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Factory Goes For Microturbines

For most companies, a power outage can cause frustration, but for a continuous process manufacturer such as Harbec Plastics, a power outage can be a disaster. Harbec needed a distributed generation solution to allow it to be able to function even when the grid could not. It had to have low emissions, be efficient and economically feasible. This is what led Harbec to implement the largest installation of microturbines to completely power a manufacturing plant.

Located outside Rochester, New York, Harbec produces highly engineered precision plastics for medical, automotive, consumer goods and other industries. In order to maintain its operations, Harbec has installed twenty-five 30 kW natural gas-fueled Capstone microturbines. The microturbines power the entire plant and provide heating and air conditioning to the manufacturing part of the plant and the warehouse.

Bob Bechtold, founder and president of Harbec, said that efficiency was the driving force behind Harbec's desire for a DG solution. "It's not only distributed generation that's important here, it's really about combined heat and power. By generating our own power, we're able to do that more cost-effectively than if we were buying it from the grid, especially because we get to use the heat that is the by-product of all generating rather than wasting it into rivers and streams or the air. It's a great efficiency improvement," he said.

For example, Harbec uses its waste heat to air condition an injection molding plant. Bechtold explained why this was so important, "These last two summers that we've been doing it we've had around 23 or 25 injection molding machines which is similar to having 23 or 25 pizza ovens with the door open in a room and then trying to air condition that room. It's a very sizeable task. One of the things that led us into this was the cost of doing air conditioning the conventional way would have added a great deal of expense to our operating. The pursuit of trying to do air conditioning and heating more efficiently is one of the things that led us to the potential of combined heat and power."

Harbec chose microturbines for three reasons, according to Bechtold. First, he believed that they would be the lowest maintenance of all the possibilities. "There's only one moving part on a microturbine as opposed to an engine which has hundreds of moving parts and therefore all of those have to be considered. All of those things are not an issue with turbine engines," he said.

The second reason was environmental. "We are an ISO 14001-certified company. That means that everything that goes into or out of your plant you take environmental impact responsibility for. Using the turbine, we have no coolant, no lubricants and no filters that we have to be accountable or worry about the disposition of," said Bechtold.

The third reason is that Harbec did not want to become a utility. "We didn't want to focus our energies and facilities and personnel and capabilities on generating power any more than we absolutely had to. So with the microturbines we're able to have a situation where we added no new people and the current force of maintenance staff that we have were each sent to school for a week at Capstone and they now do all the maintenance of the systems. So the same guys that fix the molding machines when they break are the same guys that fix the turbines. It's just basically another piece of equipment," he said.

Bechtold described the decision-making process for this project as an evolution that started out years ago with Harbec trying to have a portion or all of its power developed from renewable energy, but running into utility opposition. "Distributed generation is really a very key issue. The problem is that the environment for distributed generation is not very good in some places and in New York, it's terrible," said Bechtold. "If you have a bad environment for distributed generation, that's happening because the utility doesn't want to realize it, doesn't want to embrace it. So the utilities will put impediments to making distributed generation happen. Once you have this concept of distributed generation and if you have a utility that's against it, anything like onsite power generation which is what we're doing, combined heat and power or renewable energy generation, any of those are going to run into problems."

Ten years ago, Harbec started out trying to figure out a way to add wind to use as a renewable resource to power its plant, Bechtold said. "Quickly, because of the fact that we had no net metering and only insurmountable obstacles, we did not succeed in being able to bank and install a wind generator. We needed to think of a plan that would allow us to use as much renewables as we could and then complement that with a more standard-based system or a fossil fuel-based system. That's what led us to a hybrid system. Our plan then evolved and the decision evolved into wind-diesel, a combination of wind and diesel reciprocating generators. That seemed to be a contradiction of terms because wind was renewable and was as green as you could possibly go, but diesel was about one of the most negative ways that you could go as far as environmental impact. So, as time went on and progress evolved and the plan evolved and the obstacles were one by one overcome, the next phase of the development was to go to wind and natural gas reciprocating because natural gas was so much cleaner."

Harbec continued to fight through the utilities to try to make its project bankable and feasible. "We came into the good fortune of time when a brand new technology was happening which was microturbines and they were even cleaner than natural gas. Now we had an opportunity to

continued on page 2

In This Issue

FACTORY, CONTINUED FROM PAGE 1

do something that was, as far as burning fuel goes, the cleanest possibility, combine that with wind for a hybrid and to put together a system," said Bechtold. "The second problem we had and the reason why it took ten years to get to basically today is because it was very difficult to bank. We were actually turned down by over 30 banks during the process until we finally found one that was willing to help us and they actually did that by inviting us to get a group of lenders together. We actually had four lending institutions, a conventional bank and three state economic development agencies involved. By coming in together they reduced the risk to any one entity and they were willing to give it a try."

Despite the fact that microturbines were the most expensive alternative in terms of capital, Harbec believes that overall they are cost-effective. "We think that in terms of the life of the project, they're the most cost-effective because of the reduced cost of maintenance and the reduced burden of the environmental impact mediums like filters and oils and coolants," said Bechtold.

Harbec did have some problems with the installation of the microturbine system, but only because it had never been done before. "There were never this many microturbines put together to completely power a manufacturing plant. For a long time, we were the biggest single installation ever. There are larger ones now, but most of them just are grid inter-tied. I think we still remain the largest stand-alone," said Bechtold. Most of the issues were about software -- the controlling of the multiple units to work in unison. "That was the biggest part of the problem," said Bechtold. "We knew that when we were entering into the opportunity with Capstone that nothing like this had ever been done before and we anticipated there being a the learning curve, and that learning curve took nine months approximately. Capstone was right there with us through the whole time, developing and changing and modifying and improving until we got to the point where we were completely generating 100 percent of our own power." The system was turned on in September 2000, and in July of 2001, Harbec was able to generate all of its own power.

Even though it generates all its own power, Harbec still maintains its link to the grid. "We never really wanted to be stand-alone, but the things that are happening in New York State right now force us to maintain the option to be able to go stand alone," said Bechtold. As an example of the utility-driven, distributed generation problems that Bechtold has pointed to, he said that Harbec currently pays a $1,170 per month stand-by charge, even though it uses no grid-supplied power.

