Powering the Southwest with solar and wind

By Zack Guido

Imagine this: cities and towns hum with electric cars that speed down photovoltaic solar-paved roads, organic solar cell paint coats buildings, and sleek wind turbines spin on many roofs. Spongy sidewalks transform the mechanical energy of footsteps into electricity. Algae ponds offer up biofuels, and bobbing wave machines harness the oscillations of the ocean.

Science fiction? It may sound like it today, but a number of entrepreneurs, scientists, and energy officials say some of those clean-energy solutions to powering society aren't as far out as they sound; some have already become reality, particularly those that draw on conventional solar and wind power. These energy sources not only appeal to industrial-scale development, but also to smaller residential and commercial users who view them as good investments and strategies to reduce their carbon footprint.

"There are technical hurdles," said Kevin Koch, owner of Technicians for Sustainability, a Tucson-based company that specializes in installing small solar systems. "But it is conceivable to have most of an individual's power generated in their home."

His company is part of an expansion of businesses in the Southwest that are stimulating and satisfying growth in renewable energy that harnesses the incessant sun and captures the wealth of wind.

Greenhouse gas emissions

Energy and climate are entwined. Burning coal and natural gas to generate electricity emits greenhouse gases that trap heat in the atmosphere, and hotter temperatures boost the need for more energy.

Since the industrial revolution, humans have been releasing greenhouse gases (GHG) into the atmosphere in increasing quantities. These gases, such as carbon dioxide and methane, act like a one-way mirror—they allow solar energy to warm the land surface and atmosphere, but block some of the radiation emanating from Earth back to space. Based on physics, the more of these heat trapping gases wafting into the atmosphere, the higher the temperature.

The atmospheric concentrations of the potent GHG carbon dioxide (CO_2) has wiggled up and down between approximately 180 and 300 parts per million (ppm) for nearly 700,000 years. Samples of CO_2 and other gases that are stand-ins for temperature measurements are preserved in ice and sediment cores. They display a similar pattern: high temperatures are accompanied by high concentrations of CO_2, and vice versa.

Last year, concentrations of CO_2 hit 385 ppm. This, combined with the ice records and the heat-trapping physics of GHG, provide a granite foundation for the conclusions made in the recently published Intergovernmental Panel on Climate Change (IPCC) report: warming of the climate system is unequivocal and most of the observed increase in global average temperatures since the mid-20th century is very likely (greater than 90 percent) due to the observed increase in human emitted GHGs.

Last year the atmospheric concentrations of CO_2 jumped 2.4 ppm, an increase that surpassed projections made by the IPCC. This leap, which is part of an accelerating GHG atmospheric concentration pattern, forebodes an increasingly warm future—in the past 100 years, global temperatures have increased roughly 1.3 degrees Fahrenheit, with the majority of that warming occurring in the past 30 years. Between 1970–2004, global emissions of GHGs increased by 70 percent, and CO_2 accounted for 77 percent of the total human-produced emissions.

The largest component of human GHG emissions between 1970 and 2004 came from the energy supply sector, and the most carbon intensive form of energy production comes from coal (Figure 1). In the Southwest, most of the electricity is produced by coal-fired power plants.

There are, however, clean alternatives to energy generation, and people are becoming more concerned about the climate altering impacts of burning fossil fuels.

Solar in the Southwest

Just a few years ago, Koch had three employees helping him install commercial and residential solar systems in Tucson. Now he has 15 and needs more help; he's booked through the end of January.

"It is a real exciting time in the solar industry. Business in the last few years has exploded. We're in a real interesting spot because the foundation has been laid to build a renewable energy society," Koch said. "Solar is not the sole answer, but it is a piece of the puzzle."

In the recent report, "Solar Energy in Southern Arizona," William Harris, the President and CEO of Science Foundation Arizona, builds on Koch's views.

"Arizona is the solar capital of the United States. In fact, with the necessary technology, Arizona has enough sun to provide power for the entire country. We have the opportunity to lead the world in solar technology development in a span of five to ten years and reap enormous benefits: environmental impacts, wealth generation resulting from commercialized technologies, and economic implications for entire regions," Harris said.

The stimulus for this vision may have come in the form of the Emergency Economic Stabilization Act of 2008. If there is a silver lining to the recent economic turmoil, it may be that the

continued on page 4

Solar and wind, continued

economic bailout plan included needed tax incentives for renewable energy such as solar and wind.

The law extends to 2016 a 30 percent tax credit for homeowners who put solar panels on their roofs. The new plan removes the maximum credit of $2,000 so that a homeowner installing a $15,000 system would be able to claim a credit of $4,500. A tax credit encouraging energy efficiency in existing homes has also been extended for a year. Now, improvements such as a biomass stove or an energy-efficient water heater are eligible for tax rebates. Building contractors working on new homes will also be eligible for a credit of up to $2,000 by including energy efficient systems for heating and cooling.

These federal incentives can be combined with state tax incentives and local rebates. Tucson Electric Power (TEP), for example, has a mandate to produce 15 percent of its power with renewable energy, said Bruce Plenck, solar energy coordinator for Tucson. TEP's rebate pays $3 per watt for systems that connect to the grid so that a one-kilowatt residential module would receive a $3,000 rebate.

