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Report of Energy Efficiency Study and Metering/Utilities Profile for Electricity Deregulation at the West Texas A&M University (WTAM - U) Canyon, Texas

Submitted to

West Texas A&M University
The Texas A&M University System

Submitted by

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Acknowledgement

The Electric Utility Regulation and Energy Efficiency Study for all universities in the TAMU 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 West Texas A&M University (WTAMU) do a very good job of maintaining WTAMU facilities and keeping expenses down. During our visit, however, we were able to identify several opportunities for improving energy efficiency.

Energy Savings Potential for the Campus

1. Total: $95,000 to $110,000/yr for the campus-wide buildings.
2. For top commissioning targets: about $50,000/yr or 10% of the estimated cost of utilities for these buildings.

Top Commissioning Targets Ranked by Potential Energy Savings

1. Cornette Library
2. Old Main
3. Museum and Petroleum Wing
4. Classroom Center and Jack Center
5. Plant at the Classroom Center
6. Plant at Activity Center

Metering Recommendations for Electric Deregulation

Several options exist –install ESL meters, tie into the EMCS meter or purchase the utility interval data. 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.

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Energy Efficiency Study

General Introduction

The WTAMU campus is located in Canyon, Texas. The weather is dry and hot in the summer and cold and dry in the winter. Low dew point temperatures allow for large diurnal temperature swings.

There are a total of 2,089,000 square feet of building area on the campus of which 66% or 1,384,000 square feet encompass 16 buildings with central air conditioning. The remaining building floor area on campus is served with radiant steam heat or rooftop package units only. All the dorms except two high rise dorms have steam radiator heating only and are not occupied from mid May to mid August.

The electricity and natural gas costs for FY99 were $838,689 and $410,834 respectively. This translates to about $\$0.6/ft^2$ for all of the buildings on the campus or approximately $\$0.9/ft^2$ for the air-conditioned buildings.

Five boilers are located in the central power plant. No economizers were installed on the boiler stacks and no variable frequency drives (VFDs) were used for the boiler pumps. The firing rate for the boilers, and on and off control, is set manually by the operator based upon the load.

Five water-cooled chillers are located in 3 buildings and provide chilled water to a loop for the campus. There are two air-cooled chillers that serve the Museum area only. Most secondary and building chilled water (ChW) pumps are equipped with VFDs. Primary pumps for the chillers are constant speed pumps. Most ChW loops have blending stations, also called decouplers, and there are no manual shut-off or control valves on the decoupler pipe section.

Johnson Controls Inc. is in the fourth year of a 10-year performance contact with WTAMU. Johnson installed an extensive JCI Metasys direct digital control (DDC) system and established the control schemes for most of the air-conditioned buildings. JCI has a prominent presence on the campus and is very active with the maintenance of the Metasys system.

From July 5 to July 9, 1999, we conducted a commissioning and metering survey for the campus. A total of 17 buildings were visited during the trip. All of the 16 air-conditioned buildings were surveyed in detail and measurements were also performed on some air-handlers and pumps.

According to the information from the DDC control system and from the plant operator, JCI had determined the reset schedules for most of AHUs. Based on our survey results, some of the reset schedules have since been modified. All air-conditioned buildings except Jones Hall, Cross Hall, Activity Center, Dining Hall and the computer area in the basement of Library have an aggressive night time shut down schedule for the

mechanical equipment.

From our observations during the survey, it appeared that the general mechanical systems are well operated and maintained in a very good condition. However, some energy savings potential has still been identified. Following is a summary of the results.

The layout of the WTAMU campus is shown in Figure 1.

