ESL-TR-99/12-03

Report of Energy Efficiency Study and Metering/Utilities Profile for Electricity Deregulation at Texas A&M International University (TAMIU) Laredo, Texas

Submitted to

Texas A&M International University
The Texas A&M University System

Submitted by

Yeqiao Zhu
Dan Turner
David Claridge

Energy Systems Laboratory
The Texas A&M University System

December, 1999

Acknowledgement

The Electric Utility Regulation and Energy Efficiency Study for all universities in the TAMUS System was initiated in May 1999 and is funded through an interagency agreement between the Chancellor's office and TEES's Energy Systems Laboratory. Detailed site visits were made to all system universities throughout the summer and fall. The Energy Systems Laboratory wants to thank all physical plant directors and their staff for their cooperation and support during the site visits.

Executive Summary

The physical plant director and staff at Texas A&M International University at Laredo do a very good job of maintaining TAMIU facilities. During our visit, however, we were able to identify several opportunities for improving energy efficiency.

Energy Savings Potential for the Campus

Total savings estimated: $100,000/yr or about 20% of energy savings for the campus.

Commissioning Targets Ranked by Potential Energy Savings

1. Plant
2. Library
3. Building C
4. Building B
5. Gym
6. Building E
7. Building F
8. Building H

Metering Recommendations for Electric Deregulation

Several options exist –split the signal from the main meter and install a data logger or purchase the utility interval data from CP&L. If the energy efficiency study is pursued, then hourly gas data will be necessary. Our recommendation is to install the ESL metering system and meter both the total gas and total electrical consumption for the campus. Fifteen-minute electrical data are needed for any electrical deregulation program.

Table of Contents

Energy Efficiency Study

General Introduction

The TAMIU campus is located in Laredo, Texas. The weather is very hot in the summer and warm in the winter. The hot weather lasts more than half of the year on average.

There is a total of 409,000 square feet of building area on the campus, all of which is connected to the central plant. The campus is only four years old; thus the facilities are new. The student housing is private and is not connected to the central plant.

The electricity costs for 1998 were $476,997. This translates to about $1.17/yr/sq-ft for all of the buildings on the campus.

Three 1000-ton water-cooled chillers are located in the central plant and provide chilled water (ChW) to a loop for the campus. One 500-ton heat pump is used to provide the hot water (HW) to the campus. Two 10 MMBtu/hr boilers are on standby as backups. Two secondary ChW pumps and all building ChW pumps are equipped with VFDs. Three primary pumps for the chillers are constant speed pumps. All the ChW and HW loops have an auto control valve on the return line. All the HW pumps are equipped with VFDs.

The HVAC systems are controlled by a Landis Insight 600 DDC system with the APOGEE system interface.

On August 16, 1999, we conducted a commissioning survey for the campus. A total of 7 buildings were visited during the trip. All of the 7 buildings were surveyed in detail and measurements were also performed on most air-handlers and pumps.

According to the information from the DDC control system and from the plant operator, Landis personnel determined the operation schedules for most AHUs. The Gym and Library are on 24-hour operation and other buildings have a nighttime setback for the room temperature setpoint only.

Based on our survey results, the general mechanical systems are well maintained. However, some significant energy savings potential has been identified. Following is a summary of the results.

The layout of TAMIU Campus is shown in Figure 1.