Unfortunately, New York state will soon have a very high stand-by tariff which has already been approved by the PSC. "That stand-by tariff, in our best estimates right now, will exceed $4,000 a month for a service Class 8 customer like ourselves, plus nine and half cents per kilowatt hour if we use power. We'll have to go off the grid," said Bechtold. "There goes your concept of distributed generation. If things like that keep happening, there will be no distributed generation no matter how good the technology gets or how much sense it makes, the utility has the ability to kill distributed generation by tariffs. If the powers that be let them continue to do that, distributed generation will be a failed concept."

Despite the utility discouragement, Harbec's system is working great. "We love the results. The past two summers, we were able to provide air conditioning to our facility, which we couldn't do in the past. That not only gave wonderful improvement of facility conditions to the workers, but also gave a wonderful improvement of our quality because we are a specialized injection molder who uses a lot of very high tech engineering resins," said Bechtold. "They are often hydroscopic, so during the summer time, from May to September-October, we would have very significant problems in our company trying to keep our materials dry. We would run as many as a dozen and a half material dryers just to keep cooking the material all through the moist time of the year. By doing the air conditioning of the environmental control of the manufacturing space now, for the last two years we've dropped our need for those dryers down to about 25 percent of what it was before and our quality issues related to moisture don't exist anymore, that's completely gone. Now Harbec has exactly the same quality no matter what time of year it is, as a result of our generating plant, by using the heat from it. We use the waste heat in the summer time through an absorption chiller to make air conditioning."

Bechtold said that he knows that they have a long way to go with distributed generation. "This has shown us that there is so much more that we can do because with all that I've said, we still have an enormous amount of thermal potential that we are wasting -- it goes up the exhaust. We are in the process right now of adding wind power and actually our wind will be up and running during the month of December. That will bring this whole first phase to closure, the idea of renewable hybrid-type generating. Our next goal to accomplish will be taking the excess heat potential that we have into our molding process. We believe and know that there are a number of places where we're using alternatives to get heat right now and we could be using the heat from our turbines. So that will be the next generation of what we're hoping to do."

Bob Bechtold with a Capstone microturbine. *Courtesy of Capstone*

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Newsmaker Interview: Mike Bergey

Although utility-scale wind power receives a significant amount of press, wind power for distributed generation is a much more obscure topic. One company that has survived the storms of the wind power market and wants to see small wind realize its market potential is Bergey Windpower. Bergey Windpower was founded by Mike Bergey and his father in 1977.and is the world's leading supplier of small wind turbines.

To learn more about wind-powered distributed generation, *DG Insight* spoke with Mike Bergey, president of Bergey Windpower and chairman of the American Wind Energy Association Small Wind Turbine Committee.

DGI: What is the current state of the U.S. small wind turbine market?

MB: It's quite active. It's not quite as active as it was at the height of the energy crisis in the late 70s-early 80s, when there were federal tax credits as well as state tax credits in most states. It's the most active it's been since 1986. Electricity costs have gone up in a number of areas. Several states have put in place rebate programs and grant programs that subsidize purchasers at meaningful levels. California has a 50% rebate, Illinois has a 50% grant, New Jersey has a 60% rebate and that's enough stimulus to start perking up those markets. It's doing well. I don't see states retreating from their clean energy programs. In the coming years more states will add subsidies and hopefully the federal government will reinstate subsidies for small wind turbines.

DGI: How has the market changed over time?

MB: The small wind turbine industry goes back 70 years when the systems were for electrifying rural farms that had no power, and that industry thrived until the Rural Electrification Administration (REA) was set up and subsidized extending wires out to rural areas. So the industry collapsed under the programs of the REA. Starting about 1976-1977, due to the energy crisis, there was a rebirth, all new players, all new technology of course. The industry grew at a pretty good clip. There was a very active market. Unfortunately the technology was not very mature, the products were not very reliable. There were high maintenance costs. About the time the industry got the technology issues pretty much worked out and there were good solid products on the market, the domestic market collapsed. That was in the 1985-1986 range when the federal tax credits expired in 1985 and then of course oil prices went below ten dollars a barrel in 1986. That wiped out virtually all of the domestic manufacturers. In fact, our company is the sole survivor from that period. From about 1986 until about 1998 it was almost all export markets and some off-grid markets here in the U.S., people who had homes which were off the power grid. The real growth in the last three or four years has been grid connected homes, people wanting to reduce their utility bill, which is of course the same market that was active in the early 80's.

DGI: Is small wind competitive with grid-supplied power?

MB: In general, no. It needs a subsidy to get the payback period to a point that people will accept the economics. Wind turbines are relatively expensive, of course. They have no operating cost, no fuel cost, but they're relatively expensive to install because they're a pretty big piece of equipment for a home-sized system and they're produced in low volume, so they're expensive. What will make it more competitive is subsidy programs that boost production rates and allow us to reduce the manufacturing cost. That's true of most distributed generation technologies. States are showing leadership and I think there's growing awareness at the national level but the federal government needs to be a player as well. There are tax credits for both residents of homes and businesses under consideration in the energy bill that's being formulated in Washington.

DGI: What other benefits does wind DG provide to customers?

MB: The primary benefit is reduced utility bills in a system with almost a zero operating cost. After the system pays for itself in 6 to 15 years depending upon the site and the support programs and wind resource and that sort of thing, the electricity is essentially free. So the life-cycle energy costs are very low, but that's taking a 30-year horizon. That's the primary benefit. There are environmental benefits and many customers appreciate the cleanliness of wind, but sales are primarily based upon the economics, not the environmental attributes.

DGI: What barriers exist to greater market penetration?

MB: One of the most important barriers is the cost of the equipment. We've got to get the cost down by some improvement in technology. By investing more in tooling and designing turbines for higher production rates, we're bringing the cost of the equipment down. The second barrier is zoning restrictions in many parts of the country which limit the height of the towers to 35 feet or less and that's not sufficient for a small wind system to be effective. We have to work to change the rules for installing structures so that our customer don't have to get a variance or a conditional use permit every time they go to install one of these. In most places we do it county-by-county or city-by-city and it's based on a particular customer wanting to install a system and they'll work to get the rules changed. In California, we worked with the state legislature and passed a law in 2001 that took effect this summer that overrides local ordinances pertaining to small wind systems and makes them essentially permitted use. That's a much more effective way of handling the problem, because instead of us having to change 550 separate ordinances, we just have the state setting the framework consistently.

DGI: What is the market potential for small wind?