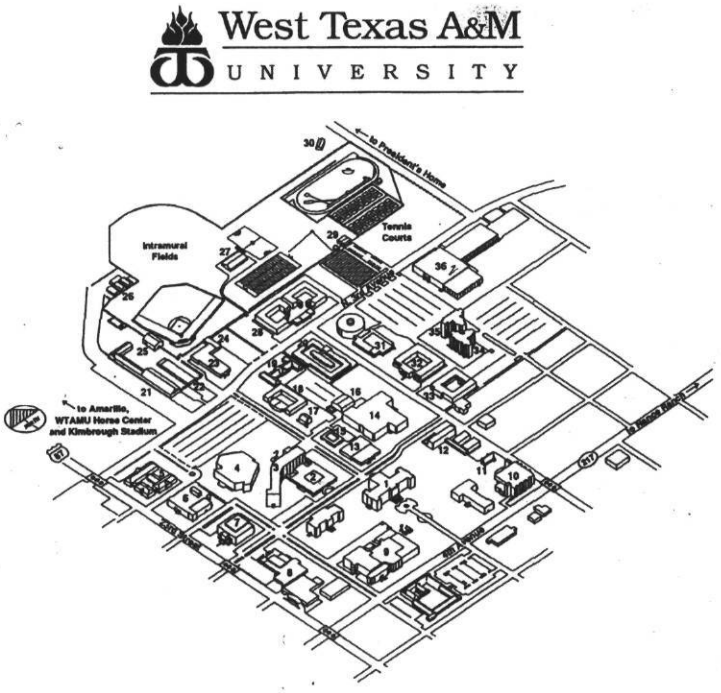

Figure 1. WTAMU Campus and Major Buildings.

Energy Savings Potential for the Campus and Top Commissioning Targets

Energy Savings Potential for the Campus

1. Total: $95,000 to $110,000/yr for the campus-wide buildings.
2. For top commissioning targets: about $50,000/yr or 10% of the cost of utilities for those buildings.

Top Commissioning Targets Ranked by Potential Energy Savings

1. Cornette Library
2. Old Main
3. Museum and Petroleum Wing
4. Classroom Center and Jack Center
5. Plant at the Classroom Center
6. Plant at Activity Center

Summary of Building Information and Major Recommended Energy Measures

It is recommended that the unoccupied shut down for the fans and pumps be maintained for all the buildings.

Cornette Library (library, offices and computer center) - building 648

Building Information
It is a 2-story building plus basement with an area of 151,000 ft^2. The HVAC systems are controlled by a Johnson Controls Metasys DDC system.

The building receives chilled water and steam from the chilled water loop and the central heating plant respectively. The hot water pump was on, but no steam was being supplied to the hot water converter at the time of our survey. One ChW pump was running with a VFD setting of 55 Hz. The manual valve on the decoupler was partially open. The ChW temperature difference was 13° F.

Three dual duct VAV (DDVAV) AHUs serve all areas in the Library except the computer area in the basement. The AHU fans are two speed with variable inlet guide vanes modulated to maintain the static pressure setpoint. The static pressure setpoints were 1.5 in. w.g. for AHUs -1 & 2 and 2.0 in. w.g. for AHU-3. The cold deck setpoints were 52°F to 55° F for AHUs 1, 2, & 3. The hot deck reset schedules were from 70° F to 120° F for outside air temperatures of 70° F to 0° F. Preheat was found to be on for AHUs -2 & 3 with a discharge air temperature of 117° F for AHU-3. These DDVAV systems were shut down from 11pm to 6am. AHU-2 was found to be set at about 50% outside air (OA).

Two single duct VAV systems (SDVAV) serve the computer area in the basement. The terminal boxes have HW reheat coils. The discharge air temperature for this system was 57° F.

Recommended Energy Measures

1. Balance ChW loop and differential pressure reset.
2. Optimize operation of HW pumping system.
3. Reset cold deck and hot deck temperature and static pressure schedules.
4. Optimize box operation.

Classroom Center (classrooms and offices) – building 607

Building Information
It is a 4-story building plus a basement with an area of 144,496 ft^2. The HVAC systems are controlled by a Johnson Controls Metasys system.

The building receives chilled water and steam from the chilled water loop and the central heating plant. One ChW pump was operating and it's VFD was indicating 48 Hz.

Two DDVAV AHUs serve the classroom. The static pressure setpoints were 1.5" and 2" for AHUs-B & C. The cold deck temperatures were 49.9° F for AHU-B and 57.9° F for AHU-C. The hot deck reset schedule was from 70° F to 130° F when OAT was from 70° F to 0° F. These DDVAV systems were shut down from 11pm to 6am. Two small DDVAV AHUs serve the book store and post office. The static pressure setpoint was 1.9".

