

Converting 15-Minute Interval Electricity Load Data into Reduced Demand, Energy Reduction and Cash Flow

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Abstract

Whole-building-electric (WBE) 15-minute interval data is an extremely low-cost, easy approach to reap an immediate reduction in energy consumption. With the advance of lower cost Internet based metering technology integrated with TCP/IP Internet communications, equipment costs and installation issues are not the issues as were in the past. The challenge is to be able to interpret the data and then implement actions to correct operational and equipment problems and anomalies. This paper will address the types of data acquisition equipment and systems available and the different components of a data. Lastly, actual graphs of data will be presented to demonstrate how to dissect and analyze a data set and then implement measures that will optimize operations and maintenance of which will effect a reduction in energy costs.

Introduction

One cannot manage or control the assumed or unknown. Data acquisition systems for buildings eliminate the uncertainty of assumptions and unknown operation parameters by providing a visual graph of the building's energy consumption. Even a few days of recorded data will reveal unforeseen and revealing details of how a building is functioning. Data is the backbone of optimum, stable operations of just one building or an entire world-wide portfolio. A data set can range from monthly utility bills to "near real-time" interval pulse data from a datalogger or utility meter. The data can be frequently checked for problems in the building(s) visually with a load profile graph or out-of-bounds situations can be alarmed to alert the operations manager that an anomaly has or is about to occur. Without a historical utility consumption data set, a building is "assumed" to be operating at the optimum conditions, i.e., the building is operating according to original programmed on/off equipment times and temperature setpoints. Once this maintenance assumption becomes fact, the owner "will" start wasting energy and overspending on energy. Experience has documented that at some point in time a programmable thermostat, an Energy Management Control System (EMCS) or Building Automation System (BAS) "will" default to factory settings after an electrical surge or power outage, "will" change or drift from programmed temperature setpoints or on/off times without operator input. Although DDC (direct digital control) systems are much more stable and exact than older pneumatic systems, internal components are still capable of failing.

Data graphs are ideal for the following scenarios.

- Understanding which ECMs (energy conservation measures) are the most economically viable for a building owner to further evaluate and pursue.
- ESCOs to pre-meter a project to mitigate risk for a performance contract.
- End-users to measure and verify (M&V) performance contracts or energy efficiency upgrades.
- Submetering of individual components such as chillers, pumps, motors, etc.
- Integrating end-devices with different signals into existing BAS/EMCS.
- Cost allocation, sub-billing and utility accounting.
- Verifying utility bills.

After one understands the value of a building's data set and how it either initially reduces energy costs or maintains the measures implemented, the question remains, "Why isn't each and every building equipped with such equipment?" The answer is almost always first costs, especially for small to medium sized buildings. Because most HVAC and construction contractors do not fully understand the value of acquiring monthly interval data and "least cost construction practices" often prevail in the construction industry, building owners are frequently swayed to just install programmable thermostats or analog thermostats without any way to acquire and/or trend the building's consumption. If building owners were required to watch a presentation on the subject of how low cost data systems reduce "long-term" energy

consumption, almost all owners of small-to-medium sized buildings would install a data acquisition system.

Almost all larger facilities (with chiller plants) have an EMCS/BAS. Most have the ability to acquire, trend, graph and trend interval data, but that component of the system was typically not sold or implemented. Once again, ignorance about the value of interval load data is the culprit to high energy costs for a unsuspecting building owner.

Once a data system is implemented, the ongoing challenge is to capitalize on the value of the data on a regular basis. For small-to-medium sized building owners, the “chore” of assessing the resultant graphs are usually delegated to maintenance personnel. It is very typical that an owner has a minimum number of maintenance personnel that take care of several buildings. In the course of staying up with their daily maintenance tasks, evaluation of the graphs easily goes by the wayside. For larger buildings, Chief Building Engineers are also challenged to find the time to evaluate the resultant data. In both cases, the common denominator is that the person(s) assigned to view the data may not have the time, background or knowledge to understand the data and how to implement strategies gleaned from the data graphs. And, an inherent underlying problem that can't be prevented is the turnover of personnel and the loss of their corporate knowledge about the data system.

The best case scenario for long-term results is to have someone adept at understanding data graphs set up alarms (if the system allows) so out-of-bound conditions trigger e-mails, text messages, etc. to maintenance personnel. But as with any technology, the data system still needs to be viewed frequently by someone with a trained eye to ensure the alarms are appropriate and to evaluate the graphs so anomalies and “trend problems” are identified.

Description of Data Acquisition Systems

Data acquisition systems vary in functionality, data quantity and type acquired, communications capability and how the data is presented. Some are stand-alone systems and others are integrated into another building system such as an EMCS or BAS. In general, “data acquisition” or “metering” is used to describe a system for acquiring or collecting data from a source such as electricity, gas or water. Most data acquisition equipment allows the user to change the interval to any value such as one minute, hour, day, etc. Intervals less than fifteen minutes are usually too granular and provide little more information a 15-minute graph can provide. The acquired data is a rate and as such has a date-time stamp associated with each data point. For electricity, the preferred interval in the U.S. is fifteen minutes. A 15-minute interval also correlates to the utility industry's index-based tariff schedules such as ratchets, peak demands and coincident peaks.

Many incorrectly use the terms “data acquisition or metering” and, “monitoring and control” synonymously. There is a marked difference in costs and types of equipment used in the two scenarios. Merely acquiring load profile data to evaluate and assess through a visual graph is relatively cheap and easy. But once one says the words “monitoring” or “control,” an entire different and more costly, hardware infrastructure must be installed to react to alarms generated by the metered points.

Before beginning a data project, two significant questions should be answered.

1. What data do you want?
2. What are you going to do with the data when you get it?

The answers to these fairly simple questions are critical to formulate a strategy and level of sophistication of the project, all of which will impact a project's costs. The real focus of this paper is to concentrate on the output of a data project so an in depth assessment of “monitoring and control” functionality of a system will not be presented.

Components of a Data Project

To acquire data from a building, there are five distinct components of a data project. Figure 1. is an overview of the components. Moving from left to right, one can follow the flow of the data being acquired (i.e., from the end-point devices that are in the proximity of the building, through the datalogger/EMCS/BAS, to the software presentation) and how they integrate to become a complete data system. Even though the “data” flow is from left to right, the most important component that drives what

type of hardware to install for a data project is the software presentation. When developing a project, the format of the data (e.g., Modbus RTU, Modbus ASCII, MV-90, etc.) received by the computer that hosts the software will dictate what type of end-point devices are required.

- Meter point hardware (metering devices, equipment), Figure 2.
- Hardware Inter-connectivity, Figure 3.
- Central Datalogger and Control Platform, Gateway and Communications Device, Figure 4.
- Data warehouse and hosting, Figure 5.
- Data presentation, Figure 6.

When developing a data project, “each” end-point must be assessed to determine what data is required and what the data will be used for, as previously mentioned (“What data do you want?”). Figure 1. is an overview of the components that should be reviewed for each project. Figures 2. – 6. further depict input options within each component.

Building Proximity						Building Proximity			Building Proximity	Data Transport Medium		End-User		
End-Point Hardware (Metering Devices, Equipment)						Connectivity			Central Data Gateway Device	Communications		Software		
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

Figure 1. Overview of a Data Project’s Components

Building Proximity					
End-Point Hardware (Metering Devices, Equipment)					
15	14	13	12	11	10
End-Point(s) and Quantity of Each Type	Type of Activity and Data Required	Frequency of Data Acquisition or Type of EMCS/BAS	Metering and Other End-Device Hardware	Intermediate Communications (Device)	Metering Device Data Output Protocol or Personality Module
Whole-building electric via main electric feed panel.	15-minute data acquisition of building electricity 1.) kWh. 2.) kW. 3.) Power factor. 4.) kVARh 5.) Amps per phase. 6.) Volts per phase. 7.) Outside air temperature.	Data acquired at 15 minute intervals (retrieved once per day)	5 amp secondary output, split-core current transformers	1.) Direct hardware between end-point and logger, or 2.) Hardware with RS-485 to LAN node, or 3.) Hardware with RS-485 to wireless modem, or 4.) Hardware to building fax line.	5 amp output.

Figure 2. Example of End-Point Hardware Options

Building Proximity		
Connectivity		
9	8	7
Connectivity	Intermediate Instrumentation and Equipment	Intermediate Communications Device
RS-485 (RS-232, Ethernet, ModBus are options)	N/A	N/A

Figure 3. Example of Connectivity Options

Building Proximity
Datalogger, Gateway Device
6
Central Data and Control Platform, Gateway and/or Communications Device
WEMM datalogger

Figure 4. Example of a Datalogger option

Data Transport Medium	
Communications	
5	4
Intermediate Communications Device	Communications
Wireless, cellular modem with DHCP.	Cellular.

Figure 5. Example of Communication options

End-User		
Software		
3	2	1
Data Warehouse Location for Data Flow and Data Management	Data Format	Software Engine
1.) EKG computer/Server. 2.) Client based software.	N/A (system is a closed, seamless system).	Energy@Desktop energy software.

Figure 6. Example of Software Options

The next decision path in developing a data project is to determine which of the different options within each of the five components will best meet the overall needs and costs of the project for each meter point. Just to get the data from the end-device format into a protocol or format the data presentation software engine can read and use from “each” meter point in every facility in a portfolio of buildings, is often very challenging.

