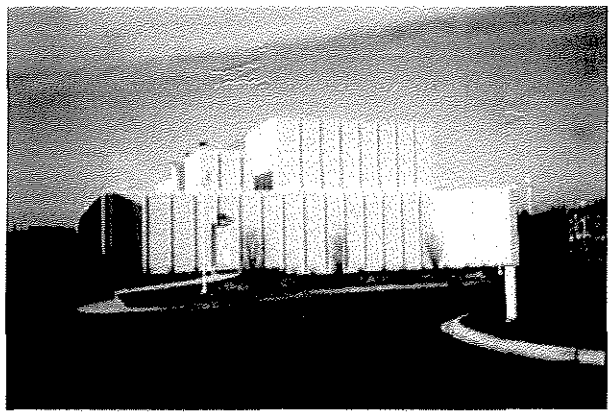
Ballard Engineering Case Studies

(Healthcare)



Control Operations Desk in Control Room

Northwest Community Hospital, a growing suburban hospital, has a state of the art Central Utility Plant that was designed and built by Ballard Engineering. This plant received an ASHRAE Excellence in Engineering Award in 1998 for its innovative energy saving design. The Central Utility Plant consists of a 3.5 MW cogeneration facility, a high-pressure steam plant, and a chilled water plant. By centralizing all the utilities in one location, the hospital accrues significant energy savings as well as improved maintenance efficiency.

The cogeneration plant provides electricity for the hospital as well as 6000 lbs.//hr of high-pressure steam. The boiler system has heat recovery on the blowdown and stack economizers to further increase the efficiency. The chillers are a combination of high efficiency centrifugal chillers and an absorption chiller that uses the steam from the engine heat recovery.

Additional Material

- **Northwest Community Hospital Cover Sheet (http://www.ballardcos.com/userfiles/file/nwch%20cover.pdf)**
- **Northwest Community Hospital Article in *"Distributed Energy"* (http://www.ballardcos.com/userfiles/file/NCH_Article.pdf)**
- **Northwest Community Hospital Article in *"Midwest CHP Application Center"* (http://www.ballardcos.com/userfiles/file/chp%20nwch.pdf)**

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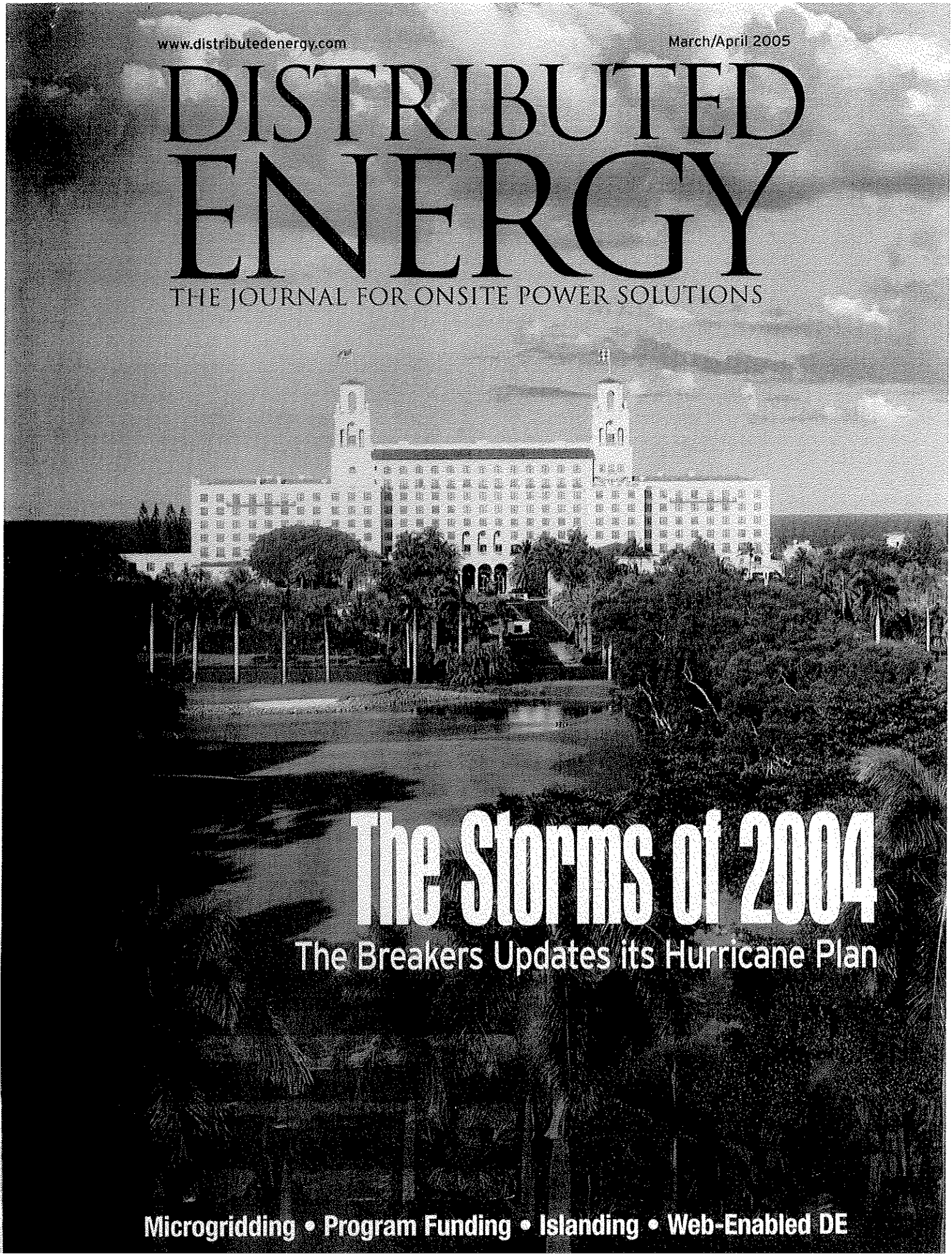
THE JOURNAL FOR ONSITE POWER SOLUTIONS



The Storms of 2004

The Breakers Updates its Hurricane Plan

Microgridding • Program Funding • Islanding • Web-Enabled DE

Miracle Cure for Utility-Rate Headaches

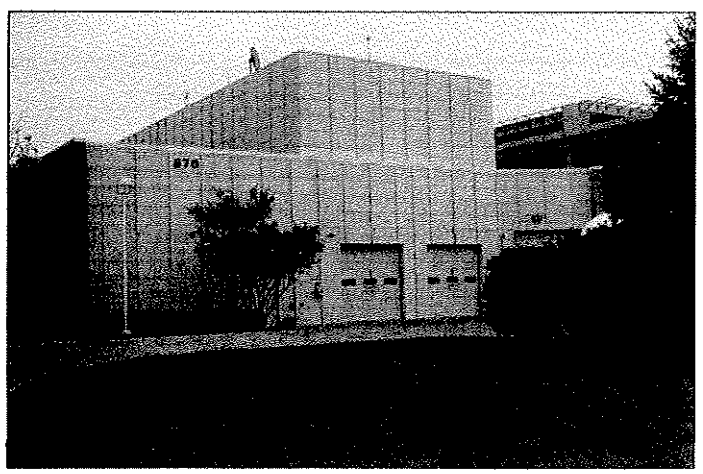
Sprawling health facility saves millions with CHP trigeneration.

BY DAVID ENGLE

Fixed or sluggish revenues, rising costs, slashed budgets. Not exactly an unheard-of scenario, and, perhaps surprisingly, sometimes occurring simultaneously with growth and expansion. More than a few hospital plant-and-facilities departments in the 1990s were probably experiencing this kind of chronic—well, sort of squeezing—pain "right here in my budget." As Charlie Stevenson, head of the plant operations at Northwest Community Hospital (NCH) near Chicago, IL, describes it, "My predicament here is that, year after year, our income keeps going down because insurance reimbursements are being reduced"; hence, the only real way he can stay within cost parameters, as he labors to energize and climate control a 563-bed, million-square-foot facility, is with judicious investments "in operational cost savings."

Above all, the critical triage patient here, he explains, is his utility meter. NCH's gas and electric bills typically account for better than 50% of the annual operations budget (currently $4.3 million). Of that figure, natural gas is now taking $1.7 million, and electricity $600,000. "Those are my big dollars," Stevenson says, and thus he routinely pulls out the scalpel to pare them down. Conserving energy is a key. So too is wringing out maximum efficiency from his fuel and energy expenditures: "That's the big bang for my dollar."

For the past eight years, the biggest bang by far has come from onsite combined cooling, heating, and power (CCHP). Commissioned in 1997, the integrated system paid for itself in the first four years. Since 2001 it's all been gravy. In terms of net impact, for the two most recent accounting periods, Stevenson's department has saved an estimated $600,000 to $700,000 respectively on total energy costs (i.e., reduced electric billings and multiplied heating efficiency). Extend these figures over the equipment investment's full lifespan of roughly two decades and multiple millions of dollars will be lopped off from assorted utility billings. And, given the income pressures Stevenson describes, it's money the hospital urgently needs to pay for repairs that otherwise might be hard to do.



