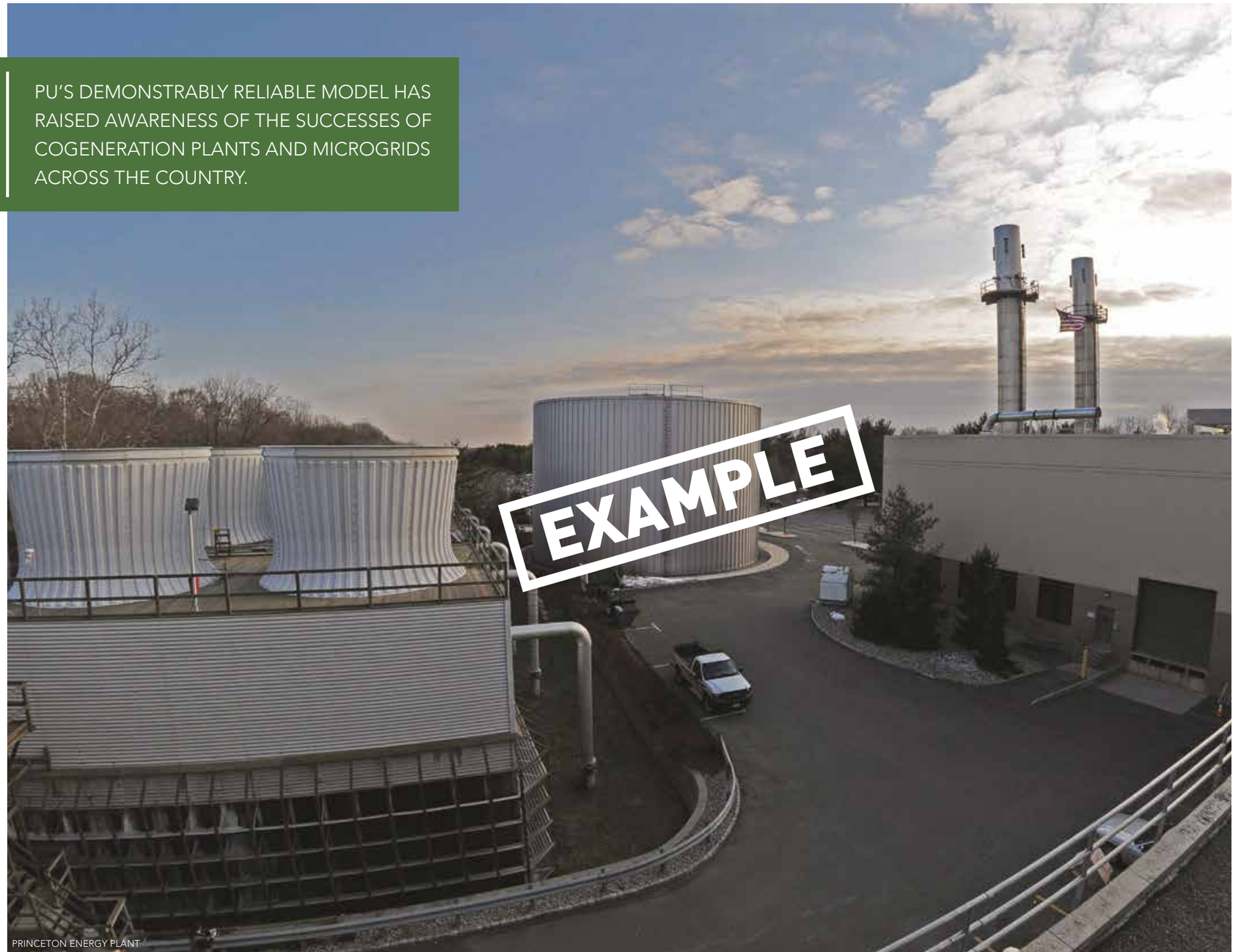
PRINCETON UNIVERSITY

AN EDUCATION IN THE ENVIRONMENT

Sustainable Business Magazines talks to three key representatives from Princeton University about the investment, research, and technology undertaken on its campus that has made it stand out as a leader in environmental issues.
Photos courtesy of Princeton University Facilities. ▶

PU'S SOLAR COLLECTOR FIELD (SCF)

PU'S DEMONSTRABLY RELIABLE MODEL HAS RAISED AWARENESS OF THE SUCCESSES OF COGENERATION PLANTS AND MICROGRIDS ACROSS THE COUNTRY.