MB: The industry did a roadmap between now and 2020. In that, we showed that the potential is very high because there are 21 million homes in America with an acre of property or more. We estimate that 61 percent of those are in a wind regime that over the next ten years we can economically install the systems in. Maybe not today, but where the technology will be in ten years, we could. That's a potential market of 15 million homes. That could be something in the range of 3 percent of total electricity consumption in the U.S. or 6 to 7 percent of residential electricity consumption. So there's significant potential if the barriers can be overcome.

DGI: When will that level be reached?

MB: The goals for the industry, I think is 50,000 megawatt by 2020. I wouldn't call it realistic, I would call it ambitious, but I do think that the impact of small wind could be as much or greater than fuel cells for homes or solar for homes.

IEEE Interconnection Standard Near

Many in the industry have felt that one of the big barriers to widespread penetration of distributed generation has been the lack of an interconnection standard. Hopefully, that barrier will soon come crumbling down as the Institute of Electrical and Electronics Engineers (IEEE) is nearing the final steps of its P1547 Standard, which has moved along twice as fast as most IEEE standards.

The IEEE P1547 Standard establishes uniform requirements for interconnection of distributed resources with electric power systems. The requirements are relevant to the performance, operation, testing, safety considerations, and maintenance of the interconnection.

Tom Basso is secretary of IEEE Standards Coordinating Committee 21. This is the committee that oversees the development of standards for fuel cells, photovoltaics, dispersed generation, and energy storage, and coordinates efforts to ensure that all standards are consistent and properly reflect the views of all applicable disciplines.

Basso said that interconnection is very cumbersome right now. Each interconnection application is often viewed on a case-by-case basis. He said that often times in one place, the utility will have their specific piece of the equipment that they're comfortable with and would prescribe and someone who interconnects in another place will possibly have a different piece of equipment complying with the same functional performance.

"Throughout the U.S. there are hundreds if not thousands of interconnection standards today," said Basso. "The IEEE serves the purpose of being a single standard that is universal among different generator technologies and different utilities. It's technology neutral. That's the generator end. It's universal on the electric power system or utility grid. It's equal footing for all technologies and all utilities. It's a functional technical requirements approach to standards as opposed to being equipment specific or prescriptive. It doesn't identify which piece of equipment, which make and model to use whereas often utilities indeed have those requirements."

Most importantly, P1547 would standardize the requirements across the country. "Whoever chooses to adopt this standard will help manufacturers and producers, consultants in applications, and engineers to apply distributed generation technology in a consistent manner. It will help manufacturers to develop technology that's more uniform and therefore compatible across platforms and across different makes and models," said Basso. "It should simplify interconnection, make it more uniform. It will improve the cost effectiveness if people don't have to prove their application again and again using the same technology."

Richard DeBlasio, chairman of IEEE Standards Coordinating Committee 21, said that the P1547 Standard is in reaction to the changes going on within electric power industry. "It started around 1998 with the idea of deregulation. California, Texas and New York were in the process of that. Also, the reliability of electric utilities -- looking at possibilities of other energy sources. With all of this in mind, allowing people to participate in the energy markets, the need for a technical standard was brought to the IEEE Standards Board. In 1998-1999 we started a project to write technical standard for interconnection of distributed generators with the electric grid. That was approved in March of 1999," said DeBlasio.

"In 1999, the DOE got wind of all this. They have been very helpful in funding our activities," said DeBlasio. "It's really an industry-driven activity. There's over 350 members in this working group and we have been meeting quite a lot. We've had 15-20 meetings over the last three years. It's evolved from draft one through draft ten. We've had a couple ballot actions voted by the committee. There's been some downside and some upside and recently a very good upside."

The IEEE working group members decided at the onset of this activity that they wanted to publish this on a fast track schedule, Basso said. "Typically starting to develop a new standard would take anywhere from 4 to 7 years. This standard was first balloted basically two years after formal approval by IEEE."

A balloting committee was chosen from the IEEE membership with 230 balloters volunteering to be on it. In September, the tenth draft of the IEEE P1547 Draft Standard for Interconnecting Distributed Resources with Electric Power Systems received 90 percent affirmative votes by the IEEE balloting committee. In order for a ballot action to be successful, 75 percent of the ballots must be returned and there must be 75 percent approval. "We were fortunate this time to get 93 percent returns of all ballots and were fortunate to get a 90 percent approval rate in the most recent ballot action which is a big breakthrough. It basically gives me authority to move on to the next stage, which is to resolve and address the negative comments. There were 20 negatives out of 180 approvals," said DeBlasio. "What we need to do is respond to the negatives, try to respond to their comments and talk to them regarding their comments and see if we can resolve them or if they're unresolvable, come up with a rebuttal."

When this resolution period is over with, according to the IEEE rules and protocols, the Standards Committee has an obligation to the majority to move forward with the standard. After a period of trying to resolve the negatives, assuming it retains its affirmative rate of 75 percent or higher, P1547 will move forward to the IEEE standards board. With their approval, the draft document is approved and becomes an IEEE standard.

The Standards Coordinating Committee is targeting the IEEE Standards Board meeting in March of 2003 as the target date to have its final approval package into the standards board for that meeting.

A lot of IEEE projects are wanted by a large group of people but P1547 has been unique, according to Basso. "There's really been a groundswell from the bottom up of people who want to see this standard developed and out there. In the IEEE there's a lot of very focused and targeted activities and individuals. It's sometimes easier to write a standard when you're looking at a focused project, a targeted project. This is a systems standard. There are other systems standards of course, but this has definitely caught the public's eye as well as energy professionals and stakeholders," he said.

P1547 does have its skeptics and naysayers. "It's kind of a catch-22," said Basso. "They want to see it in operation and working before they accept it, but you can't get to that point until you are really using it and working with it. Some people say it's good enough the way it is, we have our way of doing it and you have your way of doing it and somebody else has their way of doing it. I think that's kind of old thinking. People are always looking for better faster more effective ways of doing things. This standard meets that bill. It's kind of a fast track of interconnecting."

Utility Pursues DG With Gusto

It seems that a utility would naturally drag its feet along the trail of distributed generation, but at least one leading utility is actively embracing distributed generation and the possibilities it holds for its customers and its business.

PPL is a diversified energy company with an electric utility with 1.2 million customers and a gas utility with a little over 100,000 customers, both in Pennsylvania. It owns SWEB, an electric distribution company in England with several million customers and has several ownership asset distribution companies in Latin America and Brazil. Finally, it has 14,000 megawatts of generation spread across the country.