Assessing Options

Back in 1995, NCH's administrators undertook a basic risk assessment and building

survey of the hospital's plant. They were contemplating a $112 million capital investment for expansion. Would the campus's aging stock of boilers, chillers, and piping be able to support more development? And what were its reliability, energy efficiency, and maintainability?

Alas, bad news. The engineering prognosis wasn't good. Over the years, urban sprawl (hospital style) had tacked on new wings and additions piecemeal. Mismatched and scatter-shot heating and cooling elements were "over-burdened, undersized, and environmentally unfriendly," a report stated. Steam loops were incompatible; chilled-water hydronic flows were problematic; and the equipment rooms lacked space for more hardware—all while the community's demand for health care services continued to grow.

The engineers' recommendation: Basically, NCH's entire mechanical plant badly needed an overhaul.

Administrators sought proposals on what to do, and received a half-dozen replies. Three alternatives emerged:

- Option one was to remain decentralized and try to swap out and upgrade the old equipment in place.
- Option two would entail buying state-of-the-art boilers, chillers, and pumps, and centralizing them within a new plant building; this approach would shorten maintenance response times and achieve other efficiencies.
- Option three took this centralization concept one step further, as Stevenson recalls. "We said, 'Well, if we're going to centralize it all, doesn't it make sense to do a CHP—and generate our own electricity, to reduce our demand load, and then capture the heat of those engines and utilize all that for heating and/or cooling?'"

Smart logic, and a formal assessment easily confirmed that this would be tantalizingly cost-effective and potentially very remunerative. By contrast, taking the more conservative and seemingly affordable approach of upgrading boilers and chillers in place turned out to be surprisingly costlier. Far better—both for meeting long-term growth and solving immediate infrastructure shortcomings—would be to "start again from scratch" by designing high-efficiency CCHP, all under one roof.

One of the six engineering proposals actually laid out this scenario in some detail, including making the attractive business case for a cogen investment; this was the design-build plan offered by Ballard Engineering Inc. of Rockford, IL. Ballard also noted its requisite experience: onsite power installations (as of today, a combined total of 80 MW developed, in the 1- to 10-MW range). The firm's prospectus also documented for NCH some of the hospital's actual utility usage data of recent years. Clearly, an onsite power plant would drastically cut energy billings; the equipment payback would arrive in about three years. "Bottom line was," recalls Stevenson, "the incremental cost to add three engines to our already centralized plant was going to be just $2,057,000. That would give us a payback of 2.85 years, and, from our perspective, you just have to do that."

Sizing the Plant

How big should this new power train be? Ballard partner Joe Sinclair advised his client that the generators should approximate the daily peak load, as the driver. "Electrical rates here are fairly high," he says, referring to regulated utility Commonwealth Edison (ComEd), serving Chicago. Sinclair calculates current average peak energy cost at about $0.12 to $0.14 per kilowatt-hour, when factoring in unusually hefty demand charges (aka "rate 18"). Even eight years ago, when Sinclair did the original analysis, about 70% of the hospital's utility costs were for electricity, and the balance for thermal.

By comparison, in many other successful CHP projects nationwide, it's perhaps more typical that the engine sizing be based on the heat load and especially natural gas usage, the generators being sized and run to provide the necessary heat output relying on engine exhaust—thus multiplying the energy efficiency. Here, though, Ballard's strategy differed by aiming directly at electricity peak load shaving. Sinclair advised knocking down ComEd's extremely high rate 18. In 1997 this was the critical driver so Ballard specified a configuration that would meet most of the hospital's load for nine hours daily.

Next, as for specific gensets, Ballard recommended three 1.1-MW Waukesha VHP rich-burn engines, which would yield a total megawattage of 3.45. Other drivetrains were also carefully considered, with their respective pros and cons compared to reliability, anticipated maintenance costs, first-time cost, operational profiles, and control issues. As Stevenson recalls, the Waukeshas looked particularly good for their initial price and low maintenance, offering a

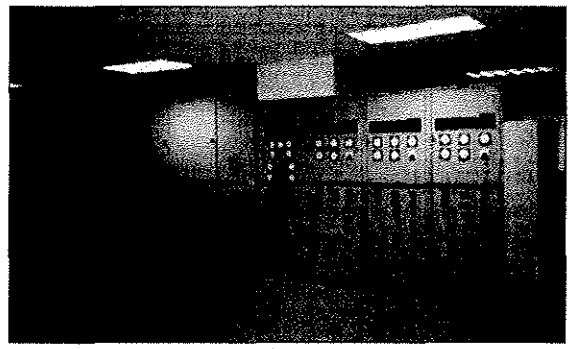
strong prospect of rapid payback and long-term savings.

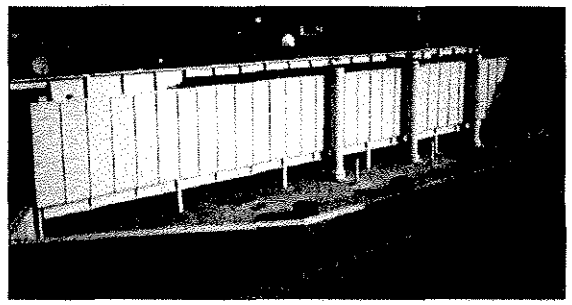
And, indeed, after nearly a decade in service, those Waukeshas and the initial expectations about them have panned out nicely. Payback on the three units came in 2001. The system has been delivering pure savings ever since. Avoided costs naturally fluctuate year to year, but, to take 2003 as an example, NCH'S electric bill savings alone, attributed to onsite power, came in at $563,000. This figure accurately reflects, says Stevenson, "all costs," including "fuel, maintenance, expenses from breakdowns, replacement parts, and repair." A midsize-figure net is now "the bottom-line saving to running those engines." (More details follow.)

Boilers and Chillers

Don't forget, either, that other heat-recovery benefits come on top of this. The Waukeshas each exhaust around 1,600°F, which is captured by Cain heat-recovery units for reduction to between 700°F and 800°F, notes Stevenson. Resulting output is translated into domestic hot water and steam, at the rate of around 2,000 Btu/kW of electricity produced, or around 2,000 pounds of heat per hour. Those figures reflect recent years' performances, but actual operation can vary considerably year to year, depending on a cost-optimization strategy, which is pegged to the often volatile price of natural gas purchased for heating.

On that score, also installed in 1997 were three brand-new, high-efficiency natural gas–fired Cleaverbrook boilers, capable of producing 600 bhp apiece, and supplementing the CHP heat as required. Steam is maintained at 150 psi, yielding 6,000 lb/hr at this pressure. To increase heat efficiency even more, the Cleaverbrooks are equipped with heat recovery on the blowdown, and with stack economizers. All comfort heating, hot water, and even steam for the autoclaves and sterilizers is thus supplied and piped from this central plant.

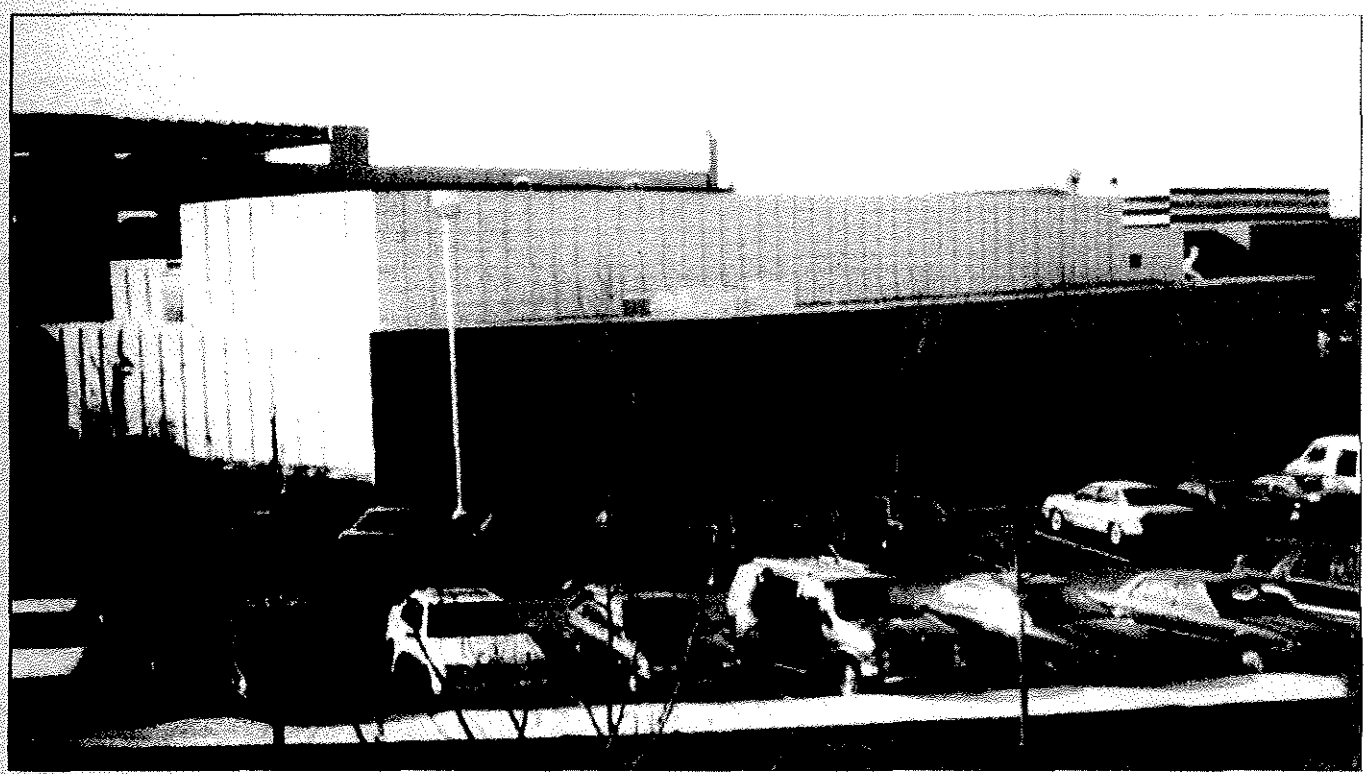




When the need for comfort cooling arrives, two high-efficiency, 1,300-ton centrifugal York chillers carry the main burden. They're supplemented by an 850-ton York absorption chiller (which is heat fired by the "free" generator exhaust during the summer). For light cooling loads, says Stevenson, "There's what we call our baby chiller," a 240-ton York that's also exhaust heat–fired. Again, all are centralized and balanced for differential pressure controls.