Recommended Energy Measures

1. Reset cold deck and hot deck schedules.
2. Reset static pressure setpoints.

Jack Student Center (student activity, café and offices) – building 606

Building Information

It is a 1-story building plus a basement with an area of 63,989 ft^2. This building is connected to the Classroom Center. The HVAC systems are controlled by a Johnson Controls Metasys system.

The building receives chilled water and steam from the chilled water loop and the central heating plant.

One DDVAV AHU serves the building. The static pressure setpoint was 1.0". The cold deck temperature was 59.9° F. The hot deck reset schedule varies from 90° F to 130° F for OAT of 70° F to 0° F. The systems were shut down from 11pm to 6am.

Recommended Energy Measures

1. Reset cold deck and hot deck schedules.
2. Reset static pressure setpoints.

Old Main (offices and classrooms) – building 501

Building Information

It is a 4-story building plus the basement with an area of 124,446 ft^2. The HVAC systems are controlled by a Johnson Controls Metasys system.

The building receives chilled water and steam from the chilled water loop and the central heating plant. One ChW pump was operating and it was noted that the pump VFD was "hunting" with a speed range of 37 to 48 Hz and a period of about 30 seconds.

Six DDVAV AHUs serve the building. The static pressure setpoints were from 1.5" to 2" for different AHUs. The cold deck temperature reset schedule varied from 50° F to 60° F for RATs of 76° F to 72° F. The hot deck reset schedule varied from 90° F to 120° F for OAT of 70° F to 0° F. Those DDVAV systems were shut down from 11pm to 6am daily.

Recommended Energy Measures

1. Reset cold deck and hot deck schedules.
2. Reset static pressure setpoints.
3. Balance ChW loop.
4. Fine-tune the PID loop for ChW pump VFD control.

Killgro Research Center (offices) – building 604

Building Information
It is a 2-story building with an area of 29,197 ft^2. The HVAC systems are controlled by a Johnson Controls Metasys system.

The building receives chilled water and steam from the chilled water loop and the central heating plant. One ChW pump was operating at a VFD reading of 48 Hz and a DP of 16 psi. The HW pump was off.

Two multi-zone AHUs serve the building. The cold deck temperature was 55° F. The hot deck was off. These DDVAV systems were shut down from 11pm to 6am.

Recommended Energy Measures

1. Reset cold deck and hot deck schedules.
2. Balance the zones.
3. Optimize OA intake.
4. Reset differential pressure setpoints for ChW loop.

Mary Moody (offices and classrooms) – building 651

Building Information
It is a 2-story building with an area of 80,345 ft^2. The HVAC systems are controlled by a Johnson Controls Metasys system.

The building receives chilled water and steam from the chilled water loop and the central heating plant. One ChW pump was operating with a VFD reading of 46 Hz and 36 psi of DP. The HW pump was on.

Four SDVAV AHUs and one SDCV AHU serve the building. The four SDVAV AHUs have 2-speeds fans. The static pressure is maintained by shifting the fan between the two-speeds. The lower limit and higher limit of static pressure setpoint was 0.8" and 1.2". The discharge air temperature setpoint varied from 55° F to 65° F for RAT's of 76°F to 70° F. These systems were shut down from 11pm to 6am. The room temperature was 69°F for the area served by AHU-2W.

Recommended Energy Measures

1. Optimize OA intake for the units.

2. Reset static pressure setpoint.
3. Reset differential pressure setpoints for ChW loop.

Fine-Arts (classrooms and practicing rooms) – building 592

Building Information
It is a 3-story building with an area of 62,944 ft^2. The HVAC systems are controlled by a Johnson Controls Metasys system.

The building receives chilled water and steam from the chilled water loop and the central heating plant. The cooling/heating is a two pipe system. ChW is supplied to the coil during summer and HW is supplied to the coil in winter. The changeover point is the time when outside air temperature (OAT) is in the range of 60° F to 65° F. Two ChW pumps were operating with VFD readings of 54 Hz for the large unit and 30 Hz for the small unit. The blending valve on the decoupler was 100% open for the building loop.

