UTILITY SERVICES

IOWA STATE UNIVERSITY

ENERGY

The world today revolves around energy. We all use energy each day for heating, cooling, electricity, cooking, transportation, etc. We recognize these sources because we spend our own money to purchase the energy. However, we also use energy that we don't directly purchase. All goods and services we purchase require energy to produce and manufacture. It also takes energy to transport those goods and services to our homes and stores. Energy truly makes the world go round.

Iowa State University was founded in 1858. At that time, energy requirements were quite small. Electricity did not yet exist, so lighting was supplied by candles or gas lamps. Buildings were heated by burning local wood or coal in stoves or fireplaces. Windows were opened for cooling in the summer. Materials and supplies were procured locally. People produced much of their own food.

Today, energy demands are much higher and continue to increase. Much of this increase is due to technology. People are concerned about the environmental effects of producing the energy we need each day; therefore, regulations continue to be implemented to reduce emissions that result from producing the energy we need. People are taking interest in energy conservation and efficiency, something Iowa State University has focused on since 1891.

IOWA STATE UNIVERSITY UTILITY SERVICES

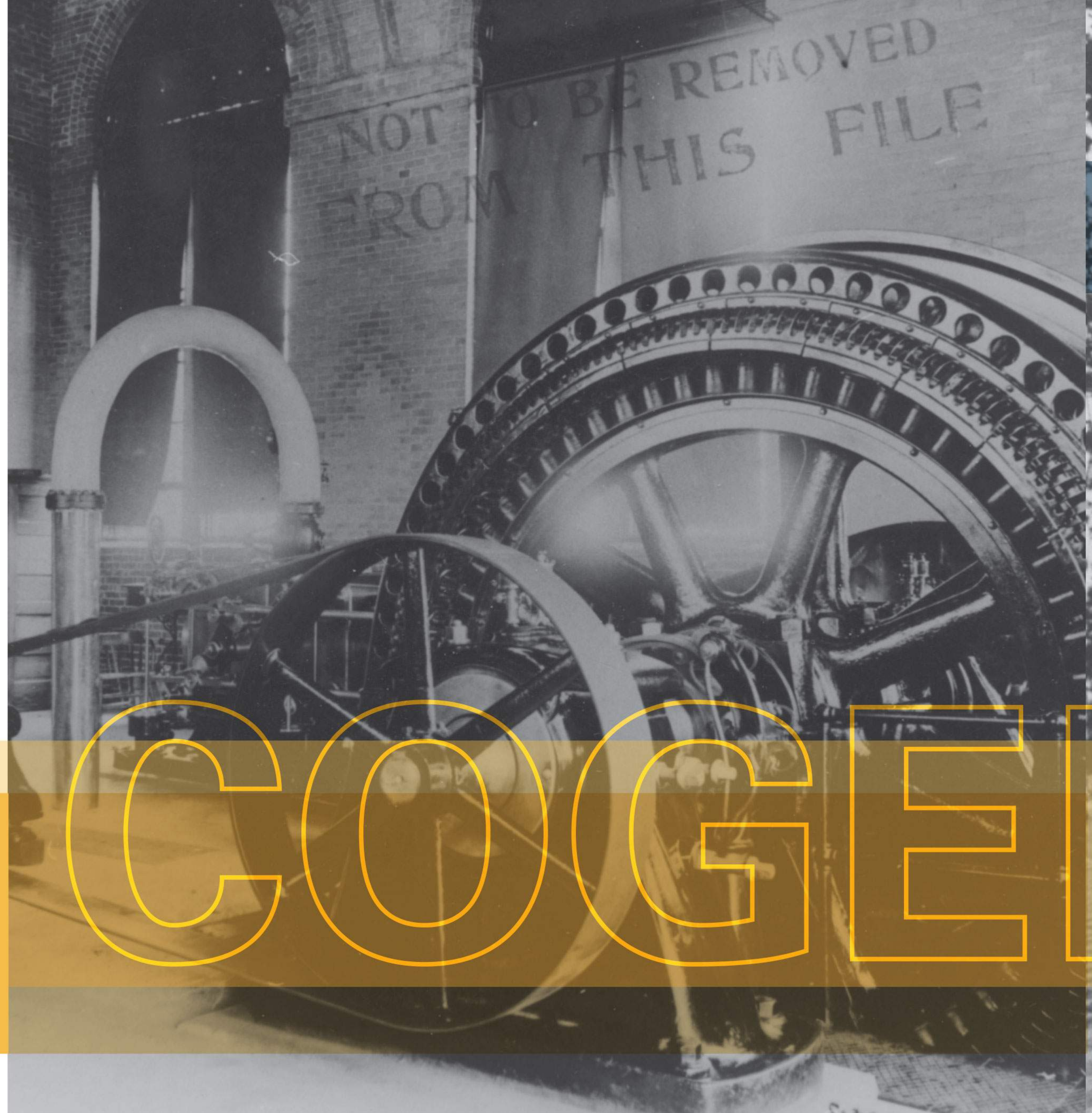
Iowa State University is a large research institution. Each day, nearly 50,000 students, faculty, and staff are on campus, making the university one of the 15 largest cities in Iowa. Universities are like cities and require large amounts of energy for heating, cooling, and operating their facilities. Vast utility infrastructure systems are necessary to support university operations and to educate our students.

Utility Services operates and maintains the production facilities and infrastructure systems necessary to provide utility services to the university community. A highly trained and diverse group of more than 70 people are dedicated to provide utility services to the university in the safest and most reliable, economical, and sustainable manner possible. After safety, the reliability, economical, and sustainability goals can conflict with each other. Utility staff must balance these goals each day.

HISTORY

Iowa State University has a long history of generating electricity, dating to some of the first electric lights that came from the inventor of the light bulb himself. In 1880, J.K. Macomber, a physics professor at Iowa State Agricultural College, received electric lamps from Thomas Edison to use for demonstrations in the Physics Lab. Four years later, an Edison Isolated Electric Plant was installed at the college to produce electricity.

By 1890, all major buildings on campus had electric lights. Electricity demands had grown to the point that a new power station was needed. A new power station was built in 1891, directly north of Engineering Hall (Lab of Mechanics Building). It housed a Corliss steam engine to generate electricity, and the exhaust steam heated the nearby Engineering Hall. The original power plant was designed to use a process called cogeneration. This process significantly increases the efficiency of the power plant. Thus began Iowa State University's long legacy of cogeneration.



In 1914, this Corliss steam engine produced less than one percent of the capacity of the current power plant.

COGENERATION

The current power plant viewed from the south in the 1930s.

The present power plant was constructed on the east edge of campus along Beach Road in 1906. Since that time, the power plant has been upgraded and expanded to meet the ever-increasing demand for energy. The power plant has also been upgraded many times to meet increasingly stringent environmental regulations.

In the 1960s, few campus buildings had air conditioning. Buildings with air conditioning each had their own chillers. The university was planning construction of the Iowa State Center and Maple-Willow-Larch dormitory complexes. The university wanted to provide cooling for these facilities. After considering various alternatives, the university decided to provide cooling for the entire campus from the power plant rather than installing chillers in each building. During the next several years, more than five miles of large chilled water lines were installed throughout campus and a large chiller was added to the power plant.

