Monitoring & Analysis Program of Prison Sites for the Texas Department of Criminal Justice

James A. Eggebrecht
Research Associate
Energy Systems Laboratory
Texas A&M University System

Tia Heneghan
Energy Manager
Utilities & Energy
Texas Department of Criminal Justice

ABSTRACT

The Texas Department of Criminal Justice (TDCJ) and the Energy Systems Laboratory (ESL) at Texas A&M University have collaborated to extend the LoanSTAR Monitoring & Analysis Program to Texas' prison facilities. Data loggers are in place in eleven 1,000-bed prison units recording the energy use patterns of the administration, kitchen, laundry, medical, training, and inmate housing units. Specialized software has been developed that will allow TDCJ personnel to customize the data presentation and analysis in-house.

A second effort involved the development of a Utility Billing Audit Database program. This database accepts customized entry of the utility bill calculation parameters from the utility company rate schedules and contracts, and provides storage of the parameters for monthly

Texas State Agency Natural Resources End-Use Database (SANRED) (B. Hunn et al 1995) and other internal TDCJ reporting needs. Bills for all monthly purchases of electricity, natural gas, water, waste water, and solid waste removal are audited using this software.

INTRODUCTION

The Texas LoanSTAR program grew out of efforts that began in 1983 by the State Energy Conservation Office to foster energy conservation in state facilities. In May, 1989 a monitoring program was initiated in various buildings where energy saving retrofits had been installed. The latest finalized data (as of September, 1995) indicated the cumulative program savings topped $25 million, and were increasing by nearly $1 million per month. Currently, there are 368 buildings at 124 sites where 126 energy data loggers are recording over 2,000 channels of building energy use information. Papers in the Bibliography (Athar et al 1992, and Turner 1990) report on aspects of the effort.

The LoanSTAR monitoring program provides installation of energy data recorders, or "loggers" to a site. Sensors, which measure electrical, natural gas, or thermal energy use, convert that information to an analog or digital output that is scaled to the level of usage. The logger captures this information for periodic downloading to a data collection site at Texas A&M University. The resulting information is available for analysis to document the results of energy saving retrofits. Papers in the Bibliography (Claridge et al 1990, and Haberl et al 1990) provide some examples of the results from this data and analysis.

Since February, 1995 the Texas Department

Documentation of some of the early results of this project is the purpose of this paper. Monitoring of energy consumption at the first site began in May, 1995. Eleven 1000-bed sites were initially chosen for monitoring. Fully operational data recording did not take place until August, 1995 due to some faulty chips in the data loggers that required replacement. No interruption to data recording has taken place since the date of the last chip replacement.

The monitoring program will expand to include six State Jails and six Transfer Facilities. These new sites should be on line by March 31, 1996. Five State Jails and five Transfer Facilities are the same prototype with slight modifications among them. One Transfer Facility, Segovia in Edinburg, was originally a Substance Abuse Treatment Facility but it was

"hardened" to accommodate state prisoners. [1] It was chosen to be in the pilot project because cooling coils are to be added to some cells and monitoring will verify the sense of extending this program throughout the TDCJ System. The State Jail is a co-gender facility located in El Paso. It was chosen as a monitoring site because it has TDCJ's highest electric rates with a basic demand charge of $20.25 per kW.

Another facet of the project was the establishment of a utility billing audit database that will perform calculation audits of the utility billing charges for electrical, natural gas, water, waste water, and solid waste disposal for the TDCJ facilities. The database uses the published utility rate schedules, or contract terms between TDCJ and their utility suppliers, to confirm the correctness of the billing charges. In addition, the usage information is captured for later use in analysis, internal TDCJ reports, and state reports such as the Texas State Agencies Natural Resources End-Use Database (SANRED).

The basic database program developed by ESL will be programmed in a more robust database package by TDCJ programmers. It will include all the features in the version delivered to TDCJ plus additional features identified by the Bill Analysis Section of TDCJ as necessary to do a true audit of the utility bills. It will produce data streams that are easily read by SAS for icon-driven graphical reporting.