Full Recovery With Healthy ROI

Totaling up costs and benefits of this vastly more efficient and environmentally friendly equipment inventory, the combined outlay in 1997 came to about $8 million. Another $2.5 million was incurred for its installation and for construction of the new central plant building to house it all. Ample extra space was included to provide for future expansion. Removal and retirement of the old boilers and chillers opened up even more space for other uses. Add to these expenses another $1.5 million for landscaping, annual maintenance, and plumbing for the hospital's new chemical and medical gas systems. Total investment: $12 million. And again, the portion of that spent on cogen machinery—proceeds from which are pay-



ing for the entire freight here—came to just over $2 million.

Moreover, energy projects often receive public subsidies, and in this case, a generous low-interest loan came in from the State of Illinois, underwriting the Waukeshas.

As this financing began to gel, what Sinclair remembers best was the look of delight from a hospital's accountant, upon realizing what the power plant would mean. "The beauty of this CHP to him," Sinclair recalls, "was not simply the return for the cogen system, but the fact that these savings would pay for the central energy plant too [i.e., for the entire $12 million centralization and mechanical upgrade]. "The whole theme of it was, basically, 'We can get this built, we can get all the equipment in it—and it will pay for itself,' " all thanks to cogeneration. The accountant was overjoyed because the hospital had already committed itself to the $112 million campus expansion before it had fully appreciated the inadequacy of the heating and cooling infrastructure, for which, Sinclair says, "They hadn't really allocated funds." Thus, the cogen plant savings "provided them a nice way out."

Moreover, one year after the plant's commissioning, NCH received an ASHRAE Excellence in Engineering Award for its innovative energy-saving investment. Notable from a technical standpoint was the fact that this was true co- or tri-generation, using well-integrated, high-efficiency components assembled from the ground up, making the gains even more dramatic.

Strategies to Maximize Benefit

As had been planned from the outset, the Waukeshas began running 9 a.m. to 6 p.m. daily for peak shaving, and have largely continued that schedule ever since. At day's end Stevenson idles them, and ComEd power takes over. During the winter months the engines' nine-hour work shift adds up to 98%-plus of the daily electrical load. Summer heat increases the load considerably so that the Waukesha's, at full throttle, can contribute about 72%.

What's the most cost-effective energy delivery point, you may ask? There's a tradeoff here, in that a fourth engine would enable 100% daytime load-following, but idling during winter and nighttime would increase, too. Thus, as Stevenson explains, "You have to find the right balance. You don't want to buy too much generating capacity so that the payback isn't there."

After-hours rates from ComEd are actually quite low, at only $0.02 or $0.03 per kilowatt, Sinclair points out. During the daytime this jumps a few cents higher at the peak, but is still far from exorbitant. The real "killer," in this particular rate structure, is the per-kilowatt demand charge. It's calculated by taking the average of the three highest-demand excursions during a billing period, then multiplying this by either $13 or $14, depending on the season. Tacking this surcharge on to the base rate makes ComEd's effective hourly rate more like $0.12 or $0.14 per kilowatt (of which the actual energy charge is only about $0.52). Incidentally, utilities argue that the huge demand charge is justified by the expense in having to maintain a ready reserve of power on demand. From a customer standpoint, though, gripes Stevenson, "It's almost like a penalty."

At any rate, compared to $0.12 or $0.14, NCH's in-house power production cost comes to about $0.10 per kilowatt; and again, that's including fuel, maintenance, hardware, etc.

How many thousands of dollars does a few cents' differential add up to in savings? Actually, Sinclair is able to track usage precisely, in real time, via Ballard's SCADA (for supervisory control and data acquisition) serial connection. Incremental shifts in load can be flagged; and making appropriate,

timely adjustments results in bigger savings. So, says Sinclair, "It pays to keep close watch" on your power generators via SCADA (which has been widely used by utilities and power managers for decades).

Also, to share this monitoring benefit with NCH, Ballard installed graphical monitoring tools there. Stevenson's operators "can pull up on the displays the actual loading that the system took care of the previous day, right up to the hour," notes Sinclair. Assorted other logs are accessible, as is real-time monitoring of machine temperatures, pressures, and assorted metrics.

Equipment Care and Feeding

Daily operation of the three generators, for long hours, year after year, demands unusually good regular maintenance, Sinclair emphasizes. This may actually go well beyond what one might be used to from experiences with less-critical systems. At NCH the highly specialized task of machine health care has been outsourced from day one. Stevenson and Sinclair alike recommend this approach, both for quality results and the fact that it will probably be cheaper and more efficient. Considering the almost punitive impact of downtime and the resulting demand charges, the money you might spend for top-flight maintenance is well worth it. Stevenson even suggests obtaining a contractual guarantee ensuring timely repair response.

Waukesha's local vendor, Charles Equipment Co., provides NCH's preventive maintenance and all other servicing. Charles' techs visit at least weekly for inspections and testing. Billings vary year to year, depending on operational hours logged and whether a top-end or major overhaul is required. (Ballard initially assisted Stevenson in doing an extended 10-year estimate for these expenses.) In 2003, NCH's maintenance tab came to around $50,000, but in 2004 that figure doubled, due to the need for two costly overhauls.

On that score, note this: Breakdowns happen! Despite the very best care, ailments come, and eventually all engines conk out. Human error also intervenes. In 2004, for instance, one of the Waukeshas threw a piston, reportedly because the operator hadn't followed a prescribed shutdown procedure. The machine was severely damaged, and, due to the mistake, its five-year extended warranty was invalidated. Recovery from this loss took about 21 days (a reasonable turnaround time for this kind of event) and impacted Stevenson's budget to the tune of tens of thousands of dollars, not to mention the expense of reverting to peak-demand power rates.

Apart from that one human failing, however, Stevenson reports that the Waukeshas have proven very reliable. He advises that, when budgeting for upkeep, one should calculate the cost of shutting down for occasional overhauls, and also for an unscheduled breakdown or two. In sizing the system in the first place, consider carefully the value of having reserve power, both to accommodate future load growth and to provide a backup when a unit goes offline. Similar estimates of projected downtime should be figured into your negotiation for purchased power. And, lastly, don't neglect operator training and oversight.

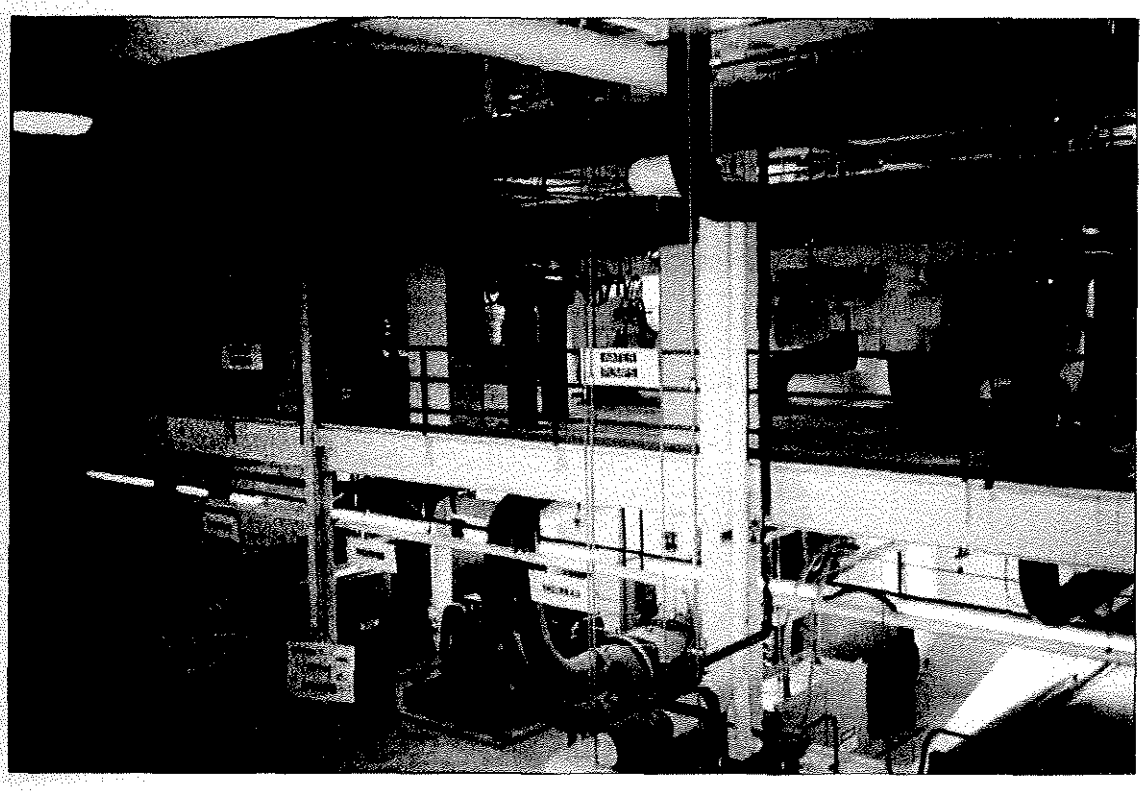
Sinclair characterizes this power train, CHP, and its maintainability as "a very sophisticated system, in that it is standalone. It almost operates itself. It has its own diagnostics. All the operator really has to do is basically check gauges and computer readings." As for the overall supervision, all that's needed is for someone "to make sure that somebody at least looks after the system to see it is still running and the 'roof is still on.' "