PPL began its distributed generation program in June 2000 through PPL Energy Services. "We have power plants installed anywhere from 300 to 1,000 megawatts and the distributed generation group goes down to as small as 30 kilowatt Capstone units," said Steve Gabrielle, manager of PPL Energy Services.

PPL Energy Services was established in 1995 as both an energy services company and a mechanical contracting company which is made up of about 16 mechanical contracting businesses, according to Gabrielle. "In the last two to three years, the effort was made to include distributed generation as part of that group. We are a representative for FuelCell Energy and for Capstone Turbine. We've done various Caterpillar engine projects. Basically the Energy Services arm also is evolving into a distributed generation part of the company," said Gabrielle. "From our standpoint, obviously being a power generation company, the distributed generation is just a natural extension of what we do on a larger scale and just doing it on a smaller scale on customer properties."

Gabrielle said that the majority of the projects that PPL is looking at are combined heat and power projects. "It takes the strength that we have in the power side and also the mechanical contracting for the heat side of it. When you look at it, the customer is looking for reliability and savings and also we have the operating companies in place to design, install and in some cases own and operate these different projects on customers' properties."

Why would a utility want to be a DG provider? "From our standpoint distributed generation is something that we can offer that customers are asking for in the sense of savings and reliability and we see that as a benefits as a whole to the corporation, not taking away from the utility," said Gabrielle. "From the other standpoint, from the power generation side, we don't see distributed generation as ever replacing central generation, especially the large power plants. PPL owns about 14,000 megawatts of power plants (large generators), and distributed generation is really just a way of getting some the power when you can't get it there from the large site through the transmission lines to the source or the customer."

In addition, PPL doesn't want to be left behind as the industry evolves. "It's another beneficial package that we bring when customers are asking for it, not waiting for it to happen to us. Even through deregulation, we take the standpoint that we would want to set the trend. We see that there's a need out there for something like this and customers are asking for it, especially again reliability and savings," said Gabrielle. "So we'd rather be part of setting the trend and being part of that instead of watching to see what happens in the marketplace. We see it as definitely a compliment to the business, not taking away from business."

Providing distributed generation offers benefits to both customers and utilities, Gabrielle said. On the customer side, customers are looking for more stability. "Customers are looking for savings especially as the energy market is very volatile. They're looking for savings on their electric bill or savings on their energy bill and also predictability," said Gabrielle. "In today's market, where there's a lot of volatility and deregulation has kind of taken place, distributed generation offers more predictability to customers. The other aspect which is definitely gaining more steam is the green power aspects of fuel cells or microturbines using methane gas or Caterpillar engines using methane gas or solar projects even. There's definitely an environmental benefit that customers and states and the government see. PPL has always been very strong with their environmental belief and this also supports that in our view."

On the utility side, Gabrielle said that for PPL or any utility, a tremendous benefit is the strengthening of the grid. "We help strengthen the grid. We actually bring the power to the point where the customers are where they can't place central power generation stations anymore, yet there's still a growing demand for energy. It actually helps where there may be transmission constraints on the utility's grid -- PPL's or any other utility."

PPL's two direct relationships with distributed generation manufacturers are as a distributor for Capstone Microturbine for several years and also as a distributor and equity owner in FuelCell Energy. "Those are the only two that we directly have a relationship with a vendor. All the other relationships are purely more of an alliance," said Gabrielle. "We'll look at what's the best technology for the need that the customer has and we'll look at the best technology whatever that may be and bring that to the customer."

PPL has used its energy skills to good effect in implementing distributed generation. Some of its projects include a fuel cell project going on in Cape Cod, Massachusetts at a Coast Guard facility to address co-generation and reliability needs, two fuel cells going into a Starwood Sheraton Hotel in New Jersey to address co-generation, economic and reliability needs, and a fuel cell being put in Ocean County College in New Jersey for its co-generation and green power aspects, according to Gabrielle. PPL has a landfill project in Pennsylvania and some microturbines at a wastewater treatment plant in Allentown Pennsylvania. Finally, PPL has some proposals to install larger co-generation systems.

As for the future of its distributed generation program, PPL is optimistic. "We see it as a very positive future and a growing future in the sense that the volatility in the energy marketplace continues. People want predictable power prices," said Gabrielle. "There's definitely a drive for greener power and this definitely fits that. And PPL has set itself up well with a backbone of mechanical contracting companies that help support and grow the business through the mid-Atlantic and northeast corridor, which is where most of our business is."

As far as other utilities getting into the DG business, Gabrielle said, "I think we've already seen that some have tried and didn't succeed and some will try. We try to treat it as a customer-based technology independent solution, not trying to force fit any one technology into any customer and not necessarily focus in a one-niche market."

Texas Promotes Fuel Cells

When most people think of Texas, they think of oil. But with global warming, trouble in the Middle East, and fears that we're running out of fossil fuels, Texans are turning their eyes to a new energy source -- fuel cells.

However, fuel cells are caught between the need for more research and the development of mass manufacturing. This has led to an inability to fund either adequately. Private investment has not been forthcoming in significant amounts, and most fuel cell manufacturers lack sufficient unit sales to gain economies of scale.

According to the Texas State Energy Conservation Office (SECO), fuel cells could provide both public and private benefits, with their largest benefit being an improvement in air quality. Other benefits include energy security, improved power reliability, transmission and distribution relief, consumer savings, and economic development.

But SECO says these benefits cannot be realized until a series of hurdles are overcome. Foremost among these is the high cost of fuel cells. Additional challenges are the need for capital investment, the lack of harmonized codes and standards, various infrastructure concerns including regulatory issues, and the need for technical training and public education. SECO believes that resolution of these challenges will require the efforts of both the private and public sectors.

In order to rectify this situation, the Texas State Legislature passed House Bill 2845 in 2001, directing SECO to develop a statewide plan for accelerating the commercialization of fuel cells in Texas and to submit a report on this plan to the House Energy Resources and Senate Business and Commerce Committees no later than September 15, 2002. Specifically, SECO was instructed to "draw conclusions about the availability and efficacy of alternative mechanisms that might be created in cooperation with the private sector, utilities, and other agencies to accelerate the commercial availability and economic viability of fuel cells for use in this state."