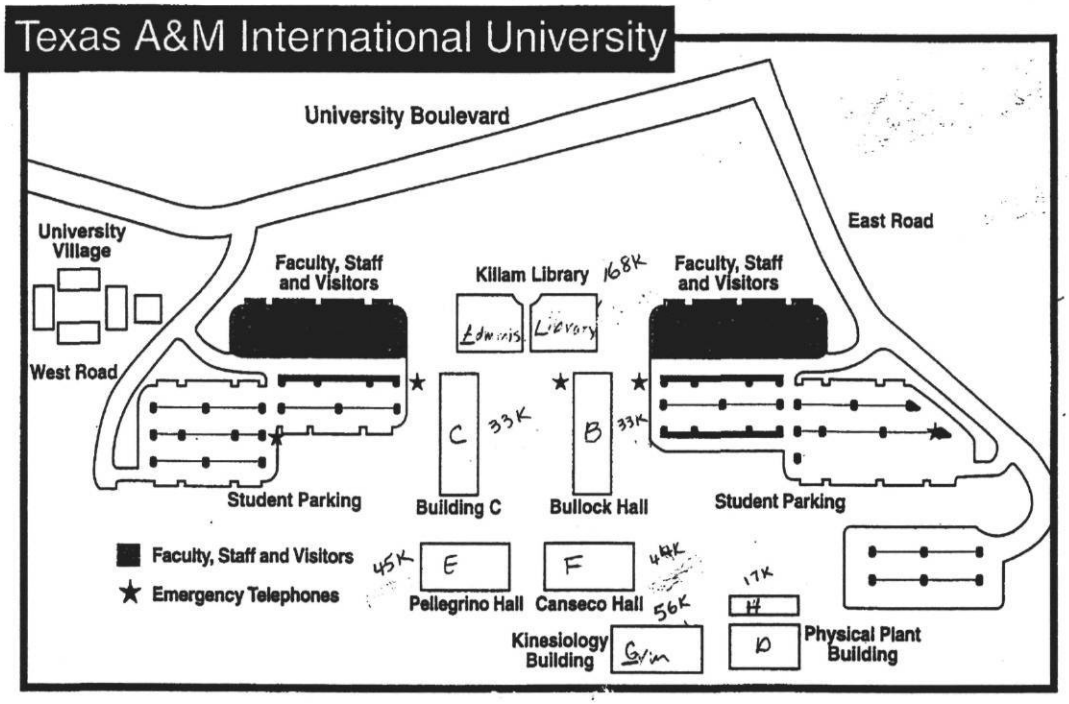

Figure 1. TAMIU Campus and the Buildings

Energy Savings Potential for the Campus and the Commissioning Targets

Energy Savings Potential for the Campus

1. Total: $100,000/yr for the campus or 20% of the electricity cost.

Top Commissioning Targets Ranked by Energy Savings Potentials

1. Plant
2. Library
3. Building C
4. Building B
5. Gym
6. Building E
7. Building F
8. Building H

Summary of Building Information and Major Recommended Energy Measures

Killam Library (library, offices)

Building Information
It is a 4-story building plus a basement with an area of 168,000 sq-ft. The HVAC systems are controlled by a Landis DDC system.

The building receives chilled water and hot water from the chilled water loop and the hot water loop. The hot water pump was on at 86% speed. The manual discharge valve was 50% open for the HW pump. The temperatures for supply and return hot water were 127°F and 117°F respectively. Two ChW pumps were operated at 28 Hz and 2 Hz speed while the manual discharge valves were 30% open for both pumps.

Nine double duct VAV (DDVAV) AHUs (1-15 hp, 2-25 hp, and 6-30 hp) and a make-up air unit serve the Library building. The fans are equipped with VFDs. The static pressure setpoint is maintained by modulating the VFD speed. The static pressure setpoints varied from 1.5" to 2.0" for AHUs. The cold deck setpoints were 55°F for the AHUs. The hot deck setpoints were fixed for each AHU and ranged from 85°F to 120°F. The measured cold deck temperatures were from 52°F to 56°F for the different AHUs. All the hot deck coil valves were open. Most of the manual valves for the ChW line were partially open. The make-up unit was running at 100% speed. The pre-cooling coil cooled the air to 48°F, and then the reheat coil heated the air to 58.7°F. The DP setpoints were 10 psi and 15 psi respectively for the ChW and HW building loops.

Recommended Energy Measures

1. Balance the ChW loop and optimize the differential pressure reset schedule.
2. Optimize the operation of the HW pumps and balance the loop.
3. Optimize HD, CD and preheat reset schedules.
4. Optimize the static pressure reset schedule through non-intrusive balancing.
5. Adjust room temperature setpoint and optimize the mixing box control.
6. Measure the outside air flow and optimize the temperature control for the make-up air unit.

Bullock Hall- Building B (classrooms and offices)

Building Information

It is a 2-story building with an area of 33,000 sq-ft. The HVAC systems are controlled by a Landis DDC system.