Prior to 1970, there were few environmental regulations. Congress enacted the first environmental regulations in the early 1970s that applied to the university power plant. Iowa State University responded by installing pollution control equipment on the existing coal boilers. The university also installed new coal boilers in the mid-1970s and late 1980s. These changes were needed to serve increasing energy demands and to comply with the new regulatory requirements.

Aging equipment, and new, more stringent environmental regulations resulted in further changes in 2015 and 2016. The university chose to replace the older 1970s vintage coal boilers with new boilers that burn natural gas. The two coal boilers installed in the late 1980s met all the new regulations but one and were modified to meet that requirement.

Today, the Iowa State University Power Plant has five boilers, three that burn natural gas and two that burn coal. The steam produced from these boilers is used in steam turbine generators to produce electricity and to drive centrifugal chillers to produce chilled water for cooling and to heat the campus buildings. The power plant operates continuously and is capable of supplying all the heating, cooling, and electricity needs of the university.

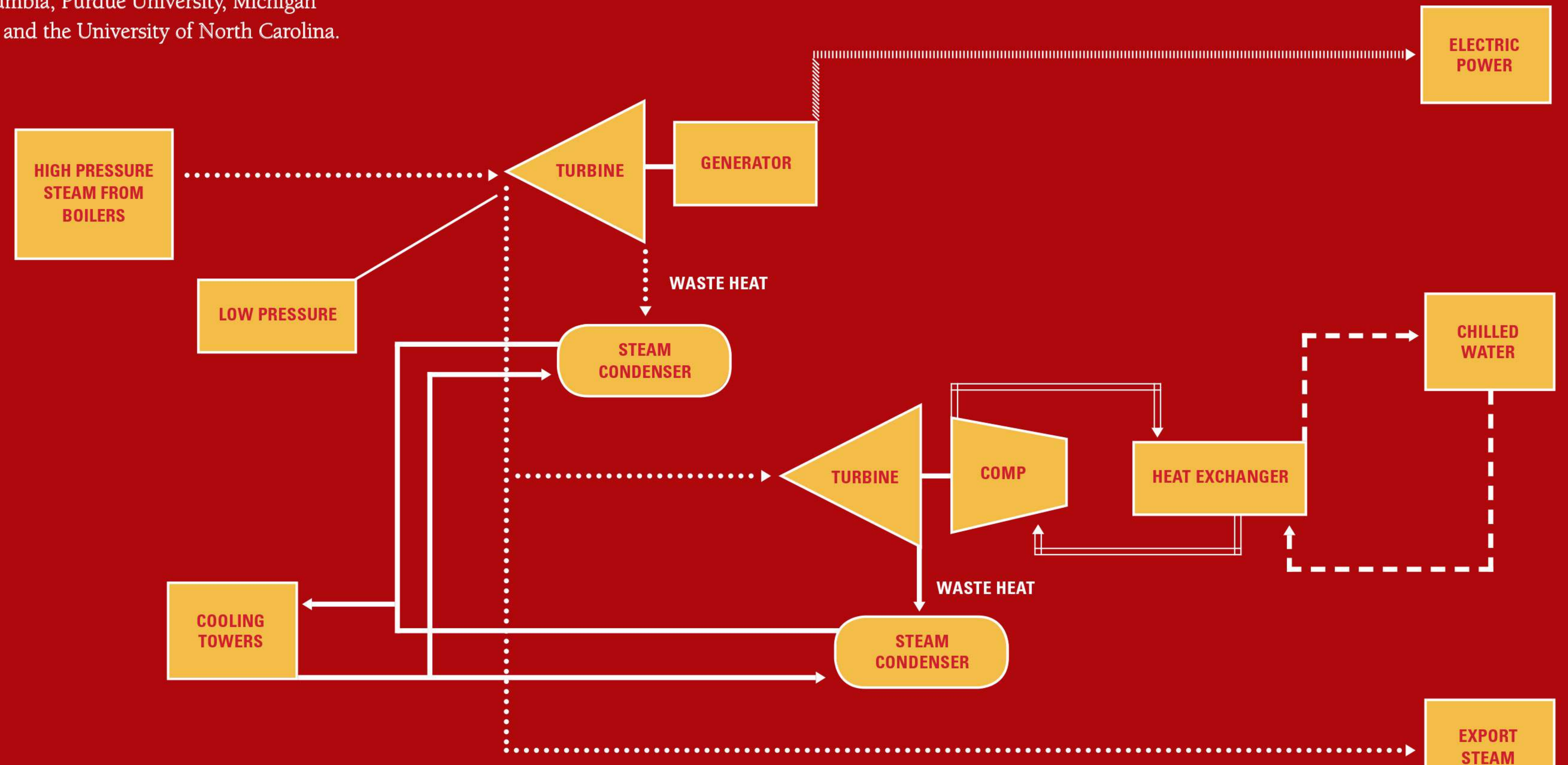
COGENERATION

Most colleges and universities provide heating and cooling for their buildings, but they usually purchase electric power. Combining these services, however, can achieve higher energy efficiency and significantly reduce costs. Iowa State University supplies all the energy necessary for heating and cooling the campus while simultaneously generating electric power. The term for this type of operation is cogeneration. Another term often used is combined heat and power or CHP. Cogeneration facilities use a fuel source to simultaneously produce thermal energy and electricity.

Cogeneration avoids much of thermal energy loss that occurs when low-level energy is discharged from the steam turbine into the cooling towers. The thermal efficiency of a typical large power plant that does not cogenerate is about 33–35 percent, due to the low level energy discharged from the steam turbine. By using this energy to heat or cool buildings, the thermal efficiency of a cogeneration plant can be increased up to nearly 75 percent. Iowa State's cogeneration plant typically operates at an overall thermal efficiency of about 60 percent. The higher efficiency means less fuel is needed to provide the same amount of energy.

Cogeneration also reduces emissions of air pollutants from burning the fuel. The increased plant efficiency requires less fuel. Less fuel means lower emissions of sulfur dioxide, nitrogen oxides, and carbon dioxide.

Few institutions operate facilities similar to the Iowa State University Power Plant. Universities with similar facilities include the University of Iowa, University of Missouri in Columbia, Purdue University, Michigan State University, and the University of North Carolina.



BOILERS

The ISU Power Plant has five boilers that are capable of producing a total of 790,000 pounds of steam per hour. The steam is produced at 400 pounds per square inch of pressure at a temperature of 750 °F. The steam is used to generate electricity, heat the campus, and to produce chilled water to cool campus buildings. Two of the boilers burn Midwest bituminous coal, and three burn natural gas.

The ISU Power Plant has five boilers that are capable of producing a total of 790,000 pounds of steam per hour.