Undoubtedly, Koch's business is spurred by the tax breaks for builders and consumers and by the combined forces of increasing energy costs and a growing consciousness that global warming is real and in large part brought on by burning fossil fuels.

"There are very few people I come in contact with that don't have an interest in helping the environment," Koch said, adding that the economic bailout plan also helped. "People can now receive a 7–8 percent return on their solar investment; people are now also motivated by economic concerns."

A three-kilowatt photovoltaic system in Tucson generates enough electricity to meet the needs of the average household. This small residential system can eliminate electricity bills, avoids burning 4,800 pounds of coal that would generate 7,200 pounds of CO2, and can save 1,920 gallons of water that are required to cool coal power plant turbines. Solar systems also last an average of 30 years.

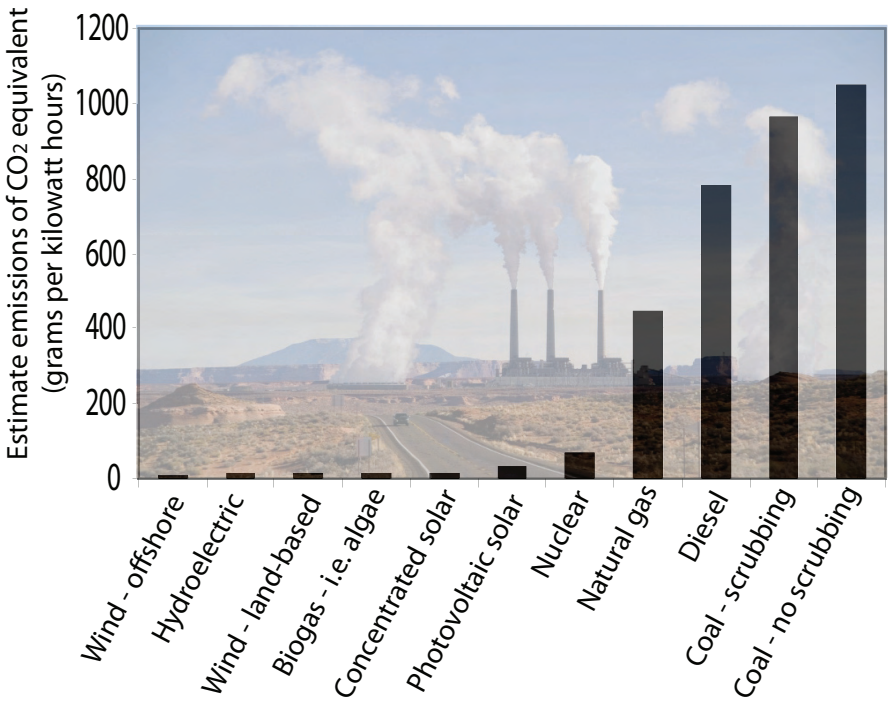

Figure 1: Greenhouse gas (GHG) emissions from numerous energy production types. Emission are in CO2 equivalents, which tallies all GHG emitted in the common unit of CO2. Lifecycle emissions include the carbon footprint required in all aspects of the energy production, from resource extraction (i.e. coal mining), to operation, to decommission of the facility. Data obtained from Sovacool, 2008.

Despite a sun that is rarely hidden by clouds, solar energy development in the Southwest has been slow precisely because coal is cheap. The price per kilowatt hour (kWh) of coal-generated electricity in Arizona is around 3 cents; solar electricity nears 20 cents per kWh. As a result, 90 percent of Arizona's electricity comes from coal-fired power plants. Many solar industry economic analysts believe that the cost of solar electricity has to fall to 10 cents per kWh to compete with fossil fuels.

To meet this challenge, the U.S. Department of Energy's (DOE) Solar Energy Technologies Program began stimulating collaborative public-private partnerships to reduce the cost of solar energy to 7 to 10 cents per kWh by 2015 and to 5 cents by 2020.

And now that the tax incentives for solar energy are guaranteed until 2016, companies can feel safe that solar projects are good investments. The extension of the credits will also stimulate large projects with megawatt capacities. Near Gila Bend in Arizona, for example, construction on a 280-megawatt solar-powered plant is in overdrive, Plenck said. If this power plant were to turn light bulbs on today, he said, it would be the largest solar plant in the world.

Wind in the Southwest

It's not just solar energy in the Southwest that offers an alternative to fossil fuels. It is also the invisible power of the breeze, which can transform wind into energy—on a relatively small scale—for a house or a building.

continued on page 5

Solar and wind, continued

"Small wind has been growing so rapidly," said Andy Cruz, co-founder and vice president for Southwest Wind Power. "We hope to double or triple our business next year."

Cruz's business, based in Flagstaff and bent on expanding the market for small-scale wind power, recently developed a wind turbine that can connect to the electric grid. Now, consumers can sell their surplus energy back to the utility companies, overcoming a past impediment to small-scale wind energy use.