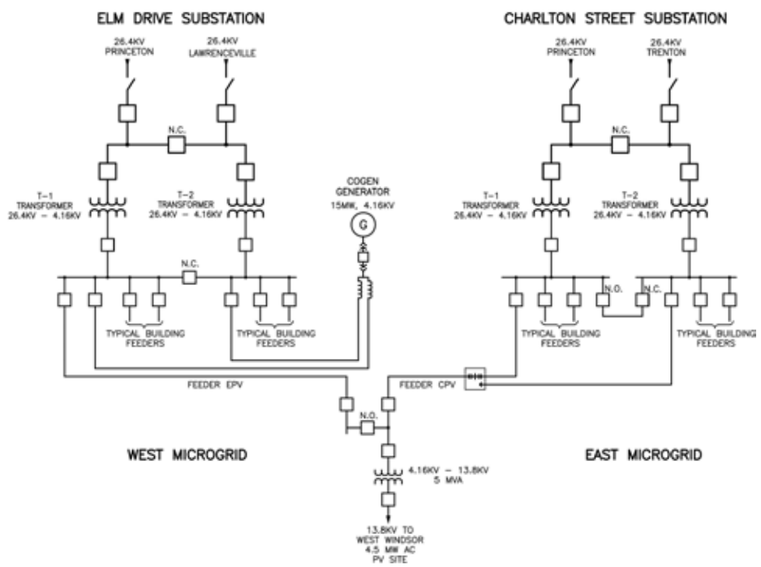


PRINCETON ENERGY PLANT

Princeton University (PU) is at the frontier of energy sustainability. As a major university it has the opportunity to research and invest in new technology across many sectors, and as an environmentally conscious institution it has chosen not only to fund research but also to turn its own site into a model of sustainability. At the centre of this is a 15 megawatt cogeneration plant, 4.5 megawatt solar collector field, microgrid, and a sustainability plan running until 2020.