Logistical challenges also often plague data projects. The implementation of a national level installation project can often be very costly due to contractor ineptness, return trips, etc. Another common obstacle is detached meters that are far from a power source or in the middle of a parking lot with no way of terminating wires to it without cutting concrete or tunneling underneath. In these instances, a solar powered wireless solution is required. These issues highlight the need for a well thought through plan of action in order to deploy an effective data project with hundreds of meter points.

What Data Should be Acquired?

kW, kWh, kVARh, Volts, Amps

The data is acquired is dependent on the type of hardware used, of which is driven by the type of software or database used. There are mainly two types of hardware/software configurations.

1. The end-point device such as the CTs (current transformers) or electric meter calculate the values being acquired, (e.g., kW, kWh) and port the data to the database for warehousing.
2. The end-point device such as a 5-amp secondary CT sends a signal (e.g., 4-20 mA, 0-10 V, etc.) to a datalogger or EMCS/BAS and this system derives the values. This is the more common system for existing buildings. New buildings may have an EMCS/BAS or control system but rarely has the metering, trending and monitoring component of the software activated.

The data acquired should as a minimum should be Watts and kVARh. From these, kW, kWh, Power Factor, Volts and amps can be derived. Most data acquisition systems of recent manufacture present all of these values without the requirement for secondary calculations.

Outside Air Temperature (OAT)

Outside air temperature (OAT) is also a critical value that should be obtained. The issue is that this is an analog signal from an OAT sensor and requires a different input requirement for the hardware being used. Some systems obtain the “area” OAT from an Internet site and then has the presentation software overlay the temperature data with the load data when the data is populated into the software. If site-specific OAT is not required, this will prevent the requirement for additional costs of installing an OAT sensor at the building and potentially adding costs to the datalogger hardware or configuration. If possible, it is best to use an on-site OAT sensor. If a demand-response program is implemented through the datalogger/EMCS/BAS systems, then temperatures at the building’s location is required and not temperature at the local airport of which might be miles away.

Power Factor

Although Power Factor does not directly impact the demand (kW) or consumption (kWh) per se and the associated costs, it is a critical value to know, especially in a facility that has a high induction load such as motors. And by virtue that the data acquisition system is inherently acquiring data from the building's whole-building-electric system, it only makes sense to go ahead and acquire the PF value.

The reason PF is critical to know is that many utility companies base different components of their tariffs on the PF. It is also typical that larger buildings and the commensurate consumption require more intense contracts. If the building resides in a deregulated state, the TDSP (Transmission Distribution and Service Provider) or "wires" company, is the entity that charges for less than optimum PF values. Because PF is not one of the primary values for a data acquisition system, PF can be considered a secondary, passive value. If hardware components (e.g., capacitor banks) or strategies are implemented to increase the PF, the resultant is a reduction in overall energy costs through lower demand charges in the tariff. The following is an example of a PF charge.

"If the Power Factor of Retail Customer's load is found to be less than 95% lagging as measured at the Meter, Company may require Retail Customer to arrange for the installation of appropriate equipment on Retail Customer's side of the Meter necessary to correct Retail Customer's Power Factor between unity and 95% lagging as measured at Meter, or, if Retail Customer fails to correct its Power Factor consistent with this standard, the demand associated with Retail Customer's use of Delivery Service, as determined in the appropriate Rate Schedules in Section 6.1 RATE SCHEDULES, may be increased according to the following formulas: (see reference for formulas);"

Peak Demand; 4CP (Four Coincident Peak)

Although this is not a value directly acquired from a data acquisition system, it is an important value to derive from the database, especially for large facilities. Most TDSPs have a component of their tariff for large facilities call 4CP. If the facility has a lower peak demand, say less than 1,000 kW, it is on a "non coincident peak (NCP)" demand charge. If the facility has a peak demand larger than 1,000 kW, then it is on a 4CP demand charge schedule. The following is a definition of 4CP from TDSP in a deregulated state (Oncor, Texas).

"The 4 CP kW applicable under the Monthly Rate section shall be the average of the Retail Customer's integrated 15 minute demands at the time of the monthly ERCOT system 15 minute peak demand for the months of June, July, August and September of the previous calendar year. The Retail Customer's average 4CP demand will be updated effective on January 1 of each calendar year and remain fixed throughout the calendar year."

Just by being able to graph a building's interval load profile, one can better understand how where a buildings peak demand occurs, what is causing the peak and how to implement strategies to abate or avert the load during a specific time frame.

Costs

The following are some issues that impact the costs of a data project.

- Datalogger and related hardware costs (CTs, sensors, etc.).
- Remote accessibility (TCP/IP, LAN, dial in/out via a telephone line) and the related costs of the service, i.e., cellular, warehousing of data, Internet fees, etc.
- Location vs. labor availability and their expertise.
- Software.
- Engineering evaluation and assessment of the profiles.

Localized, onsite loggers can be as low as the \$50 range. There are usually no networking or remote access capabilities with these loggers. The data has to be retrieved with a separate device or the logger has to be removed and downloaded to a PC or laptop. These types of loggers are optimum for facilities that have on-site staff with the skill sets and understanding of how to use and evaluate the resultant data.

Short-term datalogging solutions can range from \$2,000+. These projects are usually turnkey projects that provide data from 1-4 weeks with the ability to remotely acquire the data via cellular or Internet.

These are best suited for pre-development assessment of energy projects, sub-metering and isolating problematic issues with equipment and M&V of a recently installed energy project.

Long-term data projects include the permanent installation of aforementioned equipment. The primary issue that should be addressed with a long-term project is who is going to maintain and manage the data. If the data is not looked at and evaluated on a regular basis (monthly as a minimum), then the cost of the data project will be a waste of resources. If the data is not being monitored and managed regularly, the system should as a minimum have the capability to alarm an out-of-bound condition by sending an e-mail or text message to maintenance staff.

If the metering, trending and monitoring of the component of a EMCS/BAS is activated, this can be a minor cost when considering the overall cost of the EMCS/BAS since it is an integral part of the software presentation system. Other costs such as annual maintenance and service agreements or warehousing of the data may be relevant.

Dissecting and Analyzing a Data Graph

Either real-time data logged by a datalogger or interval data from a utility company is presented for a chain of small retail stores, a large commercial building, a meat processing plant and a large hotel.

Retail Chain Stores

Observations

In the month of September, 15-minute interval electrical load data was acquired for five small retail chain/franchise stores throughout Texas for one month. The stores are open seven days per week between 7-12 hours per day. All stores have standard Roof Top Units (RTUs) HVAC units and programmable thermostats. The thermostats are battery operated, non-networked (cannot be accessed remotely by a computer or an energy management control system (EMCS)) and have to be adjusted and programmed at the local level by the managers. The thermostats were found to be in different conditions with some fans in the constant run position of "on" and all on/off times improperly programmed when correlated to each store's open hours. The reasons are a result of a combination of human and technical factors.

Almost all of the stores are managed by younger people of which for the most part do not understand how to program the thermostats. As simple as programming a thermostat may seem to many, they are actually intimidating and confusing to most people. As with any battery operated device, they are susceptible to electric surges, power outages, electrical storms, etc. Even though the programs are backed up by a battery, the problem is that the batteries are never changed out because there is not a corporate or local plan in place to do so. As such, the false security that "the battery is maintaining the program," is a major pitfall. The other major issue is that thermostats are seldom re-programmed for daylight savings time.

An additional problem with any thermostat is that most people do not understand the fan on/auto switch. If the thermostat's fan "on" position is selected, the fan runs 24/7, even if the HVAC unit is not running and conditioning the space. Fan motors are not large and do not consume a lot of energy when compared to the entire HVAC system but when it runs 24 hours per day, the wasted energy can be enormous. As an example, for a store that is open 7 days a week for an average of 9 hours per day and the fan in the "on" position all the time, the fan will run unnecessarily after hours approximately 60%+ of the time during a year.

Data from four of the small retail chain stores is plotted in following graphs in Figures 7. – 10. Each graph emphasizes different scenarios.

