TEXAS
The University of Texas at Austin

DISTRICT ENERGY SYSTEM

Award Application for
International District Energy Association
System of the Year Award
April 6th, 2018

COVER PAGE

System Name
The University of Texas At Austin

Location
Austin, TX

Owner
The University of Texas System Board of Regents

Type Of Ownership
University

Contact
Juan Ontiveros, P.E.
Associate Vice President, Utilities and Energy Management
The University of Texas At Austin
215 East 24th Street
Austin, TX 78712

Phone: 512-232-4191
Email: juan.ontiveros@austin.utexas.edu

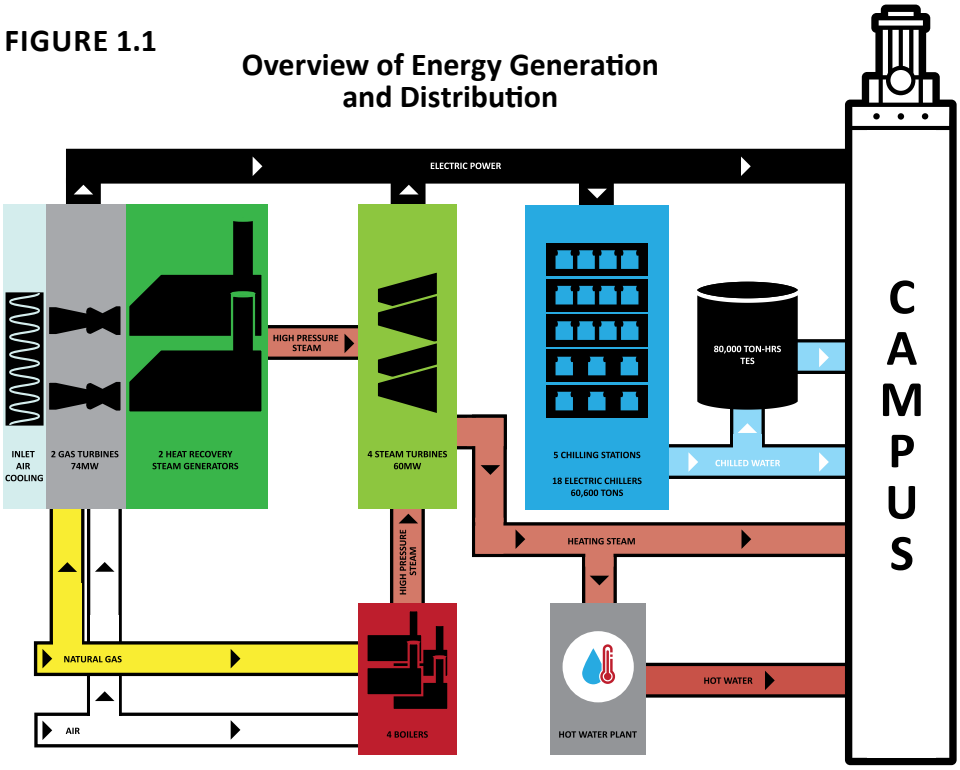
SYSTEM DESCRIPTION

WHAT STARTS HERE CHANGES THE WORLD

It's not just a motto, it's our mission at The University of Texas at Austin. Before Texas was annexed to the United States, UT Austin's original 40 acre main Austin campus was reserved by the Texas Congress in 1838, along with 50 leagues of land (approximately 288,000 acres) from which substantial oil and gas reserves have provided considerable funding resources to the University of Texas System's flagship Austin campus and its 13 sister institutions. Ranked among the biggest and best research universities in the country, UT Austin is home to a combined 70,000 students, faculty, and administrative staff. It offers nearly 400 degree programs and enjoys a network of nearly a half million alumni. Eighty percent of the 20 million square feet on campus is research-focused, operating 24 hours a day, 365 days a year. These research facilities support nearly $600 million dollars in contracts and research grants annually, demanding a highly variable and uninterrupted supply of energy at all times. The critical nature inherent in the university's new Dell Seton Medical Center creates a heightened mandate for reliable energy as the first new medical school in the Southwest United States in nearly fifty years. UT Austin's Combined Heat and Power system was commissioned in 1929 with a lignite-fired boiler steam system powering two 1.5 MW steam turbines and for campus heat. The system was converted to use natural gas in the 1930s and has evolved steadily over the years to self-generate 100 percent of all energy since 1929, with extremely high reliability and unparalleled efficiency.

FIGURE 1.1

Overview of Energy Generation and Distribution



BY THE NUMBERS

85%
Overall Campus Thermal Efficiency (gas btus consumed vs. thermal energy delivered to buildings)

134 MW
Generation Capacity (two CTGs and four STGs)

60,600 TONS
Chilled Water Production Capacity (18 chillers among five chilling stations)

9.1 MILLION GALLONS
Thermal Energy Storage Capacity (two independent CHW tanks totaling 80,000 ton-hours)

1.2 MILLION POUNDS PER HOUR
Steam Production Capacity (two HRSGs and four boilers)

4 – 50 MVA TRANSFORMERS
in ring-bus configuration
City Electric Grid Connection (provides N+4 redundancy during 80% of operating hours)

360,000 GPD
Distributed Deionized Water at < 15 microSiemens and < 0.5 ppm TOC

9 MILES
Distribution Tunnels

60 MILES
Electrical Distribution Duct Bank

SYSTEM ENERGY

A HISTORY OF INNOVATION

While UT Austin's Utilities and Energy Management (UEM) department has led among its industry peers for years as the most efficient university utility in the U.S., it continuously strives to improve. Despite incredible growth in both served space and energy output, carbon emissions are equivalent to 1976 levels due to ongoing efficiency improvements in both demand at the buildings and supply at the power and chiller plants. As a result, fuel consumption has remained flat for over forty years despite UT Austin more than doubling overall served building space, representing carbon-neutral growth spanning four decades. For the last ten of those years, UT Austin has made unprecedented reinvestment into its system, using money from energy savings and reduced fuel costs to obtain more avoided cost than debt used to pay off nearly $250 million dollars in energy efficiency and capacity improvements.