Fourth Unit on the Way

After several years of tracking load growth, and in light of the rate 18 surcharges and assorted power reliability concerns, Stevenson and NCH have opted to purchase yet another generator, for a commissioning date in 2005. This fourth Waukesha will thus pick up some of the hospital's previously unserved building loads and will also help balance other loads (which, again, have been growing). Adding another 1.1 MW virtually ensures that the hospital can either eliminate outright or greatly curtail its remaining demand charges, at least apart from summer months. Matching virtually 100% of daytime loads, at times, there will also be some reserve left for future growth.

With this quartet of megawattage in place, NCH will attain energy self-sufficiency. And, whenever the grid goes down some evenings, the idling Waukeshas will power up automatically: The system now has sufficient redundancy for full standalone capability.

Better still, the new 2005 model Waukesha is a prototype design boasting 20% higher efficiency. NCH negotiated a sweet deal to serve as a pre-production test site for the engine maker, to run the new machine 24/7 for a full year, with the supplier footing much of the fuel bill. After



the field trial ends, Waukesha Co. will install a permanent high-efficiency version. Simple payback is projected in five years, and the amortized depreciation method will shorten this to three.

Bottom-Line Savings

Remember, too, that in NCH's pre-generator era, the facility department was forking over about 70% of its utility budget for purchased power and 30% for natural gas. Today those proportions are pretty much reversed. However, the real material difference comes in the fact that—whereas before millions of therms of gas were only heating water—today it's also firing 4.5 MW of energy. This output is sufficient to power virtually all of the daytime peak load for this million-square-foot facility. Total net budgetary impact varies year to year (engine-running being sensitive to fuel price). A figure noted above, $563,000, illustrates electricity bill savings for 2003 alone. However, notes Stevenson, add to this a realistic valuation of the assorted heat energy gains—such as from the exhaust heat–fired chiller and the more efficient CHP boiler output, etc., and the impressive figure easily increases by another $100,000. In terms of paying back the $12 million investment in 1997, the hospital is now probably beyond the halfway point, and Stevenson expects full cost recovery by 2010.

Fuel prices make or break the payback for cogen and dictate operation. Matters here suddenly looked bleak in 2001, when NCH's per-therm costs rocketed up to $1.10. Once-rosy expectation vanished. Nevertheless, the administrators opted to keep the power running, despite the marginal benefit, and focused on better purchasing. NCH hadn't been particularly adept here, but Stevenson (promoted to head of the plant department that year) began researching markets and shopping wholesale. Figuring that the 2001 price leap was temporary, he signed a cautious one-year commitment for gas at a much more affordable $0.55 per therm. When this expired, he determined that prices were probably bottomed out, and signed a three-year future commitment for delivery at $0.45. This is well below the current market. "We made out OK on that deal," Stevenson says with some satisfaction. It pays to study market forecasts, he says, then negotiate aggressively when you can.

NCH's glowing success with power overall, despite one or two snafus, has spurred confidence in developing new energy projects. There's that new experimental Waukesha test-drive coming in 2005, and Stevenson is also exploring a relatively novel technique for using cooling-tower water to supply off-season cooling indoors. From autumn until spring, indoor chilling loads are light, in the 100- to 260-ton range. During these times, Stevenson wants to see how much he can gain by using free, "pre-cooled" water residing in the water tower outside, for his supply side, relying less on the two York chillers.

NCH senior execs, he adds, "continue to support me in my effort to create an infrastructure that's reliable, that's state-of-the-art, and that's essentially giving us some cost savings" through leaner operations, new technologies, or staffing changes. Stevenson feels fortunate that NCH's leadership expresses a strong commitment to facility department needs. "Not all health care organizations are as healthy as we are," he observes. "Not all of them can say, 'We're willing to spend $12 or $14 million on a central utility plant.'" Even if the payback numbers do make sense, "That's a big expense," he says, "but, fortunately, we were able to do that." DE

La Mesa, CA–based writer David Engle *specializes in construction and energy topics.*

MIDWEST CHP APPLICATION CENTER

DESIGNED AND BUILT BY

Ballard

CHP Application

Northwest Community Hospital 3.45 MW CHP Application

Fact Sheet

In September of 1997, a 3.45 megawatt Cooling, Heating, and Power (CHP) system was placed into operation by Ballard Engineering for Northwest Community Hospital (NCH) of Arlington Heights, Illinois. The CHP system was part of a new 20,612 sq. ft. Central Utility Plant that provided the 750,000 sq. ft. health care facility with cooling, heating and power. The new plant contained the 3.45 MW CHP system, a high-pressure the steam plant, and a chilled water plant. By centralizing all of the utilities in one location, the hospital accrued significant energy savings, as well as improved maintenance efficiency.

QUICK FACTS

Installed Cost:	$2.1 Million
Annual Savings:	$722,000*
Simple Payback:	2.9 Years
Current Savings:	$554,000**
Generating Capacity:	3.45 Megawatts
Operation Since:	August, 1997
Facility Size:	750,000 sq. ft.
Number of Beds:	360 beds (Licensed for 500)

* Annual Savings during first three years of operation
** Current Savings lower in 2002 due to engine overhaul

REASONS FOR CHP
"HOSPITAL EXPANSION"
"ENERGY SAVINGS"
"POWER RELIABILITY"

There was an immediate need to act on a decision to replace the current decentralized chiller and steam boiler plant system, some of the equipment being over 30 years old. The current and future infrastructure needs of the hospital were not met due to the aging equipment and a 210,000 sq. ft. hospital expansion. A completed economic analysis supported a centralized utility plant including the CHP application which would provide peak load shaving.

Additional benefits:

- Greatly reduced dependence on electric utility - rates were extremely high
- Provided "safety net" of back up electric power to ComEd and emergency generators
- CHP system allowed the hospital to take advantage of ComEd's voluntary peak electric reduction program during critical summer power shortages
- Provided NCH with most cost efficient use of electric power, steam and chilled water

SYSTEM EQUIPMENT

- 3 Waukesha 1150 kW, 1,200 RPM natural gas fired engines
- 3 Cain heat recovery units producing 6,000 lb./hr. total of 125 psig steam for heating and cooling
- 3 - 600 H.P. fire-tube dry back two pass boilers with non-condensing exhaust heat recovery (one unit for redundancy)
- Programmable logic controller controlling CHP system for optimum economic performance
- 1 - 850 ton two stage steam absorption chiller
- 2 – 1,250 ton electric centrifugal chillers
- 1 - 240 ton rooftop compression chiller for winter cooling requirements in north wing surgical suites
- Tunnel connecting central utility plant to hospital facility; used as conduit for all piping tie-ins to existing steam, chilled water, piping, etc. into hospital rooms

CHP OPERATION

The 3.45 MW CHP system peak shaves during ComEd's 9AM – 6PM On-Peak Demand period, providing the greatest economic opportunity to Northwest Community Hospital.

The three primary chillers operate in sequence, utilizing the absorption chiller as the base load chiller. The centrifugal chillers automatically begin operation as the cooling load increases during peak hours. This sequence saves the hospital 500 kW in demand charges and significant peak energy costs.

