

Becoming SMARTER about Energy

A Guide to Submeter Deployment and
Greater Energy Management Insights



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 **legrand**®

Executive Summary

Legrand North America committed to reduce its energy intensity by 25% over 10 years through the Better Buildings Better Plants Challenge (BBBP). Part of this commitment included an implementation model – an approach used to overcome barriers to achieve portfolio-wide energy efficiency improvement. Legrand chose to manifest the implementation model through the installation of submeters at many of its facilities.

Submetering is a way to monitor energy used within a building. From 2011 through 2013, Legrand’s submetering initiative allowed us to become smarter about energy management and uncover energy saving opportunities.

This Guide highlights the lessons Legrand has learned to date through the submetering process – from research, to project approval, to installation and data mining to making actual changes in our operations. It also upholds our commitment to the Department of Energy to share what we have learned on our energy intensity reduction journey, and also to clarify the level of involvement and benefits from utilizing submetering as a means of energy management.

Included are 10 different lessons Legrand has learned through submetering. These lessons can be applied directly to other manufacturing, distribution, and office facilities, independent of whether or not the facilities have submeters in place or are contemplating submeters as a means for energy management.

The lessons include:

1. The Case for Submetering
2. Technical Knowledge Wanted: Electrical Engineering & IT
3. Dashboard the Data
4. Assemble the Right Team
5. Peak Demand Drives Up Costs
6. Operate at Optimum Ratios
7. Break Down the Complex Facility
8. Detect the Basic Anomalies
9. Employee Engagement is Key
10. Communicate Results

This Guide is the latest resource to be released from Legrand in an effort to share best practices around sustainability. Other no-cost tools can be found at www.legrand.us/sustainability.

A Guide to Submeter Deployment and Greater Energy Management Insights

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Submetering and Why it Matters

Submetering is a method to monitor the energy used within a building. Submeters are smaller electrical meters that can be strategically placed on electrical lines to monitor energy consumption of specific sections of a building or specific pieces of machinery. When paired with a dashboard that allows data to be displayed in a graphical form, submetering provides visibility into how, where, and when an organization can reduce energy demand and energy consumption, and therefore energy bills. Submetering can provide insightful energy efficiency strategies when the building is both fully occupied and unoccupied, 24 hours-a-day, 7 days-a-week, 52 weeks-a-year.

The lessons shared about submetering in this Guide are both hands-on and theoretical. They have been developed slowly, learned over months and years. Legrand plans to continually learn about the energy management capabilities of submetering and apply those findings to the various facility types within its building portfolio, thereby increasing its energy efficiency and becoming smarter about energy use.

Background

Legrand North America embarked on an energy efficiency journey in 2010 by joining a U.S. Department of Energy (DOE) program, now called the Better Buildings, Better Plants Challenge (BBBP). Legrand committed to a 25% decrease in energy intensity over 10 years. In 2012, Legrand undertook an additional challenge at its headquarters facility in West Hartford, Connecticut, to reduce energy intensity there by 10% in just two years. In fact, by the end of 2013, Legrand reduced its energy intensity by more than 30% across 14 U.S. sites, and was well on its way to achieving the commitment at its headquarters “Challenge” site.

To achieve this level of success, Legrand has taken advantage of many straightforward retrofit opportunities and process changes in its project portfolio such as lighting retrofits, machinery upgrades, and rethinking shift hours for energy-intensive processes. In parallel with these energy improvements, Legrand implemented a submetering initiative to uncover further energy saving opportunities.

Examples of Legrand submeter savings:

- California Distribution Facility – 57% reduction in kW demand
- Connecticut Manufacturing Facility – \$4,600 savings in air compressor use
- Tijuana Manufacturing Facility – alteration to shift schedule saves \$9,700 in electricity costs

1. Lesson Learned: The Case for Submetering

Overview:

Investing in submetering provides visibility into a facility's energy demand and consumption and helps realize energy saving opportunities.

The energy to operate the buildings in which Americans work, shop, and go to school costs the U.S. approximately \$200 billion each year. On average, 30% of this energy is wasted (DOE, 2011). Legrand's facilities are no different from the national average. Legrand chose to implement submetering to avoid waste and:

- Verify the return on investment (ROI) of energy efficiency projects and investments
- Provide site energy managers with a tool to focus on continuous operational improvement
- Meet the energy intensity goals of our BBBP commitments
- Be less impacted by volatile and rising electricity prices
- Show our support for federal activity around energy efficiency and energy monitoring included in Executive Order 13514, and laws EPAAct 2005 and EISA 2007
- Reap a competitive ROI on the submetering project itself

2. Lesson Learned: Technical Knowledge Wanted: Electrical Engineering and IT

Overview:

To successfully install submeters, Legrand needed the subject matter expertise of electrical engineers and information technology (IT) employees.