CAMPUS-WIDE EFFICIENCY

UT Austin's combined heat and power and district energy system eliminates the need for separate equipment at each building and enables the use of larger, more efficient equipment. The chillers have operated at an annual average of 0.67 kW/ton, well below the 1 kW/ton rate typical of district-scale systems. With the ongoing commissioning of Chilling Station #7 constructed in parallel with Dell Seton Medical Center, further efficiency gains of 15 to 20 percent have been demonstrated, and with the support of its two TES tanks, UT Austin can continuously run its plant closer to its maximum efficiency point, resulting in an overall System Energy Efficiency (SEE) of 85 percent (2014-2015). Because it runs on natural gas, UT Austin has an electricity Source Energy Intensity (SEI) of 7.4 MMBtu/MWh delivered – compared to a state baseline of 9.2 – and significantly lower CO2 and SO2 emission rates.

FIGURE 2.1

Campus-wide Efficiency

	2014	2015	2016	2017
Btu of Electricity Produced per Btu of Gas Consumed	35.7%	35.9%	36.3%	36.8%
Btu of Chilled Water Produced per Btu of Gas Consumed	192.7%	186.6%	179.0%	207.6%
kW/Ton for Chilling Stations	0.672	0.669	0.689	0.690
COP of Chilling Stations	5.234	5.257	5.104	5.097
Overall Efficiency to Campus	85.71%	84.08%	82.72%	83.20%

BEHIND THE NUMBERS

The values in FIGURE 2.1 were derived using the following formulae:

kW/Ton for Chilling Stations

$$Eff_{kW/ton} = \frac{\text{Total Power Consumed by Chilling Stations}}{\text{Total Chilling Station Output in Tons}} = 0.672$$

COP of Chilling Stations

$$Eff_{COP} = \frac{\text{Ton}}{0.714\ kW} \times \frac{kW}{3412\ Btu} \times \frac{12{,}000\ Btu}{\text{Ton}} = 5.234$$

Overall Efficiency to Campus

$$Eff_{overall} = \frac{\text{Total Thermal Energy Delivered to Campus}}{\text{Total Natural Gas Energy Consumed}} = 0.8571$$

CAMPUS DOLLARS, BUILDING SENSE

The Energy Management and Optimization (EMO) team within UEM aims to reduce 20 percent of demand-side energy consumption on campus by the year 2020 (2009 baseline). Working well ahead of schedule, the main UT Austin campus has achieved an 18.4 percent energy reduction by utilizing behavior-based strategies for campus occupants and engineered strategies to optimize campus building systems. Behavioral programs include "Longhorn Lights Out" to curtail lighting in unoccupied spaces and "Horns Up, Sash Down" to minimize unnecessary lab exhaust. Technical efforts include HVAC scheduling and reset strategies, ventilation reduction, and lighting retrofits. Finally, EUI targets for new construction based on building type, along with new construction commissioning targets, were both published in 2017 to ensure new projects on UT Austin's campus meet UEM's high bar for performance. The EMO campus team measures the success of building efficiency using Energy Utilization Index (EUI), with an impressive reduction from 207 MBTU/sf/yr in 2010 to 160 MBTU/sf/yr in 2018, as shown in FIGURE 2.2.

FIGURE 2.2

UT Austin Campus EUI

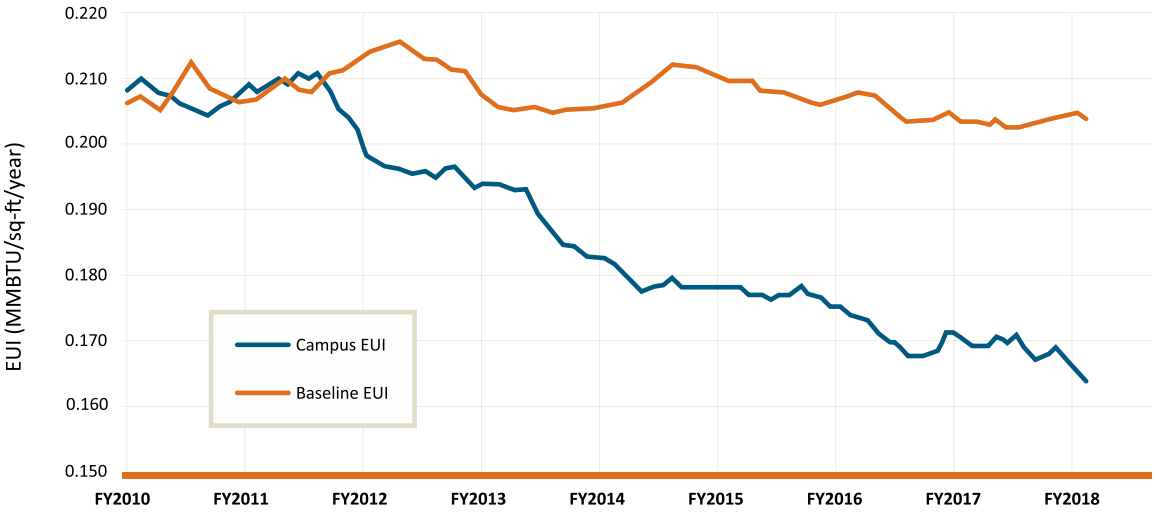


FIGURE 2.3

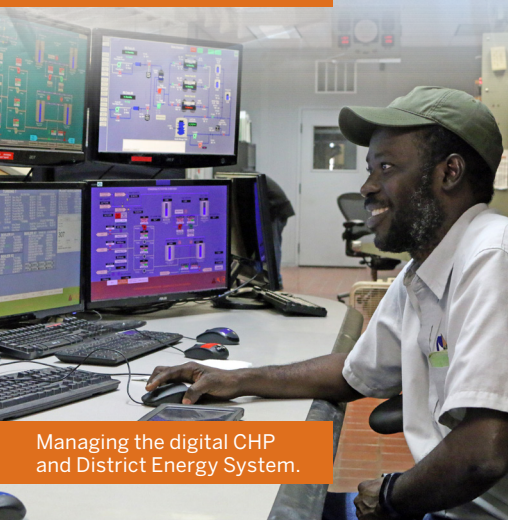
Key Successful Demand-Side Projects

Building	Total EUI Before Project	Total EUI After Project	Percent Reduction
Gates Dell Complex	212	135	36%
Belo Center for New Media	137	102	25%
Liberal Arts Building	130	97	25%
Blanton Museum of Art	776	239	69%
Biomedical Engineering Building	303	270	11%
Peter T. Flawn Academic Center	119	97	18%
North End Zone Building	115	96	16%
UT Administration Building*	48	43	12%
Edgar A. Smith Building	200	164	18%

*Electricity only

Modernizing from legacy technologies to digital.