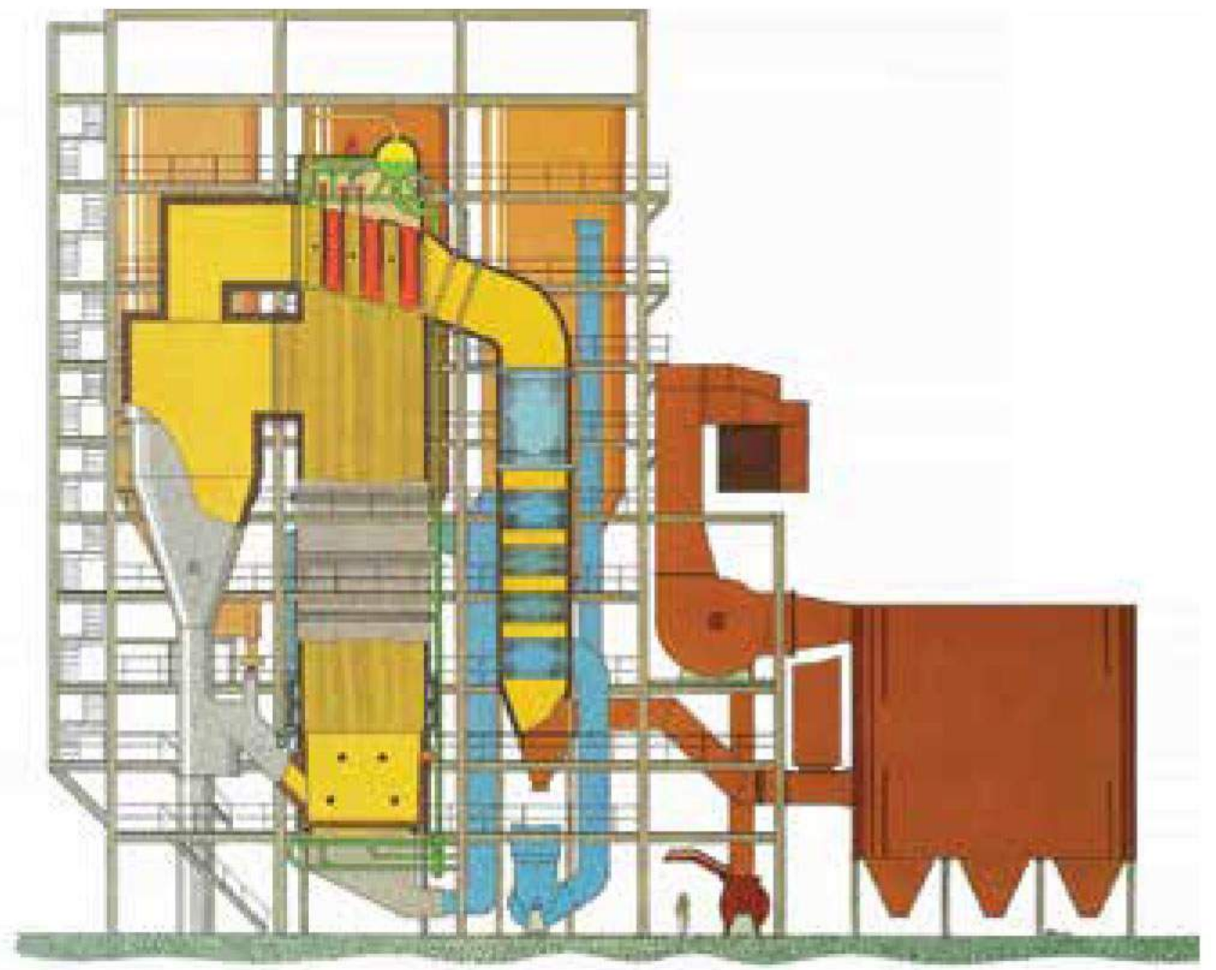
BOILER	MANUFACTURER	BOILER TYPE	FUELS	BOILER CAPACITY IB/HR	EFFICIENCY	YEAR INSTALLED
01	Pyro-power	Fluidized Bed	Coal	170,000	87%	1988
02	Pyro-power	Fluidized Bed	Coal	170,000	87%	1988
08	Cleaver-Brooks	Packaged boiler	Natural gas w/ oil backup	150,000	83%	2016
09	Cleaver-Brooks	Packaged boiler	Natural gas w/ oil backup	150,000	83%	2016
10	Cleaver-Brooks	Packaged boiler	Natural gas w/ oil backup	150,000	83%	2016

The two coal boilers were installed in 1988. These are circulating fluidized bed boilers, a technology developed in Europe. The coal boilers were some of the first of this type installed in the United States. The fluidized bed technology was chosen because of its ability to meet stringent environmental requirements. Fluidized bed boilers burn coal in a turbulent atmosphere inside a combustion chamber that is fed air, coal, and limestone. The fluidizing air ensures complete combustion of the coal, while the limestone reacts with the sulfur in the coal to form calcium sulfate, which is removed as a solid dry ash product. Fluidized bed boilers are able to remove more than 90 percent of the sulfur in the coal. Lower combustion temperatures also reduce nitrogen oxide emissions.

The three natural gas boilers were installed in 2016. They were designed to maximize efficiency and minimize emissions. The boilers were designed to be able to start and stop quickly. This feature allows the power plant operators to closely match boilers to campus energy demands, thus maximizing efficiency.

Having some boilers that can burn coal and some that can burn natural gas provides fuel flexibility. The plant operators can switch from one fuel to another to follow energy prices and minimize campus energy costs.

A cross section of the circulating fluidized bed boilers in the late 1980s. These boilers reduce emissions of sulfur dioxide more than 90 percent compared to other types of boilers.



Three natural gas boilers were installed in 2016, similar to that pictured above.

The university has installed pollution control equipment on the coal boilers that remove 99.5 percent of particulate emissions.

EMISSIONS

Emissions from the university power plant are regulated by the Iowa Department of Natural Resources and the Environmental Protection Agency. These regulations define the fuels that can be burned and how emission levels must be controlled. The university has installed pollution control equipment on the coal boilers that remove 99.5 percent of particulate emissions. Similar pollution control equipment is installed on all material handling systems. Limestone is added in the fluidized bed boilers to reduce sulfur dioxide emissions by more than 90 percent.