The submeter design and installation process was more involved than Legrand originally thought and we could not have successfully installed submeters without the support and commitment of our electrical engineers and IT staff. Now equipped with specialized knowledge, our staff is prepared to continue submeter installations at additional sites.

Electrical Engineering

Electrical engineers were needed for each submeter installation to provide local knowledge of the electrical layout of the facility, a hands-on understanding of how submeter infrastructure works and ongoing support to verify the correct placement and installation of submeters.

Submeter System Design

An electrical engineer worked with a designated Submetering Project Lead to design the installation of submeters at specific sites and order electrical and submeter equipment. Legrand selected multi-point submeters that can monitor 24 phases of power plus two pulse inputs, usually water or natural gas, and offer interoperability with existing data systems.

The main considerations for the placement of the systems included:

- **Ability to monitor total facility power:** at some Legrand sites there were four or five utility meters serving the facility, and the same number of submeters were needed to monitor total facility power. At other sites, there was only one primary utility meter and all electricity could be monitored through one submeter.
- **Placement of submeter sensors to measure the largest electrical uses or efficiency projects:** to efficiently deploy the meters, it was decided early on to monitor the primary voltages in the facility and to meter in front of any stepdown transformers. This meant that most meter points would be three phase at the primary facility voltage. The net effect of this design was that multipoint meters would be used to monitor eight electrical loads per device.
- **Prioritization of electrical lines with larger magnitudes of power over smaller lines:** the placement of sensors for the initial submetering data collection were placed on large power lines, distributing power to areas within the facility or large HVAC systems instead of smaller lines, like individual manufacturing machinery. As site energy managers become comfortable with the granularity of the submetering data, sensors can be moved and placed where energy efficiency projects are needed or have been completed to measure the total impact of the selected project.

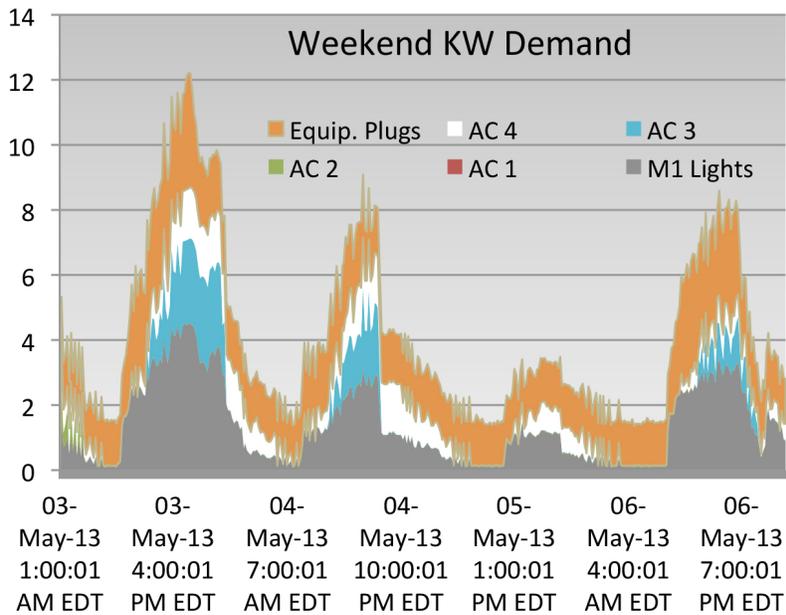
Submeter Installation

Legrand has three different types of facilities across North America: office space, distribution centers, and manufacturing. In most buildings there is a combination of these different types, and in some buildings there are engineering testing labs, and/or other ancillary uses. Additionally, Legrand's facilities were built in a span from the years 1910 to the 2000s, so the existing electrical infrastructure is varied which contributed to varying levels of difficulty for electrical engineers to successfully install submeters.

For office locations, the submeter installation was straightforward, and for some mixed-use facilities with older infrastructure, installations met delays and required unanticipated investments. Legrand's West Hartford, CT, headquarters provides a perfect example of a more complex installation process. The original building was constructed in the 1910s, with additions in the 1950s, 1970s and numerous retrofit projects. Due to the varying age levels of the electrical infrastructure and a mixed use of manufacturing and office space, this building required seven submeters. During installation, an electrical engineer discovered that additional hardware was needed from the submeter company to conduct installation in the older sections of the building. Also, three different power shut downs were required with the presence of the local utility, costing several thousand dollars for each shut down. This was the most complicated hardware installation, and it bears mention because without an experienced electrical engineer and support from the submetering company the installation would not have been accomplished.