The primary DDCV AHU, 2 SDCV AHUs and 5 small SDCV units serve the building. For the primary DDCV or PAHU, the cooling coil will be closed during the winter and the heating coil will be closed during the summer. The cold deck temperature was 55° F for the PAHU. The systems were shut down from 11pm to 6am. The OA intake was over 30% for the PAHU.

Recommended Energy Measures
1. Optimize OA intake for the primary air handling unit.
2. Balance ChW loop.
3. Reset cold deck and hot deck schedules.
4. Need to check operation of the two-pipe system.

Agriculture and Natural Science (offices, classrooms and labs) – building 647

Building Information
It is a 4-story building with an area of 103,790 ft^2. The HVAC systems are controlled by a Johnson Controls Metasys system.

The building receives chilled water and steam from the chilled water loop and the central heating plant. One ChW pump was on at a setting of 60 Hz. The differential pressure across the chilled water system was 38 psi for this building.

Two SDVAV AHUs serve the building. The fans have 2-speeds. The static pressure is maintained by shifting the fan from high to low speed. The lower limit and higher limit of static pressure setpoint was 0.8" and 1.2". The discharge air temperature setpoint was from 52° F to 65° F for RAT of 75° F to 71° F. These systems were shut down from 11 pm to 6 am daily. The outside air intake was over 40% for these two AHUs. The inlet vane was disconnected for AHU2. Very high face velocities were observed and some condensate carryover was noted.

Recommended Energy Measures

1. Repair and enable the variable inlet vane for AHU2.
2. Reset discharge air temperature schedules.
3. Reset static pressure setpoint.
4. Optimize OA intake for two AHUs and total supply air flow for AHU2.

Police Department (offices)

Building Information

It is a single story building. The HVAC systems are controlled by a Johnson Controls Metasys system.

One DDVAV and a SDVAV AHU with DX system serve the building. The Fans are both 2-speed. Static pressure is maintained by shifting the fan from high to low speed. The lower limit and higher limit of static pressure setpoints were 0.8" and 1.2".

Recommended on Energy Measures

1. Cold deck reset for AHU-1.
2. Reset static pressure setpoint.

Museum – building 532

Building Information

It is a 4-story building with an area of 88,000 ft^2. The HVAC systems are controlled by local pneumatic controllers.

The local 50 ton air-cooled chiller supplies chilled water to the building with a CV pump. The building receives steam from the central heating plant. One ChW pump was on. The HW pump was off.

Two multi-zone AHUs and two SDCV AHUs serve the building. The fans are both 2-speed. The static pressure is maintained by shifting the fan between speeds. The room temperatures for the 2^{nd} and 3^{rd} floor were 66° F to 68° F. The room setpoint was 65° F. The 1^{st} floor has RH over 63% due to a closed ChW valve. The cold deck temperatures were 50° F for the multi-zone AHUs. There are no control valves for the cooling coils.

Recommended Energy Measures

1. Optimize air supply rate for the building.
2. Use manual valves or install auto control valve to maintain the cold air temperature.
3. Repair the flex connection of AHU-4 (leaking air).
4. Balance the zones.

Petroleum Wing (Museum) – building 664

Building Information
It is a 2-story building plus basement with an area of 69,462 ft^2. The HVAC systems are controlled by local pneumatic controllers.

The two local 50 ton air-cooled chillers supply chilled water to the building with two parallel CV pumps. The building receives steam from the central heating plant. Two ChW pumps were on. The HW pump was off.

Three SDCV AHUs and a multi-zone unit serve the building. Each SDCV AHU supplied about 28,000 CFM of air to the building. The humidifier was on for 3 units.

Recommended Energy Measures

1. Optimize the air supply to the building.
2. Check the control of humidifier.

Conservation Wing (storage area) – building 665

Building Information
It is a 1-story building plus basement with an area of 17,797 ft^2. The HVAC systems are controlled by local pneumatic controllers.

The building receives steam from the central heating plant.

Two multi-zone units with DX systems serve the building. The humidifier was on for AHU2. No cooling was available for AHU1 and the space served by this unit was warm.

