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Puerto Rico: Energy Challenge

by John McPhaul

With the oil economy reaching its limits, Puerto Rico has scaled back dependence on petroleum, but the growing appeal of renewable energy alternatives leaves many energy officials cold.

Even with a volatile oil market jittery over the winds of war in the Middle East, renewed warnings about the limitation of oil supply, growing use of hybrid electric / gasoline cars, and the federal government's push to develop a hydrogen economy in the not-so-distant future, Puerto Rico hasn't exactly jumped on the alternative-energy bandwagon.

The Puerto Rico Electric Power Authority (Prepa) does plan to reduce its dependence on oil used to generate electricity from its current 71% to one third by the year 2012. Another third would be provided by natural gas and the rest by coal-fired generators. Prepa officials said they are aware that one day they won't be able to rely on cheap oil.

For that reason, Prepa has diversified its fuel sources in recent years. Dependency on oil to generate electricity has decreased from 98% to 71% since the addition of the 540-megawatt, natural gas-fired EcoElectrica plant and the 454-megawatt, coal-fired AES plant, started in the past administration. To achieve its strategic plan to reduce reliance by 2012, Prepa plans to bring a 474-megawatt, gas-fired power plant on line in 2009. Plans to refire units 5 and 6 at the San Juan plant will allow the generators to use either natural gas or petroleum. Prepa is also in talks with two waste-to-energy gas producers who would produce electricity from municipal garbage.

But a move toward renewable energy sources, such as wind and solar power, or toward the hydrogen model advanced by the federal government, isn't yet economically viable, said Puerto Rico Prepa Executive Director Hector Rosario.

The natural gas and coal alternatives embraced by Prepa do reduce Puerto Rico's dependence on oil. But the promise of renewable energy sources would scale back the use of all fossil fuels, an attractive alternative that Rosario said economics doesn't yet provide for.

"Nobody has yet proposed a renewable, alternative project that complies with the concept of avoided cost [a technical term that refers to the price of electricity sold to Prepa at or below the authority's cost to produce the same electricity]," said Rosario. "It makes no sense for us to pay more than it would cost Prepa to produce it." Prepa has entertained two wind-energy projects, one in Guayanilla and one in Cayey, but neither of them has been able to guarantee it could sell power to Prepa at six cents per kilowatt hour, which is Prepa's avoided cost, i.e., what it costs Prepa to produce one kilowatt hour, said Rosario.

Some analysts however believe the time to plan for using alternative energy sources has come. "Now is the time for Prepa to lay down the legal regulatory bases for the participation of

alternative energy sources," said Carlos Reyes, spokesman for the Puerto Rico College of Engineers.

He said Prepa is years behind in establishing interconnection requirements for private companies that want to produce energy to sell to Prepa. "There is no regulator framework. There is no standard or guide for those who want to advance their projects," said Reyes. In the absence of standard established requirements, Prepa must evaluate each project separately in a process that takes much too long, he said. A government regulatory body should be established to put time limits on project evaluations and to establish other rules of the game.

Rosario's answer is that avoided cost is the only required standard. "If someone came to me saying they can produce electricity at 6 cents a kilowatt hour, I'd approve it tomorrow," he said. Prepa estimates that advances in wind technology could bring the cost of wind energy down to the required 6 cents per kilowatt hour within 10 years.

Reyes maintains, however, that Prepa is self-regulatory and has little incentive to change in response to innovations. He proposed that a regulatory body separate from Prepa be established. Reyes said decentralized energy production could be the result of the development of alternative technology.

For example, 30 states already allow individuals and small businesses to sell excess electricity generated by wind generators or solar panels back to the local energy utility by using net metering. With this system, the meter measuring electricity at residences or small businesses automatically runs backwards when more electricity is generated than is used. Regulations would be needed to institute net metering so individuals would be allowed to sell energy to Prepa's energy grid, said Reyes. Rosario dismissed net metering as purely symbolic since only a wealthy few are using alternative energy sources to generate their own renewable energy. In fact, maintained Rosario, in the mainland U.S., only 2.2% of energy is produced by renewable energy sources.

A hydrogen economy?

The rapidly advancing technology of fuel cells would provide even greater opportunities for individuals or small entities, businesses, factories, or individual buildings to generate energy.