The building receives chilled water and hot water from the chilled water loop and the hot water loop. The hot water pump was running at 49% speed. The manual discharge valve was 50% open for the HW pump. The setpoint for the building HW loop was 18 psi. Two ChW pumps were running at 25% speed while the manual discharge valves were partially open for both pumps. The setpoint for the ChW DP was 18 psi.

A total of three double duct VAV (DDVAV) AHUs (1-20 hp, 2-15 hp) and two single duct VAV (SDVAV) AHUs (1-7.5 hp, 1-5 hp) serve the building. The DDVAV systems serve all areas except the two lecture rooms. The fans are equipped with VFDs. The measured cold deck temperatures varied from 51°F to 56°F for the DDVAV AHUs. The hot deck temperatures were from 101°F to 108°F. Most of the manual valves for the ChW line were partially open. The preheat was on for the units. The two SDVAV systems were running at 100% speed. For B1-3, the cold deck was 55°F, the discharge after reheat was 65°F. The outside air (OA) intake was over 30% to all AHUs. A motion

sensor was not installed yet for the lecture rooms, but according to the operation staff, was going to be installed. The temperature in the lecture rooms was about 68°F.

Recommended Energy Measures

1. Balance the ChW loop and optimize the differential pressure reset schedule.
2. Optimize the operation of HW pumps and balance the loop.
3. Optimize HD, CD and preheat reset schedules.
4. Optimize the static pressure reset schedule through non-intrusive balancing.
5. Adjust the room temperature setpoints and optimize the mixing box control.
6. Optimize the outside air intake.
7. Install the motion sensors for the lecture rooms.

Building C (offices, computer labs, classrooms and a small café)

Building Information

It is a 2-story building with an area of 33,000 sq-ft. The HVAC systems are controlled by a Landis DDC system.

The building receives chilled water and hot water from the chilled water loop and the hot water loop. The hot water pump was running at 70% speed. The manual discharge valve was 50% open for the HW pump. There is an auto control valve on the HW and ChW return lines and a blending valve for the HW loop. The HW pump was hunting badly. The setpoint for the hot water DP was 20 psi. Two ChW pumps were running at 68% and 75% speed, respectively, while the manual discharge valves were partially open for both pumps. The DP setpoint for ChW was 24 psi.

A total of four double duct VAV (DDVAV) AHUs (2-15 hp, 1-20 hp, and 1-25 hp) serve the building. The fans are equipped with VFDs. The VFD speeds ranged from 50% to 76%. The measured cold deck temperatures were from 49°F to 56°F for different AHUs. The hot deck temperatures were from 97°F to 105°F. Most of the manual valves for the ChW lines were partially open. The preheat was on for AHU C2-1 and C1-2. There is a bypass duct which bypasses the air above the preheat coil for unit C2-1. The outside air (OA) intake ranged from 20% to 50% for different AHUs. Small hot air leaks for AHU C1-1 and C1-2 were found during the audit. According to the operator, there are 3 exhaust fans equipped with VFDs in the lab.

Recommended Energy Measures

1. Balance the ChW loop and optimize the DP reset schedule.
2. Optimize the operation of HW pumps and balance the loop.
3. Optimize HD, CD and preheat reset schedules.
4. Optimize the static pressure reset schedule through non-intrusive balancing.
5. Optimize the mixing box control.
6. Optimize the outside air intake.
7. Fine-tune the PID loop for HW pump control.
8. Fix the hot air leaks.

Kinesiology Building (gym, fitness rooms and some offices)

Building Information
It is a 2-story building with an area of 56,000 sq-ft. The HVAC systems are controlled by a Landis DDC system.

The building receives chilled water and hot water from the chilled water loop and the hot water loop. The hot water pump was running at 25Hz speed. The manual discharge valve was 50% open for the HW pump. The blending valve was closed for the HW loop. There is an auto control valve on the HW and ChW return lines. The DP setpoint for the HW was 33 psi. The ChW pump was on at 40Hz speed while the manual discharge valves were partially open. The DP setpoint for the ChW was 15 psi. The blending valve for the ChW loop was closed.