DIVERSITY OF SOURCES

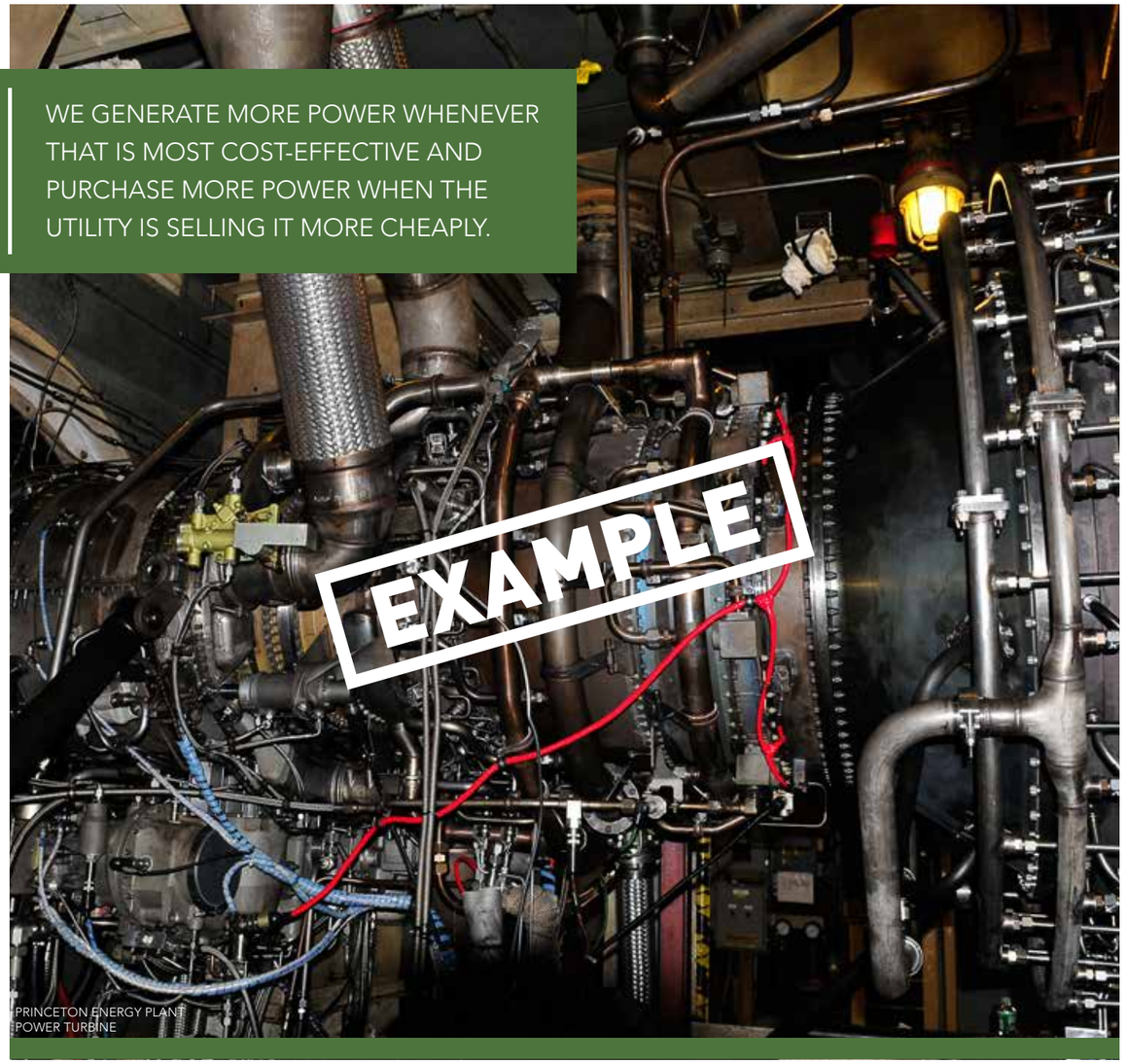
Resiliency in this network was tested in 2012 when Hurricane Sandy struck the east coast of the USA including New Jersey and the town of Princeton, bringing energy and other utilities down across the state. The university, powered by its own grid, was able to maintain power throughout the storm and to be a place of refuge for others. During the two years since this event, PU's demonstrably reliable model has raised awareness of the successes of cogeneration plants and microgrids across the country. With an energy efficiency of 80% - compared to the 25% to 45% of standard centralized utility plants – the durability of this grid is outshone only by its economic and environmental benefits. "The cogeneration system is comprised of one 15 megawatt GE gas turbine and a heat recovery boiler that transfers the engine ▶




MICROSTEAM FACILITY


PRINCETON ENERGY PLANT
MAIN SYNC PANEL

PRINCETON ENERGY PLANT



PRINCETON ENERGY PLANT POWER TURBINE

> WE GENERATE MORE POWER WHENEVER THAT IS MOST COST-EFFECTIVE AND PURCHASE MORE POWER WHEN THE UTILITY IS SELLING IT MORE CHEAPLY.

PRINCETON ENERGY PLANT MAIN GENERATOR

heat into water to make steam," explains Ted Borer, Energy Plant Manager. "Two auxiliary boilers are included to provide extra steam for peak needs and as a back-up for when the cogeneration system is out of service for maintenance. For reliability we run our electric system synchronized with the utility grid at all times it is available. We generate more power whenever that is most cost-effective and purchase more power when the utility is selling it more cheaply than we can generate it – typically at night."

Alongside this power and heat generation, the plant also chills water overnight for use in HVAC systems the next day. The Thermal Energy Storage (TES) tank has become as essential a feature of PU's microgrid as power and steam, enabling the campus to save money by chilling when energy is cheapest – that is, at night. To cool the 2.6 million gallons of thermal storage, warm water is pumped out of the top, through chillers, and back into the bottom. To discharge the tank, cool water is pumped from the bottom, through heat exchangers that supply the campus, and back into the top of the tank. As with steam and electricity, having thermal storage means the University is able to tolerate several hours with the chillers or cooling towers shut off without interrupting service to customers.