Recommendation on Energy Solutions

1. Need to check the RH requirement for the area. If there are no special RH requirements, then shut off the steam to the steam humidifiers. Currently, all humidifiers for AHU2 were active.

Henson Activity Center (gym, handball rooms, bowling areas, dancing rooms and swimming pool) – building 619

Building Information
It is a 3-story building with an area of 163,355 ft^2. The HVAC systems are controlled by a Johnson Controls Metasys system.

The building receives ChW and steam from the ChW loop and central heating plant. One ChW pump was on at a speed setting of 34Hz and with 30 psi of differential pressure. The HW pump was off.

One SDCV heating only unit serves the swimming pool. Three SDCV units serve the bowling area, dancing and handball area. Eight SDCV AHUs serve the gymnasium area. One primary DDCV unit serves all other areas in the building.

Recommended Energy Measures

1. Optimize the operation of AHUs for the gymnasium area.
2. Balance the ChW loop.
3. Reset cold deck and discharge air temperature schedules.

Cross Hall (student dorms) – building 622

Building Information

It is a 7-story building with an area of 56,700 ft^2. The HVAC systems are controlled by a Johnson Controls Metasys system.

The building receives ChW and steam from the ChW loop and central heating plant. The ChW and HW pumps were both on.

One DDCV AHU served the hallway and public area of the dorm. Each resident room has a fan coil unit (FCU) to cool or heat the room air. A small amount of fresh air is supplied from the central AHU.

Recommended Energy Measures

1. Optimize HW pumping system operation.
2. Install a VFD for the AHU.

Jones Hall (student dorms) – building 621

Building Information

It is an 8-story building with an area of 66,300 ft^2. The HVAC systems are controlled by a Johnson Controls Metasys system.

The building receives ChW and steam from the ChW loop and central heating plant. The ChW and HW pumps were both on.

One DDCV AHU served the hallway and public area of the dorm. Each resident room has an FCU to cool or heat the room air. A small amount of fresh air is supplied from the central AHU.

Recommended Energy Measures

1. Optimize HW pumping system operation.
2. Install a VFD for the AHU.

Dining Hall – North End

Building Information
It is a 2-story building. Total area for north and south ends is 54,338 ft^2. The HVAC systems are controlled by a Johnson Controls Metasys system.

The building receives ChW and steam from the ChW loop and central heating plant. One ChW pump was on at a setting of 55Hz. The HW pump was on.

Two SDCV AHUs and two multi-zone AHUs serve the building. AHUs 4 & 1 run at high speed and AHUs 2 & 3 run at lower speed. The cold deck temperatures were 51° F to 52° F for the multi-zone units. The OA intake was over 50% for AHU4.

Recommended Energy Measures
1. Optimize the operation of AHUs for the building.
2. Optimize OA intake for AHU-4.
3. Reset cold deck and hot deck schedules for AHUs.

Dining Hall – South End

Building Information
It is a 1-story building. It shares the pumping system with the north end of the Dining Hall.

Two multi-zone AHUs serve the building. The cold deck temperatures were 51° F for the multi-zone units. The preheat was on for AHU 2. The hot deck coils were using steam (summer).

Recommended Energy Measures
1. Shut off preheat coil for AHU 2.
2. Reset cold deck and hot deck schedules.

Summary of Plant Information and Recommended Energy Measures

Plant and ChW Pumping System Located at Classroom Center

Plant Information
Two 500 ton water cooled Trane chillers with two CV primary pumps, one secondary loop pump, and four building pumps with VFDs are located in this plant. Currently, the differential temperature was only 9° F across the chiller. Blending water was about 10%. There are 22 psi of loop differential pressure after the secondary loop pump. The chilled water is supplied to the campus loop.

Recommended Energy Measures
1. Optimize ChW pumping system operation.
2. Balance the ChW loop.
3. Optimized HW pumping system operation.

Plant and ChW Pumping System Located at Agriculture and Natural Science Building

Plant Information
One water-cooled Trane chiller with one CV primary pump, one secondary loop pump, and one building pump with VFDs are located in this plant. The chilled water is supplied to the campus loop.