Two 50 hp SDVAV AHUs and two 7.5 DDVAV AHUs serve the building. The fans are equipped with VFDs. The SDVAV systems are used to provide air to the gym area. The temperature for the gym area was 68°F. The VFD speeds ranged from 45% to 56%. The preheat coils heated the air to 97°F and 103°F, then cooled air down to 61°F and 56°F for two SDVAV AHUs. The measured cold deck temperatures were 54°F for DDVAV AHUs. The hot deck temperatures were about 101°F. Most manual valves for the ChW lines were partially open. The OA intake ranged about from 20% to 50%.

Recommended Energy Measures

1. Balance the ChW loop and optimize the DP reset schedule.
2. Optimize the operation of HW pumps and balance the loop.
3. Optimize HD, CD and preheat reset schedules.
4. Optimize the static pressure reset schedule through non-intrusive balancing.
5. Adjust the room temperature setpoints and optimize the mixing box control.
6. Optimize the outside air intake and the system operation.

Pellegrino Hall- Building E (offices, classrooms)

Building Information
It is a 3-story building with an area of 45,000 sq-ft. The HVAC systems are controlled by a Landis DDC system.

The building receives chilled water and hot water from the chilled water loop and the hot water loop. The hot water pump was running at 64% speed. The manual discharge valve was 50% open for the HW pump. There is an auto control valve on the HW and ChW return lines. The blending valve was closed for HW loop. The setpoint for the HW DP was 16 psi. One ChW pump was running at 57% speed while the manual discharge valves were partially open. The setpoint for the ChW DP was 18 psi. The blending station was closed for the ChW loop.

Three double duct VAV (DDVAV) AHUs (1-25 hp, 2-20 hp) serve the building. The fans are equipped with VFDs. The VFD was hunting for AHU E2-1. The measured cold

deck temperatures ranged from 53°F to 54°F for different AHUs. The hot deck coil valves were open. Most manual valves for the ChW lines were partially open. The preheat coils heated the air from 83°F and 85°F to 94°F and 96°F for AHU E1-1 and E2-1. The outside air (OA) intake ranged from 30% to 50% for different AHUs. According to the operator, the exhaust fans run 24 hours a day, 7 days a week.

Recommended Energy Measures

1. Balance the ChW loop and optimize the DP reset schedule.
2. Optimize the operation of HW pumps and balance the loop.
3. Optimize HD, CD and preheat reset schedules.
4. Optimize the static pressure reset schedule through non-intrusive balancing.
5. Optimize the mixing box control.
6. Optimize the outside air intake.
7. Solve the VFD hunting problem for AHU E2-1.

Canseco Hall-Building F (offices and classrooms)

Building Information

It is a 3-story building with an area of 45,000 sq-ft. The HVAC systems are controlled by a Landis DDC system.

The building receives chilled water and hot water from the chilled water loop and the hot water loop. The hot water pump was running at 33% speed. The manual discharge valve was 30% open for the HW pump. There is an auto control valve on the HW and ChW return lines. The blending valve was closed for HW loop. The setpoint for the HW DP was 17 psi. One ChW pump was running at 47% speed while the manual discharge valve was 30% open. The setpoint for the ChW DP was 15 psi.

Three double duct VAV (DDVAV) AHUs (3- 20 hp) serve the building. The fans are equipped with VFDs. The measured cold deck temperatures ranged from 52°F to 54°F for different AHUs. The hot deck temperatures were from 90°F to 96°F for different AHUs. Most manual valves for the ChW lines were partially open. The preheat coils heated the air by 11°F for AHU F2-2. According to the operator, the exhaust fans run 24 hours a day, 7 days a week. At the time of visit, eleven exhaust fans were running from 57% to 79% speed.

Recommended Energy Measures

1. Balance the ChW loop and optimize the DP reset schedule.
2. Optimize the operation of HW pumps and balance the loop.
3. Optimize HD, CD and preheat reset schedules.
4. Optimize the static pressure reset schedule through non-intrusive balancing.
5. Optimize the mixing box control.
6. Investigate the exhaust fan operation.

Physical Plant Building- Building H

Building Information

It is a 1-story building with an area of 17,000 sq-ft. The HVAC systems are controlled by a Landis DDC system.

