Iowa State University

THE EXPANDED LEGACY of Co-Generation

BACK WHEN THOMAS EDISON used to send light bulbs to college campuses, Iowa State University in Ames was generating its own electricity to test them. This concept of co-generation got a foothold in central Iowa 116 years ago, long before the term was coined. And now the university has expanded on that legacy.

In 1891, Iowa State utilized reciprocating steam engines to generate electricity and supply steam for heating campus buildings. Now in the 21st century, the university remains an even stronger proponent of co-generation and with a far more sophisticated system capable of generating all of the electrical needs of this renowned engineering and agricultural institution.

Not only does it provide the energy for its peak load of 34 megawatts, the equipment now in place provides heating and air-conditioning through steam extraction. "Our system heats all of the main campus," said Jeff Witt, assistant director of utilities for the university. The school was founded in 1858, became the country's first land grant college in 1864 and now has a student body of more than 25,000.

Until two years ago, the school wasn't quite capable of meeting its peak load demands, until it installed a 10-stage frame RD7MPQ steam turbine by Tuthill Energy Systems of Burlington, Iowa. (In 2005, Dresser-Rand acquired certain assets of Tuthill Energy Systems, an international manufacturer of single and multistage steam turbines and portable ventilators under the Coppus, Murray and Nadrowski brands.)

"It was a 10-stage 15-megawatt generator set," said Dick Perry, Dresser-Rand's manager of applications in Burlington. It replaced a 1948, 3-megawatt system, bringing its electrical generating capacity to 46 megawatts. "They needed more power. The system that was manufactured is capable of electric generation, steam heating, and air-conditioning. The whole fact that it's an integrated system for heating in the winter and cooling in the summer makes it ideal for a large campus that operates year-round."

Generator sets weren't popular for a long time, according to Perry. In the early 1990s chiller drives started to come into vogue. The system designed and manufactured for Iowa State is the "largest one we've done," Perry said. Dresser-Rand recently installed an 18-megawatt system for the University of Rochester in Rochester. But, it operates at a higher exhaust pressure and requires smaller blading.

The power generation facility at Iowa State University, in Ames, Iowa, produces electricity for the campus, as well as heating and air-conditioning through steam extraction.

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Assistant Director of Utilities,
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Sega Inc., an engineering consulting firm based in Stilwell, Kansas, developed the specifications for the system for the university, according to Derek Jacobs, Sega's project manager. The system was so large, that it had to be disassembled partially to get it out of the plant, and at Iowa State, the existing building had to be reconfigured.

The result of the lower vacuum and higher specific volume of steam was that the equipment took up more area. As a result, large blades had to be designed.

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In addition to the steam turbine, the system included a Lufkin Speed Reduction Gear mounted on a base plate; separate 15,000 KW, 13,800-volt Ideal synchronous generator; Ideal generator instrument and relay cubicle; separate lubrication system; Graham surface condenser, plus miscellaneous items such as couplings, coupling guards, and turbine-to-condenser expansion joint.

"College campuses have been employing co-generation for years and years," said Mike McGuinness, Dresser-Rand's director of sales for the Americas. On most campuses, the co-generation facilities use the excess steam from electric generation to chill water for air-conditioning, according to Jacobs of the Sega engineering firm. "They all want to do that," he said. "It's the efficiency. It's more efficient to take the wasted steam and use it for something else."

According to McGuinness, nearly every college campus in the country has Dresser-Rand equipment for its utility operations, ranging in size from a couple of megawatts to 45 megawatts. Worldwide, Dresser-Rand has turbines in more than 140 countries in all sizes up to 75 megawatts.

U.S. campuses are particularly well suited for co-generation. In the Midwest and the Northeast, the universities are ideal for co-generation because of the need for electricity, air-conditioning, and heat. "This trio of uses makes co-generation extraordinarily cost effective for college campuses. There is a definite payback," McGuinness stated.

At Iowa State they are able to use excess steam to heat the entire campus and to operate its air-conditioning system, in addition to providing all of the school's other electricity needs. They first began to air-condition the campus in 1968. "We have underground piping and tunnels to convey the steam throughout the campus," Witt said of the heating system.

The main reason for expanding its utility operations is economics. "The cost to purchase energy was getting high enough to make it cheaper to make it ourselves," Witt said. "On average, we're probably saving about 1 to 1.5 cents per kilowatt. The public utility price ranges from 4.5 to 4.8 cents a kilowatt for us."

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"We've been engaged in co-generation since 1891, starting with a steam engine. This was back when Thomas Edison mailed light bulbs to the university for professors to experiment with."

Because of its long history with co-generation, Iowa State had to re-work its operations facility before installing the new equipment. "The whole construction project was a challenge," Jacobs of Sega recalled. While Sega was the design engineering firm, Iowa State took on the responsibilities of construction manager.

"The new steam turbine was going right in the middle of our operating plant," Witt said. "We have other generators and switch gear there. We had steam piping to relocate. It took about eight different phases of piping operations to keep steam in service to the campus. It took a while to figure all that out. This is an old plant and a 1948 turbine and 3-megawatt generator and its foundation had to be removed, as well as another 1952 generator."

They had to excavate beneath the plant to find out what they had. And what they found was an underground creek. "We had a lot of stabilization to do before starting construction," Witt added. And when it was all finished, there was still more to do - they had to take the top of the new turbine off to fit it through the doorway.

At most campuses, natural gas is the dominant fuel and they typically utilize a gas turbine generator and steam. But at Iowa State, they decided on coal.

Iowa is not far from coal country. It ships in coal from Illinois and Kentucky by barge on the Mississippi and Ohio rivers to southeast Iowa where it is transferred to truck for transport to Ames in central Iowa. In keeping to an environmental commitment, the coal trucks return with loads of corn or soybeans.