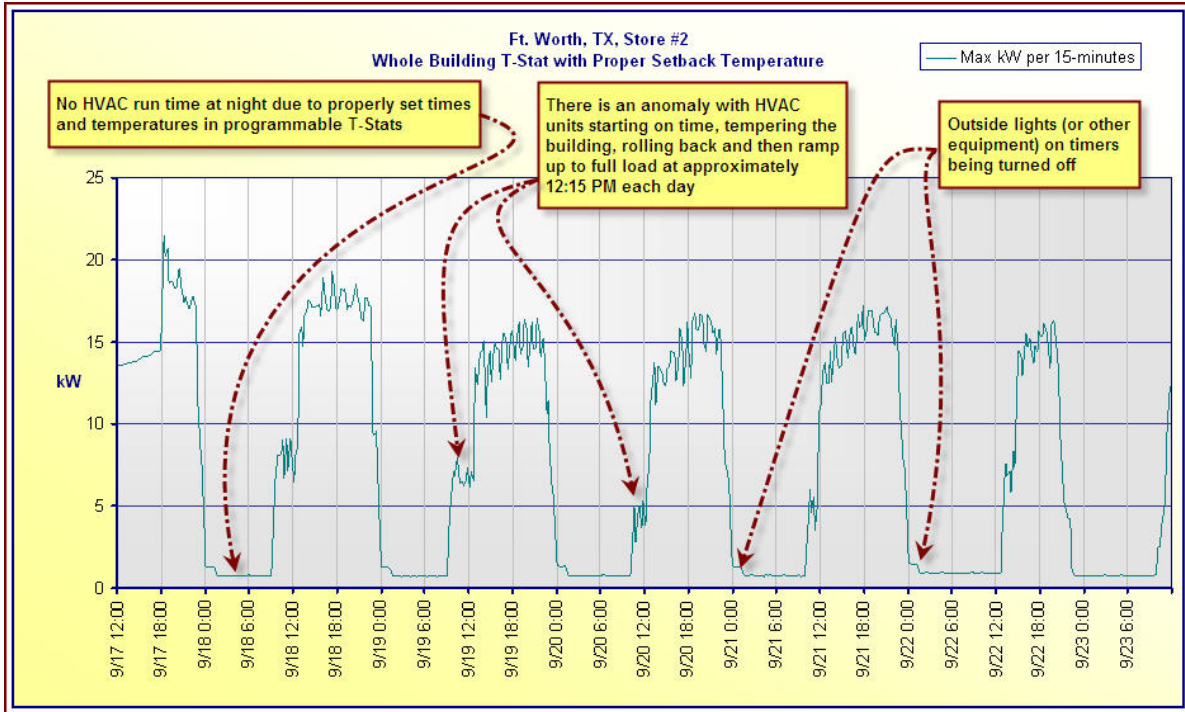


Figure 7. Whole Building T-Stat with Proper Setback Temperature

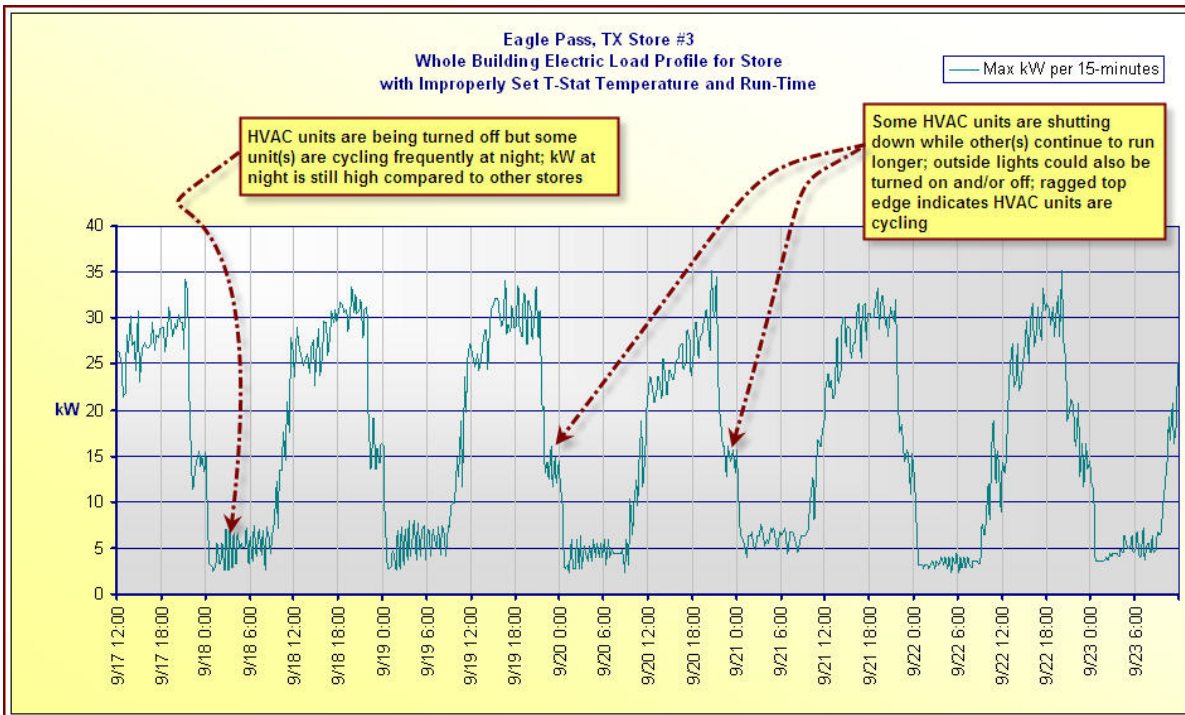


Figure 8. Whole Building Electric Load Profile for a Store with Improperly Set T-Stat

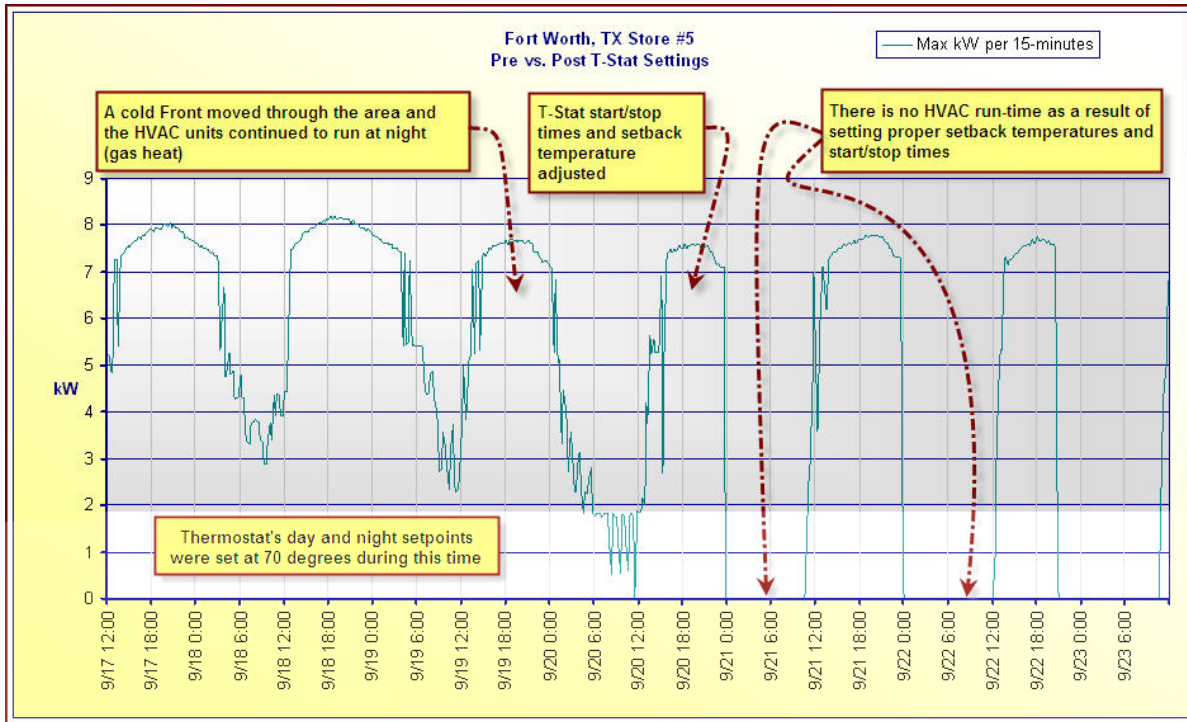


Figure 9. Pre vs. Post T-Stat Settings

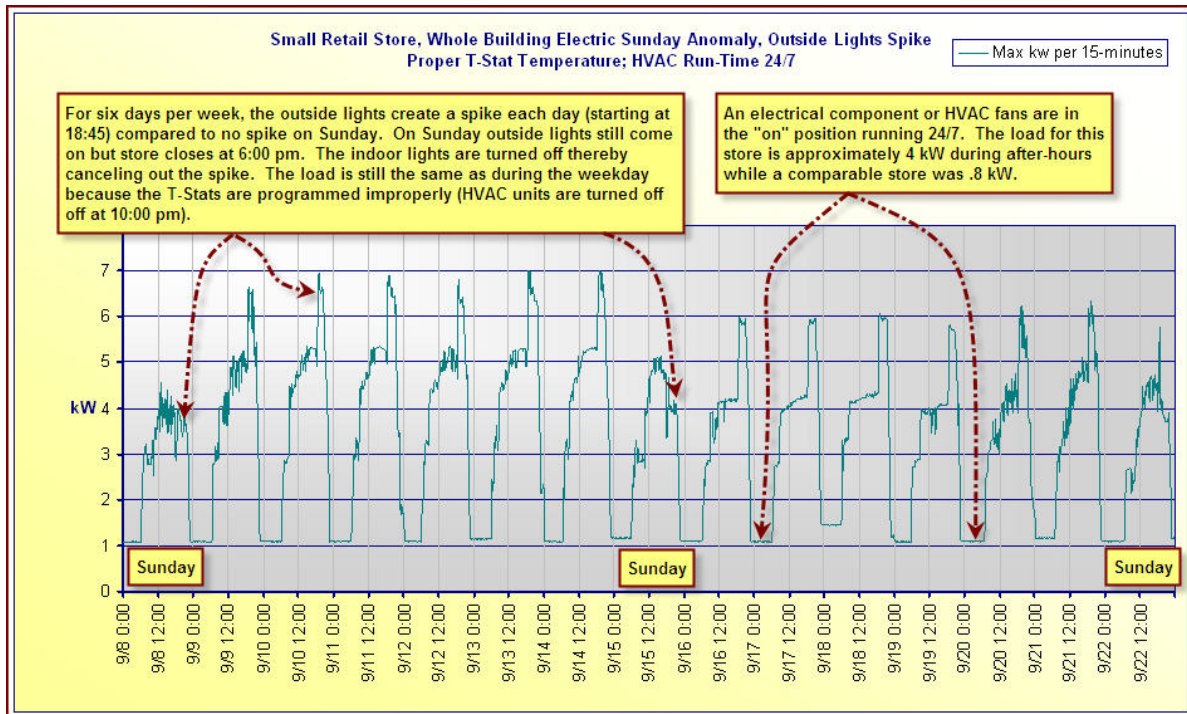


Figure 10. Small Retail Store with Sunday Anomaly and Outside Light Spike

Recommendations

Recommendations and strategies to correct the issues observed in the graphs and reduce kW and/or consumption are presented below.