PU's solar collector field (SCF) comprises 16,528 photovoltaic (PV) solar panels on 27 acres of land. Nine DC to AC power inverters are used in series with five step-up transformers that convert the power from 480v to 13,200v for efficient transmission to the campus, where it is then stepped back down to 4160v for distribution. The array accounts for 6% of PU's total annual electric energy usage. Though this sounds slight, Mr. Borer is emphatic in highlighting that this is a large absolute amount given the size of the campus and that the SCF supplies upto 100% of the energy for the substation it is connected to during low demand daylight hours. On particularly sunny days this can even be exceeded, with the substation exporting energy into the outside power grid.

PRINCETON ENERGY PLANT MAIN GENERATOR

PU'S SOLAR COLLECTOR FIELD (SCF)

SOLAR FEED AT ELM DRIVE

Efficient, reliable power production means little without an excellent management system. Bill Broadhurst, Campus Energy Manager, talks more about the work his team carries out. "The building management system controls HVAC across at least 120 buildings, and in some buildings it controls the lighting as well. We utilize several different manufacturers for all of our equipment but it is all connected to one centralized control centre where we do the scheduling and optimization assistance. What this means is that we need to know when to bring systems online and take them offline. It's not just classrooms that we are responsible for but research labs, clean rooms, performing arts and athletics ▶

PU'S SOLAR COLLECTOR FIELD (SCF)


PU'S SOLAR COLLECTOR FIELD (SCF)


ANDLINGER CENTER FOR ENERGY AND THE ENVIRONMENT (UNDER CONSTRUCTION)

spaces, and vivarium spaces. Some of these have a lot more data points than others. There are approximately 100,000 data points across PU."

HOLISTIC APPROACHES

Sustainability is also a core feature of policy and research at PU. The Office of Sustainability has a stated mission to "cultivate the desire in all of us to lead meaningful lives in service of global human and environmental well-being", an ethic taken seriously not only by the institution but by its students, faculty, and staff as well. The use of bicycles and carpooling by people travelling to and from the university is encouraged, for example, with a university carpooling system in place to facilitate this approach. Food waste is currently composted off site. A programme called


PRINCETON CAMPUS


ANDLINGER CENTER FOR ENERGY AND THE ENVIRONMENT (UNDER CONSTRUCTION)

PU ANNOUNCED A SUSTAINABILITY PLAN TO ROLL BACK ITS CARBON DIOXIDE EMISSIONS TO 1990 LEVELS BY 2020 THROUGH DEVELOPING TECHNOLOGY.

Campus As Lab uses the environmental issues faced by the university itself to foster learning, allowing students to study the cogeneration plant, solar array, and microgrid to learn about sustainability. Students can work with professors and researchers tackling these issues to deepen their own field of understanding.

"There is also a staff initiative called Sustainability Ambassadors," elaborates Kristi Wiedemann, Manager of the Office of Sustainability. "The program gathers staff members across different departments together for an annual training programme where they learn about how PU is itself sustainable as well as steps they can take in their personal lives to live in a more environmentally friendly way. We also have a partnership with Sustainable Princeton, based in the town of Princeton, where we work together on broadening capabilities. At the moment we are working on better unifying the identity of the two parties across shared recycling initiatives."

SECURING THE FUTURE

In 2008 PU announced a sustainability plan to roll back its carbon dioxide emissions to 1990 levels by 2020 through developing technology and changing behaviors on campus rather than outsourcing through the purchases of offsets. Development continues along this guiding principle with, for example, current campus modifications reducing water and chemical usage as well as the swapping out of over 200,000 lamps for LED alternatives. "We are replacing thousands of steam traps with newer, more efficient technology, and adding variable frequency drives to dozens of large pump and fan motors," says Mr. Borer.

Over the next few years researchers and strategists will analyze the advancement of technology and see how it can best be implemented at PU to establish a sustainability plan reaching beyond 2020. In doing this, the university will continue marking its position at the forefront of sustainability. □