Absorption chiller utilizing waste heat saves hospital 500 kW in demand charges

CHP APPROVAL PROCESS

The process began with the hospital's vision and risk assessment of the existing infrastructure system (age of equipment/reliability, efficiencies, maintenance costs and utility costs)

- Initial stage included searching for a design-build team with experience in mechanical and CHP design/construction (Ballard Engineering)
- The team consisted of NCH Senior Management, Facility Staff and Ballard Engineering
- Several options were considered including centralized vs. decentralized heating and cooling and CHP vs. no CHP
- The Board of Directors approved the project in December of 1995
- Authorization was granted by the Illinois Health Facilities Planning Board in Oct. 1996
- Construction began immediately; the Central Utility CHP Plant was operational in August 1996

CHP System provides $553,000 to $722,000 Annual Energy Savings

ADDITIONAL FACTS

- In 1998, the Central Utility Plant received an ASHRAE Excellence in Engineering Award for its innovative energy saving design.
- The Central Utility Plant project was financed through a favorable bond rating of A++. (A lease back agreement was considered, but bond rates were favorable and NCH opted to own the building and equipment

2.9 Year Payback

For further information contact

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Chicago, IL 60607-7054

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Fax: (312) 996-5620
www.**CHPCenterMW**.org

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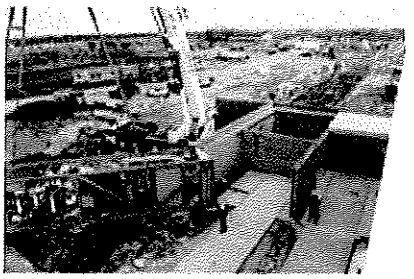
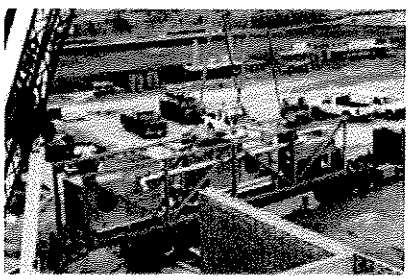
Ballard Engineering Case Studies
(Industrial)



Ballard Engineering, Gas Technology Institute, and Trane Company, Waukesha, Charles Equipment Company, and the University of Illinois at Chicago have teamed to develop and demonstrate a modularized "plug and play" Integrated Energy System (IES) that will supply electricity, hot water, and chilled water to facilities.



The Department of Energy (DOE) issued the subject solicitation to stimulate several BCHP development programs. Reciprocating engines offer one of the most reliable and low cost options for powering these advanced energy systems. The system will include standard designs for packaging the engines with standard heat recovery, for hydronic heating, absorption cooling, desiccant dehumidification. The system will include heat recovery from two cooling loops, emissions control technologies, and closed loop fluid cooler technology.

The team objectives are to match generators in the 290kW - 770 kW size range with

absorption chillers to achieve optimal performance; develop modular systems in a range of sizes to optimize performance for a variety of energy customers; and demonstrate prototype system(s) in one or more target applications.

Additional Material

- **The Gas Technology Institute CHP Packaged System Team (http://www.ballardcos.com/userfiles/file/Engineering_gti.pdf)**
- **Modular BCHP System Article in "*Distributed Energy*" (http://www.ballardcos.com/userfiles/file/modular_bchp_article.pdf)**

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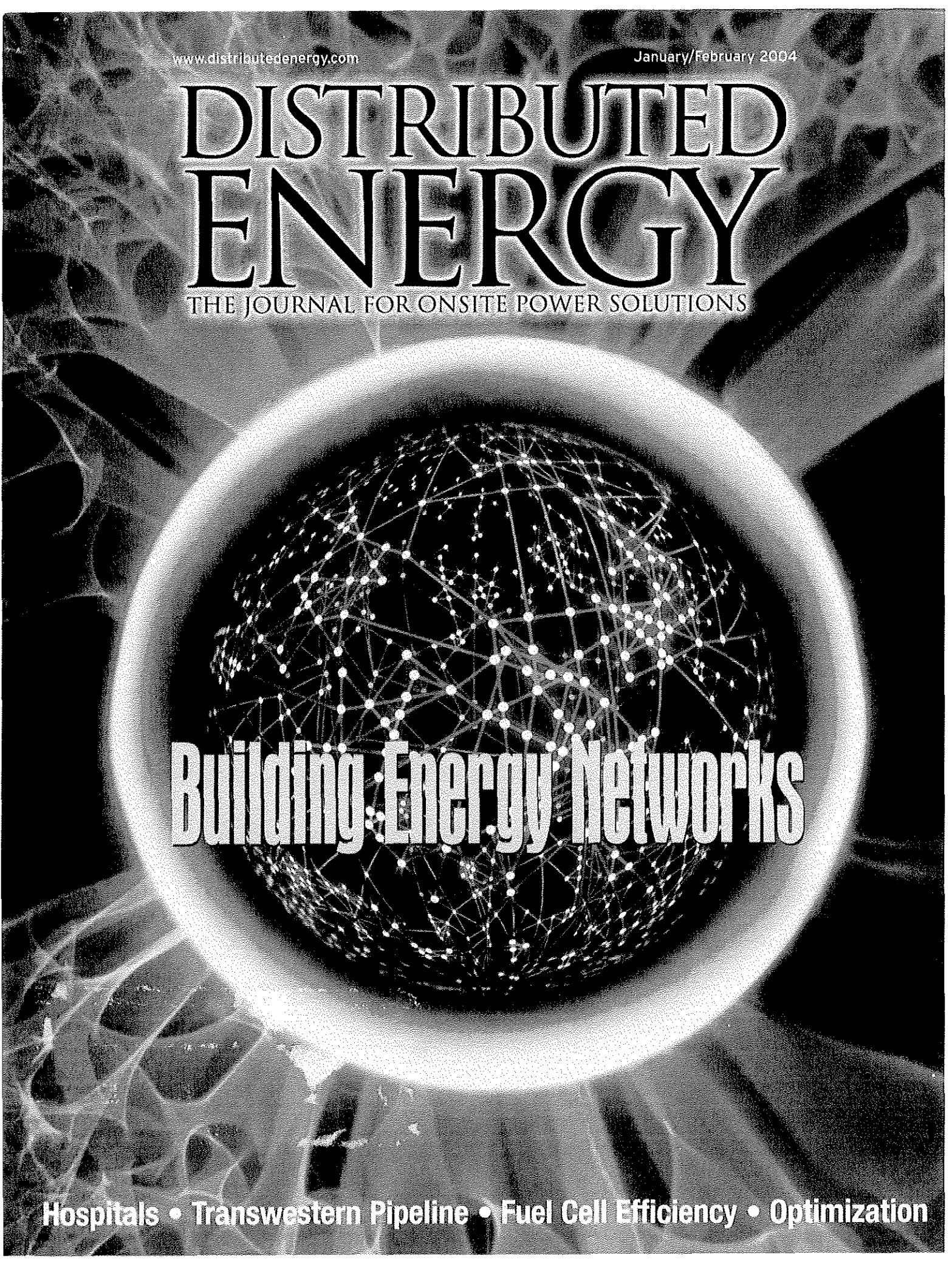
THE JOURNAL FOR ONSITE POWER SOLUTIONS



Building Energy Networks

Hospitals • Transwestern Pipeline • Fuel Cell Efficiency • Optimization

CJ CÓRDOVA

Packaged Systems Pave the Way to Up-Front Cost Savings

In the November/December issue's column, I profiled major types of onsite power generation and related equipment. In this issue, I'm very pleased to introduce guest columnist Ronald Fiskum, distributed-energy resources (DER) program manager at the United States Department of Energy, to describe DOE's initiative with industry partners to combine individual pieces of equipment into prepackaged systems for buildings. Fiskum, who oversees this initiative along with other DER programs, encourages you to visit WWW.EERE.ENERGY.GOV/DER/BCHP_PACKAGED.HTML ***to learn more or to contact him directly at*** ronald.fiskum@ee.doe.gov ***or 202/586-9154.***

Traditionally, energy customers interested in installing onsite generation and combined heat and power (CHP) systems hire engineering firms to combine individual components into a unit designed to serve their specific needs. Depending on application size and complexity, business as usual means that hundreds of hours of up-front engineering and design work might be required, with multiple weeks or months needed for installation and start-up.

Custom-engineered systems feature highly efficient fuel use, reduced energy costs, and improved power reliability, among other advantages. However, a shorter, less costly, and simpler route to achieving these benefits in buildings is evolving: packaged CHP systems, also called *integrated energy systems* (IES). Equipment manufacturer teams, along with DOE and Oak Ridge National Laboratory (ORNL), are collaborating to improve and standardize IES by packaging formerly separate components into one streamlined unit at the factory. These systems, which leave the factory ready for use in a variety of buildings, feature power generation units matched with heat recovery and thermally activated technologies in optimal configurations. The smaller-scale systems can even be delivered on a single skid.

What's in It for Me?

"DOE's goal is to accelerate the market introduction of packaged IES that offer customers lower up-front costs and less complicated and time-consuming installations," notes Phillip Fairchild, who leads the CHP group at ORNL. "The industry teams that DOE is supporting through ORNL are prematching components and tailoring them to function together in the most efficient manner possible." In fact, the teams are designing IES to provide buildings with systems that closely match their energy loads. Examples of facilities with loads that can be served efficiently by an IES include hotels and motels, hospitals and other healthcare facilities, schools and universities, supermarkets, and other commercial or institutional buildings.

The advantages that an IES offers customers over a conventional system include the following:

One-Stop Shopping—You don't need to specify separate pieces of equipment, deal with multiple manufacturers, and hire someone to string components together for you and make them work. Manufacturers have anticipated your needs and partnered to pair and optimize the performance of selected components.