To generate enough power to make small-scale wind energy viable, the wind needs to blow at an average 12 miles per hour. Winds that descend from the Rocky Mountains help create an environment suitable for large-scale wind farms and residential units in the Southwest, particularly in New Mexico (Figure 2). New Mexico's wind energy-generating capacity leaped from one megawatt at the end of 1999 to 496 megawatts at the end of 2007, according to DOE. As a comparison, the average home uses around 1,000 kWh per month; 496 megawatts could supply roughly 50,000 homes with their yearly energy needs.

Arizona, on the other hand, lags behind New Mexico in wind development, primarily because the wind only passes the 12 miles per hour threshold in isolated pockets, such as Flagstaff, near the White Mountains, and on some tribal lands.

Similar to solar, the wind sector will profit from the tax incentives passed in the economic stabilization plan.

"I spent a good portion of my life in Washington meeting with endless offices trying to push this legislation through," Cruz said. "When tax incentives would expire, the market would collapse."

Cruz sees the future role of wind energy much like Koch sees solar: as one critical part of the larger sustainable living picture.

"People don't buy small wind turbines solely on economics," Cruz said. "They buy based on energy security, climate change, and hedging that future prices of fossil fuels will go up."

With a carbon tax on the table and higher transportations costs, it seems likely that the price of coal and natural gas will indeed increase in the future. The economics for wind power, however, seem favorable today, even without increases in the price of fossil fuels. A typical system costs around $15,000 and last 20 years. With the federal tax rebate and local rebates offered by utility companies (Arizona Public Service offers approximately $5,000), wind systems can be installed for around $8,000. This may sound expensive, but bundling the amount into a 30-year mortgage, which, according to Cruz is a common practice, lowers the installation cost to about $5 per month. The monthly savings on electricity can be six times that amount.

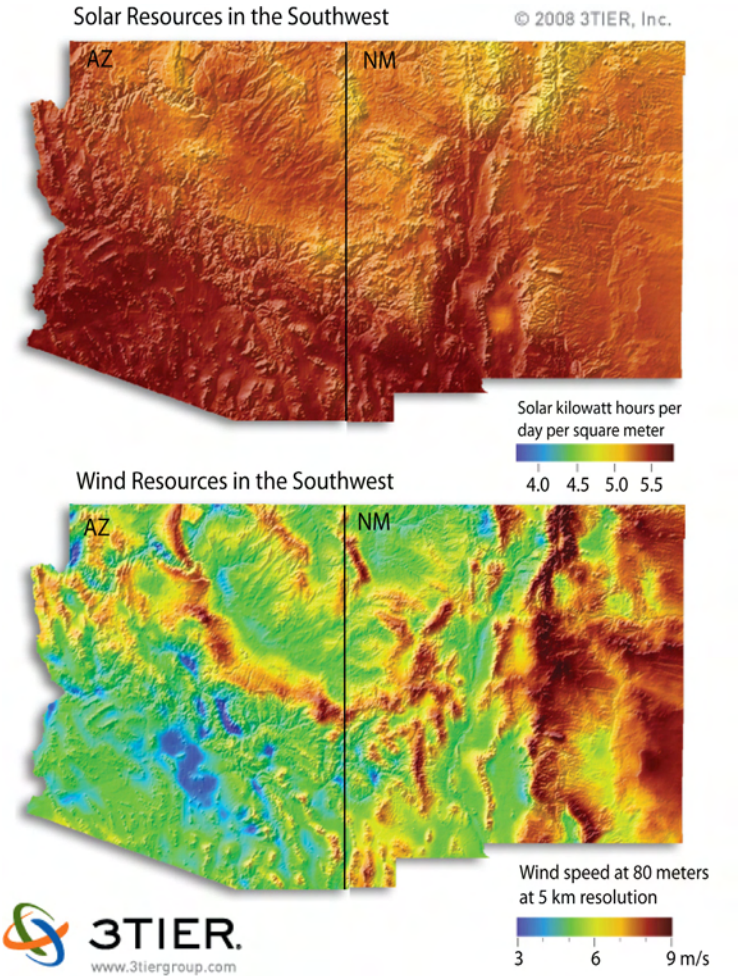

Figure 2: The solar resources for the Americas as well as the wind resources over most of the globe, were made accessible to the public by 3 Tier Group, a Seattle-based company that provides assessment and forecasting for solar, wind, and hydroelectric development.

Wind farms and residential units combined can create energy independence and reduce GHG emissions. A U.S. Department of Energy report concluded that wind can supply 20 percent of U.S. electricity by 2030 and reduce projected CO2 emissions by 25 percent—the equivalent of taking 140 million cars off the road.

A look ahead

Recently, prices at the gas pump have thinned wallets. Drought in key regions around the globe has conspired with high transportation costs to drive up food prices. And the concerns for climate change have mounted. In light of these issues, the economy and public policy may be ready for widespread commitment to renewable energies.

Clean energy is everywhere, from gusts of winds to light streaming from the sun. "We can keep waiting and waiting for huge technological advances," Plenck said, but good options for clean energy are currently available.

Koch elaborated: "Fantastic options."