- The lesson learned in this scenario is that the most effective method to save energy is to “turn off equipment and turn it off consistently.” The only way to do this effectively across a retail chain store scenario where equipment cannot be physically maintained or controlled by one individual, i.e., maintenance manager or building engineer, is to let technology complete the redundant daily tasks and then have them networked through an EMCS or other means so the units can dial out and send an alarm if there is a problem or improper setting change or a corporate Energy Manager or third party can dial-in to check a unit’s functionality. If the stores are sophisticated enough, all HVAC equipment and controllers today are Internet based and can be accessed through the store’s standard Internet Protocol (IP) communications.
- Implement a portfolio wide EMCS/BAS that has the following capabilities.
 - A. Remote access and control of each building’s HVAC systems, outdoor lighting and other equipment and components.
 - B. A monitoring and verification (M&V) feature of which the data is being ported into a database via the Internet or local PSTN telephone line. The 15-minute snapshots of the building’s consumption can be ported into a graphic format to allow one to identify equipment that is running when it should not be or when the consumption rate is abnormal compared to a store with newer, more efficient equipment, i.e., poorly running equipment can more easily be identified because of the increased energy consumption.
- Also, most electric companies will price more aggressively if they have a year or more worth of 15-minute electrical consumption data which allows corporate management or each store to negotiate a better electricity price or contract.
- Another benefit of logging data is that each store’s energy consumption can be indexed by comparing each store’s consumption data. The worst performing stores can then be identified and tackled in priority.
- Integrating all of these factors, the programmable thermostat often wastes significantly more energy than it can potentially save. As can be seen in this project, these stores can easily save 10%+ by implementing a strategy to replace the programmable thermostats with different technology. When considering some chain or franchise corporations have thousands of stores, the amiable well-meaning device can actually waste thousands of energy dollars under the guise of being a simple, “no-brainer” energy efficient measure. With this level of savings, the economic IRR (Internal Rate of Return) and NPV (Net Present Value) prove without a doubt that spending money for the newer technology is typically a much better investment opportunity than the best performing money investment products on the market.

Large Commercial Building

Observations

This building is a first-class, 3-tower office building with Tower A, the tallest tower at 20 stories high. The lower floor plate spans all three towers and is 40,000 sqft/floor. The middle floor plate spans two towers and is 27,000 sqft/floor and the upper floor in the tallest tower is 14,000 sqft/floor. There is also a detached 8-story parking garage to the West. Other business operations require unique equipment such as computer servers, deli, restaurant and a snack shop.

Three chillers and electric heat provide comfort cooling/heating. A pneumatic-to-DDC signal EMCS provides control of the HVAC system.

The daytime setpoint is estimated to be 72 degrees F. After reviewing 15-minute interval load data from the electric company, the chillers are setting back but there is still a significant load above the lag chiller. This could be that the other chiller(s) may be also running at night.

There are approximately 1,800 people that work in the building with an occupancy rate of 80-84%. The hours of occupancy are:

7:00 am – 6:00 pm, Monday – Friday
8:00 am – 1:00 pm, Saturday

No occupancy schedule on Sunday.

The Energy Management Control System (EMCS) hours were not available but it was stated that the on/off times accommodate the hours of occupancy above.

There is no load data being acquired. The TDSP (Oncor) for this building is required to acquire 15-minute interval load profile. This data was retrieved from Oncor and graphed to analyze representative months for summer, winter and shoulder (spring or fall) months.

The graphs have two profiles, the actual kW for the month and a pseudo profile that merely indicates optimum on/off times and a 5% reduction in kW demand. The latter is not an actual profile but merely gives a sense of how “out of bounds” the actual load profile is when compared to the hours of operations (highest occupancy load) and a realistic obtainable kW reduction. Also, the pseudo profiles do not reflect equipment cycling, any excessive HVAC run time resulting from extreme temperature deviations such as is suspected in the Winter graph (cold front passing through the area) or the seasonal requirement to keep the building warmer or cooler during the night so the HVAC system can achieve the proper temperature during the first business hours of the following morning. Any actual kW “above” the optimum profile line is considered wasted energy consumption.

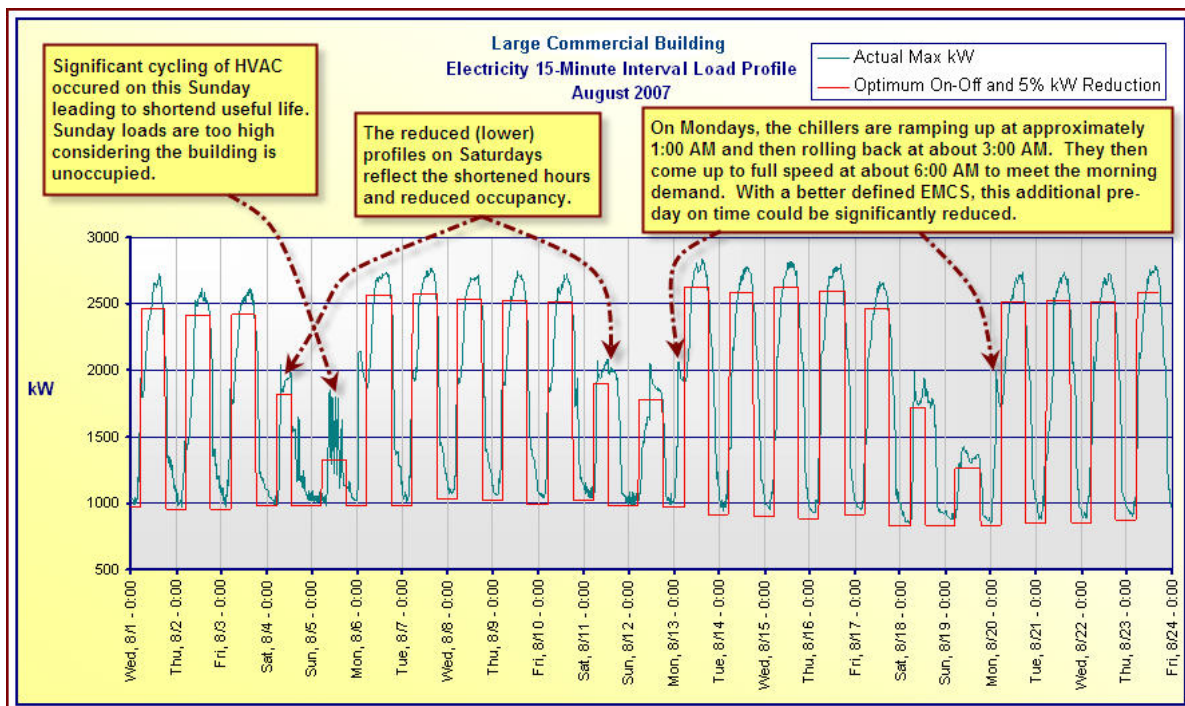


Figure 11. Large Commercial Building, Electricity 15-Minute Interval Load Profile, Summer Month

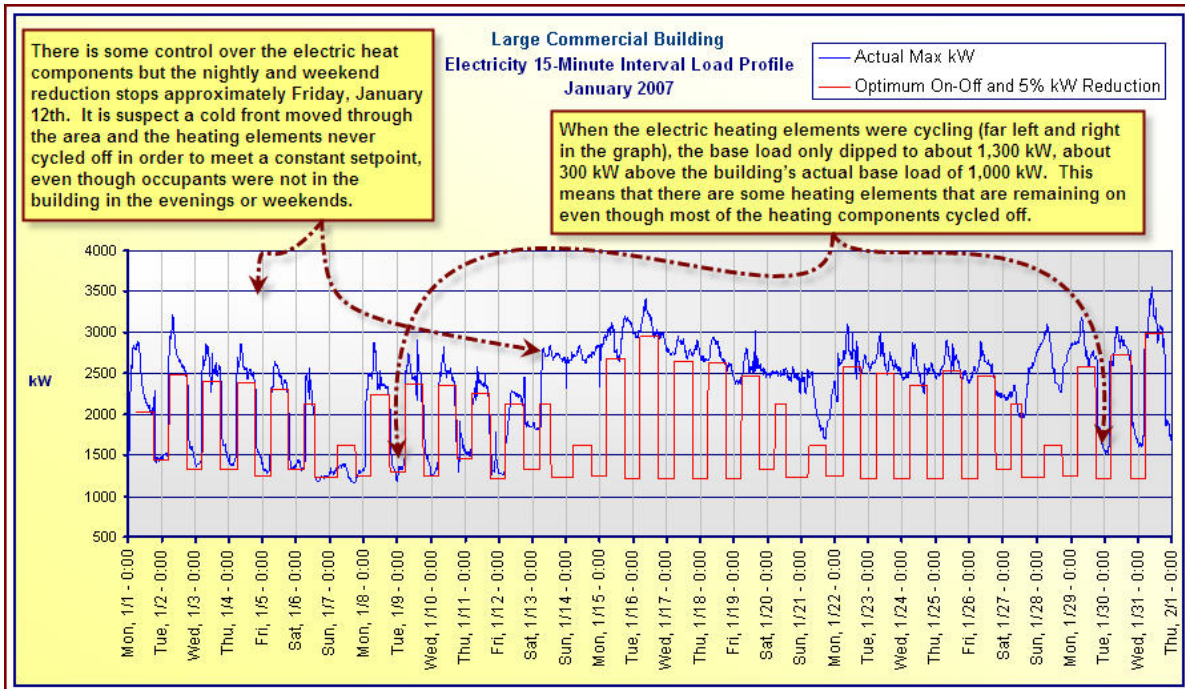


Figure 12. Large Commercial Building, Electricity 15-Minute Interval Load Profile, Winter Month