Transfer of the technology is now complete as TDCJ personnel have been trained in the methods of developing metering plans and installing equipment to meet their energy management goals. TDCJ is currently engaged in extending the monitoring effort to an additional thirteen institutional sites around the state. They are using the utility billing audit database to greatly reduce the time necessary to manually audit their utility bill purchases every month. Preparation of time-consuming monthly, quarterly, and annual reports has been greatly aided as well.

[1] Means to add more security measures such as razor fencing and guard towers.

DISCUSSION

Monitoring Analysis Project

All of the facilities listed in Table 1 are 1000-bed medium-security prison units in various areas of Texas that were built using very similar layouts. All but one have an additional 334-bed emergency addition. These units are "cookie cutter" designs so comparisons of the differing consumption levels can be made between the units. When comparing the housing at the eleven units TDCJ administrators can identify where the energy hogs are. The metered data can direct the Utilities and Energy Section to review the lower consumers for energy practices that could be adopted by the other units. TDCJ can see the potential for a little friendly competition between the wardens to reduce energy costs and be the most efficient warden of the year. TDCJ managers are also getting profiles for energy use at correctional facilities which will enhance their position when looking for locations to site new prison units.

Table 1. TDCJ Units and Commencement Date of First Recorded Information.

Unit Name	City	First Date of Information
Torres	Hondo, TX	7/18/95
Boyd	Teague, TX	6/15/95
Stevenson	Cuero, TX	7/18/95
Briscoe	Dilley, TX	7/18/95
Lynaugh	Ft. Stockton, TX	6/8/95
Smith	Lamesa, TX	5/30/95
Wallace	Colorado City, TX	5/26/95
Roach	Childress, TX	6/7/95
Neal	Amarillo, TX	7/18/95
Jordan	Pampa, TX	7/18/95
Dalhart	Dalhart.TX	7/18/95

Installation for the first three sites was completed in May, 1995 at the TDCJ Boyd Unit, Torres Unit, and Wallace Unit. Installation at eight other sites proceeded, and was finished in June, 1995. Table 1 provides the Units, their nearest cities, and the date of initial collection of information by the loggers.

As a part of the technology extension of the LoanSTAR practices that formed the basis for this project, two TDCJ electrical technicians were assigned to assist experienced subcontract equipment installers in the installation of the loggers and sensors at the first three sites. The

TDCJ personnel would complete the installation at the other sites.

The monitored data includes the whole building electrical usage for each major building on the TDCJ sites. Sensors (CTs) were placed at the main panels for each building.

The information recorded on the data loggers is downloaded weekly by modem to a workstation at Texas A&M University. Plots of the data, referred to as weekly inspection plots, are reviewed for data integrity and to gain understanding of the energy usage. Temperature and relative humidity information from nearby weather stations is combined with the energy use data to aid in understanding the weather dependence of the energy usage of the facilities. The hourly changes in energy consumption also show the impact of occupancy schedules and equipment operation. Comparisons of energy usage among each of the facilities listed in Table 1, as well as among buildings within a facility, are easily made using these plots.

To date about eight months of consumption data are available and the energy use picture of the units is becoming evident. Examples (using the weekly plots) that illustrate the following observations are given in this paper:

1. Perfectly regular patterns of energy consumption that exhibit little change for long periods.

2. Random patterns of energy use that have no obvious relationship to weather or other influences.

3. The influence of weather on the heating and cooling period energy consumption.

4. Weekend occupancy schedule changes in certain administrative areas.

Some buildings within a prison unit have exhibited very consistent energy consumption profiles that change little for significant periods of time. Figures 1 and 2 show a weekly inspection plot from two prisoner dormitories in the same facility. Each vertical gridline represents the start of a new day at 12:00am. Energy demand is shown to be about 40 kW from midnight until about 7am each morning, 50 kW through the bulk of the daylight hours, increasing to 65 kW in the evening and again falling to 40 kW at about midnight. This regular pattern is exhibited despite changing weather conditions during the week that had high daytime temperatures that ranged from 72° to 32°F.