The bill, sponsored by State Senator David Cain, is intended to make fuel cells more affordable for Texans according to Cain who says, "With rising gas prices, the California energy crisis and concerns about the environment, it's time to find some practical solutions to our energy problems. I believe fuel cells are a great way to do that. I believe fuel cells will not only become more affordable for Texas businesses, but they will become affordable for many Texas families, too."

Well, SECO has now completed its report and the results look promising. The report estimates that fuel cell manufacturers must be able to produce and sell 1,000 megawatts of generation capacity in Texas to achieve competitive pricing and industry self-sufficiency. This estimate compares to 87,000MW currently being generated in Texas.

However, to get to this number, the government of Texas must play a role by supporting research and development and "priming the pump" in the marketplace by funding demonstration projects and purchasing fuel cells as they become available. One way to prime the pump of the early market is for the state itself to use fuel cells in a wide variety of applications. SECO believes that fuel cells could provide heat and power for state facilities and backup power for core data systems. Portable applications could power remote highway signs or rest stops and provide emergency backup power for small-scale stationary applications.

In the past, Texas has funded some research projects but thus far has made no attempt to improve the market for fuel cells. Therefore, in its report, SECO makes a number of key recommendations to put Texas at the forefront of the fuel cell marketplace. These include creating a public/private partnership to encourage the commercialization of fuel cell technology and the growth of a fuel cell industry in Texas; adopting a goal of 1,000 MW of fuel cell-generated power in Texas by 2009; becoming an early adopter of fuel cell technology; purchasing fuel cell power through "off-take" utility contracts to help fuel cell owners secure financing for their equipment; developing and funding fuel cell demonstration projects; providing matching funds for federal grants; and amending or creating state laws, regulations and permits as needed to accommodate the use of fuel cells.

But SECO isn't the only one interested in pushing Texas ahead in the fuel cell race. While it was developing its strategic plan, others have been doing heavy lifting. The Texas Natural Resource Conservation Commission (TRNCC) formed the Texas Fuel Cell Partnership to conduct a 3 kW fuel cell technology demonstration project to power all the equipment in a Continuous Air Monitoring (CAM) Station.

Unocal, via funding through DCH Technology, the fuel cell manufacturer, is sponsoring the Houston project to further the commercialization and field-testing of fuel cell applications. Praxair, Inc. is providing the hydrogen fuel. The Port of Houston Authority is providing site management for the project and the Houston Advanced Research Center (HARC) is providing technical support.

HARC is a major player in trying to move Texas into the fuel cell future. It's a private research and development center which has organized a partnership with Entergy, Southern Company, Texaco Energy Systems, Technology Ventures and Walt Disney Imagineering Research & Development to test fuel cells.

According to HARC, the centerpiece of its current research activities is a large, multi-year project focusing on the application of proton exchange membrane (PEM) fuel cells with the objective of demonstrating the value of stationary, near-zero emission PEM units in both small and large-scale applications. Researchers are looking at issues including power quality and reliability, technology transfer and training and the development of long-term performance emissions data, says HARC.

Recently, HARC and Entergy successfully connected a 5-kilowatt PEM fuel cell system to the electric grid. The unit was manufactured by Plug Power and is believed to be the first residential size system in Texas connected to the grid using the state's interconnection codes.

Another major player is Fuel Cells Texas, a non-profit trade association representing the fuel cell industry in Texas. The founding members of Fuel Cells Texas include FuelCell Energy, Hunt Power, Methanex, Siemens Westinghouse Power Corporation, DuPont Fuel Cells, IdaTech, Plug Power, Air Liquide, UTC Fuel Cells, Ballard Power Systems and Shell Hydrogen. Fuel Cells Texas' stated mission is to accelerate the broad commercialization and deployment of fuel cells in the state of Texas through public education, policy alignment, and development of state-sponsored initiatives.

Through these efforts, Texas hopes that in the future instead of being thought of as the state of big oil, it will be thought of as the state of fuel cells.

South Africa Experiments With Solar

In July, Eskom, South Africa's state power utility, began operating South Africa's first solar dish-engine system at the Development Bank of Southern Africa (DBSA). The bank will make use of the power generated for a small percentage to its needs. The DBSA site was chosen for the project because it affords Eskom's technical staff easy access to the system during the research and assessment phase while at the same time introducing this technology to industry and the public.

The dish-stirling project is a part of Eskom's SABRE-Gen (South African Bulk Renewable Energy Generation) initiative, which aims to assess and demonstrate renewable energy generation options for application within South Africa. The dish-stirling project specifically is aimed at the assessment of the dish-stirling technology in order to quantify its applicability as a distributed generation option for Eskom, according to Dr. Louis van Heerden, technical manager for Eskom's distributed & renewable energy technologies group.

Solar dish-engine systems convert sunlight into electricity at higher efficiencies than any other solar technology and provide a renewable solar energy source which is abundant, safe, reliable and energy-efficient, according to Greg Tosen, general manager of research, development and demonstration for Eskom.

The major parts of the system are a dish and a power conversion unit, including a thermal receiver and generator. The dish is the primary solar component of the system, collecting energy from the sun. The resulting solar beam has all the power of the sunlight hitting the dish, but is concentrated in a small area so that it can be used more efficiently.

The first $300,000 parabolic dish system has been imported from Boeing and is 18 meters high made up of 82 curved mirrors. The glass mirrors reflect approximately 92 percent of the sunlight that hits them. The thermal receiver absorbs the concentrated beam, converts it into heat and transfers the heat to the generator, which produces electricity. The most common type of heat engine used in these solar systems is a Stirling engine.

"The dish-stirling system offers a potential stand-alone power generation unit that has the highest conversion efficiency measured to date for a non-lab solar generator. The systems are further modular and can be used to meet any demand size," said van Heerden. The pilot system is expensive when compared to diesel generation sets but Eskom envisages cost reductions when and if the system goes into mass production in South Africa.

Some wonder why a utility is exploring distributed generation technology. Eskom constantly assesses and evaluates new and promising technologies to find solutions that can be implemented with South Africa, van Heerden said. "The dish-stirling is one of these promising options, and it is Eskom's desire to quantify whether it can be cost effectively applied within South Africa."