Capital Costs Cut Significantly—Pre-engineering results in standardized off-the-shelf packages that cost less.

Installation Time Reduced by Up to Two-Thirds—Manufacturer teams are striving to come as close to "plug-and-play" as possible so a system can be dropped in, plugged in, and turned on in minimal time.

Simpler Control Systems—Instead of separate controls on each piece of equipment, you get a streamlined control system. There is no need to master multiple complicated control systems and ensure that each is successfully integrated with existing building controls. You may even be able to simplify the operation of existing controls with the packaged system.

Greater Adaptability—The modular packages are adaptable to various capacity requirements and space limitations. There is no need to custom engineer; a system suited to your facility's needs can be configured easily.

Building Systems Simplified—All of the packaged systems being developed feature exhaust-fired absorption chillers/heaters that eliminate the need for steam/hot-water generation equipment at your site.

Replicable System Designs—Got more than one facility with energy needs? Packaged systems are suitable for multiple applications across facilities.

How Do Integrated Energy Systems Work?

A key to realizing the full potential of IES lies in energy-use optimization. Central to this component are computer-based controls that link and simplify equipment and/or building system operations from the facility-engineering point of view while optimizing equipment operation from the energy-use point of view.

"In their ultimate form, online supervisory controls can optimize both supply- and demand-side energy options on a real-time, campuswide basis," notes Steve Gabel, project manager at Honeywell. "On a smaller scale, integrated systems controls offer a streamlined approach to making different pieces of equipment work together in the most efficient and cost-effective manner possible."

Who Is Packaging CHP Components?

Here are short summaries of what each ORNL-sponsored industry team is accomplishing, along with contacts who can answer your questions in greater detail.

Smaller Systems

UNITED TECHNOLOGIES

United Technologies partnered with Capstone Microturbine and Carrier Corporation to develop systems that power air conditioning with waste heat from microturbines, maximizing fuel efficiency and energy cost savings. The team recently introduced the PureComfort Solution, featuring four Capstone 60-kW microturbines coupled with a Carrier 110-ton, double-effect, direct-fired absorption chiller. The team is fast-tracking preparations for a test facility. It also analyzes factors that influence market success by developing a screening tool and optimizing the modular system to achieve significant savings.

Project Contacts: Tom Rosfjord, Ph.D., United Technologies Research Corporation, 860/610-7418, *rosfjord@utrc.utc.com*; Tom Coulbourn, national accounts manager, UTC Power, 804/353-5327, *tom.coulbourn@utcfuelcells.com*

CAPSTONE TURBINE CORPORATION

Capstone Turbine is developing and integrating packaged CHP systems driven by its ultralow-emission 30- and 60-kW microturbines in arrays of up to 20 microturbine-driven systems. The team is focusing on (1) creating packages that provide optimal energy savings for small turbine-based integrated systems; (2) improving end-user power quality, capital and operating costs, and reliability; and (3) providing the best value for clean, onsite cooling, heating, and power generation.

Project Contact: Steve Gillette, director of CHP business development, 818/734-5472, *sgillette@capstoneturbine.com*

NISOURCE ENERGY TECHNOLOGIES

NiSource Energy Technologies and Rahmat Shoureshi, controls consultant, are developing, integrating, and packaging an energy system that optimizes facility energy usage by combining multiple 60-kW microturbines with absorption chillers/heaters in packaged systems. The project builds on a successful hotel installation in Chesterton, IN, to develop future applications in other industries with high water-heating needs. The system optimizes energy options for a facility's specific energy-use patterns, including space heating, thermal load from hot-water heating, and swimming pool and spa heating.

Project Contact: Robert Kramer, chief scientist, 219/647-5500, *rakramer@nisource.com*

INGERSOLL-RAND

Ingersoll-Rand Energy Systems and IR Hussman teamed with Energy Concept Company and Advanced Mechanical Technology Inc. to combine CHP components into a package ideal for supermarket applications. The system, which can supply 70–100 kW, provides steady, grid-independent, microturbine-based power integrated with an ammonia-water absorption refrigeration system on a single skid serving applications to -20°F. The team is focusing on meeting the challenges posed by the need to aggregate supermarkets' typically small, dispersed refrigeration loads and on creating standard product suitable for store designs that vary widely.

Project Contact: Jim Kesseli, advanced technology director, 603/430-7116, *jim_kesseli@irco.com*.

Larger Systems

GAS TECHNOLOGY INSTITUTE

The Gas Technology Institute, Waukesha, Trane, Ballard Engineering Inc., Charles Equipment Company, and the University of Illinois at Chicago teamed to develop and demonstrate reciprocating engine generators ranging from 290 to 770 kW matched with absorption chillers (e.g., 90 RT) to optimize performance. The resulting modularized plug-and-play IES are easily adaptable to various requirements for electricity, hot water, and chilled water. The team is using market analysis to guide development of this system to expedite commercialization.

Project Contact: John Kelly, distributed-energy group director, 847/768-0665, *john.kelly@gastechnology.org*

BURNS & MCDONNELL

Burns & McDonnell has teamed with Broad USA, Solar Turbines, and Austin Energy, a municipal utility, to develop a modular system that integrates a 5-MW turbine generator with an advanced waste heat-fired, 2,500-RT absorption cooling to provide energy to an Austin Energy microgrid to a high-tech industrial park. Costs will be reduced because chilled water is used for air conditioning, increasing fuel-use efficiency from 33% to 70–80%. The modular design is adaptable to various capacity, space, and grid interconnection requirements.

Project Contacts: Ed Mardiat, director of CHP development, 816/822-3344, *emardiat@burnsmcd.com*; Rod Schwass, program manager, 816/822-4213, *rschwass@burnsmcd.com*

HONEYWELL LABS

Honeywell Labs has teamed with Broad USA, Chelsea Group, and I.C. Thomasson to develop reference designs to improve economics and simplify installation. Honeywell Energy Services is installing a prototype system at the 82nd Central Heating Plant at the Ft. Bragg military base in North Carolina. The 82nd plant, one of 14 central plants on the base, serves a large number of barracks and other buildings with steam for heating and domestic hot water, in addition to chilled water for cooling. The prototype IES features a 5-MW turbine generator integrated with a 1,000-ton Broad USA absorption chiller that uses waste heat from the turbine and/or natural gas to meet air-conditioning needs. The absorption chiller will be used to displace the cooling load of an existing 800-ton electric centrifugal chiller. Turbine waste heat will also be used to produce steam. A supervisory control system will optimize energy supply. Packaged systems with supervisory controls can be a key component in maximizing the cost-effectiveness of a site's energy choices, health, and safety.

Project Contacts: Steve Gabel, project manager, Honeywell, 612/951-7555, *steve.gabel@honeywell.com*; John Wimberly, president, I.C. Thomasson, 615/346-3400, *jwimberly@icthomasson.com*.

CHP for Buildings Integration Test Center

In addition to the equipment manufacturer teams, DOE is sponsoring equipment integration testing through the CHP Integration Test Center at the University of Maryland. The center is housed in a 52,700-ft.^{2} office building at the edge of the University of Maryland campus. The 200-employee administration building is an ideal test site because it represents a typical commercial building, with a total power demand of 300 kW and a requirement for 60 RT of cooling capacity.

The center is testing two different IES, both of which supply actual building needs. To take an exciting online tour of this facility and the two systems, please visit WWW.CHPB.NET/VTOUR/INDEX.HTML. DE

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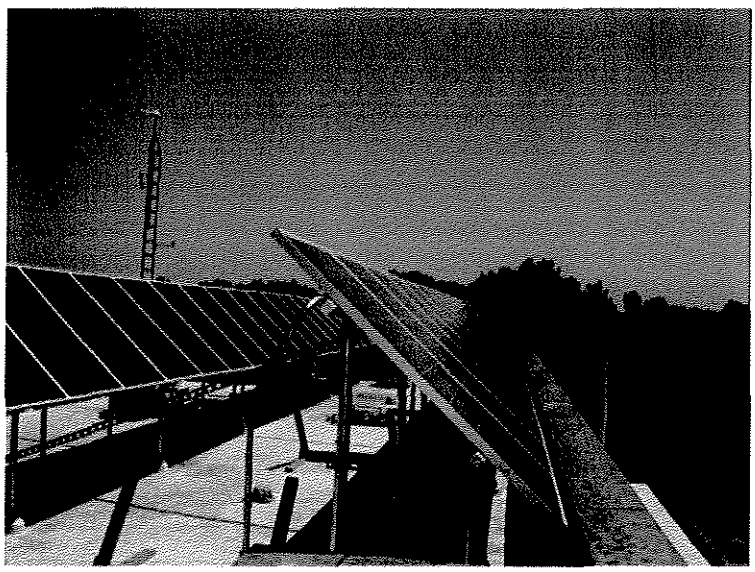
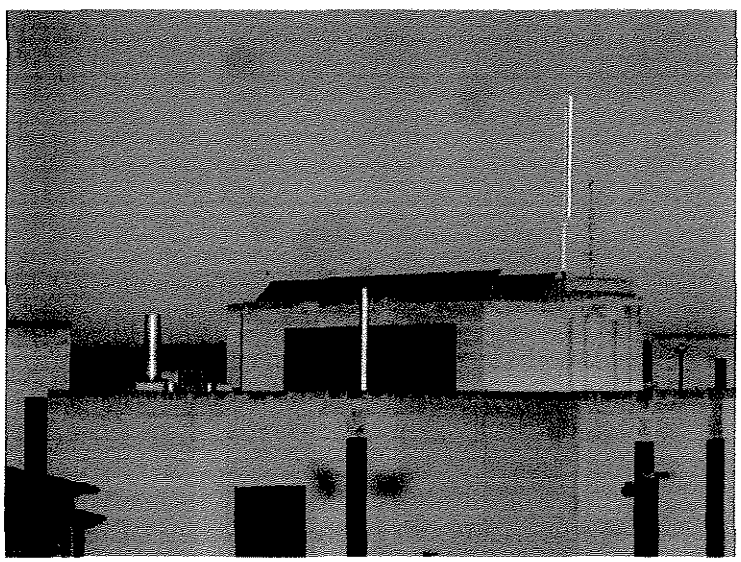
12,000 watt PV system at Freedom Field Renewable Energy 3333 Kishwaukee Street Building 9 Rockford Illinois 61109