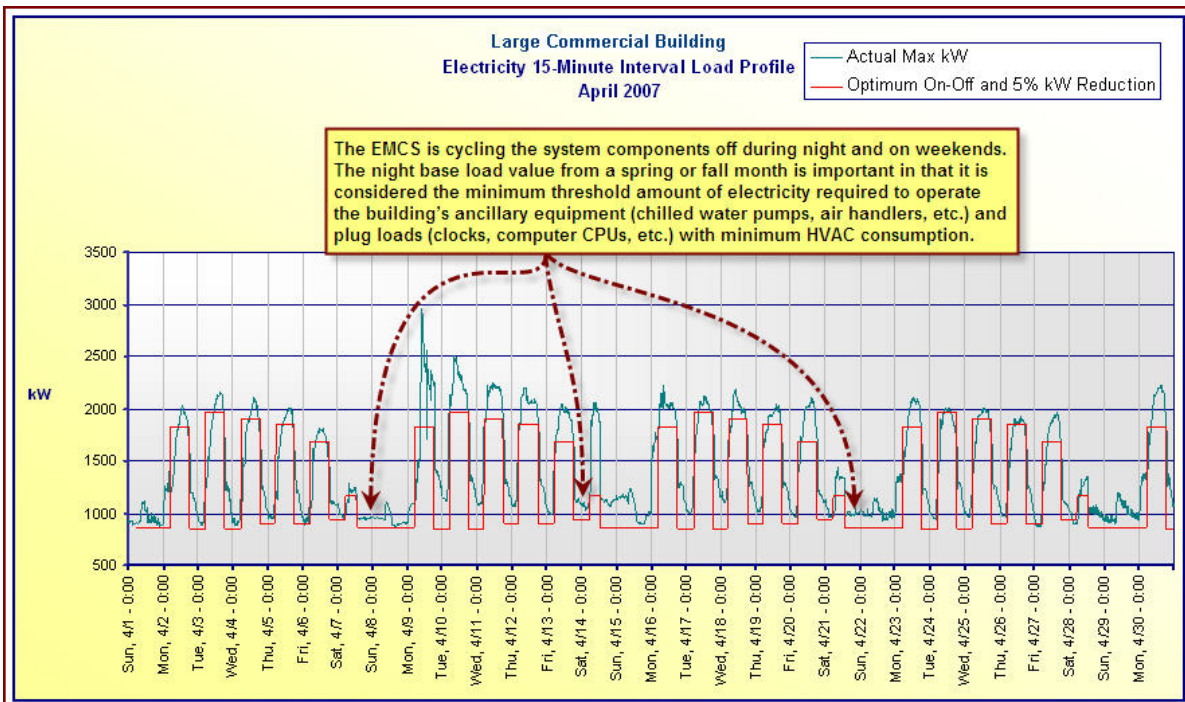


Figure 13. Large Commercial Building, Electricity 15-Minute Interval Load Profile, Shoulder Month

Graph Summaries

Recommendations and strategies to correct the issues observed in the graphs and reduce kW and/or consumption are presented below.

Summer Month

- The summer graph indicates the control system is turning off the HVAC equipment after hours and on weekends although there could be a widening of the valleys and a lowering of the peaks through a more precise control system.
- On Mondays, the chillers are ramping up at approximately 1:00 AM and then rolling back at about 3:00 AM. They then come up to full speed at about 6:00 AM to meet the morning demand. With a better defined EMCS, this additional pre-day on time could be significantly reduced.
- There may be some additional reduction on Sundays. The caution is not to “loose the building” on Sundays so that the heat mass (gain/loss) of the building is too much for the system (cooling/heating) to overcome on Monday mornings. The chillers and/or other equipment are dramatically cycling on Sundays, especially on 8/5.
- The maximum demand is about 2,800 kW. If this were reduced on average by 5%+, not only would the electricity costs be impacted by the 4CP charge for the following year could also be significantly reduced.
- The “base load,” or the amount of electricity consumed to temper the building and run all the ancillary equipment in off hours, is approximately 1,000 kW, i.e., the lowest average values as seen in the valleys of the curve. The base load does drop to the building’s springtime base load of about 800 kW during the latter part of the month. This minimum value should be a goal for every night throughout the year barring significant weather/temperature changes.

Winter Month

- The winter graph indicates there is some control over the electric heat components but the nightly and weekend reduction stops approximately Friday, January 12th. It is suspect that a cold front moved through the area and the heating elements never cycled off in order to meet a constant setpoint, even though occupants were not in the building in the evenings or weekends. It can be seen that the kW only dipped once below about 2,500 kW (Monday 1/22) but then resumed its previous state. To emphasize this anomaly, the winter had a greater maximum kW peak than the summer graph, approximating 3,000 kW.
- When the heating elements were cycling (far left and right in the graph), the base load only dipped to about 1,300 kW, about 300 kW above the building’s actual base load of 1,000 kW. This means that there are some heating elements that are remaining on even though most of the heating components cycled off.
- The winter graph indicates there is much that can be achieved by recommissioning the EMCS and winter heating components of the HVAC system.

Shoulder Month (spring or fall months)

- The EMCS is cycling the system components off during night and on weekends. Again, one can see the demand is reduced on average to approximately 2,000 kW and that the base load for the building is verified at approximately 900 kW. The base load value from a spring or fall month is important in that it is considered the minimum threshold amount of electricity required to operate the building’s ancillary equipment (chilled water pumps, air handlers, etc.) and plug loads (clocks, computer CPUs, etc.) with minimum HVAC consumption.
- The graph remains flat during the weekends indicating the HVAC system is remaining off. Compare this to the summer graph weekends and one can see that the HVAC system has a significant amount of runtime during the weekends during the summer.
- As noted above, it can be seen that there is some cycling of maverick equipment on Saturdays and Sundays.

Recommendations

Recommendations and strategies to correct the issues observed in the graphs and reduce kW and/or consumption are presented below. Additional ECMs that could further reduce the demand or

consumption such as replacement of HVAC units, upgrading the lighting system, installing a cool roof technology, etc., are not discussed.

- The EMCS should be re-commissioned as a minimum and possibly transitioned to a full DDC (direct digital control) system. A DDC hardware platform would eliminate the existing pneumatic system which would give a more exact control of the building. Solid-state sensors and controllers used in DDC systems have considerable advantages over pneumatic systems such as calibration, maintenance and the accuracy and reliability of positioning of valves and dampers. DDC systems also provide a level of precise airflow measurements and control that permits energy efficient operation of VAV systems.
- Install a data acquisition system or activate the energy trending and presentation component of the existing EMCS/BAS to accomplish the following.
 - A. Optimize HVAC runtime and operational efficiency by setting daily on/off times and temperature setpoints for different areas of the building.
 - B. Alarm HVAC units, lighting or other equipment when there is an apparent problem.
 - C. Measure and verify predicted savings.
 - D. Leverage annual interval data to negotiate a more favorable electricity rate when the existing electricity contract ends.
- The historical consumption data received from the TDSP confirms that the average Power Factor is 86%. There is a monthly Power Factor “adjustment” (penalty) charge by the TDSP tariff (Oncor) for Power Factors below 95%. To determine the formula used and the potential reduction in Power Factor penalties, a review of the electric contract will be necessary so the CP or NCP (coincident peak or non-coincident peak) value can be determined. Installing capacitor banks will correct the PF to a value closer to the 95% threshold.
- This facility should investigate the merits of installing ECMs or equipment that will shift or eliminate the loads during periods of the electric grid’s peak demand. This would result in a substantial reduction of tariff 4CP demand charge costs.

Meat Processing Plant

Observations

A meat processing plant has a significant base load as a result of the required refrigeration load 24/7. The facility uses ammonia system for their refrigeration and rooftop units (RTUs) for their office comfort cooling. The company works two shifts and no weekends. There is no EMCS/BAS or data acquisition system.

As seen in Figure 14., the base load ranges from about 300-600 kW. And as expected, the average kW load for the facility’s compressor motor load is 485 kW (Figure. 15.). This obviously correlates directly with the annual average base load. Since the compressor load is constant for 8,760 hours per year, it is considered the “sweet spot” target load to address. The objective will be to implement measures that will dramatically reduce the load required by the compressor motors followed by lesser loads such as lighting and office HVAC comfort cooling units.