Maintenance is performed using in-house forces.



Managing the digital CHP and District Energy System.

DEMONSTRATED RELIABILITY

GRID CONNECTION … A LIABILITY?

Given the incredible breadth of research customers on UT Austin's campus as well as the inherent criticality of a budding new medical school, UEM's commitment to reliability is first and foremost. Over the last forty years, the UT Austin grid has proven substantially more reliable than the City of Austin's municipal power grid, which itself favors well against national averages. (See "Reliability" chart below.) With that in mind, UT Austin has maintained firm capacity to deploy grid islanding capability for 100 percent of its 65MW peak main campus load. In terms of performance metrics, UT Austin has an Average Service Availability Index (ASAI) of 99.998 percent compared to Austin Energy's ASAI of 99.989 percent, far better than the U.S. average of 99.955 percent. These values translate to System Average Interruption Duration Index (SAIDI) values of 10, 58, and 240 outage minutes per year, respectively. UT Austin's Average Interruption Frequency Index (SAIFI), 0.11, also compares an order of magnitude lower than the U.S. average, 1.5 events/year. Features enhancing our impressive availability include:

Utilities Savings Reinvestments – For nearly twenty years, cost avoidances resulting from efficiency gains, pricing, and campus improvements have been reinvested into our mission, creating a financial model of ongoing success for other district utilities world-wide. These investments not only elicit confidence from campus administration and customers, but also maintain high morale among UEM staff members.

Redundant Redundancies – UT Austin's CHP system is comprised of two CTG/STG pairs that are completely N+1 redundant for 99 percent of annual load hours up to 60MW, in addition to double redundant ties to Austin's municipal grid, enabling 2N+2 redundancy for all but <1% of annual hours, during which it is conservatively N+2 redundant. In addition, each of the main campus' five chilling stations is at least N+1 redundant.

Underground Utilities – Our utility system serving 18 million square feet of facilities and over 150 buildings is entirely underground, and includes nine miles of tunnels, 60 miles of electrical duct bank and 100 percent redundant electrical, steam and chilled water connections to buildings. Only the two stand-by redundant 69kV feeders from Austin's municipal utility run overhead to UT Austin's substation. Hurricane-induced severe thunderstorms bringing high winds and lightning, and even tornados, would have little impact to our utility network. Underground utilities also enhance safety and campus aesthetics.

True Utility Looping – We loop utility distribution lines for all services (electricity, steam, hot water, chilled water and domestic water) and employ automated SCADA-based load shedding and ring bus distribution for electric customers on our campus.

TERMIS Live Chilled Water Model – Our TERMIS system allows us to compare expected building loop pressures with live data via real-time model to spot and remedy cooling issues before they impact the customer.

Utility Outage Communication – We work with assigned building managers to schedule necessary utility outages for their buildings. In addition, a UEM-developed software solution used in conjunction with the SCADA system will be deployed in summer of 2018 to automatically notify electric outage status to customers by text in real time. It includes a link to live web based outage mapping complete with real time outage information.

GIS Mapping and Utility Locates – We have a complete campus GIS underground utilities map and a robust utility-locating and surveying team to help reduce the chance of accidental utility outage from construction and beautification efforts.

Security and Surveillance – We use a combination of fencing, gates, surveillance cameras, and campus police department-tied motion detectors to protect our utility plants and tunnels. A complete overhaul of this system completed in 2017 included dozens of new cameras and plant entrance proximity card readers. An audit of card access lists is completed annually. This helps ensure the security of our utility assets, our staff, and our campus community.

FIGURE 3.1

Availability and Reliability

Year	Utility	Total Hours of Forced Outages	Availability	Hours of Unplanned & Interrupted Services	Reliability
2016	Steam	0	100%	0	100%
	Electric	0	100%	0.01667	99.99999%
	Chilled Water	0	100%	0	100%
	Deionized Water	0	100%	0	100%
2017	Steam	0	100%	0	100%
	Electric	0	100%	38.167	99.99374%
	Chilled Water	0	100%	0	100%
	Deionized Water	0	100%	0	100%

We use a load control system to manage all electricity, steam, hot water and chilled water along with digital controls with the capability of sustaining 100% of the utility services to the campus. This system uses natural gas and electricity via a 25 MW stand-by agreement with Austin Energy to provide 100% of the electricity, steam, hot water and chilled water to 164 buildings.

The values in FIGURE 3.1 were derived using the following formulae:

$$\textbf{Availability \%} = 1 - \frac{\text{Total hours of forced outage}}{\text{(total hours in period) (no. of production units)}} \times 100$$

$$\textbf{Reliability \%} = 1 - \frac{\text{Customer hours of unplanned and interrupted service}}{\text{total annual customer hours}} \times 100$$

The values for 2016 Electric were derived as follows:

$$\text{Availability} = 1 - \frac{0}{(8760)\,(6)} \times 100$$

$$\text{Reliability} = 1 - \frac{0.01667 \text{ hours}}{(8760)\,(164)} \times 100$$

DEMONSTRATED RESILIENCY

UT Austin paves the way as a leader in resilient enterprise operation. It has strategically diversified its various assets and has developed change management and response methodologies to weather any conceivable challenge. Some key resiliency elements to our system include:

100 Percent On-site Generation – Generation capacity to meet 100 percent of annual demand, including on-site N+1 redundancy for our prime movers under 99 percent of all load conditions, provides the flexibility to serve our critical research customers.

