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

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One Cannot Manage the Assumed or Unknown

- Data is the backbone of optimum, stable operations of just one building or an entire world-wide portfolio.

- Without a properly maintained control system and alarming capability, a historical utility consumption data set is needed as a minimum.

- If a building is “assumed” to be operating properly, energy *WILL* be wasted!
The culprits:

• EMCSs/BASs that are not maintained.

• Pneumatic control systems. Solid-state DDC sensors and controllers have:
  • Have better calibration.
  • Have less maintenance.
  • The accuracy and reliability of positioning of valves and dampers are more accurate and reliable.
  • Permits precise airflow measurements and control that results in energy efficient operation of VAV systems.
The culprits (continued):

• Programmable thermostats.
  
  • *Power outage and electrical surges reverts thermostats to factory default settings.*
  
  • *Are usually in small-to-medium buildings where there is no or inexperienced maintenance personnel.*
  
  • *Albeit simple to us, store managers are intimidated.*
So what are the solutions?

• A data acquisition system.

  • *Pro-active with alarming and demand-response.* Is there staff to maintain and ensure a response?

  • *Passive.* Acquire the data and then evaluate and assess to identify anomalies, equipment operating out-of-bounds, improper temperature setpoints and/or on-off times. Who is going to do this?

• A combination.
CAUTION!

• If you invest your hard earned cash into a data system, have “someone” with the knowledge to do something with the data.

• Do not just let a computer collect the data and then brag that you are metering your building when nobody is looking at the data, especially large buildings that have sophisticated EMCSs/BASs.
What data and the resulting graph can do for you.

- Verify how your building is operating, especially if you are “assuming” it is operating properly, i.e., give your building an ekg.

- You can measure and verify (M&V) performance contracts or energy efficiency upgrades.

- Optimize equipment operations by submetering individual components such as chillers, pumps, motors, cooling towers, etc.

- Verify utility bills or use the data for cost allocation, sub-billing and utility accounting.
Description of data acquisition systems.

• “Data acquisition or metering” is not the same as “monitoring and control.”

• For monitoring and control, different and more costly, hardware infrastructure must be installed to react to alarms (control) generated by the metered points.

• Before you start your data project, ask:
  • *What data do I want?*
  • *What am I going to do with it?*
Components of a data project.

- Meter point hardware (metering devices, equipment).
- Hardware inter-connectivity.
- Central datalogger and control platform, gateway and communications device.
- Data warehouse and hosting.
- Data presentation.
Components of a data project (continued).

- **End-point hardware** (sensors, CTs, etc.).

<table>
<thead>
<tr>
<th>End-Point(s) and Quantity of Each Type</th>
<th>Type of Activity and Data Required</th>
<th>Frequency of Data Acquisition or Type of EMCS/BAS</th>
<th>Metering and Other End-Device Hardware</th>
<th>Intermediate Communications (Device)</th>
<th>Metering Device Data Output Protocol or Personality Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole-building electric via main electric feed panel.</td>
<td>15-minute data acquisition of building electricity 1.) k/Vh. 2.) k/V. 3.) Power factor. 4.) kVARh 5.) Amps per phase. 6.) Volts per phase. 7.) Outside air temperature.</td>
<td>Data acquired at 15 minute intervals (retrieved once per day)</td>
<td>5 amp secondary output, split-core current transformers</td>
<td>1.) Direct hardwire between end-point and logger, or 2.) Hardwire with RS-435 to LAN node, or 3.) Hardwire with RS-435 to wireless modem, or 4.) Hardwire to building fax line.</td>
<td>5 amp output.</td>
</tr>
</tbody>
</table>
Components of a data project (continued).

- Connectivity.

<table>
<thead>
<tr>
<th>Building Proximity</th>
<th>Connectivity</th>
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<tbody>
<tr>
<td></td>
<td>9</td>
</tr>
<tr>
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<td>8</td>
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<td>7</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Connectivity</th>
<th>Intermediate Instrumentation and Equipment</th>
<th>Intermediate Communications Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS-485 (RS-232, Ethernet, ModBus are options)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Components of a data project (continued).

• Datalogger or gateway device.
Components of a data project (continued).

• Communications.