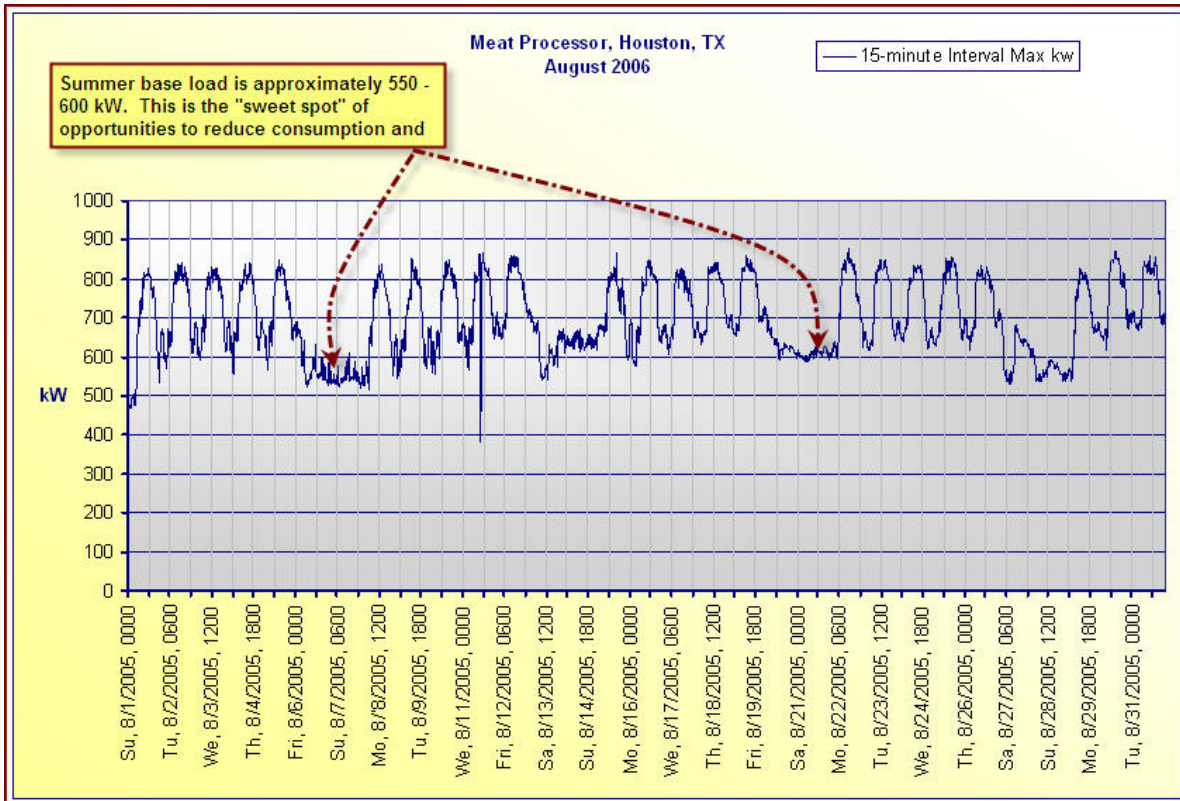


Figure 14. Meat Processing Plant, Electricity 15-Minute Interval Load Profile, Summer Month

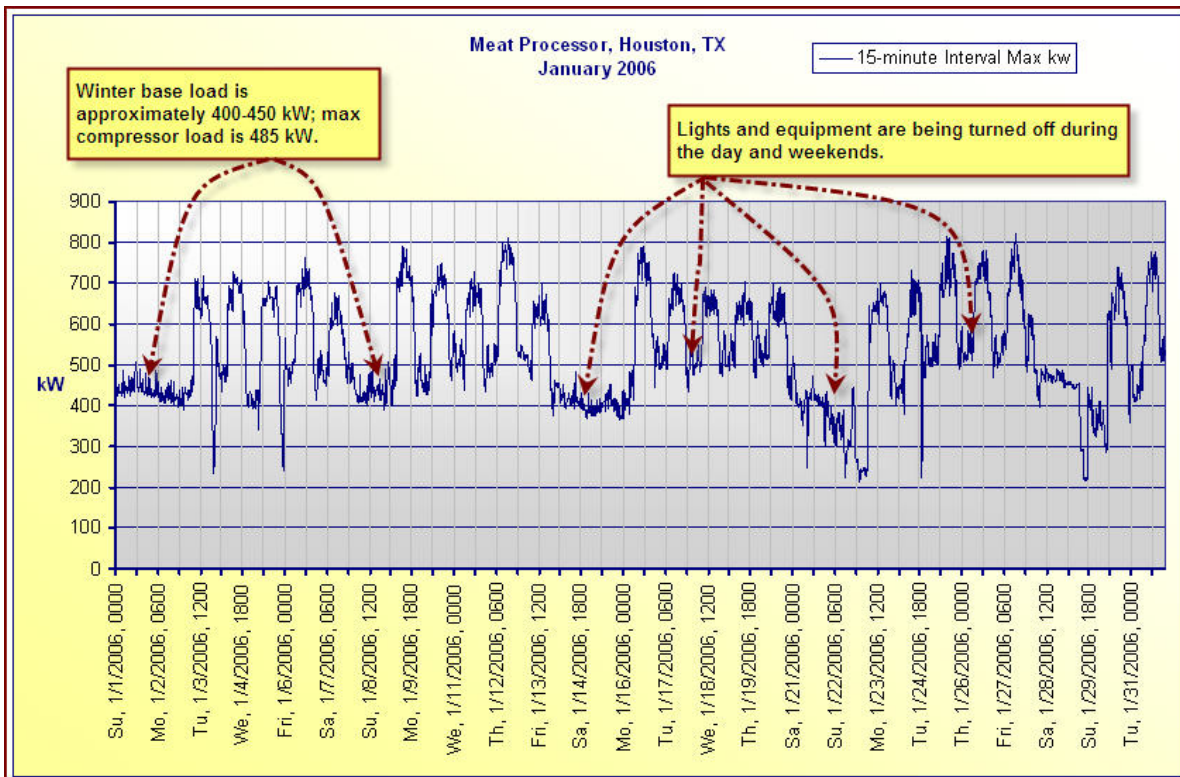


Figure 15. Meat Processing Plant, Electricity 15-Minute Interval Load Profile, Winter Month

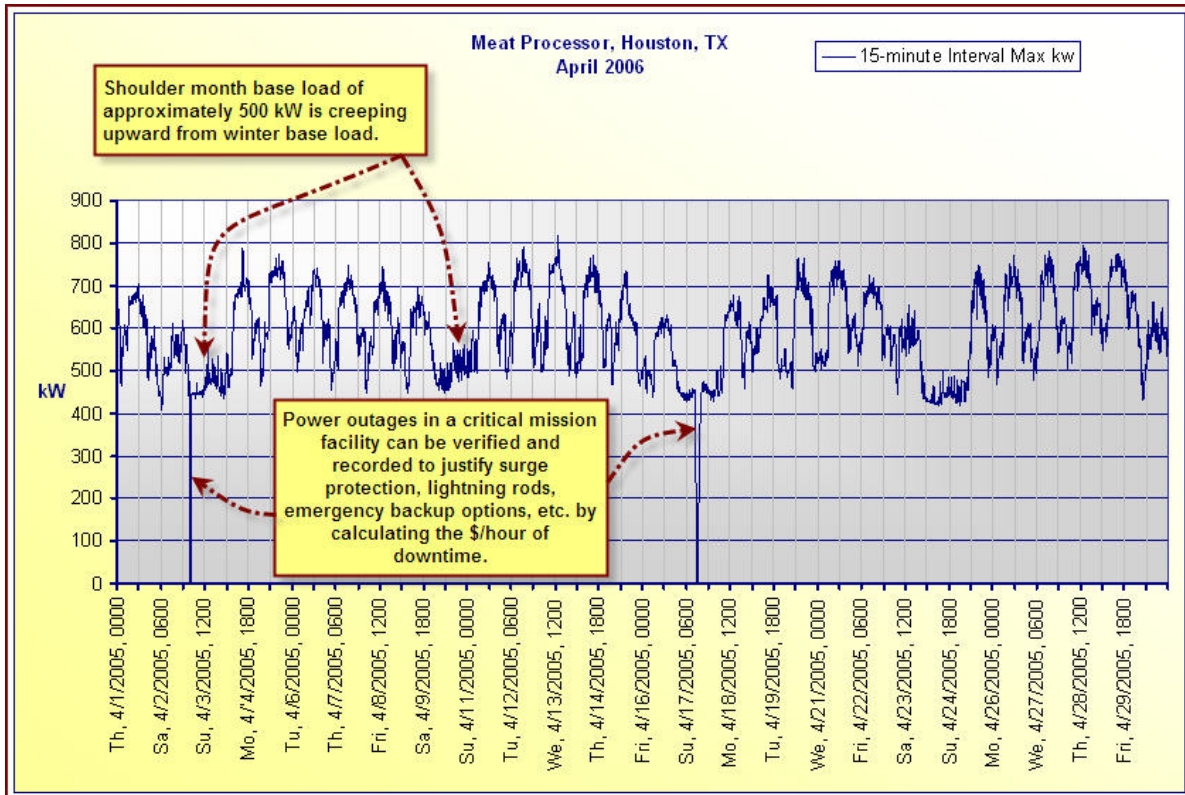


Figure 16. Meat Processing Plant, Electricity 15-Minute Interval Load Profile, Shoulder Month

Recommendations

Recommendations and strategies to correct the issues observed in the graphs and reduce kW and/or consumption are presented below. Additional ECMs that could further reduce the demand or consumption such as replacement of HVAC units, upgrading the lighting system, installing a cool roof technology, etc., are not discussed.