Islanding Capabilities – The load control system is capable of seamlessly islanding the campus if frequency, voltage or back-up power availability from Austin Energy/ERCOT (Electric Reliability Council of Texas) meets critical criteria.

> **"UT AUSTIN PAVES THE WAY AS A LEADER IN RESILIENT ENTERPRISE OPERATION"**

Load Shedding Capabilities – The load control system can handle excess internal power demand by using the TES capacity first, shedding chillers second if needed, and third, by shedding building loads if needed to prevent a loss of the power plant. In addition, excess steam created by a tripping steam turbine can cause the system to have 400K lbs per hour of excess steam at 420 psi, 700F. This excess is handled by an automated on-line steam quenching station vented to a muffler tuned to 85 dB at a low frequency. This venting noise is invisible to the campus, allowing the plant to resolve the issue and get back on line.

Leveraged Technologies – Our district energy system employs fully-automated SCADA-based controls. Over 900 building meters tie 100 percent of building loads to the HanAra Prism historian for data integrity, validation and trending and the TreFoil utility billing software.

Redundant Electric Interconnection to Austin Energy Grid – This interconnection allows 2N+2 system redundancy for nearly all system load conditions.

Steam Backup – If a combustion turbine (CTG) were to trip, burner management systems allow stand-by boilers to stay in hot stand-by with very little efficiency penalty. They utilize a 0 percent to 100 percent turn-down capability, which allows for a full load response in a matter of minutes.

Generation Redundancy – We maintain N+1 redundancy for all major equipment producing steam, electric, and chilled water, including two independent high-pressure natural gas mains to the plants.

Equipment Flexibility – Our district energy system has two combustion turbine generators, four steam turbine generators, four boilers, and 18 electric chillers, providing great flexibility to reliably and efficiently dispatch our equipment.

Thermal Energy Storage – Two TES tanks totaling over 9 million gallons of chilled water storage not only provide efficiency through added dispatch flexibility and load shifting of up to 10 MW, but also add resiliency during unexpected conditions.

Network Security – UT Austin operates and maintains multiple dedicated, highly secure utility data networks separate from the main campus network. These isolated networks have extremely limited external connectivity and are secured via multiple firewalls and other industry best practice protection systems and methodologies.

Disaster Recovery – Completed in 2017, our newly-authored Disaster Recovery Plan defines the response strategies to all conceivable risks and serves as a model document for other UT System institutions.

Reliable Distribution – Over 70 miles of underground, looped distribution systems provide utilities for the entire campus and include redundant 12kV electrical feeds to all buildings.

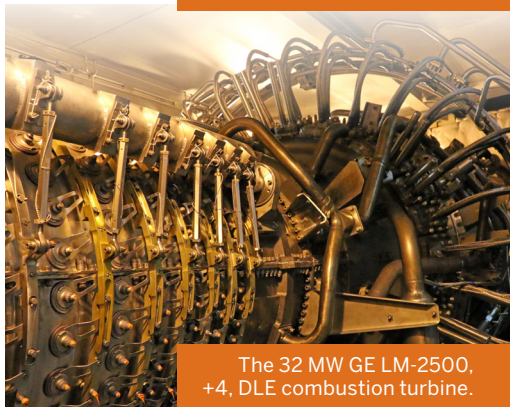
People – UT Austin's district energy system is sustained by a professional staff of 170, including nearly a dozen registered professional engineers, to provide the in-house expertise essential for a system of such incredible complexity and size.

Fuel Flexibility – Fuel options consisting of both natural gas and 200kgal of fuel oil storage provide reliability and redundancy.

Live Plant Health Monitoring – Our district energy system uses a real-time monitoring system, Plant Health Index by HanAra software, which has proven effective in nuclear plants world-wide to predict equipment failures far earlier than other common technologies.

Six new 2,500 ton chillers in the chilling station supporting the Dell Medical School and main campus.


Exterior view of the new Chilling Station #7 serving Dell Seton Medical Center.


The 32 MW GE LM-2500, +4, DLE combustion turbine.

ENVIRONMENTAL BENEFITS

Our district energy philosophy has provided major contributions to UT Austin's environmental stewardship. From the incredible improvements to both supply and demand side energy conservation, as well as with careful stewardship of our resources wherever possible, key benefits are derived from the following:

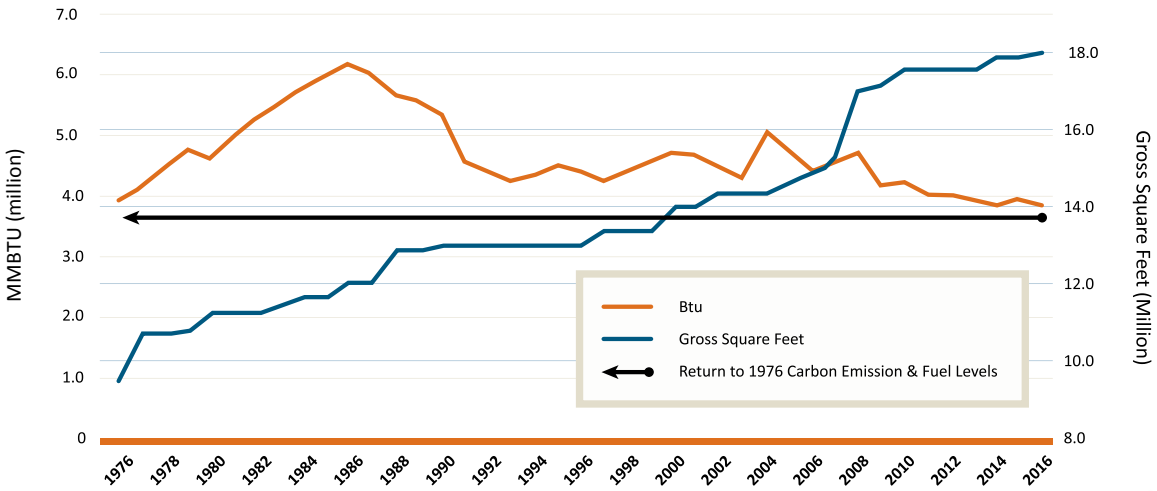
Energy Conservation – Since 2009, demand-side energy use has been reduced by nearly 20 percent, and annual utility cost avoidance from supply-side energy conservation measures has reached $12 million, totaling nearly $160 million over the last 15 years.