Installed July 2010





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Print Page

By Mike Wiser

July 04, 2010 12:01AM

Believers hope region catches Freedom Field fever

The believers are sold. But as the calendar flips to September, when Rockford hosts International Bioenergy Days, two questions surface: How many others can be converted? Will Freedom Field be the boon its supporters hope it will be?

ROCKFORD — With little fanfare, 56 solar panels were fired up for the first time Monday morning at Freedom Field, marking another milestone for the renewable-energy lab that officials believe will help revitalize manufacturing in the Rock River Valley and protect the environment.

PHOTO / AMY J. CORRENTI | RRSTAR.COM

David Martindale, president of Ballard Engineering, gives a tour of Freedom Field Monday, June 28, 2010, and talks about the alternatives fuel sources including these solar photovoltaic panels.

Chet Kolodziej is a true believer. Ask him a question about the new solar panels, and the Freedom Field board member launches into a rapturous discussion of BTUs, optimal angles, Los Angeles, hydrophobic coverings, rooftops and manufacturing.

David Martindale, president of Ballard Engineering, is another dedicated follower. But he speaks with the brevity and specificity you might expect from an engineer. Solar panel is too broad a category, he explains; better to call them photovoltaic, or PV, panels.

Scott Christiansen also believes. So much so that he's used his influence as Winnebago County Board chairman to direct thousands of dollars to the Freedom Field project, making the county, by far, the single largest contributor to the alternative energy showcase.

All three were there for the launch.

"This is a big deal," Christiansen said to John Sweeney, who oversees maintenance at county facilities and is helping supervise the installation of the living green roof on the Freedom Field building. "These are the first Rockford-made solar panels that are up and running. ... This is just the start."

The believers are sold. But as the calendar flips to September, when Rockford hosts International Bioenergy Days, two questions surface: How many others can be converted? Will Freedom Field be the boon its supporters hope it will be?

The vision

Four years and $800,000 after its conception, Freedom Field has grown into a 22,000-square-foot classroom/conference room/exhibit hall at the Rock River Water Reclamation District on South Kishwaukee Street.

A section of the roof of the Freedom Field building is occupied by 240 solar thermal tubes that use solar energy to heat and cool the building. Another area is taken up by the 56 PV panels that went live Monday. The two systems collect enough energy to heat, cool and power the building.

There's also a weather station that tracks atmospheric conditions and sends the information to computers which keep constant watch on the roof's energy output and will do the same for soon-to-be built wind turbines.

"What we're doing is putting the weather data together to see when we're most efficient and what adjustments we will need to make to become more efficient," said Kolodziej, who serves as the nonprofit board's secretary and treasurer. "Or how efficient someone could expect these technologies to be given the conditions."

Winnebago County Board members just approved spending another $509,704 at Freedom Field, bringing the county's contribution since 2006 to $817,832 spent or committed to the project. The money comes from fees the county charges waste haulers that use the Winnebago landfill.

The most recent allocation covers the cost of buying and installing the PV panels, a wind turbine, a biogas and pellet maker and the green roof — all projects officials hope will be up and running by Sept. 26, when Bioenergy Days begins.

"The pellet maker is very interesting," Kolodziej said, holding up samples of compressed sawdust and grass clippings about the size of a golf ball and tennis ball, respectively. "We think there is real promise in the corn stover — that's material that is left over after harvest — and compressing that into these little pellets that can be used for fuel."

Such fuel can power everything from household stoves to coal-burning power plants.

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Where it goes from here

After Bioenergy Days, work is expected to begin on an algae pool. The algae will be grown and harvested for biofuel to power vehicles. Freedom Field officials also will experiment with battery efficiency to store some of the excess energy the facility is supposed to produce.

Meanwhile, Rock Valley College has begun sending students to Freedom Field to learn how to install and repair PV panels. Kolodziej said classes with Northern Illinois University students are expected to start next year.

"What we're looking at in the future is using noncommodities to produce energy," said Cliff Mirman, chairman of NIU's Technology Department. "When you think of ethanol, corn and soybeans are also a food commodity so (corn and soybean) price(s) would fluctuate depending on the supply for the food market."

That's why, he said, it's important to explore more efficient solar panels, harvesting algae for fuel and converting waste to energy.

John Holmstrom, chairman of the Freedom Field board, said $1 million to $1.5 million has been spent and/or committed to the facility, mostly from the county, but also from state grants, private donors and corporations.

"Will this ever be practical for a homeowner? It depends," Martindale said as he stood among the solar panels on the roof. "As an investment, it takes so long to recoup the startup costs that for many it's not practical. But it's also a lifestyle choice. You can justify the cost if it's important to your lifestyle."

Mirman said the advances in technology will continue to bring costs down while the depletion of finite natural resources will continue to make those costs higher.

But the finite resources of the monetary kind could put a crimp in the true believers' dreams.

"The biggest problem is finding ongoing resources that can support just our administrative costs," Holmstrom said. "As of right now, we're mostly reliant on grants, and that's not the best way to operate. We need to identify and develop some source (of steady funding) in the next 12 months."

Reach staff writer Mike Wiser at ***mwiser@rrstar.com*** *or 815-987-1410.*

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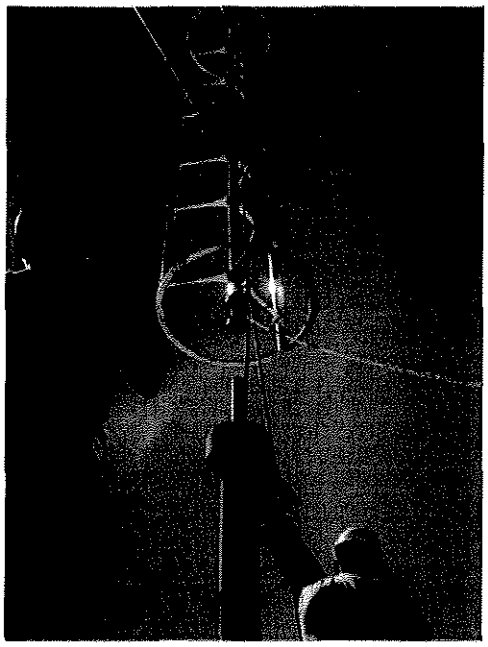
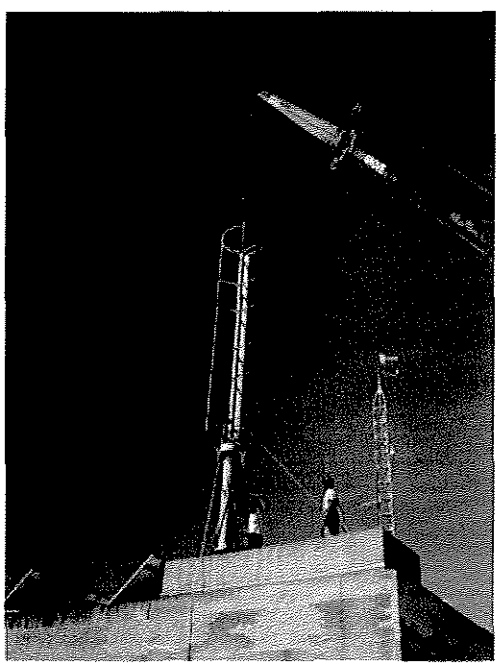
1,000 watt Vertical Wind Spire at Freedom Field Renewable Energy 3333 Kishwaukee Street Building 9 Rockford Illinois 61109