One scenario, advanced by the nonprofit Rocky Mountain Institute (RMI), believes hydrogen fuel-cell electricity generation in buildings can advance hand-in-hand with fuel cells for transportation. Under this scenario, the private sector could generate some of its own electricity, eliminating the need for large plants and big transmission lines. Nonetheless, some dismiss the idea as rather futuristic given the current costs of hydrogen, though the federal government has nonetheless included it in its hydrogen program. Such large-scale participation of private generators would reduce electricity costs, said Reyes. "That would be a practically immediate benefit," he said.

So far, Prepa's interest in hydrogen fuel cells has been modest, limited to participation in experimental projects in conjunction with the University of Puerto Rico (UPR)-Mayaguez and

the municipalities of Caguas and Carolina, which are aimed more at education than research and development.

The advent of a hydrogen economy could mean major institutional change for Prepa and could require it to overhaul the entire legal framework for energy distribution. But as Prepa doesn't see the technology developing fast enough, it feels no urgency to institute changes. "It's too early to think about that kind of change," said Prepa spokeswoman Virginia Gomez. "The market will indicate to us when we have to make them." Rosario, meanwhile, considers the widespread use of hydrogen fuel cells to generate electricity to be utopian.

The mainland U.S. and Europe, on the other hand, are progressing more quickly toward alternative energy in the face of pressures in the oil market. A New York Times editorial recently called for a national renewable energy plan and noted that states are making progress. Thirteen have adopted renewable portfolio standards, which require a fixed percentage of energy to come from renewable fuel sources. Nine western states have signed a plan to develop 30,000 megawatts of electricity–about 15% of current demand–from renewable sources by 2015.

But Rosario said these plans are based mostly on wind power in states that can count on sustained winds of 30 miles per hour or more, making the projects viable.

So, if alternative electricity sources are so uncompetitive in Puerto Rico, why is Puerto Rico's electricity so expensive? According to Rosario, the answer lies in the fact that Puerto Rico is an isolated system. As such, it has to maintain an installed capacity that is 40% to 45% greater than peak demand in case of plant breakdowns and maintenance needs. Utilities that can purchase power from neighboring jurisdictions, on the other hand, require an installed capacity that is only 10% greater than peak demand. The cost of generating electricity is no greater than elsewhere, but the cost of maintaining and financing the additional capacity increases operating costs.

States are also making other preparations for an economy based on hydrogen. In California, which has an array of tax incentives and rebates to promote the development of alternative energy, Gov. Arnold Schwarzenegger recently signed an executive order to establish a public-private partnership to build 150 to 200 hydrogen-fueling stations along the state's 21 interstate freeways. Most of the initiative's $90 million cost would be borne by energy companies, automakers, and high-tech firms. Most automobile manufacturers have developed fuel-cell prototypes and DaimlerChrysler introduced a fuel-cell car into the German market last month after Europe's first hydrogen-fuel service station opened for commercial operation in Berlin. Ford is also planning to release its first hydrogen-fuel-cell car by the end of this year.

Some experts say that one day soon, the price of oil will go up and stay up once demand for this finite resource finally exceeds production capacity. This will mark the beginning of the end of the petroleum era. The U.S. mainland already consumes more oil than it produces and its dependence on foreign oil will only increase with time. In response, the Bush administration has allocated $1.7 billion to research and develop hydrogen power, including a fuel-cell vehicle called Freedom Car in conjunction with Ford, General Motors, and DaimlerChrysler. The Department of Energy's Hydrogen Posture Plan predicts there will be a transition to a hydrogen economy beginning as early as 2010. According to the document, key milestones have been

established for achieving a hydrogen economy. Skeptics, though, see too many barriers that have yet to be surmounted and view the milestones as too aggressive.

Indeed, Prepa isn't alone in its skepticism. Doubters over the future of fuel cells would agree with Prepa that time is on their side. A number of technical hurdles must be overcome before the fuel cell can be competitive with standard energy generation. Some say they have heard the worries about oil-supply depletion before and discount them as unfounded, saying oil reserves are abundant, particularly in the Middle East where nationalized oil industries have had little incentive to make new explorations because of large proven reserves.

Still, when the price of crude oil rose to over $40 a barrel in May, consumers got a taste of the inevitable. The growing demand of India and China, with their rapid development and huge populations; the threats of terrorism in Middle East oil fields; and the increased summer demand in the U.S. all conspired to jack prices up to levels only seen after the Organization of Petroleum Exporting Countries imposed an embargo on the U.S. in the 1970s. True, Saudi Arabia's increased production lowered oil prices to below the $40-a-barrel mark for a time, and gasoline prices receded with it. But even that increase in production wasn't enough. The price has again exceeded $40 per barrel. Environmentalists argue the time has come to prepare for the day when Saudi Arabia or other countries can't increase production capacity enough to lower prices.