Carbon-neutral Growth – From our prodigious energy conservation efforts, UT Austin has maintained flat natural gas use since 1976, despite campus growth of over 100 percent, representing four decades of carbon-neutral development and offsetting over 220,000 metric tons of CO2 production each year.

Water Re-use and Use Reduction – UT Austin recaptures fin water from nearly all building HVAC equipment and utilizes it to offset cooling tower makeup. It also uses purchased reclaimed water, offsetting the need for over 1.2 billion gallons of municipal water use since 2006.

FIGURE 5.1

Effects of Utility Improvements



Emissions-Reduction Technologies – Curbing especially harmful emissions via advanced burner controls management, steam injection, FGR/NOx-reduction retrofits, and an on-demand urea hydrolysis SCR is key to meeting aggressive NOx and SO2 goals.

Asbestos Abatement – UT Austin manages an in-house abatement shop that proactively abates plant and building ACBMs whenever possible.

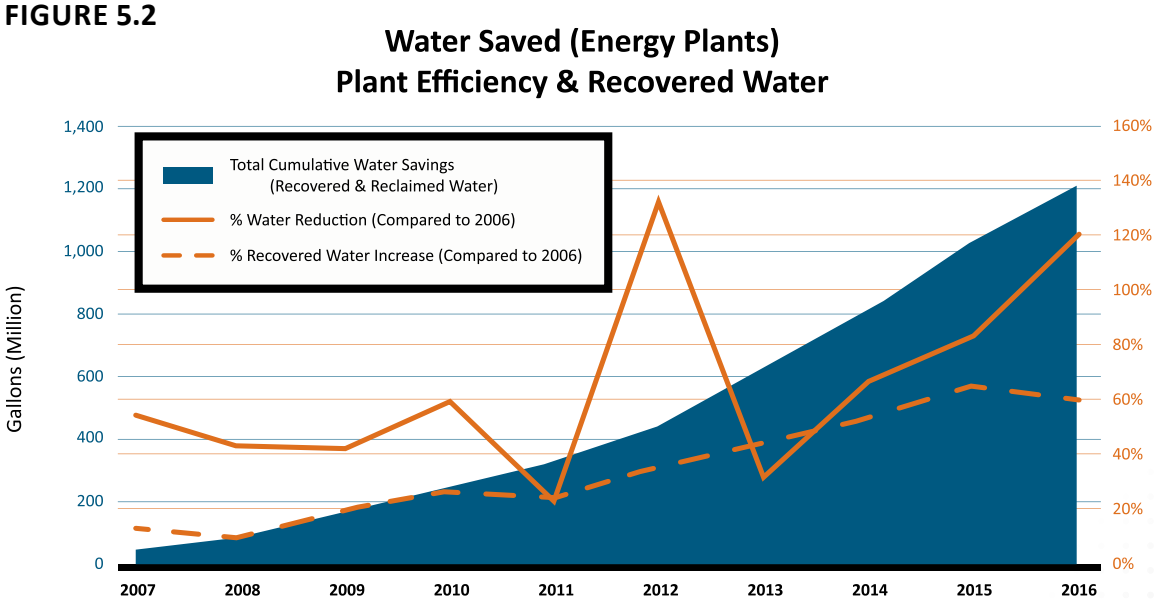
Refrigerant Stewardship – The primary refrigerant used in our chilling stations is R-134a with limited use of R-22 in older, seldom-used chillers. We are testing other next-generation refrigerants on campus, such as R-1233zd (GWP = 1), used in a pre-production York YZ centrifugal chiller that is one of only two field trial machines in the world.

Transformer PCBs – UEM has replaced PCB oil with biodegradable alternatives, and all new oil-filled transformers use environmentally friendly oil.

Chemical Management – We work closely with our water treatment partners and other vendors along with the university's Environmental Health and Safety department to properly manage bulk chemicals, turbine lubricants, stored liquid fuel oil, and other industrial products. Control measures and hazardous material management are strictly enforced.

Waller Creek Transformation – In 2017, UT Austin completed a project in concert with a team of industry experts to remove invasive species and adaptive plants to improve sustainability of the Creek's natural habitat while also enhancing safety and visibility. A comprehensive management plan was also adopted and will ensure its long-term health. The creek runs through the main UT Austin campus and is located adjacent to the power plant and other UEM facilities.

FIGURE 5.2



SUSTAINABILITY

PIONEERS NOW, FOR EVERYONE LATER

UT Austin leads the nation in carbon-neutral, campus-scale development, effectively doubling in size over the last four decades with no increase in fuel consumption. Our district energy system has been paramount to this achievement, improving steadily over this same time and with the following sustainability features:

Campus Energy Portal – UT Austin has developed original software to showcase our metering data of every building's utility use over time, and represent each building graphically in a remarkably convenient interface, making the "Energy Portal" fun to use and easily accessible to the entire campus community. It is also used by energy engineers and stewards to view energy asset production that can be trended and perform M&V functions including on the fly weather normalizations of building energy use.

Inaugural PEER Certification – The GBCI's LEED program has been long recognized as the industry standard by which all building projects are deemed sustainable, and in 2014 UT Austin's district energy system was honored to be the world's first university certified under GBCI's new Performance Excellence in Electricity Renewal or "PEER" program. PEER recognizes industry leaders for improving efficiency, day-to-day reliability and overall resiliency.