- In buildings where the operations require a considerable 24/7 constant load, i.e., the refrigeration compressors, the other loads that are usually the primary targets (e.g., comfort cooling HVAC, lighting, solar gain, etc.) become secondary. The primary recommendation for this scenario is to implement measures that will avert the load. The compressors could be rewired so they are on isolated electrical panels and then allow a renewable energy source such as solar to power each sub-load.
- Power Factor correction measures should also be considered. The TDSP data confirmed that this facility's PF is 90% and is most likely being penalized for their PF.
- By implementing an alternative power source, the 4CP tariff demand charges could be significantly reduced, especially for a base load of this size.

Large Hotel

Observations

This hotel is a premier resort hotel and convention center with over 1,500 guest rooms, 400,000 sqft of exhibit hall and meeting room space, ten restaurants and over 2,000 employees. The chillers and other comfort cooling equipment are controlled by a DDC BAS.

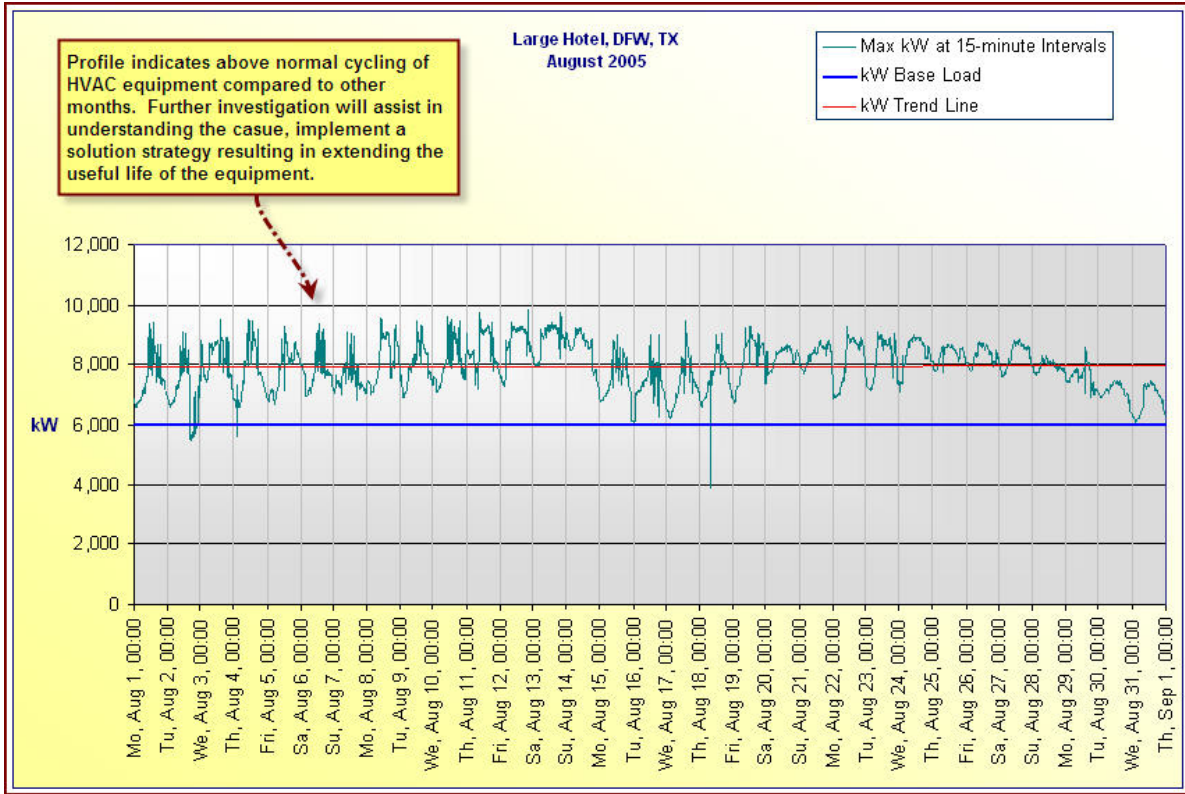


Figure 17. Large Hotel, Electricity 15-Minute Interval Load Profile, Summer Month

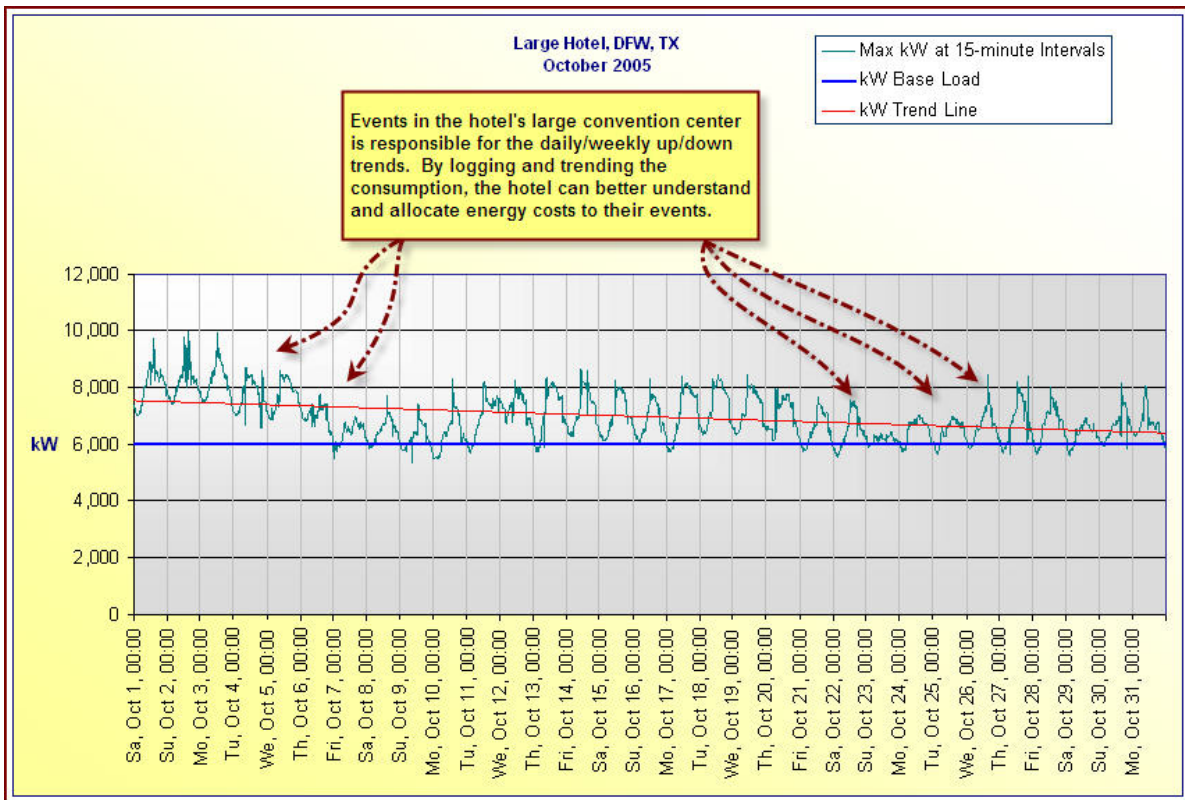


Figure 18. Large Hotel, Electricity 15-Minute Interval Load Profile, Events Example

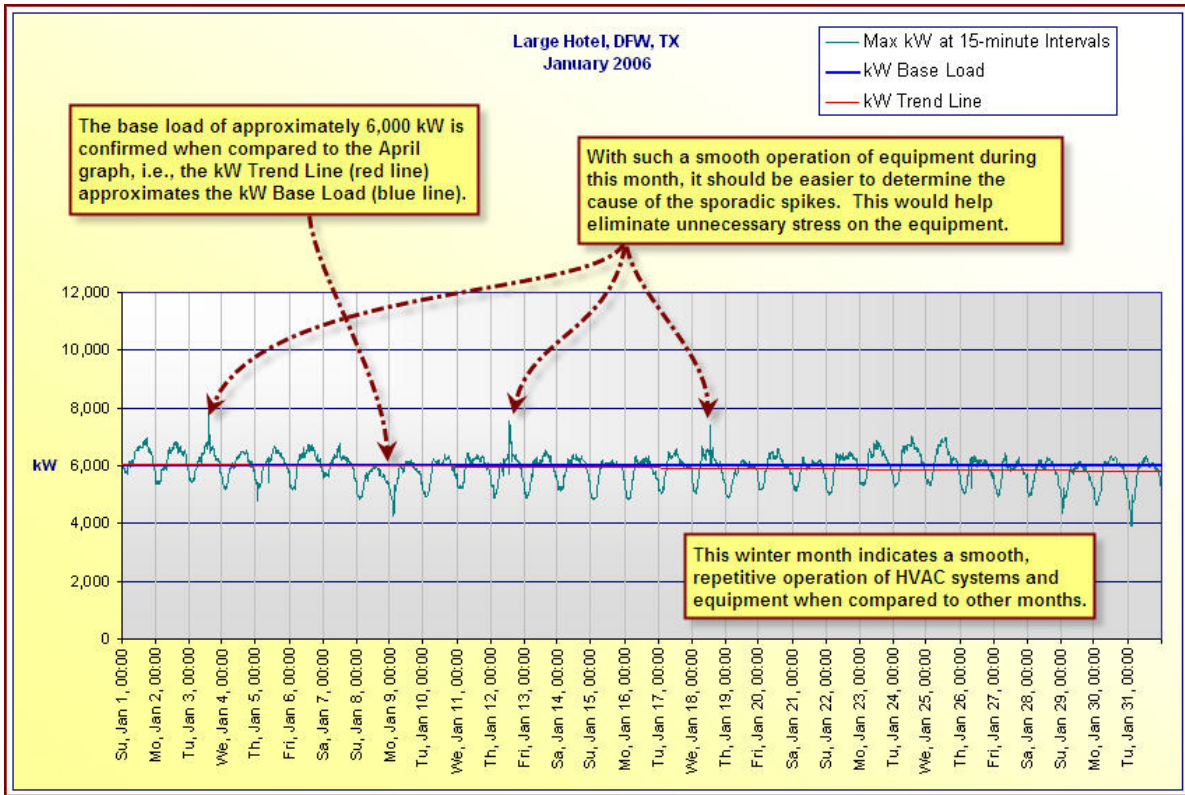


Figure 19. Large Hotel, Electricity 15-Minute Interval Load Profile, Winter Month