<table>
<thead>
<tr>
<th>Data Transport Medium</th>
<th>Communications</th>
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<tbody>
<tr>
<td>5</td>
<td>4</td>
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</table>

<table>
<thead>
<tr>
<th>Intermediate Communications Device</th>
<th>Communications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wireless, cellular modem with DHCP.</td>
<td>Cellular.</td>
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</table>
Components of a data project (continued).

• Software.

<table>
<thead>
<tr>
<th>1. EKG computer/Server.</th>
<th>2. Client based software.</th>
<th>N/A (system is a closed, seamless system).</th>
<th>Energy@Desktop energy software.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Warehouse Location for Data Flow and Data Management</td>
<td>Data Format</td>
<td>Software Engine</td>
<td></td>
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</tbody>
</table>
What data should be acquired?

- kW, kWh, kVARh, Volts, Amps.
- Outside Air Temperature (OAT); area vs. site-specific.
- Power Factor (can calculate from kVARh or kVAR).
- Peak demand; 4CP.
- Other.

  - Environmental: humidity, CO$_2$, temperature, etc.
  - Supply/Discharge air temperature, pressures.
  - Other utilities: gas, water (domestic, irrigation, etc.).
  - All are LEED applicable.
What are 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 for installation.

• Software.

• Engineering evaluation and assessment of the profiles.
What are the costs of a data project? (continued)

- Localized, onsite loggers can be as low as the $50 - $150 range for each logger.

- Short-term datalogging solutions can range in the order of $2,000 - $3,500.

- Monthly warehousing of data can range from $30 - $75.

- Monthly outsourcing of engineering assessment can be $50 - $250.

- $0 if on-staff personnel has the knowledge.
Retail chain store.

- In September, 15-minute interval electrical load data was acquired for five small retail chain/franchise stores throughout Texas for one month.
- Managed by young people.
- No on-site or outsourced maintenance personnel.
- Programmable thermostats.
  - Fan in “on” position.
  - Factory default settings.
Retail chain store (continued).

- Thermostat with proper setback temperature.
Retail chain store (continued).

- Improperly set thermostat.
Retail chain store (continued).

- Pre vs. post thermostat settings.
Retail chain store (continued).

- Sunday anomaly and outside light spike.

For six days per week, the outside lights create a spike each day (starting at 18:45) compared to no spike on Sunday. On Sunday, outside lights still come on but store closes at 6:00 pm. The indoor lights are turned off thereby canceling out the spike. The load is still the same as during the weekday because the T. Stats are programmed improperly (HVAC units are turned off at 10:00 pm).

An electrical component or HVAC fans are in the "on" position running 24/7. The load for this store is approximately 4 kW during after-hours while a comparable store was .8 kW.
Retail chain store (continued).

• Recommendations.

• Implement a portfolio wide EMCS/BAS with remote access and control of each building’s HVAC systems, outdoor lighting and other equipment and components.

• Alarm temperature setpoints and on-off times.

• Index the stores to find the “energy pigs” of the portfolio.

• Use each store’s interval data to negotiate a better electricity rate and/or contract by aggregating the loads (if in a deregulated state or city).
Large commercial building.

- 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.
- Three chillers and electric heat provide comfort cooling/heating.
- A pneumatic-to-DDC signal EMCS provides control of the HVAC system. No energy metering or trending.
Large commercial building (continued).

- Summer month.

Significant cycling of HVAC occurred on this Sunday leading to shorten useful life. Sunday loads are too high considering the building is unoccupied.

The reduced (lower) profiles on Saturdays reflect the shortened hours and reduced occupancy.

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.
Large commercial building (continued).

- Winter month.

There is some control over the electric heat components but the nightly and weekend reduction stops approximately Friday, January 12th. It is suspect 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.

![Graph](image)

When the electric 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.
Large commercial building (continued).

- Shoulder month.

The EMCS is cycling the system components off during night and on weekends. The night 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.
Large commercial building (continued).

• Recommendations.

• EMCS should be re-commissioned as a minimum and possibly transition to a full DDC system.

• Install a data acquisition system or activate the energy trending and presentation component of the existing EMCS/BAS.