About 160,000 tons of coal a year is burned. "It's blended to our specifications," Witt said. "We specify a range of coal that's acceptable to us. It has to have a BTU content of at least

9,500 a pound. Currently we're at 11,800 BTU a pound. We also specify maximum moisture content, ash, and sulfur."

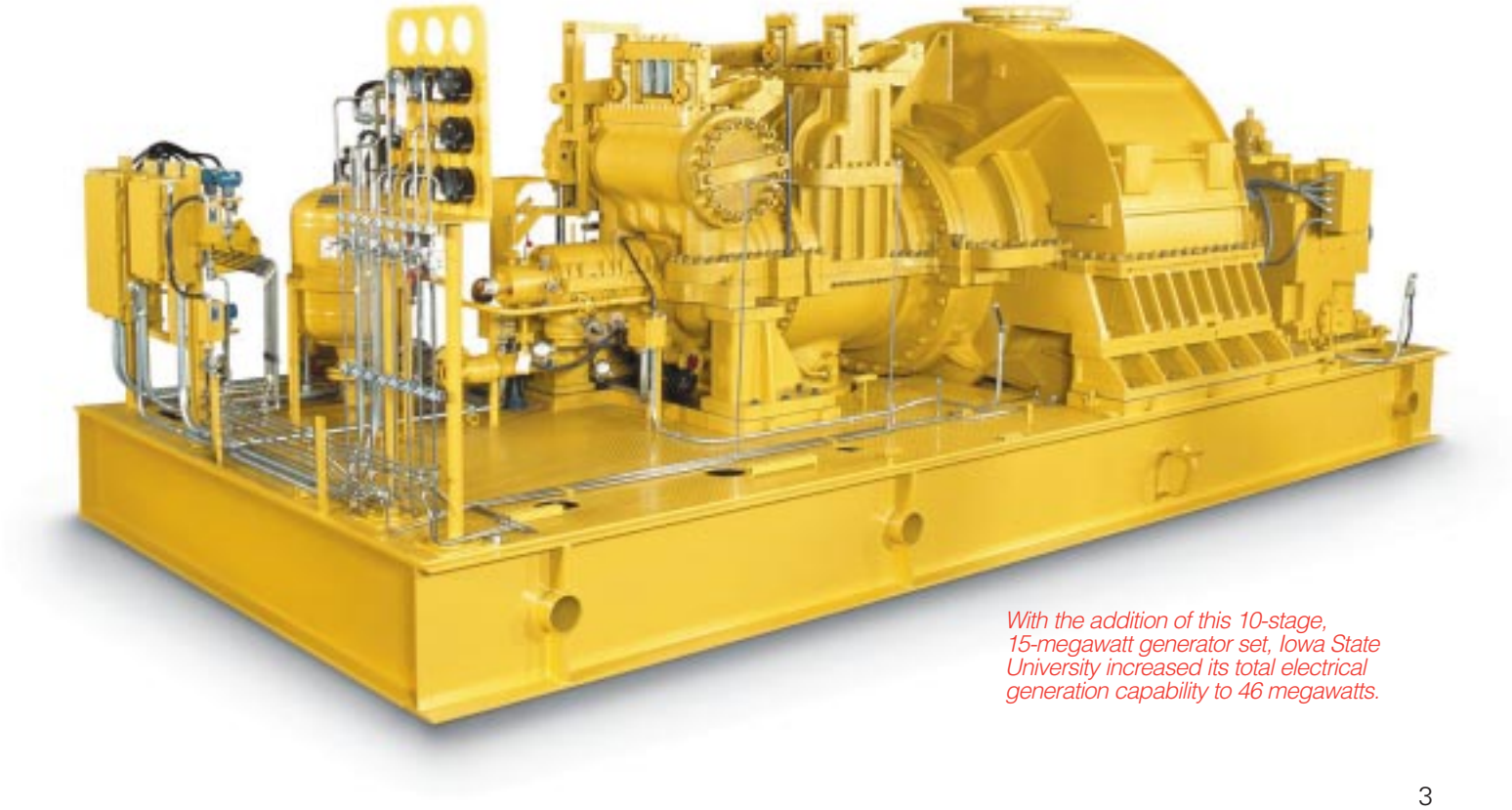
The current maximum specs are 12 percent moisture, 16 percent ash and 4.5 pounds of sulfur for every million BTUs. "We evaluate coal on the cost of the fuel and the cost of removing sulfur," Witt explained. "All are factored into the lowest cost fuel. Environmentally, we're as good as most coal-fired electric generating utilities in the country."

The two new boilers that Iowa State installed are fluidized bed boilers. "We burn limestone with the coal and the limestone reacts with the sulfur to form the ash," Witt said. The Environmental Protection Agency requires that 90 percent of the sulfur be removed. "We typically remove in the range of 91 to 92 percent."

Ash residue is recycled. "Last year about 70 percent of our ash was used for fill and reclamation at a rock quarry," Witt said. "The remaining 30 percent was used for soil stabilization, raw material for making cement, or was mixed with other waste products and made into compost."

After 116 years of steam-powered electric generation, Iowa State University has pioneered the way in co-generation. It has installed the most modern steam turbine generators, created a technologically sophisticated plan to operate and manage its power plant to provide a 22 to 31 percent savings over purchased electricity, and aggressively pursues environmental opportunities.

Witt is pleased with the equipment, the design of the operation and the results. He has good reason, as he explains, "Our overall plant efficiency is about 55 percent and that compares with most public utilities at 35 percent."■



With the addition of this 10-stage, 15-megawatt generator set, Iowa State University increased its total electrical generation capability to 46 megawatts.