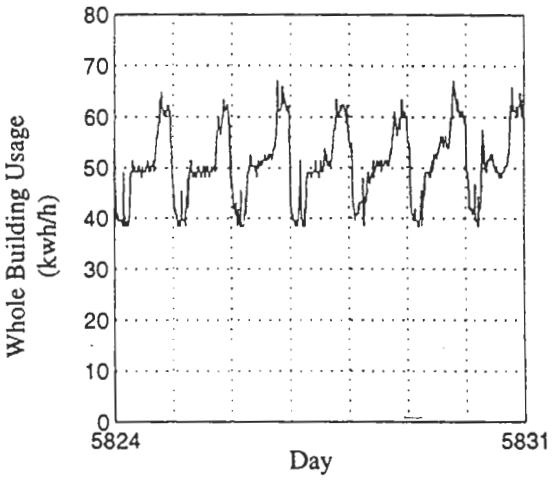

Figure 1. Illustrates Consistent Pattern of Usage for Prison Dormitory

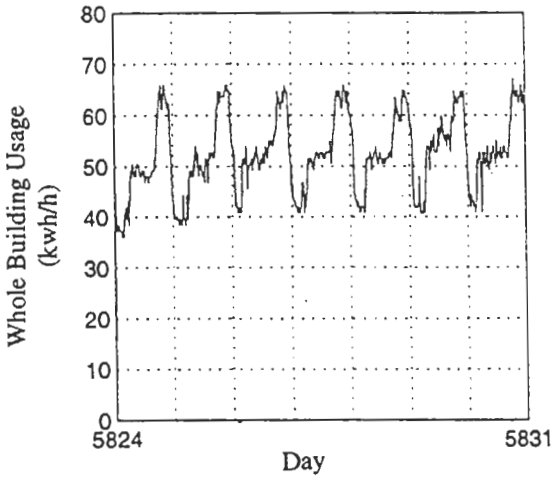

Figure 2. Illustrates Consistent Pattern of Usage for Prison Dormitory

Figure 3 shows the weekly inspection plot for a similar prisoner dormitory at a different facility that exhibits random consumption patterns. It is evidently not tied to weather since daytime highs and nighttime lows ranged from

only 72-78°F and 60-70°F, respectively. This probably illustrates differing practices of turning on and off equipment such as lights, etc.

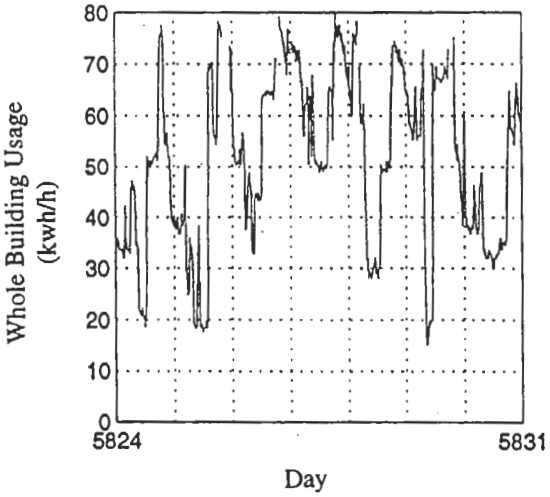

Figure 3. Illustrates Random Pattern of Usage for Prison Dormitory

The influence of weather changes is illustrated in Figures 4 and 5, weekly inspection plots for two different prison units. Figure 4 shows the energy demand at a prisoner dormitory during the first week in September, 1995 when a "cool front" dropped the daytime highs from near-100°F levels to 65-70°F during the third through sixth days of that week. The decrease in demand that is witnessed is ascribed to a decreased use of personnel comfort fans to provide cool air to the population within the building. Figure 5 is for a prisoner dormitory building at a different facility during the first week of December. A "cold front" dropped the temperatures in the fifth and sixth days of that week to 20-30°F instead of the 60-70°F range seen earlier in the week. The sharp rise in demand during the evening of the fifth day is attributed to heating requirements which are supplied by electric duct heaters.