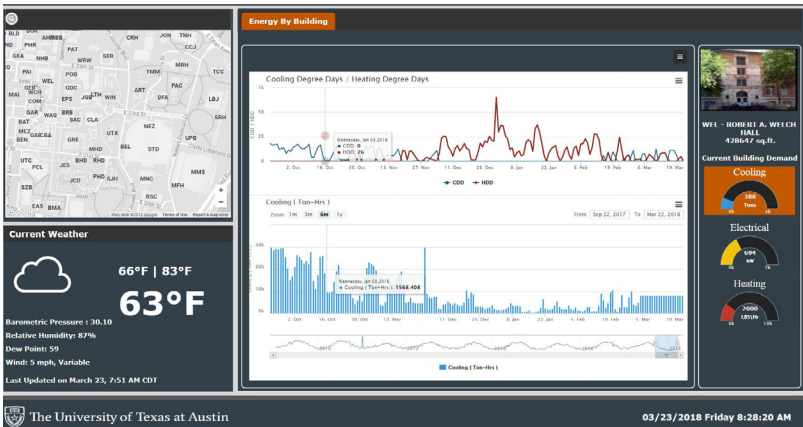
On-site Renewables – UT Austin maintains 546kW of nameplate photovoltaic capacity to complement its storied portfolio of efficient on-site energy generation and offsets 450 tons of CO2 emissions annually, in addition to the 220,000 metric tons of emissions offset annually by our carbon-neutral growth.

GreenChoice Participation – In 2015, UT Austin joined Austin Energy's GreenChoice Renewable Energy Program, in which all power not provided by UT Austin's district energy system – for example the Pickle Research Campus on which sits ***the nation's most powerful non-DOE supercomputer "Stampede II" – is powered by West Texas wind.***

Reclaimed Water – Since its connection to the Austin municipal reclaimed water use system in 2013, UT Austin's district energy system has offset over 173 million gallons of potable water.

District-Scale Water Reuse and Recovery System – In recent years, water and wastewater prices at UT Austin have risen dramatically due to price increases from the city's utility. UT Austin responded in early 2018 by proposing to install its first on-site reclamation and reuse system, which will displace up to 170 million gallons of potable water use per year while providing an N+1 redundant water supply for all utility makeup water needs and decrease wastewater discharge by nearly 50 percent. Substantial projected carbon reductions also accompany several million dollars of annual cost savings to UT Austin.

Central Irrigation System – Water conservation is a top priority for UT Austin, which uses a central irrigation system to assist in managing the irrigation usage across campus. The system detects breaks in the system and shuts down leaks within minutes, saving over 10 million gallons of water in 2012 with just that one feature. Since implementation of the central irrigation system and new irrigation practices, irrigation usage on campus on the automated irrigation systems has dropped by 66 percent, resulting in annual savings of over 100 million gallons.



UEM-developed Energy Portal software allows real-time energy trending to the UT Austin community.

SAFETY AND TRAINING

DISTINGUISH THE DEPARTMENT AS THE BEST-TRAINED UNIVERSITY UTILITY IN THE UNITED STATES

This is one of the strategic goals identified in the UEM strategic plan. We aim to accomplish this goal by maintaining a comprehensive safety and job skills-based training program.

Our programs are based on cultivating a safety conscious culture and providing our employees with the training required to support the operations of the power plant, chilling stations, and electrical and mechanical distribution.

JOBS SKILLS BASED TRAINING PROGRAM

In September 2005, UEM implemented a training certification program in response to the ongoing retire-ments of longtime employees whose valuable knowledge and experience were being lost. The initial program, based on specific training by individual job title, was subsequently converted to a self-paced plan that combines learning program with hands-on training that is directly related to the job being performed. The program is periodically updated as new equipment is brought on line and old equipment is retired.

The certification program educates employees using industry-standard power, steam and chilling station training procedures and resources. This is followed by plant-specific operations training and a hands-on demonstration and verification process that ensures the knowledge has been conveyed and tools are being used appropriately. Only by creating a program that certifies personnel for positions was it possible to formalize a complete training program.

In 2017, UEM employees completed 1,652 hours of the training program. This was higher than the 865 hours of training completed in 2016. The increase in training participation is due to the benefit of being "certified." In addition, UEM provides an incentive to complete the certification.

UEM offers incentives to complete the training program to both to new employees and to existing employees seeking a promotion. The department pays for up to six hours of overtime per week until the curriculum is completed. To encourage further progression of already-certified employees, an employee can precertify for higher-level positions, giving that individual an advantage over other candidates who are not precertified. Promotion opportunities are posted in-house before they are announced externally, further incentivizing employees to move up within the department rather than seek positions elsewhere. This approach has served UEM well, allowing employees to advance within the department based on knowledge and experience.

High lift training for employees.

SAFETY POLICIES AND PROGRAMS

Our safety program driven by the UEM Employee Engagement Plan and administered by our Support Services division focuses on the following tasks:

- Review existing safety programs, coordinate monthly safety drills and meetings, report safety violations and maintain safety training records. This is the responsibility and authority of the safety manager.
- Develop a safety committee and authorize at least one point of contact per plant shop in the committee. The safety committee point of contact, with the guidance of the safety manager, has the authority to ensure safety policies are enforced.
- Conduct plant shop focus groups to address key safety issues and concerns.

Key features of our safety policies and programs are as follows:

- **Footwear Policy** ensures safety of employees when working in areas where there is a danger of foot injuries due to falling or rolling objects, or objects piercing the sole, and where such employees' feet are exposed to electrical hazards while on the job.
- **Eyewear Policy** requires that employees wear prescription safety glasses when work operations warrant their use.
- **Respiratory Protection Program** ensures that all employees are protected from exposure to respiratory hazards.
- **Walking and Working Surfaces Program** provides safety precautions to reduce slips and trips, as well as precautions and protection systems to reduce fall hazards.
- To reduce the rate and severity of material handling injuries experienced by employees, UEM created a **Material Handling Program** to establish best practices for lifting objects and for turning valve wheels.
- **Heat Stress Program** establishes requirements to assess and mitigate heat stress hazards when performing work in the power plant and chilling stations.
- **Hazcom Program**, conducted in coordination with Environmental Health and Safety, maintains records of hazardous materials and coordinates their disposal.
- **Emergency Preparedness** ensures AED units, CPR kits, First Aid kits, and emergency escape kits for employees are inspected and maintained.
- **Other Safety Programs:** Lockout/Tagout, Confined Space Entry Program, Elevated Work and Fall Protection, Hazard Communication Program, Exposure Control Program, Hazard Assessment, Personal Protective Equipment Program, Industrial Hygiene, Contractor Safety Program, Emergency Management Plan, electrical safety and hearing protection.