UPR environmental science Prof. Jose Molinelli said as a society, Puerto Rico isn't taking seriously enough the prospect of the end of cheap oil. Molinelli maintains the government has concentrated too much on the matter of supplying energy and not enough on conservation measures to decrease demand.

"Because of the urban-sprawl model we have developed, we live farther and farther away from where we work, increasing our energy needs," said Molinelli. The Planning Board needs to adopt a development model that densifies urban growth to shorten traveling distances and take better advantage of public transportation, he said. He also said a member of government or academia should design a comprehensive energy-management plan that takes into account all types of energy sources and uses. Yet, no such plan is anywhere on the horizon, he said.

But Molinelli does see a step in that direction. The Legislature is considering a master zoning plan that would ensure planning decisions take into account the island's environmental limitations. However, the government will need the will to make sure the plans stick. "We need a government that will make decisions based on everyone's long-term interests and not on the short-term interests of those who have influence," he said.

What's being done in Puerto Rico?

Some locals are working on innovative solutions to the island's energy problem. For example, assistant Prof. Gustavo Gutierrez from the UPR-Mayaguez has proposed research on a system for keeping buildings cool without air conditioning.

In this system, the sides and roofs of buildings would be lined with panels similar to passive solar energy panels. Made of plastic on the outside and a type of conduit material (such as porous

tubing) in the middle, they would absorb solar radiation and transfer the heat to the ground. Water would circulate through the panels and to the ground in a closed circuit. It would be mainly for residential use and could be installed on existing structures or built into new residences under construction. To further develop the technology, Gutierrez has applied for a research grant from Epscor Puerto Rico, a science foundation funded by the National Science Foundation.

At the University of Turabo School of Engineering in Gurabo, scientists are conducting two hydrogen experiments. One involves incinerating garbage at high temperatures to produce hydrogen. To do this, a plasma torch is used since this heated gas can reach temperatures high enough to turn solids into gas.

In its second experiment, scientists are experimenting with redesigning the fuel cell. One of the innovations involves a new silica-based material that acts as a catalyst in the fuel cell. University of Turabo physicist Ronaldo Roque has developed the material, which will have other applications in hydrogen technology as well. For example, silica offers a promising solution to the difficulty of storing hydrogen and serves as a filter to clean hydrogen. Roque said solar and wind energy and other renewable sources can satisfy only 10% to 15% of energy demand, so hydrogen must be developed in the face of oil depletion. "For the past five years, it has been apparent that we must develop an alternative to oil very soon," said Roque.

At the UPR-Mayaguez, Dr. Jose Colucci and his team are researching fuel-cell technology in conjunction with so-called biodiesel, otherwise known as used cooking oil. According to Yaritza Lopez, a UPR-Mayaguez graduate student, the team is experimenting with ways of using biodiesel to produce hydrogen for fuel cells.

The research involves extracting hydrogen from biodiesel using partial oxidation, steam, a combination of the two (known as autothermal reforming), and other processes. They are also studying ways of making proton-exchange-membrane fuel cells more efficient with the objective of demonstrating a fuel cell that runs on hydrogen produced from biodiesel. The team will report its findings to the Arggone National Laboratory, said Lopez.

An oil-less future?

How urgent is the need to prepare for an oil-less future? Experts are divided over how much time we have before shortages become acute. "Every expert has a different opinion," said Jenny Constable, spokeswoman for the RMI.

One problem is that no one knows how much oil is left. Oil industry officials claim enough oil and gas reserves exist to make them the primary source of energy through at least the middle of the century. The U.S. Department of Energy's Energy Information Administration puts peak oil production–the moment in which the world's oil reserves begin their inexorable decline–at sometime between 2030 and 2070. But even such industries as ExxonMobil have acknowledged existing production from oil and gas fields is declining at a rate of 4% to 6% per year. As such, by 2015, the industry will have to find, develop, and produce new oil and gas equal to eight of 10 barrels produced today.

Oil discovery peaked in 1982. In light of this fact, and given the ongoing decline in the discovery of new oil and gas reserves, some say the industry can't possibly find the additional 60 million barrels of oil a day that would be needed. Such considerations have led the Association for the Study of Peak Oil & Gas, a group of European scientists, to conclude that oil production will peak in the year 2010.

David Friedman of the Union of Concerned Scientists, said production levels aren't the only important variables in assessing the need for alternative energy sources. With the developing world beginning to demand ever greater quantities of oil for its growing p populations and burgeoning industries, sooner or later demand for oil will outstrip production.