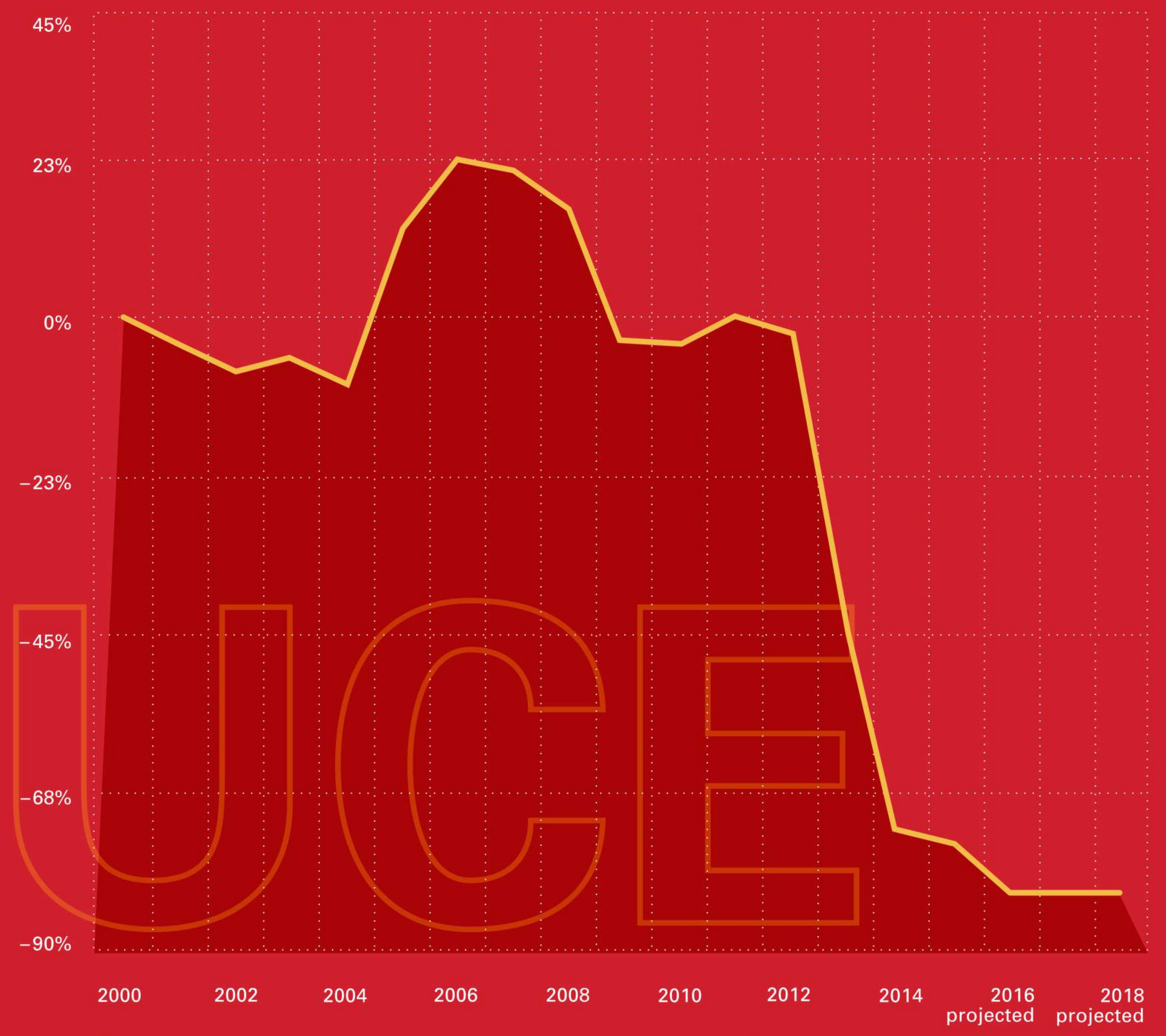
In 2013, the EPA passed new environmental regulations that applied to the boilers at Iowa State. The university studied several options to comply with this regulation and ultimately chose to replace three older coal-fired stoker boilers with new natural gas-fired boilers. The project also modified the two remaining coal boilers. By completing this project, the university was able to meet the new environmental requirements. The project also replaced aging coal boilers with new gas boilers, significantly reducing emissions.

This transformational project was completed in 2016. The university power plant had burned primarily coal since the first power plant was built in 1891. Today, the power plant is 60 percent gas fired and 40 percent coal fired.

Plant staff minimize emissions each day by properly operating and maintaining the boilers and pollution control equipment and by maximizing efficiency. The university has installed continuous emissions monitoring equipment on each boiler to verify and report compliance with applicable state and federal regulations for gaseous and particulate emissions.

These ongoing efforts and the conversion of a portion of the plant from coal to natural gas have resulted in significant reductions in emissions from the plant as can be seen in the chart.

REDUCE



(PERCENT CHANGE IN TOTAL POWER PLANT EMISSIONS (FROM 2000 BASELINE))

ENERGY CONSERVATION AND SUSTAINABILITY

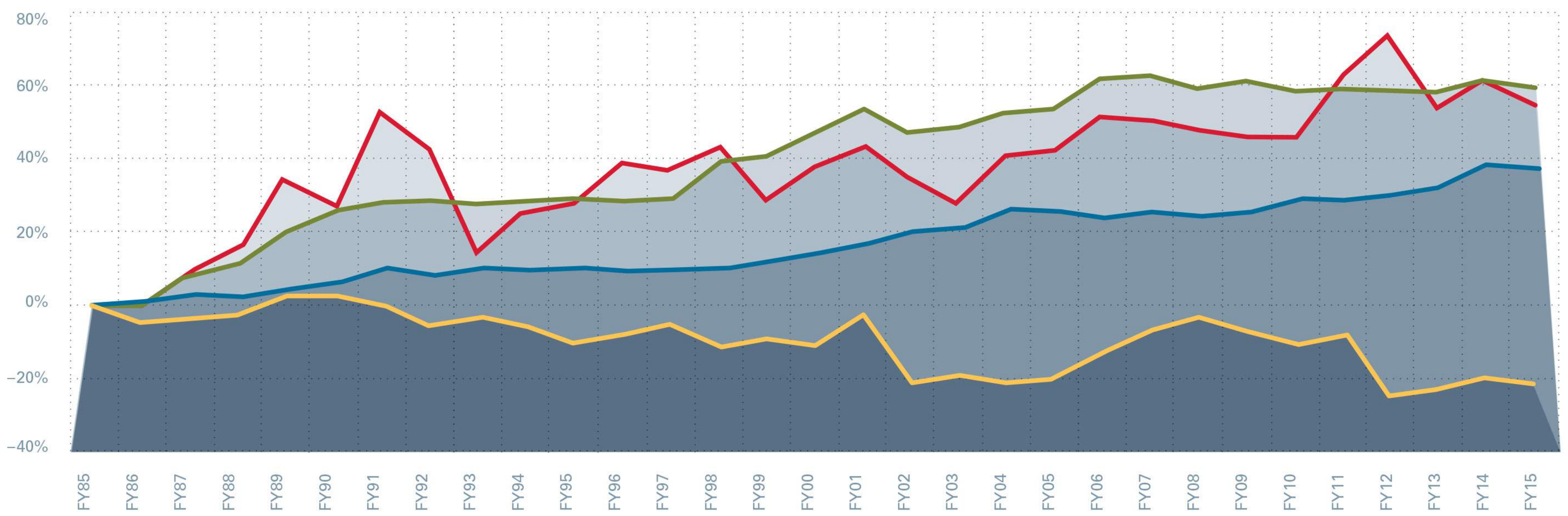
The operating and maintenance staff strive to operate the plant as efficiently as possible and keep the equipment in good operating condition. Their efforts maximize efficiency and reduce the fuel required, resulting in lower emissions.

Since steam, electricity, and chilled water cannot be stored, the power plant must continuously produce the energy needed to meet university demands. Therefore, if the university community can reduce its energy use, there is an immediate reduction in the amount of fuel needed and emissions produced.

The university's energy demands continue to increase. This is caused by new buildings, higher enrollment, additional research, and increasing technology. The chart below shows how campus energy usage has changed with more building space on campus.

New campus buildings are constructed to be more energy efficient but also utilize more technology. Today's electrical demands have a direct and significant effect on the university. Much of the electricity used for lighting, computers, research equipment, and other items also produces heat. The heat generated by this equipment reduces a building's heating requirements and increases cooling requirements. You can see this effect in the chart below.

The use of electricity is easily controlled by the customer. Customers can shut down computers, lights, or research equipment that are not in use, resulting in an immediate savings to the university and a reduction in air emissions. Reductions in consumption of steam (for heating campus buildings) and chilled water (for cooling campus buildings) also can be obtained by better controlling temperatures inside buildings.