Dr. Steve Lennon, Eskom's executive director of resources and strategy said this project complements Eskom's goal to contribute towards strengthening the country. "To achieve this, it is essential that we provide the unelectrified population with affordable energy in a sustainable manner. Environ-mental concerns such as the greenhouse effect, ozone depletion and acid rain are of paramount concern to Eskom, as we strive to achieve the correct balance between environmental quality and the provision of electricity.".

The system will be operated over the next year and assessed in terms of its technical performance and the O&M costs determined. "It will then be possible to calculate the economic and technical feasibility and determine if it can be applied by Eskom," said van Heerden.

According to van Heerden, as the system is operated, a host of research questions will be answered. "The project will also be working with the supplier to assess the feasibility of introducing local content into the system, as well as to quantify whether cost reductions can be achieved in this fashion. Decisions as to the technology's future will only be made upon answering the research questions."

Van Heerden said that so far the project has been very successful and a great learning experience. "We hope to be operating the system with very few problems for the next year and to be able to answer the required research questions and so-doing, move the technology forward."

Tech Brief: Unitized Regenerative Fuel Cells

Fuel cells have been touted as having many environmental, energy and economic benefits. Regenerative fuel cells have all those advantages with one extra -- they can run off their own byproducts.

Running on hydrogen and oxygen from the air, a fuel cell can create electricity without creating any undesirable emissions. The only byproduct is water, which is made up of the hydrogen and oxygen originally put into the system. If the fuel cell is designed to also operate in reverse as an electrolyzer, then some of the electricity generated by the system can be used to convert the water back into hydrogen and oxygen. This dual-function system is known as a reversible or unitized regenerative fuel cell (URFC).

The URFC is a closed-loop system with no materials wasted, added or discarded. Sounds ideal, right? Well, some other people thought so and are trying to pioneer this technology. In 1994, Livermore National Lab physicist Fred Mitlitsky developed a 50-watt prototype proton exchange membrane fuel cell modified to operate reversibly as a URFC. It used bifunctional electrodes (oxidation and reduction electrodes that reverse roles when switching from charge to discharge, as with a rechargeable battery) and cathode-feed electrolysis (water is fed from the hydrogen side of the cell). By November 1996, the prototype had operated for 1,700 ten-minute charge-discharge cycles, and degradation was less than a few percent at the highest current densities.

Proton Energy Systems, Regensys Technologies and Metallic Power are some of the companies who have built on Mitlitsky's efforts and are working to develop and commercialize regenerative fuel cell technologies.

Proton is developing its UNIGEN regenerative fuel cell system, which converts electricity to hydrogen and hydrogen back to electricity. Proton says that the UNIGEN systems are expected to be comparatively much less expensive than conventional batteries. In addition, its regenerative fuel cell technology can be used to provide energy storage capability which

continued on page 8

Company Profile: Clean Air Partners

Clean Air Partners, located in San Diego, California, was founded in 1991 by Dr. John Niels Beck, Craig Williams and Pete George to address the need for a cleaner and more environmentally friendly diesel generator. It's goal is to develop technologies that allow diesel generators to operate with the low emission benefits of natural gas while still having the efficiency, power, long life and low cost of compression ignition engines.

According to P.J. Jennings, a spokesperson for Clean Air Partners, core technologies and patents inherited from a precursor/sister company called BKM Engineering provided the core knowledge for Clean Air Partners. Clean Air Partners has introduced Dual-Fuel™ engines which operate simultaneously on both natural gas and diesel fuel. The majority of the fuel burned is natural gas. The diesel fuel acts as a pilot for combustion that ignites under heat caused by compression. Clean Air Partners says that for standard engines to be converted to Dual-Fuel, they are fitted with a natural gas fuel system with electronically controlled, multi-point sequential port injectors. A Dual-Fuel Electronic Control Unit is added to communicate with the existing Electronic Control Module. This combination allows for precise control of fuel metering and ignition timing.

Clean Air Partners says that its Dual-Fuel engines have lower operating costs; use low cost, domestic natural gas; provide emergency diesel fallback for safety; have greatly reduced emissions; have similar power to diesel equivalents; require fewer natural gas tanks; have an excellent long term reliability record; have similar heat rejection as diesel; are compatible with engine exhaust and compression brake systems; and are compatible with electronic fleet management and engine diagnostic tools.

Clean Air Partners, as a technology company, has 31 patents in the area of combustion technology, according to Jennings. "Commercialization of these technologies will directly benefit distributed generation by providing a new generation of engine products which are cleaner, more flexible, more cost effective and more reliable than present spark-ignited engine products. The challenge today is the proper development and commercialization of these technologies. Clean Air Partners is focused on this commercialization effort," said Jennings.

Jennings also said that in power generation, Clean Air Partners is unique in being able to guarantee the low emissions rate of 2.0gm/bhp-hr NOx. "This capability will move Dual-Fuel from the back burner of our industry to the front as customers become more aware of the potential inherent in highly-controlled engines using Dual-Fuel technology from Clean Air Partners. As an environmentally focused technology company we are very pleased to be manufacturing 3-way catalytic converters and SCR products. Our injector and controls expertise will allow us to improve these products and increase their effectiveness," she said.

In 2000, Clean Air Partners accepted venture capital financing. In 2001 Dan Kabel, formerly of GE, accepted the position of CEO at Clean Air Partners and began to position the company for growth. "Another thread to the growth story is the expansion of our commercialization effort into the Power Generation marketplace. Presently we can offer conversion of 3500B Series Caterpillar products to Dual-Fuel and we are working on expanding our offering to a greater variety of engine products," said Jennings. "Our latest products are in the Power Generation field with a Caterpillar 3500B Series engine conversion to Dual-Fuel. We can now convert the 3516B into a 1600kW Dual-Fuel engine at 85% substitution at full load using 5psi pipeline natural gas and guarantee NOx emissions not to exceed 2gm/bhp-hr. Through a recent acquisition, we now manufacture 3-way catalytic converters as well as Selective Catalytic Reduction systems using both 19% aqueous ammonia and urea agents."

Clean Air Partners has just begun with the commercialization of its technologies, Jennings said. "We have a lot of work left to do. The products that we plan to develop in the future all appear to have good market potential which should enable us to continue our growth for a few years to come," she said. "We cannot succeed alone and we are actively looking for strong partners worldwide for every aspect of our business from manufacturing to distribution. Our name Clean Air Partners is a reflection of our intent to grow our business worldwide through cooperation with key players in every aspect of the industries in which we are involved."