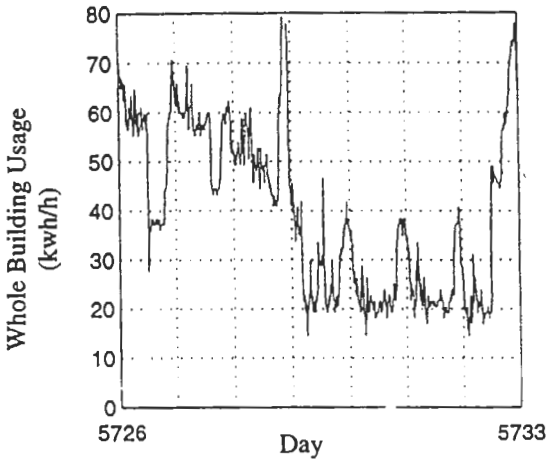

Figure 4. Illustrates Effect of Temperature Change at Prison Dormitory

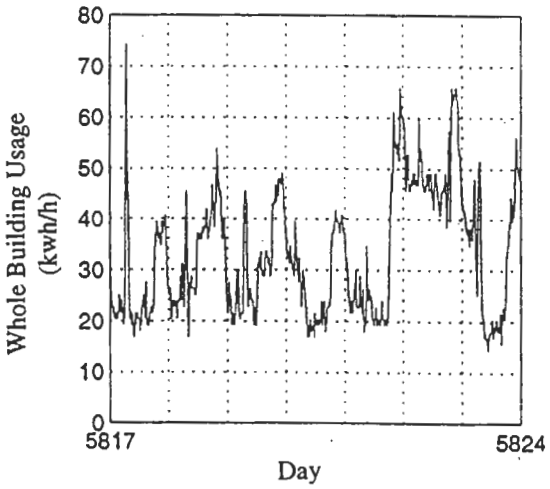

Figure 5. Illustrates Effect of Temperature Change at Prison Dormitory

The change in energy consumption due to changing occupancy levels in some of the administrative buildings has been seen. Figure 6 shows a clear example of this change. In these weekly plots the first day shown is for Tuesday,

hence the weekend occurs on days five and six. The lowered energy demand during those days is attributed to not needing lights, office equipment, and climate control for the absent clerical staff.

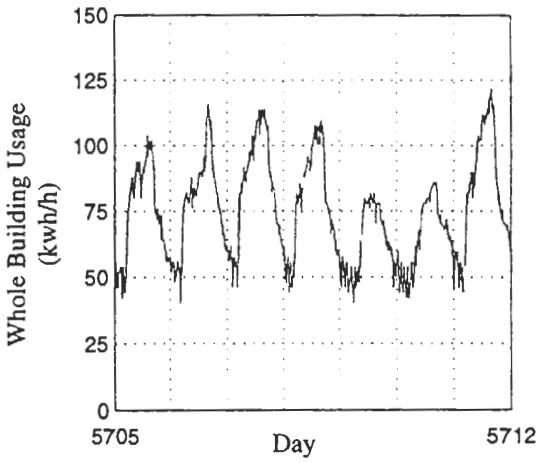

Figure 6. Illustrates Effect of Occupancy Change for Prison Administrative Bldg.

The monthly billing data for each of the sites is now being reported monthly to the wardens. Using Fiscal Year 1995 (Sept. 1, 1994 - Aug. 31, 1995) as a baseline the following graphs are being sent:

Electrical Demand
Electrical Consumption
Electrical Costs
Natural gas consumption
Natural gas costs
Total monthly energy costs
Annual FY energy costs

Monthly billing and measured energy use information will be used to verify savings and will give immediate feedback to each unit for energy cost savings measures implemented.

The measured data are reported to the wardens for their units on a monthly basis using software developed by the ESL. Icon-driven reports are being developed by the Center for Statistical Research and Applications at Sam Houston State University. The data streams generated by the software are processed by the click of an icon into boilerplate reports, such as daily profiles for every Tuesday of the year. Weekly profiles are also generated as well as total monthly consumption for each location. These reports are sent to the Warden and the Energy Management Designee at each of the units as well as each regional director (TDCJ has five regions) and the Executive Director. TDCJ is moving towards establishing unit level budgets and the reports will provide valuable information for the development of the utility portion of that budget.

Utility Billing Database

The utility billing database should allow for easy access to monthly billing data to complete the internal reports that need to be generated as well as the monthly billing information to the wardens. The extraction from the database could be linked to a spreadsheet that would reproduce the necessary reports. This function of the software is under testing. The extraction to the SANRED report should be made easier with this software.