The building receives chilled water and hot water from the chilled water loop and the hot water loop. The hot water pump was running at 58% speed. The manual discharge valve was 50% open for the HW pump. There is an auto control valve on the HW and ChW return lines. The setpoint for the HW DP was 17 psi. One ChW pump was running at 100% speed while the manual discharge valve was 50% open. The setpoint for the ChW DP was 16 psi.

One double duct VAV (DDVAV) AHU (10 hp) serves the building. The fan is equipped with a VFD. The measured cold deck temperature was 52°F. The hot deck temperature was 97°F. The OA intake was over 50%.

Recommended Energy Measures

1. Balance the ChW loop and optimize the DP reset schedule.
2. Optimize the operation of HW pump and balance the loop.
3. Optimize HD, CD and preheat reset schedules.
4. Optimize the static pressure reset schedule through non-intrusive balancing.
5. Optimize the mixing box control.
6. Optimize the outside air intake.

Summary of Plant Information and Recommended Energy Measures

Plant Information

Three 1000 ton water-cooled chillers with three 40 hp primary chilled water constant volume pumps and two 200 hp secondary loop pumps with VFDs are located in the central plant and provide chilled water to a loop for the campus. Currently, the differential temperature was 12° F across the chillers. The blending valve was about 50% open. The manual valves on the suction and discharge side of the secondary loop pumps are partially open. One secondary loop pump was running at 31Hz speed. The cooling tower pumps are constant speed while the fans are variable speed for the cooling tower. One cooling tower fan was running at 68% speed and supplied 83°F water to the condenser.

Two 10 MMBtu/hr boilers and one 500 ton heat pump are located in the central plant and provide the hot water to the campus loop. The boilers are used primarily for standby as back ups most of the year. During the visit, only the heat pump was running to generate hot water for the campus. The supply water temperature setpoint was 125°F. The hot water pump was running at 78% speed.

Recommended Energy Measures

1. Optimize the operation of primary and secondary ChW loop pumps and the blending station.

2. Optimize the DP reset schedule for the ChW loop.
3. Optimize the HW system operation, including an analysis of the heat pump operation.

Electricity Deregulation Metering Options

TAMU receives power from CP&L through a single substation on the campus. CP&L does not charge demand for TAMIU, only energy, which ranges in price from roughly 4 cents to 5 cents per kWh. CP&L can provide interval (15min) data to TAMIU and has provided the Energy Systems Laboratory (ESL) a historical print out of the electric utility energy usage.

Two metering options exist. The first is to purchase the 15-minute interval data from CP&L. These data will need to be transmitted to the Energy Systems Laboratory for archival and analysis, but this is the cheapest option. CP&L's charge for the 15-minute data will be added to the monthly utility bill, and the charges are modest. The disadvantages are that the data will be coming from CP&L at some unspecified time after the end of the month, and we will be dependent on CP&L for the data.

The other option is to install the ESL metering system and poll the data logger from College Station. We could get the data in a more timely manner and not be dependent on CP&L, but it is a more expensive option since independent metering and a data logger would need to be installed. It would give us faster access to the data, and for commissioning, it is helpful to have immediate access to the data.

We would also install some additional metering points, such as electricity consumption of chillers and heat pumps.

Utility Bill Summary

Laredo				
	Electricity			
Month	Energy -kwh	Energy Cost $	Demand-kW	Demand Cost $
Jan-98	796,800	31,361.68		
Feb-98	686,400	28,970.37		
Mar-98	801,600	32,173.55		
Apr-98	844,800	40,105.51		
May-98	950,400	42,427.97		
Jun-98	960,000	48,041.07		
Jul-98	988,800	51,761.78		
Aug-98	988,800	44,424.56		
Sep-98	1,027,200	45,297.17	1,968	
Oct-98	940,800	35,252.84	1,824	
Nov-98	1,094,400	38,590.11	1,872	
Dec-98	1,094,400	38,590.11	1,872	
total/max	**11,174,400**	**476,996.72**	**1,968**	
Jan-99	633,600	28,160.59	1,680	
Feb-99	633,600	28,160.59	1,680	
Mar-99	960,000	38,033.00	1,824	
Apr-99	892,800	44,526.96	1,728	
May-99	864,000	43,614.00	1,728	
No demand charge				
CP&L: Central Power and Lighting				