Tech Brief, continued from page 7

can be used with solar or wind in place of grid connections or to reinforce the grid. Proton adds that benefits include improving grid reliability through additional generation, reducing generation costs in isolated areas, and less pollution and impact than centralized electrical production.

Regenesys' energy storage system is based on flow battery technology. Electrical energy is converted into chemical potential energy by charging two liquid electrolyte solutions and then releasing the stored energy when it is discharged. Regenesys is implementing its technology in a large-scale demonstration plant near Columbus Air Force Base in Mississippi. The project, which supports the Tennessee Valley Authority, is being designed to store up to 120 MWh of energy. After being fully charged, it can provide power for 10 hours or more.

URFCs can also be non-hydrogen fuel cells. Metallic Power has a zinc-air fuel cell that uses zinc as fuel in the form of small pellets. The zinc is consumed and releases electrons to drive a load, and oxygen from circulating air accepts electrons from the load and the overall chemical reaction produces zinc oxide. Instead of being discarded, the zinc fuel in a zinc-air fuel cell can be regenerated. Metallic says that the additional piece of its regenerative fuel cell is an electrolyzer. The electrolyzer uses electricity from the fuel cell to convert the product from the oxide reaction back into new fuel. One of the significant accomplishments that Metallic says that its technology offers is the development of a practical regeneration process. Metallic says that in a backup power application, the fuel cell will discharge to provide power for critical processes when grid power fails. When grid power returns, an integrated regenerator can recycle the spent fuel into fresh fuel. The process can repeat indefinitely, similar to a lead-acid battery and battery charger, but without the problems.

Distributed Generation In The News

Avista Labs and Airgas In Hydrogen Agreement

Avista Labs and Airgas, Inc. have announced an agreement for Airgas to offer a hydrogen fuel supply to Avista Labs' commercial and industrial fuel cell customers. As part of the agreement, Airgas will also provide Avista Labs' customers with services related to fuel supply, including site preparation and installation, monitoring and fuel replenishment, and safety consultation regarding the storage and use of hydrogen fuel. The agreement, extending through 2005, calls for Avista Labs and Airgas to work together to further develop the market for hydrogen-powered fuel cells in the United States. Airgas' national network includes nearly 800 locations, including 25 facilities currently filling hydrogen cylinders that will be used by Avista Labs fuel cells. The company also provides a complete line of specialty gas equipment.

FCT Receives $700K in Demonstration Contracts

Fuel Cell Technologies (FCT) has received 5 purchase contracts worth a total of $700,000. The University of Alaska at Fairbanks has contracted to purchase an FCT 5 kilowatt solid oxide fuel cell (SOFC) unit that will run on natural gas and undergo testing of its combined heat and power capacity for arctic conditions. The University plans to test the performance and reliability of the system and to later use the FCT unit to provide electricity and heat for space heating and hot water to part of the University.

Another recent contract also came from Alaska. The Alaska Support Office in Anchorage has contracted with FCT for a 5 kW SOFC system for delivery to the National Park Service for installation at Exit Glacier, Kenai Fjords National Park, Alaska. The Exit Glacier unit will operate on propane.

The Department of Defense Fuel Cell Test and Evaluation Center has purchased and will install and test FCT's 5 KW combined heat and power SOFC system. This program will be significant in satisfying a number of organizations as to the viability and reliability of FCT units. FCT has also started work with Ford on a fuel cell project that tests the capability of the company's 5 kW SOFC unit.

Navy Deploys Solar Electric System

Navy Region Southwest announced that it has deployed the largest federal solar photovoltaic system in the nation. This system is a unique solar electric carport at Naval Base Coronado in San Diego, which makes innovative use of existing parking space. The installation is comprised of two contiguous solar arrays, covering a half-mile long parking structure that serves US Navy personnel. The 750 kW solar electric system was implemented as part of an Energy Savings Performance Contract (ESPC) project developed by NORESCO of Westborough, MA. The photovoltaic system was designed, manufactured and installed by PowerLight Corporation of Berkeley, CA. This photovoltaic system will produce approximately 1,244,000 kWh per year and is expected to save over $228,000 in annual operating costs by avoiding purchases of expensive peak electricity.

Fuel Cell Installed Under NJ Clean Energy Program

The first fuel cell in New Jersey installed under the Board of Public Utilities' (BPU) statewide initiative to promote the use of clean and renewable energy technologies was formally dedicated at a Merck & Co., Inc. facility. BPU President Jeanne M. Fox and NUI Elizabethtown Gas President Victor A. Fortkiewicz presented a $710,000 rebate check to Lawrence J. Naldi, plant manager of Merck's Rahway/Linden site, under the New Jersey Clean Energy Program, which rewards businesses in the state that install new energy generating equipment utilizing alternative technologies. Merck is also receiving a $200,000 rebate from the U.S. Department of Defense under an alternative technology program sponsored by the federal government. The rebates will help offset Merck's investment in fuel cell technology. The fuel cell installed at Merck is a 200-kilowatt unit manufactured by UTC Fuel Cells.

Tecogen Approved In NY

Tecogen Inc. announced that its 60 kW and 75 kW natural-gas powered cogeneration systems have been added to New York State's "Type Tested and Approved" list of equipment. This list includes all equipment that currently meets the state's standards governing interconnections between non-utility-owned distributed generation and the utility's distribution grid. In NY, distributed generation refers to small-scale power-generating technologies, such as Tecogen's, that are located at the end- user's site and interconnect with a utility's power distribution grid. In order for a DG customer to set up their on-site system, certain interconnection and operational requirements must be satisfied before the customer is allowed to connect to the grid.

GM to Market Fuel Cell in 2005

General Motors Corp. said it plans to begin selling in 2005 a fixed-site fuel cell that generates electricity from hydrogen and atmospheric oxygen. GM's target customers for the fuel cell will include industrial sites that require steady power supplies, such as semiconductor factories and data centers. The 75kW fuel cell will consume hydrogen directly, without using gasoline. Ongoing improvements are expected to bring the cost down to US$500 per kilowatt, one-thirteenth current levels. GM aims to bring that figure down to US$50 by 2010 when it plans to debut fuel-cell-powered vehicles. Test runs in the U.S. will start in 2003, and the company also hopes to find a maintenance partner. GM estimates the market for electric power equipment for semiconductor plants at $508 million, and it will seek to get a piece of that market as factory operators need to replace diesel generators.