Previously, all energy and utility bills were hand-calculated in the Accounts Payable Office of TDCJ before payment. The numbers were hand-recorded to at least three different sheets for reporting purposes. This method increased the possibility of transcribing errors. Another issue with the bills being sent to Accounts Payable was access to timely information by the Utility and Energy Department. Often billing information wasn't available until 90 days after a billing period. The calculation and verification of utility bills has been re-assigned to the Utilities and Energy Division as of June, 1995. The computerization of the Utilities and Energy Division has allowed for a timely retrieval of current monthly billing data.

TDCJ is the largest state agency as well as the largest consumer of state energy funds. In FY 1995 $33 million was spent. This is expected to increase with the addition of 8000 beds to the system in the next two years.

The Utility Billing Database program is designed to:

1. capture and store in a database environment the information that TDCJ desires for satisfying the internal and external reporting needs as described above.

2. automate the utility bill calculation audits that have slowed the payment process.

The prototype database engine that is used for storage and processing of this information, and the calculation of audits is the Microsoft ACCESS database program. Customized data entry forms are utilized to facilitate accurate entry of the needed information from utility company rate schedules and contract terms, and from the utility bills themselves. This minimizes data entry problems while allowing for the variety of calculation scenarios that are necessary because of the myriad of utility companies that TDCJ deals with across the state of Texas.

Entry of the utility rate schedules or contract terms is accomplished using the customized data entry screens The parameters to compute fixed and variable block structures, minimum billing amounts, and fixed, variable, and seasonal billing charges are easily entered into the handful of entry forms that are necessary. Once entered the rate schedule is saved for use with any number of utility accounts using that rate schedule as the basis of the billing calculations. Updates or changes are handled by recalling the saved file, altering the changed terms of the billing calculation, and saving the new file either as a totally new file or overwriting the old file. In some instances it is helpful to have the old and new schedules available. The auditing database could be applicable to other state agencies' utility bill auditing efforts.

The information from the monthly bills is also entered using customized entry screens. These screens ask for the consumption data from the bills that is necessary according to the respective rate schedule that pertains to the account, and any data desired by TDCJ for collection or tracking purposes. For electricity suppliers this information typically includes electrical consumption (kWh), and billing demand (kW or kVA), plus any charges such as the fuel or PCRF (power cost recovery factor) charges that may change every month for some utility rate schedules. The other utility accounts are handled similarly.

Once the billing information is entered the pressing of a few buttons is all that is necessary to perform the billing calculation. The calculated result is compared to the billed amount and the approval to pay is given by the analyst if the amounts agree. If the amounts do not agree a detailed listing is available of each charge from the calculation to compare with the detail on the utility bill. Unresolved cases are handled by supervisor review.

Results

The generation of monthly reports of energy and demand usage is increasing the energy awareness at the prison unit level and we hope to show a decrease in consumption during the summer of 1996 compared to the summer of 1995 at the units being monitored. A utility bill can be audited within three business days unless a complication should arise. Telephone calls are then made to resolve the problems.

The current monitoring project will be capped at 25 units. The 25 units will provide information on five prototypes. Three prototypes will have enough data for a comparison among the type of structures.

The monitoring project is being meshed with a Computerized Maintenance Management System (CMMS) at all 25 sites. The CMMS installation shall be completed by December, 1996. The data being provided by the energy monitoring system and the CMMS package will be utilized to improve energy efficiency of the units using simple Operations and Maintenance methods. The CMMS will provide information on the number of Preventative Maintenance (PM) work orders being done compared with the number of Corrective Maintenance (CM) work orders. An increase in CM work orders on a particular piece of equipment could signal an impending failure. Energy efficiency criteria for a replacement could be established before an "emergency" purchase is required. The correlation between energy costs and the type of work orders generated have yet to be assessed. This information will be valuable in the understanding of an efficiently run unit.

SUMMARY

The LoanSTAR monitoring and analysis program has been extended to Texas Department of Criminal Justice prison facilities in various parts of the state. Data is being recorded that is

leading to a better understanding of the energy consumption profiles of the housing, administrative, medical, and other support buildings. A database program was developed that has greatly aided the auditing of utility company billing calculations. It is expected that it will also aid the collection and reporting of energy use data for internal and external reports. The energy use data is being disseminated to the wardens at each of the units, regional directors, and the Executive Director of TDCJ. It is hoped that energy consumption in the summer of 1996 will be reduced relative to 1995, to be shown by the actual measurements of energy use afforded by the installed metering system.

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