especially if radioactive waste can be greatly reduced by recycling and burning down long-lived radioactive products into shorter-lived waste.

Beyond nuclear energy, our most likely option is solar energy, such as solar cells and wind. Modern wind generation is becoming economically competitive, but it cannot supply the majority of our energy needs. Photovoltaic generation needs improvement in cost and/or efficiency before large-scale deployment can occur. If generation of electricity via wind or photovoltaics is to become a major component of our energy portfolio, it will be essential to develop efficient methods to convert electricity into stored energy that we can use on demand.

There is another approach. For billions of years, photosynthesis has turned the sun's energy into chemical energy. Learning to mimic biological systems may provide an eventual solution, while advances in molecular biology may offer a shorter-term answer. We should develop rapidly growing, self- fertilizing plants that convert carbon dioxide, sunlight, water and modest amounts of nutrients into biomass, such as cellulose, and more efficient means to convert the bio-mass and bio-waste into usable forms of energy. Nature has found ways to convert cellulose within the stomach of a termite and at the bottom of a swamp. A promising avenue of research is to improve these microorganism communities or develop biology-inspired enzymes that can replace existing, less efficient processes.

Among America's most serious concerns are national security (intimately tied to our energy security), long-term economic competitiveness and the dangers of global warming. Energy is at the center of all of these concerns, and thus is the single most important problem that science and technology must solve in the coming decades. New developments in science may lead to transforming technologies that will dramatically lower the cost of reducing carbon dioxide emissions.

Hydrogen Explored as New Fuel

In an era of escalating gas prices and diminishing global resources, much attention has been paid to the quest for new, innovative energy sources. However, there is much recent debate over what type of energy will power our society's future.

Three Stanford researchers, Mark Z. Jacobson, associate professor of civil and environmental engineering, Whitney G Colella, a graduate student in the program, and David M. Golden, consulting professor of mechanical engineering, recently weighed in on the issue in the June 24 issue of the journal Science. The researchers claim that hydrogen fuel cells are superior to fossil fuels and should be developed for large-scale applications in the future.

A conversion from fossil fuels to hydrogen fuel cells would provide health, environmental, climate, and economic benefits, and would reduce reliance on shrinking oil supplies, Jacobson said.

"Fuel cells are a new car technology that uses hydrogen for power instead of gasoline," he explained. "In fuel cells, hydrogen reacts with oxygen to produce water and energy. The energy is used to power the vehicle and only water is emitted, eliminating harmful gases that all current internal combustion cars, including hybrids, emit."

Currently, the process of creating hydrogen fuel produces many pollutants, studies show. In Science, the researchers suggest that using wind power to generate hydrogen could solve this problem, fuelcellworks.com said.

Although the researchers report that wind is not the only way to produce hydrogen fuel, they published in Science that using wind energy to create hydrogen fuel could actually make this form of energy cheaper than fossil fuels, especially when the social costs of sources like coal and oil are considered.

The researchers have also identified many health benefits that could result from the use of hydrogen fuel cells. According to the paper published in Science, such a conversion could prevent millions of cases of respiratory illness and tens of thousands of hospitalizations annually.

In order to promote the conversion to hydrogen fuel and reap these long-term benefits, the researchers suggest that the U.S. government embark on an "Apollo Program" for fuel cells, referring to America's gigantic push for lunar exploration in the 1960s.

The program would include measures such as investing heavily in the development of a hydrogen fuel infrastructure and giving financial incentives to companies that produce hydrogen powered vehicles.

Jacobson said his research stemmed from his interest in problems associated with energy consumption.

"I was motivated to research the issue because I was interested in finding solutions for problems like global warming and atmospheric pollution," he added.

Jacobson told The Daily that he hopes that the attention his article creates can help further the development of new energy sources and fuel cell technology.

"It would be great if the attention we are getting can be used for a beneficial purpose, to generate a lot of industrial interest or even influence environmental policy," he said.

Students on campus have a range of opinions regarding the practicality of hydrogen fuel. Some argue that a large investment in fuel cells is, indeed, necessary and important.

"I don't know how realistic and accurate these simulations are, but the data is definitely extremely detailed," said rising sophomore Artit Wangperawong. "I totally agree with the researchers that we should put a huge short-term investment into fuel cell technology to get long-term results. The sooner the better."

However, rising sophomore Ivan Janatra, an electrical engineering major, said he is "not sure if now is the right time to make an enormous endeavor towards fuel-cell technology. We could definitely rely on hybrids for a good number of years until fuel-cell technology and hydrogen infrastructure is more developed. This way, the transition would be more natural and wouldn't put too much of a strain on the economy."

From Muskets to Missiles To Wind Turbines

The Francis E. Warren Air Force Base in Wyoming is beginning construction this month on two 900 kW wind turbines to supplement the base's power needs. The base, with a motto of "From Muskets to Missiles," evolved from a major frontier infantry and cavalry post into the largest, most modern strategic missile facility in the United States.

The project is the first Air Force initiative of its kind in the continental United States and is a joint effort between the base and Headquarters Air Force Space Command (AFSPC).

AFSPC is the only Air Force command to have wind farms on its bases. Ascension Island, in the south Atlantic, was the first AFSPC wind farm with four turbines erected in 1998 and an additional two units installed in 2003, solaraccess.com said.

The turbines will help Warren comply with an executive order to use renewable energy sources while helping the base meet its annual energy goals, according to Lt. Col. Joe Ballard, 90th Civil Engineer Squadron commander.

"Wind turbines are a perfect green energy source for Warren," said Ken Davis, Warren's Wind Turbine Project Manager. "We have plenty of wind, an ample window of free space, and the economies of payback make them a cost-effective alternative to coal- or gas-generated electricity."

The wind farm, which is being built within the western perimeter of the base, can produce enough energy to power 522 homes annually, according to Mr. Davis. The turbines will provide roughly 10 percent of F.E. Warren's main base electricity.

The project is scheduled to be completed in late September or early October. Funding of just over $2.5 million came from the Department of Defense Energy Conservation Investment Program. The turbines will pay for themselves in approximately 12 years and have a 15- to 20-year lifespan.

AMEC Earth and Environmental, an international project management and services company with offices in Lakewood, Colo., is the contractor.

Warren energy officials plan to build two to three additional turbines on base as more funding becomes available.

One of the most advanced military installations in the world will soon have two 900 kW wind turbines, like this one pictured here, providing supplemental power for the base.