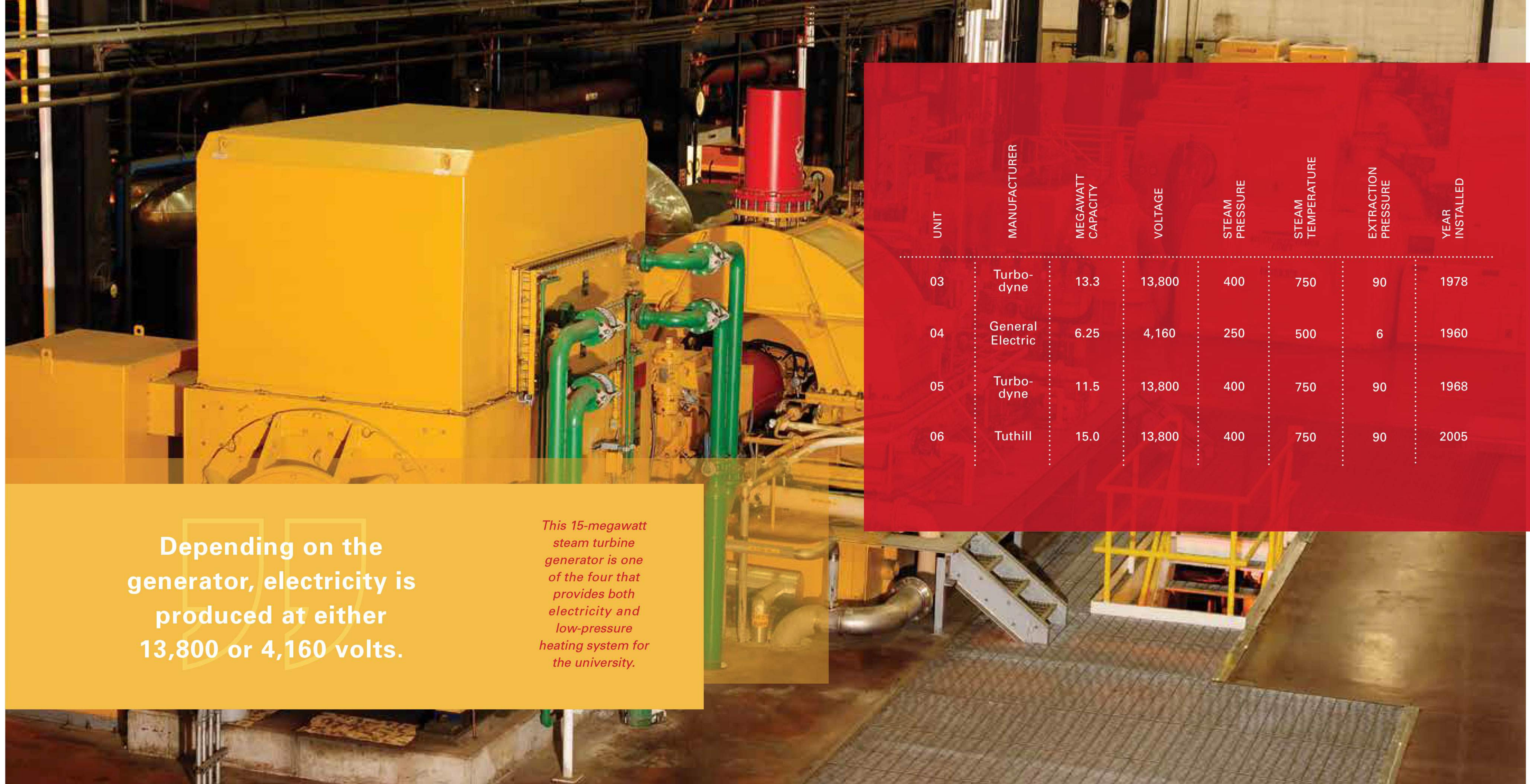
PERCENT CHANGE IN UTILITY CONSUMPTION (FY85 BASELINE) ● STEAM ● ELECTRICITY ● CHILLED WATER ● BUILDING GSF

ALTERNATIVE ENERGY

Iowa State University continuously evaluates alternative energy sources. Late in 2010, the university partnered with the city of Ames and together now purchase some electricity from a wind farm located about 15 miles northeast of Ames. Electricity from this wind farm typically provides about 7 percent of the electricity needed on campus.

The university has also installed a 100 kilowatt wind turbine and two 10 kilowatt solar panels on campus. These alternative energy sources produce electricity for use on campus. The alternative energy sources on campus are small but provide research opportunities for students.

The university has considered corn stover, wood chips, and other alternative fuels. Wood chips and wood pellets have been tested in the fluidized bed boilers. These boilers are now permitted by the Iowa DNR to burn up to 15 percent wood. However, the cost of alternative fuels is significantly more than coal or natural gas, so they are not being used at this time.



Depending on the generator, electricity is produced at either 13,800 or 4,160 volts.

This 15-megawatt steam turbine generator is one of the four that provides both electricity and low-pressure heating system for the university.

UNIT	MANUFACTURER	MEGAWATT CAPACITY	VOLTAGE	STEAM PRESSURE	STEAM TEMPERATURE	EXTRACTION PRESSURE	YEAR INSTALLED
03	Turbo-dyne	13.3	13,800	400	750	90	1978
04	General Electric	6.25	4,160	250	500	6	1960
05	Turbo-dyne	11.5	13,800	400	750	90	1968
06	Tuthill	15.0	13,800	400	750	90	2005

STEAM TURBINE GENERATORS

The power plant has four automatic extraction steam turbine generators with a total electrical-generating capacity of 46 megawatts. Steam from the boilers is used to spin turbines to generate electricity. Steam can be extracted from the turbines partway through the process. Extracted steam goes to campus buildings via an underground steam system. The steam is used for heating, hot water, and for research. In the summer months, extracted steam is used to generate chilled water to cool university buildings. The low-pressure steam for campus use is extracted at a pressure of 90 pounds per square inch.

The steam turbines power generators that produce electricity for campus use. Depending on the generator, electricity is produced at either 13,800 or 4,160 volts. This electricity flows to switchgear where it is distributed to campus buildings or used in the Power Plant.

CHILLERS

The main power plant has four large centrifugal chillers that are used to cool campus buildings. These chillers generate chilled water at 40 °F that is pumped through underground piping to approximately 85 buildings'. The chilled water circulates through the building's air handling units, where it absorbs heat from the building, then returns to the power plant at 55 °F. The chillers cool the water again and send it back to campus. Heat from buildings is transferred through the chillers to the cooling towers, where it is discharged to the atmosphere.

The power plant's total cooling capacity is 17,000 tons cooling; a typical home air conditioner is rated at 2 or 3 tons of cooling. The university has additional cooling capacity in the North Chilled Water Plant. The North Chilled Water Plant contains 4,000 tons of cooling capacity with plans to install an additional 5,000–6,000 tons of capacity by 2018. The main campus chilled water system is operated year-round to serve the cooling needs of the university.

UNIT	MANUFACTURER	TONS CAPACITY	REFRIGERANT	STEAM PRESSURE (PSIG)	STEAM TEMPERATURE (°F)	YEAR INSTALLED
01	CARRIER	5,000	R-134a	400	750	1968
02	CARRIER	5,000	R-134a	400	750	1978
03	YORK	5,000	R-22	90	500	1984
04	YORK	2,000	R-134a	4,160 volts		1997
05	YORK	4,000	R-134a	90	375	2004
06	?	5,000	R-134a	4,160 volts		2018?

Large centrifugal chillers are used to provide 40 °F chilled water to cool more than 85 campus buildings.

COOLING TOWERS

The ISU Power Plant operates a large cooling tower system to provide cooling water for the generators, steam condensers, chillers, and other plant equipment. The cooling towers discharge heat that is produced by this equipment to the atmosphere. The cooling towers are designed to cool water from 102 to 85 °F.