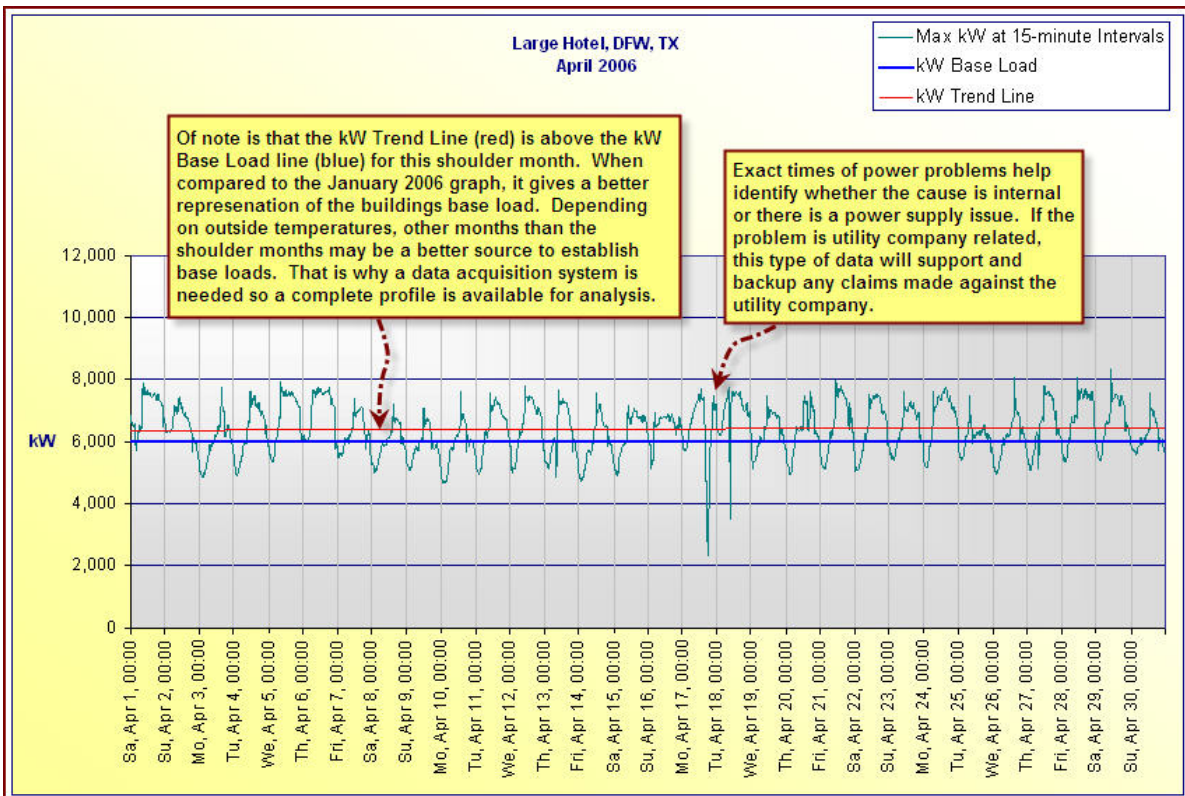


Figure 20. Large Hotel, Electricity 15-Minute Interval Load Profile, Shoulder Month

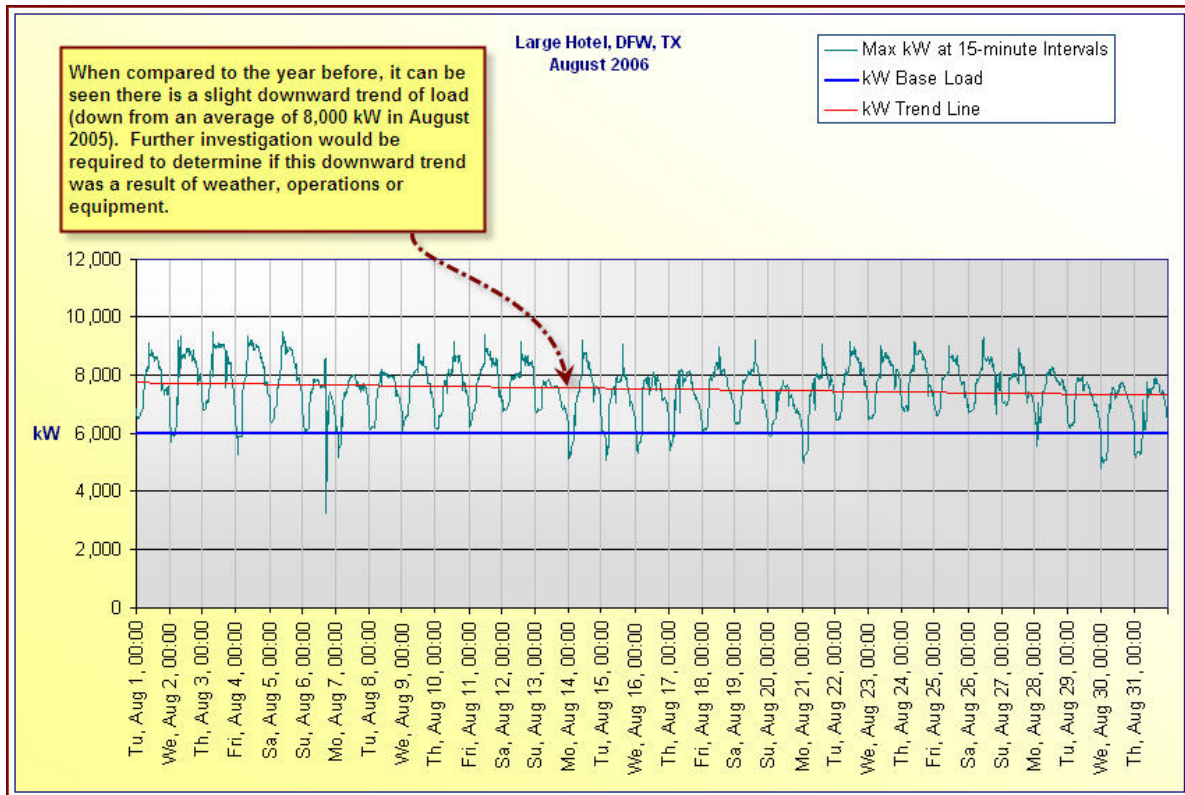


Figure 21. Large Hotel, Electricity 15-Minute Interval Load Profile, Summer Month Comparison

Recommendations

Recommendations and strategies to correct the issues observed in the graphs and reduce kW and/or consumption are presented below. Additional ECMs that could further reduce the demand or consumption such as replacement of HVAC units, upgrading the lighting system, installing a cool roof technology, etc., are not discussed.

- The BAS should be re-commissioned to ensure optimum setpoints and times.
- Install a data acquisition system or activate the energy trending and presentation component of the existing EMCS/BAS to accomplish the following.
 - A. Optimize HVAC runtime and operational efficiency by setting daily on/off times and temperature setpoints for different areas of the building.
 - B. Alarm HVAC units, lighting or other equipment when there is an apparent problem.
 - C. Measure and verify predicted savings.
 - D. Leverage annual interval data to negotiate a more favorable electricity rate when the existing electricity contract ends.
 - E. Better allocate energy costs associated with convention and meeting events.
- The average Power Factor was confirmed to be 90%. Installing capacitor banks will correct the PF to a value closer to the 95% threshold and thereby reduce future demand charges.
- This facility should investigate the merits of installing ECMs or equipment that will shift or eliminate the loads during periods of the electric grid's peak demand. Renewable power such as solar would be an ideal opportunity. Another approach is to re-circuit certain loads and take them offline or shift the loads so as to reduce the overall facility load during potential grid peak so that future 4CP demand costs will be reduced.

Summary

This paper focused on:

- The merits of installing a data acquisition system.
- The different components of a data system.
- The difference between a stand-alone data acquisition system and a component of an existing EMCS/BAS that can trend and present electricity consumption from the building.
- How to dissect and analyze a data graph and correlate measures that will reduce demand, consumption and energy costs.
- Demonstrate the different ways data can be presented with basic functions of graphing software such as Microsoft[®] Excel.

References

Tariff for Retail Delivery Service, Oncor Electric Delivery Company, 6.1.1 Delivery System Charges, Page 2 of 2, Revision: One, Effective Date: January 1, 2004.

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