Capstone And UTC Partner

Capstone and UTC Power announced they have entered into a strategic alliance. The strategic alliance between UTC and Capstone is a long-term agreement to integrate, sell and service microturbine-based combined heat and power (CHP) solutions for commercial buildings. UTC and Capstone intend to build on key product, technology and channel strengths of the companies, including those of UTC's Carrier Corp. The agreement covers North America and most of Europe. As part of the alliance agreement, UTC has committed to purchase a 4.9 percent stake in Capstone.

Financial Happenings

Plug Power and **H Power** announced that they have entered into a definitive merger agreement pursuant to which Plug Power would acquire H Power in a stock-for-stock exchange valued at approximately $50.7 million. Under the terms of the agreement, unanimously approved by the Board of Directors of each company, the exchange ratio is initially set at approximately eight-tenths of a share of Plug Power for each H Power share. Based on this initial exchange ratio, H Power shareholders would receive Plug Power common shares equaling approximately $4.70 per share for each H Power share. Currently, it is expected that H Power shareholders will receive $50.7 million of value and will own between approximately 13.3% and 15.8% of the Plug Power shares outstanding after the closing. After closing, Plug Power plans to work quickly to streamline the business and eliminate redundant operations, leading to an expected ongoing cash consumption rate of $40 to $45 million annually. As part of the post-closing integration of the combined business, it is anticipated that all operations will be consolidated into Plug Power's headquarters, located in Latham, N.Y. Certain of H Power's distribution and partnership agreements, including that with Energy Co-Opportunity, Inc. and its affiliates, will be terminated upon closing. The combined entity intends to serve a worldwide customer base through its existing exclusive distribution agreements with GE Fuel Cell Systems and DTE Energy Technologies. Plug Power expects that it will have approximately $90 million in cash at the closing date, which should be sufficient, after integration costs, to fund operations into 2005. The agreement requires approval by the shareholders of both companies. The transaction is subject to clearance under the Hart-Scott-Rodino Antitrust Improvements Act and other customary closing conditions. The transaction is expected to close no later than the first quarter of 2003.

AstroPower reported financial results for the third quarter ended September 30, 2002. For the quarter ended September 30, 2002, total revenues were a record $23.0 million, an increase of 25.0% from the third quarter of 2001. Product revenues for the three months ended September 30, 2002 were a record $22.5 million, an increase of 26.5% from the three months ended September 30, 2001. For the three months ended September 30, 2002, net income was $834,000 or $0.04 per share on a diluted basis on 22.7 million weighted average shares outstanding, as compared to $1.5 million or $0.06 per share on a diluted basis on 23.4 million weighted average shares in the year-earlier period. For the nine months ended September 30, 2002, total revenues were $64.1 million, an increase of 31.5% from the similar period in 2001. Product revenue for the nine month ended September 30, 2002 were $63.0 million, an increase of 34.9% from the similar period in 2001.

Hydrogenics announced its financial results for the third quarter 2002. All results are reported in U.S. dollars. Hydrogenics' third quarter 2002 revenues increased 80 percent to $4.4 million, compared with $2.5 million for third quarter 2001. Net loss for the third quarter 2002 was $7.0 million, or $0.14 per share, compared with a net income of $0.3 million, or $0.01 per share, for the third quarter 2001. Gross profit for the third quarter 2002 was 34 percent of revenues, or $1.5 million, compared with 32 percent of revenues, or $0.8 million, for the comparable period in 2001. Excluding $3.8 million in non-cash amortization associated primarily with the intellectual property (IP) acquired in the GM transaction of October 16, 2001, net loss for the third quarter 2002 was $3.2 million, or $0.06 per share. There was no comparable amortization of IP in the third quarter 2001. Foreign currency losses reduced earnings by $1.4 million, or $0.03 per share, for the third quarter 2002 compared with a foreign currency gain of $1.2 million, or $0.03 per share, for the third quarter 2001.

Proton Energy Systems announced results for the third quarter ended September 30, 2002. Revenues were $1,589,000 compared to revenues of $364,000 for the same period last year. Net loss attributable to common shareholders for the third quarter of 2002 was $4,287,000 or $0.13 per share compared to $1,567,000 or $0.05 per share for the comparable 2001 period. The net loss per share is due to an increase in the Company's cost of production related to accrued HOGEN 20/40 service costs, research and development activities relating to PEM technology, and a decrease in interest income resulting from decreased cash and marketable securities balances as well as lower average interest rates. Revenues for the nine months ended September 30, 2002 were $3,844,000 compared to revenues of $1,158,000 for the same period last year. Net loss attributable to common shareholders for the first nine months of 2002 was $9,630,000 or $0.29 per share compared to $3,002,000 or $0.09 per share for the comparable 2001 period. The net loss per share is due to an increase in the Company's cost of production related to accrued HOGEN 20/40 service costs, research and development activities relating to PEM technology, and a decrease in interest income resulting from decreased cash and marketable securities balances as well as lower average interest rates.

Capstone Turbine reported revenue of $3.9 million for the quarter ended September 30, 2002, compared with revenue of $3.3 million for the third quarter of 2001. For the third quarter of 2002, Capstone's net loss was $10.8 million, or ($0.14) per share, compared to a net loss of $12.5 million, or ($0.16) per share, in the third quarter of 2001. The decrease in net loss was primarily attributable to lower operating costs in the current period. Gross loss in the third quarter of 2002 was $2.4 million, compared with $2.1 million in the same period of 2001. The increase in gross loss was primarily attributable to lower production volumes. Research and development expenses decreased to $1.9 million, compared with $2.5 million in the third quarter of 2001. R&D expenses are reported net of contract offsets such as the U.S. Department of Energy advanced microturbine program. Selling, general and administrative expenses decreased to $7.1 million, compared with $9.2 million in the third quarter of 2001. Cash utilization was $10.8 million in the third quarter of 2002, substantially less than the $18.7 million used in the third quarter of last year.

ANALYST'S CORNER

Ballard Power Systems was maintained "hold" by analyst Chris Kwan at TD Newcrest. The 12-month target price was raised to $12.00 from $7.50 per share.

FuelCell Energy was rated new "buy" in new coverage by analyst Walter V Nasdeo at Ardour Capital. The 12-month target price is $9.50 per share.

Plug Power was rated new "sell" in new coverage by analyst Puneet Sanan at Fano Securities LLC.