The cooling tower system consists of 16 cooling tower cells and eight cooling water pumps. Each pump can circulate 10,000 gallons of cooling water per minute. At peak times in the summer, cooling water is provided to the power plant at a rate of 80,000 gallons per minute through two 48-inch-diameter pipes. The cooling water passes through large heat exchangers, picking up heat from the equipment. The cooling water then returns to the top of the cooling tower, where it is sprayed down through the cooling towers. Sixteen 24-foot-diameter fans pull air up through the cooling tower, cooling the water through evaporation. The fans then discharge warm, damp air to the atmosphere. During the summer months, more than one million gallons of water are evaporated in the cooling tower each day.

WATER PLANT

The ISU Power Plant also houses a water plant capable of treating 1,000 gallons of water per minute. This plant is designed to remove iron from groundwater pumped by three wells located northeast of the power plant. Up to one million gallons of water are treated daily to cool plant equipment and to replace water lost to evaporation in the cooling towers. A portion of the well water is used for irrigation at the Veenker Memorial Golf Course.

AIR COMPRESSORS

A central compressed air system was installed in 1911 to serve the campus. Compressors were installed in the power plant and air was distributed to campus buildings through pipes located in the steam tunnels. This system remains in service today and distributes compressed air at 90 pounds to campus buildings.

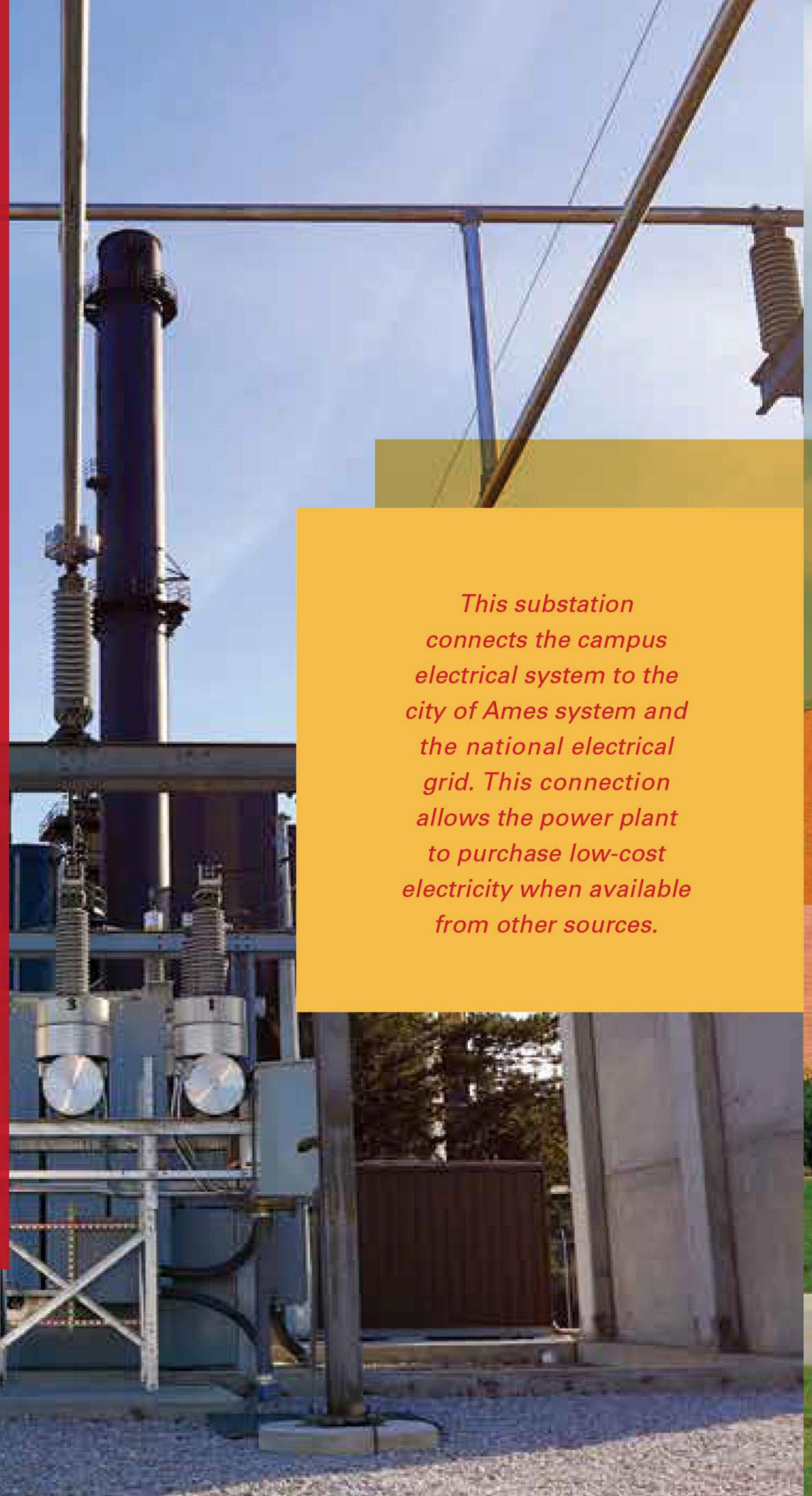
Four large rotary-screw air compressors are located in the power plant, which has a total compressed air capacity of 4,000 cubic feet per minute. Compressed air is used for control systems in the power plant and in campus buildings.

SUBSTATION

A large electrical substation located directly north of the power lant connects the campus electrical system to the nationwide electrical grid through the city of Ames electrical system. This substation contains two 30-megawatt transformers that reduce the voltage of electricity from the city of Ames system from 69,000 to 13,800 volts for use on campus. Electricity can flow either direction through the transformer depending on how much electricity is produced by the Iowa State University Power Plant.

Depending on availability and costs, Iowa State University purchases wholesale electricity from the Midcontinent Independent System Operator (MISO). MISO is the entity that operates the electrical grid in the midsection of the United States and a portion of Canada.

Plant operators each day compare hourly electricity prices with the production costs at the power plant. They determine how much electricity to purchase or generate each hour of the day. They then work with operators at the city of Ames plant to schedule and flow the purchased electricity into campus. Power purchased from MISO flows to the campus through two 161,000-volt transmission lines. The power then flows through the city of Ames electrical system to campus.



This substation connects the campus electrical system to the city of Ames system and the national electrical grid. This connection allows the power plant to purchase low-cost electricity when available from other sources.

NORTH CHILLED WATER PLANT

In the late 1990s, the cooling requirements at the university were approaching the capacity of the chillers located in the power plant, so planning began for construction of a satellite chilled water plant to serve anticipated construction on the northwest portion of the campus. The North Chilled Water Plant was constructed in 2003 and currently houses a steam-driven chiller with 4,000 tons of cooling capacity and a cooling tower.

The plant was constructed with space for additional capacity and a second cooling tower in the future. Additional capacity is needed by summer of 2018 to meet increasing campus cooling loads. The North Chilled Water Plant and the main power plant are interconnected and operated jointly to serve the cooling needs of campus.