According to Friedman, it could be sooner than we think given the dynamic economic growth rates of the world's two most populous nations, China and India. Numerous recent news reports have documented China's problems with keeping up with its electricity demand. "When we reach the point at which demand is greater than production capacity…the price of oil and gasoline, based on simple rules of supply and demand, will surge and not come back down," said Friedman.

If the world fails to prepare for such a day of reckoning, said Friedman, it has a shock in store. Constable, however, is more optimistic and believes the development of alternative energy sources and a smooth transition to a hydrogen economy will forestall such a grim scenario. "A combination of factors will spur development of alternatives to fill the supply. The depletion point will be pushed back until, eventually, alternatives will take over," Constable said. Consumers will play a large role by combining their concern for the environment, a desire to be less reliant on Middle Eastern oil, and advancing technology to prompt development of alternatives, she said. Friedman added that public concern over global warming and the release of greenhouse gas emissions will also help drive the transition.

Constable pointed to the growing popularity of hybrid electricity / gasoline cars in the States as an indication that consumers will drive the industry to produce products that are less dependent on fossil fuels. Friedman noted most carmakers are racing to jump on the hybrid bandwagon and predicted that in a few years, all makes of cars will have hybrid versions.

It may be too early to tell when Puerto Rico will join that trend. According to Merlis Miranda of Toyota of Puerto Rico's marketing department, sales of Toyota's Prius hybrid have lagged behind those of other models. Only 276 have been sold since its introduction last November. But sales did jump in May when gasoline prices rose to over $2.00 a gallon.

Communities are also demanding more environmentally friendly and reliable electricity sources. After the catastrophic experiment with deregulation in California that led to widespread blackouts, San Francisco turned to the RMI to help design a system of electricity generation that would free the city from dependence on transmission from sources outside the city. RMI designed a system to decentralize energy production that will eventually include fuel-cell generation.

The U.S. Department of Energy has established a number of milestones in its transition to a hydrogen economy. They are intended to make hydrogen production and use cheap, plentiful, and clean.

- Developing an onboard automobile hydrogen storage system in cars sufficient for them to run 300 miles.

- Development of polymer electrolyte-membrane automotive fuel cells that cost $30-$45 per kilowatt and deliver 5,000 hours of service.
- Development of zero emission coal plants that produce hydrogen and power equivalent to $0.80 per gallon of gasoline as it leaves the plant, or $1.80 per gallon of gasoline at the pump. The plants would also capture and store carbon dioxide to keep it from escaping into the atmosphere.
- Develop hydrogen production from wind-based electrolysis that would be worth nearly $2.00 per gallon of untaxed gasoline. It would use wind electricity at $0.04 per kilowatt-hour.
- Produce hydrogen fuel delivery technology that costs the equivalent of $1.00 per gallon of gasoline.

Glossary

Hydrogen economy: Currently the world's economy is powered by fossil fuels, mainly oil. But many believe the process of depleting oil supplies, the length of which continues to be debated, eventually will give way to an economy based on hydrogen. The U.S. government has drafted plans for transition to a hydrogen economy.

Hydrogen energy: Hydrogen isn't an energy source but an excellent, efficient energy carrier. By separating the single electron from each hydrogen atom, a stream of electrons produces electricity in fuel cells. Because natural gas is inexpensive and abundant, it will likely be used to produce hydrogen initially. Advances in technology could one day lead to cheap hydrogen production from alternative energy sources such as water, renewable wind and solar power, and biomass (organic matter from plants and associated residues, plant fiber, poultry litter and other animal wastes, industrial waste, and the paper component of municipal solid waste).

Fuel cells: Electrical power generators that use hydrogen as a fuel by detaching the electron from a hydrogen atom to produce electricity, then reattaching it in the presence of oxygen to produce water

Natural gas: Trapped between layers of the earth's crust, natural gas is a combustible mixture of hydrocarbon gas, principally methane. Natural gas can be used as an energy source in its own right, burning cleaner than oil or coal, or provide hydrogen for fuel cells.

Wind power: Wind turbines can generate electricity by harnessing the power of wind.

Polymer electrolyte membrane: Also called proton exchange membrane, the part of the fuel cell that allows the hydrogen ion (the positively charged hydrogen proton and neutron) to pass from the negatively charged anode to the positively charged cathode. It blocks the atom's electron that has been stripped from the atom by a catalyst.

Fossil fuels: Fuel comprised of oil, natural gas, and coal, among others, formed by the decay of plant and animal fossils over time.