Recommended Energy Measures

1. Optimize ChW pumping system operation.

Plant and ChW Pumping System Located at Activity Center

Plant Information
Two water-cooled Trane chillers with two CV primary pumps, one secondary loop pump, and one building pump with VFDs are located in this plant.
Currently, the differential temperature was only 5° F across the chiller. Blending water was about 40%. There are 28 psi of loop differential pressure after the secondary loop pump. The chilled water is supplied to the campus loop.

Recommended Energy Measures

1. Optimize ChW pumping system operation.
2. Balance the ChW loop.

Electricity Deregulation Metering Options

Whole Campus Metering

The WTAMU campus is served by two primary substations, north and south, and one primary gas meter. Water is fed through several locations and numerous individual meters. None of the buildings appeared to be individually metered. Any auxiliary services are billed on a square foot basis.

The JCI Metasys DDC system receives pulse data from both of the main electrical substations. The KYZ pulse from the north sub-station is direct wired to the powerhouse DDC panel and the south sub-station pulse is wired to the DDC panel in the Activity Center. WTAMU is not currently monitoring these points with their system.

Gas is monitored at the powerhouse boilers through flowmeters at each boiler. WTAMU personnel estimated that >95% of the gas consumed on the campus was at the powerhouse.

Metering Options

The WTAMU EMS technician offered to set up long term trend logs for both of the sub-station electrical feeds and the powerhouse gas consumption. The data could be accessed via modem directly from the JCI Metasys system. JCI currently does this type of trending to check systems operation and they regularly download 15 – 20 mb files. The file structure is in ASCII columnar format and would be easy to integrate into any subsequent data reduction required at the ESL. Costs associated with this data-logging effort would be minimal. However, ESL's history with DDC systems as energy metering equipment does not suggest success with this method.

If this is not a workable scheme, it is recommended that we install two digital data-loggers, one at the central plant and one at the activities center, and split the pulse signals from the two utility meters to the data loggers and to the JCI system. The main gas meters would need to be retrofitted with pulse initiators and the pulse signal wired via best route back to the powerhouse. Communication with both of the data loggers would be with modems, very similar to other ESL installations. The installed cost for this metering scheme would be approximately $15,000.

Utility Bill Summary

WTAMU							
	Electricity				Natural Gas		
Month	Energy - kwh	Energy Cost $	Demand-kW	Demand Cost $	Gas-MCF	Gas Cost $	Total cost $
Sep-98	2,262,400	59,059.33	3,584	30,764.00	5,202.0	15,966.25	105,789.58
Oct-98	1,932,000	43,104.78	4,452	38,142.00	10,175.0	31,229.65	112,476.43
Nov-98	1,839,600	41,766.29	3,668	31,478.00	14,432.0	44,295.46	117,539.75
Dec-98	1,713,600	37,608.43	3,472	29,812.00	22,593.0	69,343.62	136,764.05
Jan-99	1,492,400	32,516.96	3,444	29,574.00	17,350.0	53,251.54	115,342.50
Feb-99	1,391,600	28,219.40	3,472	29,812.00	14,712.0	45,154.85	103,186.25
Mar-99	1,663,200	29,304.10	3,780	32,430.00	16,161.0	49,602.19	111,336.29
Apr-99	1,738,800	31,760.47	3,892	33,382.00	11,754.0	36,075.99	101,218.46
May-99	1,610,000	28,554.97	3,808	32,668.00	5,983.0	18,363.34	79,586.31
Jun-99	2,111,200	35,803.39	4,340	37,190.00	5,533.0	16,982.18	89,975.57
Jul-99	2,265,200	34,224.12	4,480	38,380.00	5,263.0	16,153.48	88,757.60
Aug-99	2,268,000	35,945.25	4,340	37,190.00	4,696.0	14,416.21	87,551.46
total/max	**22,288,000**	**437,867.49**	**4,480**	**400,822.00**	**133,854.0**	**410,834.76**	**1,249,524.25**
SPSC: Southwestern Public Service Company							
Enermart, Inc.							
Charge demand							