VETERINARY MEDICINE CAMPUS

Utility Services is responsible for the operation and maintenance of a satellite facility at the veterinary medicine campus. The plant contains four gas-fired steam generators to produce steam for the facility. There are four electric chillers to produce chilled water for cooling the facility. There is also a heat recovery chiller that simultaneously produces chilled water and hot water. The total cooling capacity for the vet med campus is 4,500 tons. Electricity for the vet med campus is purchased from the city of Ames.

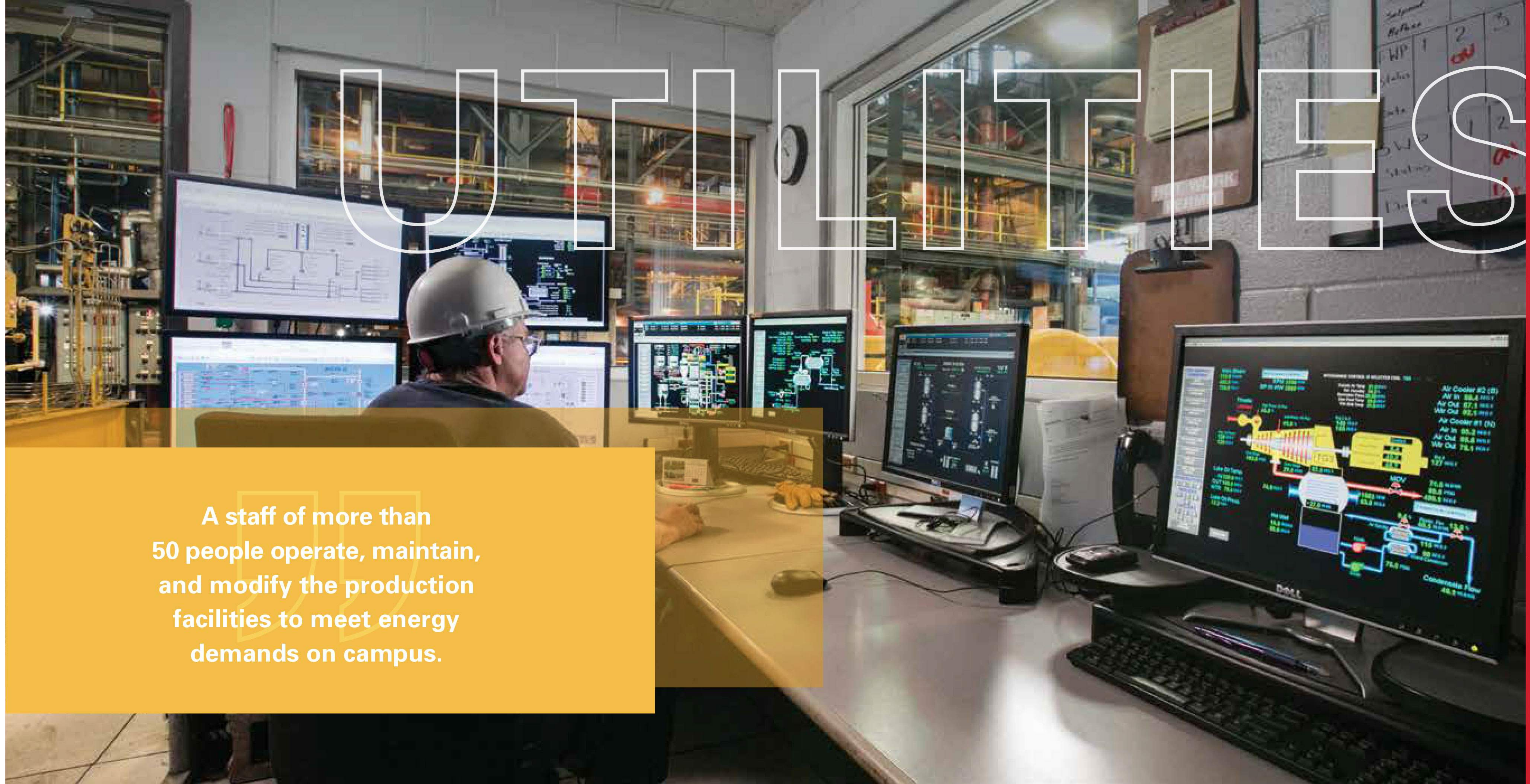
UTILITIES

APPLIED SCIENCES COMPLEX

Utility Services is responsible for the operation and maintenance of a satellite facility at the Applied Sciences Complex. This complex of buildings is located north-west of the main campus on Scholl Road. This plant consists of a modular chiller and two gas-fired steam generators. Electricity for the Applied Science Complex is purchased from the city of Ames.

PRODUCTION FACILITIES

A staff of more than 50 people operate, maintain, and modify the production facilities to meet energy demands on campus. Staffing consists of operators, mechanics, material handling staff, engineers, and other support staff. Their goal is to operate the production facilities in a safe manner and provide reliable, efficient, and environmentally sound utility services to the campus. Operators are on staff 24 hours a day to oversee the operation of all four production facilities.



A staff of more than 50 people operate, maintain, and modify the production facilities to meet energy demands on campus.

UTILITY METERING

Utility Services operates as a rate-based enterprise and charges the colleges and other campus customers for their utility consumption. This process allows the university to fully account for operating costs of the various entities on campus and to build an awareness for energy conservation opportunities for the campus buildings. In order to bill our customers, Utility Services maintains more than 750 meters for electricity, steam, chilled water, domestic water, and natural gas. Meters are read each month and customers are billed. Building consumption and customer energy data are available on the facilities planning and management website at www.fpm.iastate.edu.