In 2017, UEM employees completed a total of 525 hours of classroom and online safety training. Our reportable accidents resulted in only 2 days of lost time in 2017 and 117 days in 2016.

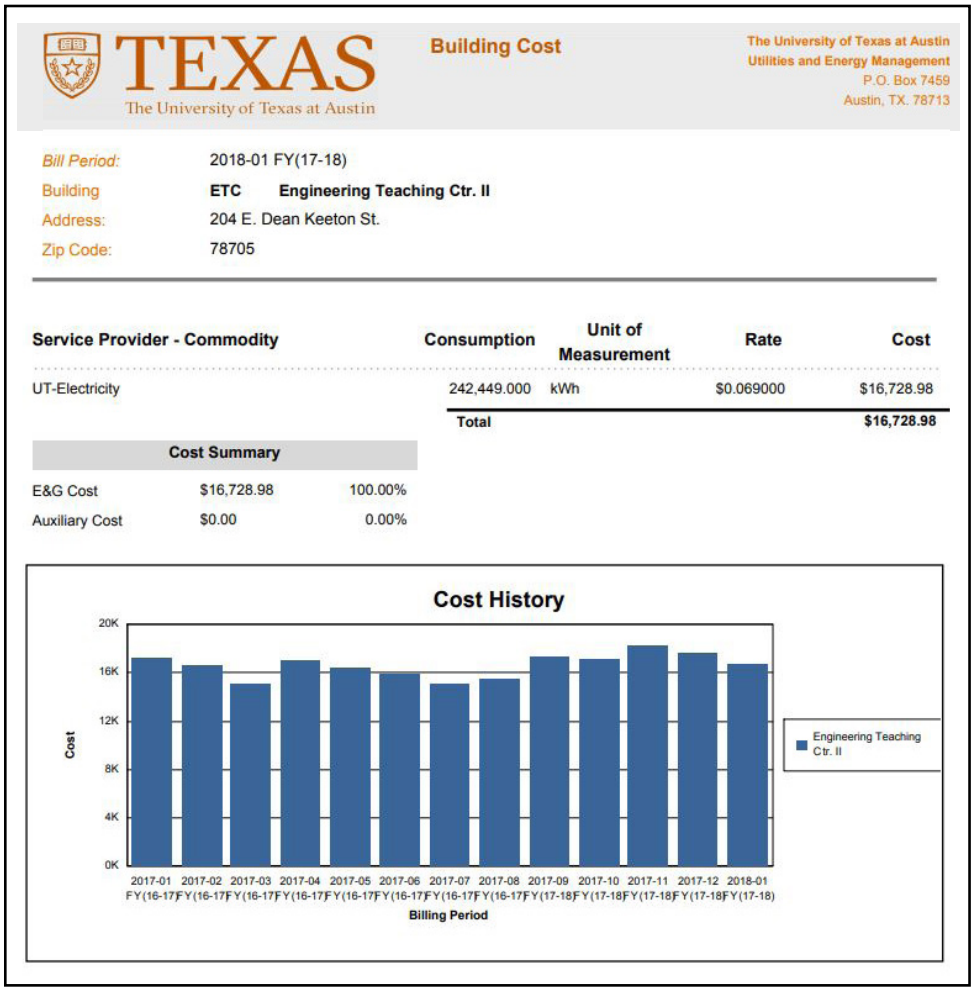
CUSTOMER RELATIONS AND SERVICE IMPROVEMENTS

UT Austin is constantly utilizing tools, technologies, and techniques to achieve its goals of maintaining high efficiency and performance required to offset campus growth. The use of these tools has allowed UEM to maintain a high level of service to university customers.

BILLING SYSTEM

All utilities are included in the automated monthly bill, including purchased utilities such us fuel gas and water. The system also validates purchased utility billing for over 200 meters and the 4 million MMBtus of natural gas purchased by scanning in the paper bills overnight, results of which are then validated with a click to compare the bill accuracy against the calculated validation. Historical cost behavior is easily accessible and can be trended, and cost allocation calculations for multiple occupancy facilities are also part of the new billing system. Energy bills are now sent to customers via email in a timely manner, and any reported issues are addressed within a couple of days.

FIGURE 8.1



TEXAS
The University of Texas at Austin

Building Cost

The University of Texas at Austin
Utilities and Energy Management
P.O. Box 7459
Austin, TX. 78713

Bill Period:	2018-01 FY(17-18)
Building	**ETC Engineering Teaching Ctr. II**
Address:	204 E. Dean Keeton St.
Zip Code:	78705

Service Provider - Commodity	Consumption	Unit of Measurement	Rate	Cost
UT-Electricity	242,449.000	kWh	$0.069000	$16,728.98
	Total			**$16,728.98**

Cost Summary

E&G Cost	$16,728.98	100.00%
Auxiliary Cost	$0.00	0.00%

ENERGY PORTAL

UEM's Energy Portal was created to support demand-side energy conservation. The portal is a tool which faculty, staff and students can use to look at the energy behavior of an individual building or a group of buildings. The portal allows users to customize visualization by building categories, energy use index, cost, energy type, environmental impact and time-frame.

Information offered through the portal can be used for research, as well as to reduce energy consumption by monitoring building energy use.

DELL SETON MEDICAL CENTER

The Medical Center, built adjacent to the southeast end of the campus, went live in May 2017. UEM provides day-to-day chilled water and hot water to cover the hospital needs. Considering reliability of supply, a new 15,000 tons chilling station was built to complement the already reliable chilled water loop to the main campus.

New infrastructure was also developed on the hot water distribution, with three sources available for use: Heat Pump Chiller technology, hot water boilers, and steam-to-hot water heat exchangers, making the supply of hot water a robust and reliable source to the Medical Center.