• Optimize HVAC runtime and operational efficiency by alarming daily on/off times and temperature setpoints for different areas of the building. Acts as a verification tool to ensure EMCS/BAS is operating properly.
Large commercial building (continued).

• Recommendations.

  • Leverage annual interval data to negotiate a more favorable electricity rate when the existing electricity contract ends.

  • Power Factor is 86%. Correct to 95% to reduce Power Factor penalties by TDSP.

  • Install ECMs or equipment to shift or eliminate the loads during periods of the electric grid’s peak demand to reduce 4CP demand charge costs.
Meat processing plant.

• Location is Houston, Texas.

• 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.

• A significant base load as a result of the required refrigeration load 24/7. The average kW load for the facility’s compressor motor load is 485 kW.

• The base load ranges from about 300-600 kW.

• There is no EMCS/BAS or data acquisition system.

• On-staff, very astute facility engineer.
Meat processing plant (continued).

- Summer month.
Meat processing plant (continued).

- Winter month.

![Graph showing energy usage](image-url)

Winter base load is approximately 400-450 kW; max compressor load is 485 kW.

Lights and equipment are being turned off during the day and weekends.
Meat processing plant (continued).

• Shoulder month.

Shoulder month base load of approximately 500 kW is creeping upward from winter base load.

Power outages in a critical mission facility can be verified and recorded to justify surge protection, lightning rods, emergency backup options, etc. by calculating the $/hour of downtime.
Retail processing plant (continued).

- Recommendations.
  
  - *Implement measures that will avert the compressor load.* Rewire so they are on isolated electrical panels and then allow a renewable energy source such as solar to power each sub-load.
  
  - *Install ECMs or equipment to shift or eliminate the loads during periods of the electric grid’s peak demand to reduce 4CP demand charge costs.*
  
  - *Power Factor is 90%. Correct to 95% to reduce Power Factor penalties by TDSP.*
  
  - *Install a data acquisition system.*
Large hotel.

- 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.
Large hotel (continued).

- Summer month.

Profile indicates above normal cycling of HVAC equipment compared to other months. Further investigation will assist in understanding the cause, implement a solution strategy resulting in extending the useful life of the equipment.
Large hotel (continued).

- Summer month comparison.

When compared to the year before, it can be seen there is a slight downward trend of load (down from an average of 8,000 kW in August 2005). Further investigation would be required to determine if this downward trend was a result of weather, operations or equipment.
Large hotel (continued).

- Winter month.

The base load of approximately 6,000 kW is confirmed when compared to the April graph, i.e., the kW Trend Line (red line) approximates the kW Base Load (blue line).

With such a smooth operation of equipment during this month, it should be easier to determine the cause of the sporadic spikes. This would help eliminate unnecessary stress on the equipment.

This winter month indicates a smooth, repetitive operation of HVAC systems and equipment when compared to other months.
Large hotel (continued).

• Shoulder month.

Of note is that the kW Trend Line (red) is above the kW Base Load line (blue) for this shoulder month. When compared to the January 2006 graph, it gives a better representation of the buildings base load. Depending on outside temperatures, other months than the shoulder months may be a better source to establish base loads. That is why a data acquisition system is needed so a complete profile is available for analysis.

Exact times of power problems help identify whether the cause is internal or there is a power supply issue. If the problem is utility company related, this type of data will support and backup any claims made against the utility company.
Large hotel (continued).

- Recommendations.
  - 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 (haven’t done so yet due to internal issues).

  - Optimize HVAC runtime and operational efficiency by alarming daily on/off times and temperature setpoints for different areas of the building. Acts as a verification tool to ensure EMCS/BAS is operating properly.
Large hotel (continued).

• Recommendations.
  
  • Leverage annual interval data to negotiate a more favorable electricity rate when the existing electricity contract ends.
  
  • Better allocate energy costs associated with convention and meeting events.
  
  • Power Factor is 90%. Correct to 95% to reduce Power Factor penalties by TDSP.
  
  • Install ECMs or equipment to shift or eliminate the loads during periods of the electric grid’s peak demand to reduce 4CP demand charge costs.
Remember: One Cannot Manage the Assumed or Unknown

Data is knowledge...and knowledge is the power to reduce your energy spend!

Questions and Comments...

Thanks!