DISTRIBUTION SYSTEMS

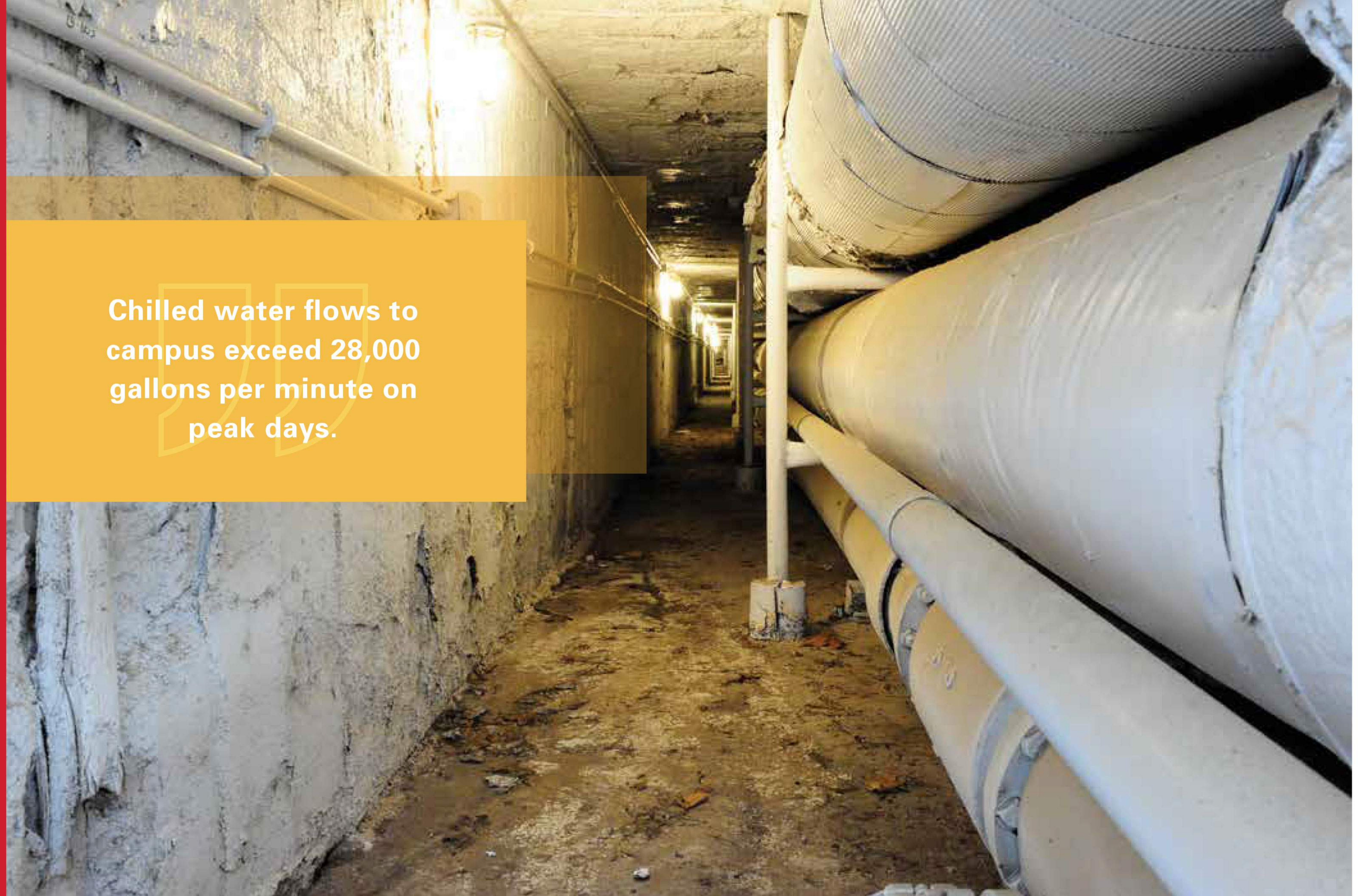
Once the steam, chilled water, and electricity are produced in the power plant, they must be distributed throughout campus to each building. Other utilities are also distributed throughout the campus. The distrbution systems consist of networks of steam tunnels, piping systems, and electrical systems. These systems are designed to provide reliable service to campus. Systems are looped and interconnected so they can be maintained with minimal impact to building operations.

A staff of nearly 20 steamfitters, pipefitters, eletricians, high-voltage electricians, and engineers are responsible for all campus distribution systems. They operate and maintain these systems and modify or expand the distri-bution systems to serve a growing campus.

MECHANICAL DISTRIBUTION SYSTEMS

STEAM Low-pressure steam, which was already used to produce electricity, is extracted from the steam turbine generators. This steam, at 90 pounds per square inch pressure, is distributed throughout campus for heating and process uses. The main campus has 4.8 miles of steam tunnels. An additional 2.5 miles of direct-buried steam pipes supply steam to outlying facilities. The steam is distributed to campus buildings, flowing through radiators, air handling units, and water heaters to provide heat and hot water to the buildings. Peak winter steam flow exceeds 250,000 pounds per hour of steam. As the steam gives up its heat to the buildings, it is condensed. The condensed steam, called condensate, is returned to the power plant where it is used to make steam again.

CHILLED WATER The cooling needs of the campus are provided by chilled water that is produced in the power plant and the North Chilled Water Plant. Chilled water is distributed at 40 °F to more than 85 buildings and returns to the chiller plants at 55 °F to be cooled again and reused. Chilled water flows to campus exceed 28,000 gallons per minute on peak days. The chilled water distribution system includes more than 8.5 miles of direct-buried ductile iron pipes up to 36 inches in diameter. At each building, the chilled water flows through air handling units and fan coil units to provide cooling to the buildings.



Chilled water is provided to some buildings year around to cool research equipment, computer rooms, and animal rooms that need cooling, even in the winter months.

DOMESTIC WATER Utility Services operates and maintains the distribution system for domestic (drinking) water for the campus. This system also is used for fire protection. This system consists of more than 15 miles of direct-buried ductile iron or PVC pipe on central campus. The water for this system is purchased from the city of Ames, but the university owns, operates, and maintains the water distribution system on campus.

NATURAL GAS Utilities Services operates and maintains a natural gas distribution system on central campus. Gas is distributed at a pressure of 55 pounds per square inch through a network of more than 7 miles of polyethylene pipe. On central campus, natural gas primarily is used for cooking, laboratory, and research. Buildings north of the Union Pacific Railroad are heated with natural gas. Natural gas for campus is purchased from Alliant Energy, but the university owns, operates, and maintains the natural gas distribution system on campus.

COMPRESSED AIR The steam tunnel system also is used to distribute compressed air from the power plant at a pressure of 90 pounds per square inch. This distribution system has about 3.5 miles of copper pipe. The air is used primarily for pneumatic building controls and for laboratory or research needs.

SANITARY SEWERS Utility Services operates and maintains a sanitary sewer collection system. This system consists of a network of more than 13 miles of sanitary sewer lines on central campus that discharge to the city of Ames sanitary sewer system. The sewage is treated at the city of Ames wastewater treatment plant, which is jointly owned by the university and the city. The Wastewater Treatment Plant is located south of Ames along Interstate 35.

STORM SEWERS Utility Services operates and maintains more than 37 miles of storm sewers on central campus. The storm sewer system collects storm water runoff across the campus and ultimately discharges the storm water into Squaw Creek.

ELECTRICAL DISTRIBUTION SYSTEMS

ELECTRICITY Electricity is supplied to campus by a combination of the power plant generators and power purchased from others. Electricity is distributed to nine substations on campus. The substations include transformers and/or switchgear to reduce voltage and distribute electricity to the individual buildings. Electricity is supplied to the buildings at either 13,800 or 4,160 volts. Each building has a transformer or set of transformers to reduce the voltage down to 480, 208, and or 120 volts for use in the building.

The electrical distribution system is an underground network consisting of electrical manholes, medium voltage switches, and more than 25 miles of medium voltage cables. The cables are installed in duct banks made of conduits encased in concrete.

TELECOMMUNICATION CABLES Iowa State University owns and operates a telecommunication system on campus for voice and data service. It is network of more than 100 miles of fiber optic and twisted-pair copper cables in an underground conduit system. The system supplies voice and data services to all campus buildings. The telecommunications system is operated and maintained by the Information Technology Services department on campus.

STREET, WALKWAY, AND PARKING LOT LIGHTS Utility Services operates and maintains exterior lighting for pedestrian and vehicle safety. There are nearly 2,200 lights on poles throughout campus, serving roads, sidewalks, and parking lots.

TRAFFIC CONTROL Utility Services operates and maintains traffic signals at seven intersections on campus for vehicular control and pedestrian safety.

UTILITY LOCATES The extensive network of underground utilities on the campus requires care when excavating to make repairs, plant trees, or even to put stakes in the ground. Utility Services staff will locate all utilities before excavation can begin. Utility Services maintains maps of all underground utilities and provides the locate service. The utility maps also assist with campus planning.

For more information, please visit our website at www.fpm.iastate.edu. To arrange a tour of the power plant, please contact the Utility Services office at 515-294-8795.

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UTILITY SERVICES

IOWA STATE UNIVERSITY

CELEBRATING 150 YEARS OF COGENERATION

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