Installed July 2010





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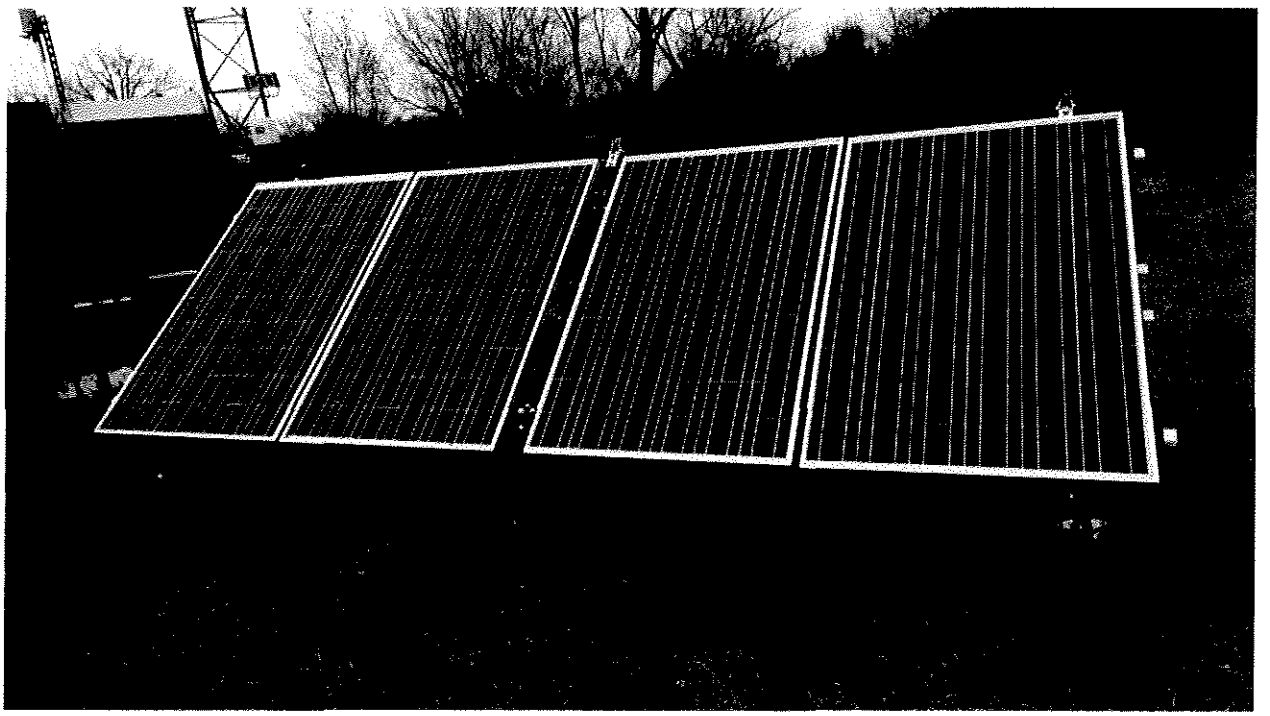
940 watt Stationalry PV South facing at Freedom Field Renewable Energy 3333 Kishwaukee Street Building 9 Rockford Illinois 61109

Installed July 2012

h.

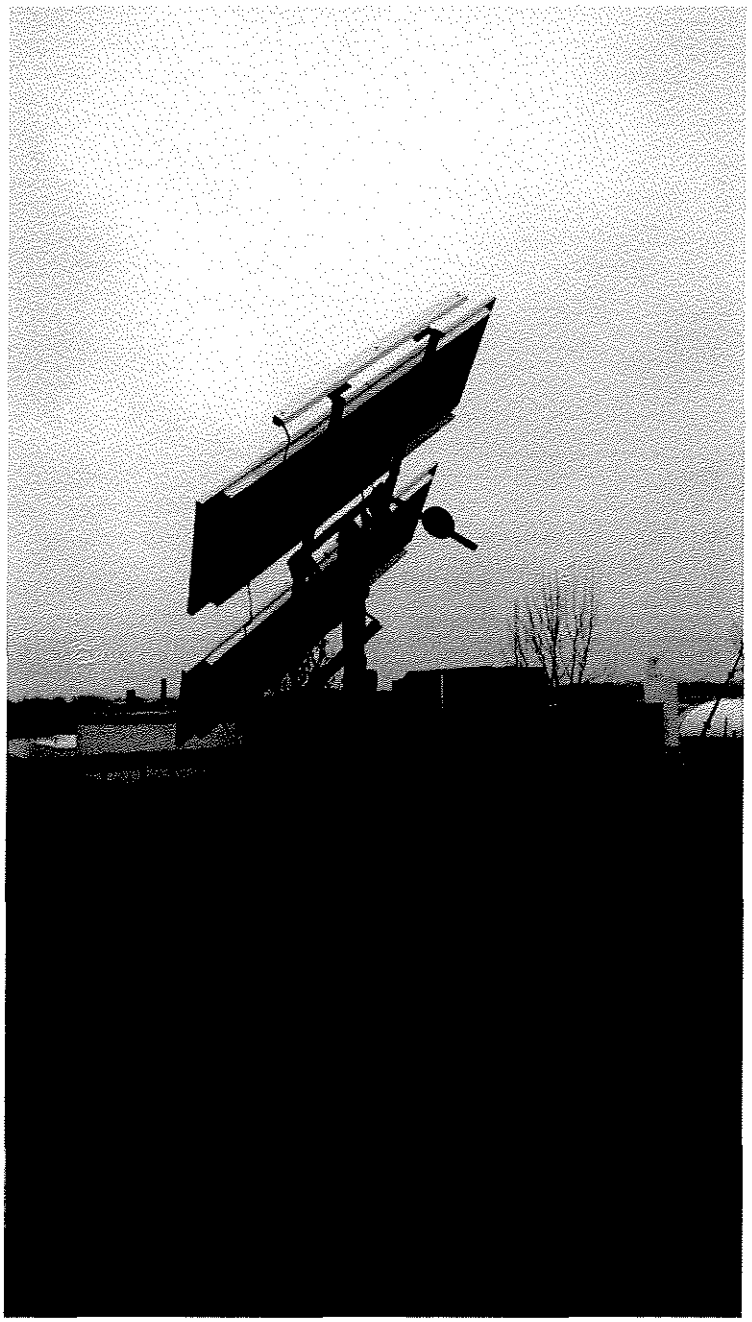
940 watt Stationalry PV South WEST facing at Freedom Field Renewable Energy
3333 Kishwaukee Street Building 9 Rockford Illinois 61109

Installed July 2014



940 watt Stationalry PV TRACKING east to west at Freedom Field Renewable Energy 3333 Kishwaukee Street Building 9 Rockford Illinois 61109

Installed July 2013



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10,000 watt Horizontial Bergy wind turbine at Freedom Field Renewable Energy
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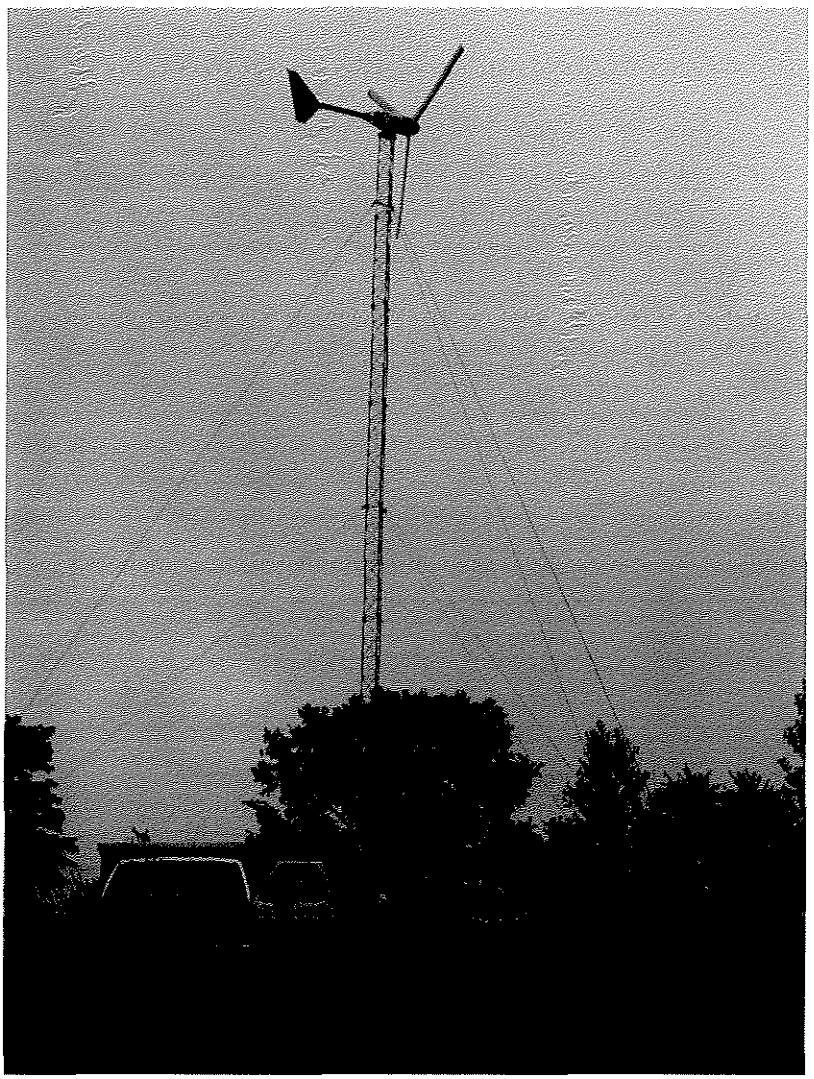
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