ENERGY SAVINGS PROJECTS WITH CAMPUS CLIENTS

UEM's Energy Management and Optimization (EMO) group performs existing building commissioning consisting of minor repairs and a system-wide sequence of operation overhaul. This existing building commissioning effort resulted in a 24 percent overall energy reduction in one section of UT Austin's football stadium, saving the university's Athletics Department over $215,000 to date, with a payback period of less than two months.

After the success with Athletics, the EMO group is now partnering with the university's Division of Housing and Dining to perform a similar commissioning effort at two of their residence halls.

INVOLVEMENT IN THE COMMUNITY AND PROFESSIONAL ORGANIZATIONS

EDUCATION

Partnering with campus departments, local colleges and trade schools has provided us with unique insight from professors and students to enhance the campus utility operations. We have partnered with the local educational community in the following ways:

- UEM staff has worked with UT Austin professors in the Engineering program to conduct classroom instructional sessions based on our chilling station equipment, as well as collaborated in a graduate student's federally funded grant project to study cooling tower water constituents and biological activity.
- We have partnered with local community colleges and trade schools and created a trainee program for utility workers. The program was established in response to the industry aging population and the difficulty in finding trade workers in the Austin area. The trainee program started with a handful of student workers; now we have a total of eight full time workers who came out of this program.
- Students enrolled in the engineering colleges are hired to work on special plant-related projects. There is a mutual benefit to these programs as students gain real world working experience and the plant gains valuable low-cost opportunities from the students performing supervised engineering jobs.
- UEM staff participated in developing a hydraulic model for a domestic water leak detection study. The study utilized actual data from the power plant and campus buildings to characterize detection limits and identify potential buildings causing transients.

The Green Fee, a competitive grant program funded by UT Austin tuition fees, is used to support sustainability-related projects and initiatives proposed by university students, faculty or staff. Since the program's creation in 2011, over 160 grants have been awarded, totaling over $3 million dollars.

LOCAL GOVERNMENT AND BEYOND

UEM and UT Austin staff members participate actively in the City of Austin Joint Sustainability Committee to advise the city council on matters related to conservation and sustainability. Our plant staff actively engages with Austin Water, the city's water utility, to develop and keep informed of potable water, wastewater, reclaimed water and rain water capture initiatives and how we can work with the city to manage growing water demand.

UT Austin staff members have served in board member positions for the following organizations:

- International District Energy Association (IDEA)
- Texas Association for Physical Plant Administrators (TAPPA)
- Central Association of Physical Plant Administrators (CAPPA)
- Big Ten and Friends

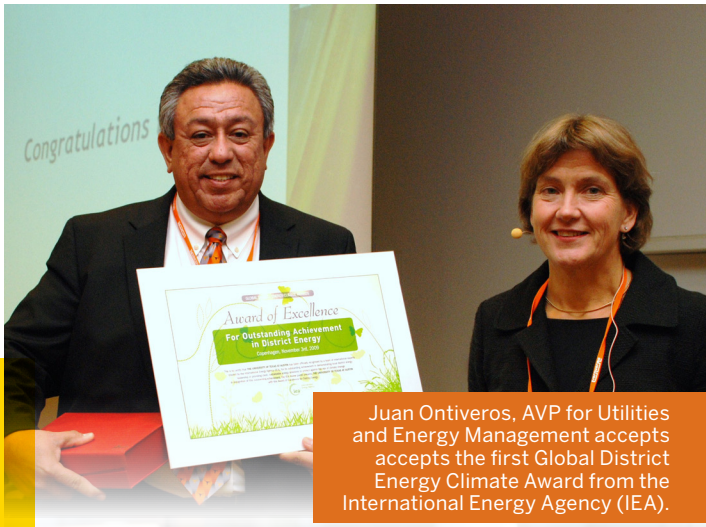
Our technical staff maintains memberships and interacts with the following professional organizations to ensure we utilize the latest standards and technologies in the design and operation of campus plant and buildings: ASHRAE, U.S. Green Building Council, IEEE, AASHE, APPA, ISA, EPA CHP, Microgrid Resources Coalition and AWWA.

UEM staff has conducted more than 50 plant tours in the past two years alone, to educate students and professional organizations on the operations of our CHP and district-energy system.

AWARDS AND RECOGNITIONS

We are proud to be recognized by nationally and internationally renowned industry related associations, publications and organizations. Some of the awards we've received over the past years include:

- Pacesetter Plant Award by the Combined Cycle Journal for The University of Texas at Austin Carl J. Eckhardt Heating & Power Complex
- Certificate of Recognition by the Texas Comptroller of Public Accounts-State Energy Conservation Office for the university's efforts in energy efficiency and improving air quality in the state of Texas
- Energy Star System of the Year Award presented by the Environmental Protection Agency (EPA) and U.S. Department of Energy for excellent leadership in energy use and management
- Award of Excellence for Outstanding Achievement in District Energy by the International Energy Agency
- American Council of Engineering Companies of Texas Engineering Excellence Award (Building/Technology Systems Silver Medal) for The University of Texas at Austin Chilling Station 7
- Steel Tank of the Year/Special Storage Systems: The University of Texas at Austin by the Steel Tank Institute/Steel Plate Fabricators Association
- Certificate of Avoided GHG Emissions by Combined Heat and Power (CHP) and the EPA in recognition of The University of Texas at Austin's contribution to efficient U.S. energy production
- ICI Conservation Award by the Water Conservation Division Water and Wastewater Department, City of Austin
- Corporate Energy Management Award for Region IV by the Association of Energy Engineers (AEE)
- GBCIs' Performance Excellence in Electricity Renewal (PEER) program recognition for UT Austin's district energy system.



Juan Ontiveros, AVP for Utilities and Energy Management accepts accepts the first Global District Energy Climate Award from the International Energy Agency (IEA).

Mahesh Ramanujam, president and CEO of U.S. Green Building Council presents Juan Ontiveros, with PEER Certification award.

TEXAS

The University of Texas at Austin