Legrand's lead electrical engineer in West Hartford authored a Technical Submeter Installation Guideline document to help all other Legrand electrical engineers follow a fairly standardized approach for the submeter system design and installation. However, every Legrand facility is different, and small adjustments were made after installation. One example of an after-installation adjustment occurred in one of Legrand's office locations.

After reviewing a chart for weekend energy use (see chart below), submeters tied to AC units 1 & 2 were not registering energy consumption. A quick calculation of possible lighting demand revealed that the submetering Current Transformer (CT) was not properly placed during installation, therefore the lighting energy consumption displayed by the submeter titled "M1 Lights" also included the energy consumption of AC units 1 and 2. The local site energy manager made the necessary changes to the location of the CT for a more accurate depiction of energy consumption and demand.



This chart of Weekend kW Demand displays the result of a misplaced submeter CT. In this chart, the M1 Lights energy demand, depicted in grey, is too high for the building's lighting capacity. Secondly, AC units 1 and 2, depicted in red and green, are absent from the data. The energy demand of AC units 1 and 2 is included in the grey M1 Lights demand. Had the site energy manager not corrected the placement of the CT, it would have led to incorrect assumptions about lowering the demand peaks within the facility.

Information Technology (IT)

Legrand recognized there would be some reliance on IT staff to correctly set up submeters and gain access to the energy data provided by the submeters. Legrand made a decision to utilize existing ethernet IP infrastructure instead of a new network specifically for submeters. Utilizing the existing ethernet required a larger time investment by IT staff than originally anticipated, but it came with a smaller price tag compared to building a new network for the submeters. Legrand's IT staff worked on implementing each site's submeter VLAN (Virtual Local Area Network) with the overall IT Infrastructure in parallel with the electrical design of the submetering hardware. Legrand also chose to house the submeter data behind its firewall, adding another layer of dependency on IT staff.

IT issues that were addressed included:

- Maintaining security of the data
- Routing BACnet messages across the internet
- Setting up a virtual server to provide meter data via web pages
- Storing the submeter histories and archiving the data

Each site was issued a VLAN network for building automation and submetering. Each multipoint meter and IP router was assigned a Legrand internal IP address. The type of IP router used was a JACE (Java Application Control Engine) which was ideally suited for the application. The JACE stores temporary histories in case of network outages, and provides secure access to the data. It also normalizes the data into BACnet protocol so it can be transported and communicated across the internet.

BACnet is a communications protocol that stands for Building Automation and Control Networks. It was designed to allow communication between building automation and control systems for applications such as lighting control, HVAC control, ventilation, and security systems and their associated equipment. Legrand housed all of its submetering data on a virtual server which allowed the Submetering Project Team to view all of the submetering sites in one cloud-based application.

Setting up the necessary IT specifications for the submeters took more time than anticipated. Between the sometimes challenging physical installation of submeters as well as the number of IT integration measures required, the timeframe for the full submeter infrastructure installation was delayed. However, throughout this process, some Legrand site energy managers and IT personnel developed subject matter expertise and became trouble-shooting contacts for other Legrand submeter installations.

3. Lesson Learned: Dashboard the Data

Overview:

Submetering data is more easily digested in graphical form. Utilizing the “real-time” submeter data requires the use of a web-based dashboard. Web-based dashboard platforms can help site energy managers decipher their submetering data.

The submetering project included a dashboard – a real-time snapshot of energy use in any facility. The first phase of the dashboard project was aimed at site energy managers, so they could become comfortable with what information could and should be displayed as well as how to identify energy saving opportunities from the dashboard. The second phase is aimed at the entire Legrand employee population. Legrand anticipates displaying site-specific dashboards via TV monitors in common areas such as break rooms, cafeterias, and lobbies to make the information available to all people in a facility so each and every employee can become an “energy manager”.

Dashboard Phase 1: Designed for Site Energy Managers

After the submeter hardware and IT infrastructure were in place, Legrand utilized a free basic web service that enabled site energy managers to log into a secure website, select their site from a drop down menu, and select submeter data to view. Even after training, it became evident that digging for this data, or “data mining,” was time intensive. Because Legrand’s site energy managers also have other duties as manufacturing engineers or product quality professionals, they wanted a more easily accessible and navigable application. The dashboard would need to automatically update, show the latest data in easy-to-read graphs or charts, and be customizable by site. If the data was automatically updated, site energy managers could more easily decipher anomalies in energy demand throughout the day. Updated dashboards utilized a visualization tool called fluid integration (FIN), which is capable of displaying data from multiple sources on a screen.

The benefits of a dashboard include the following:

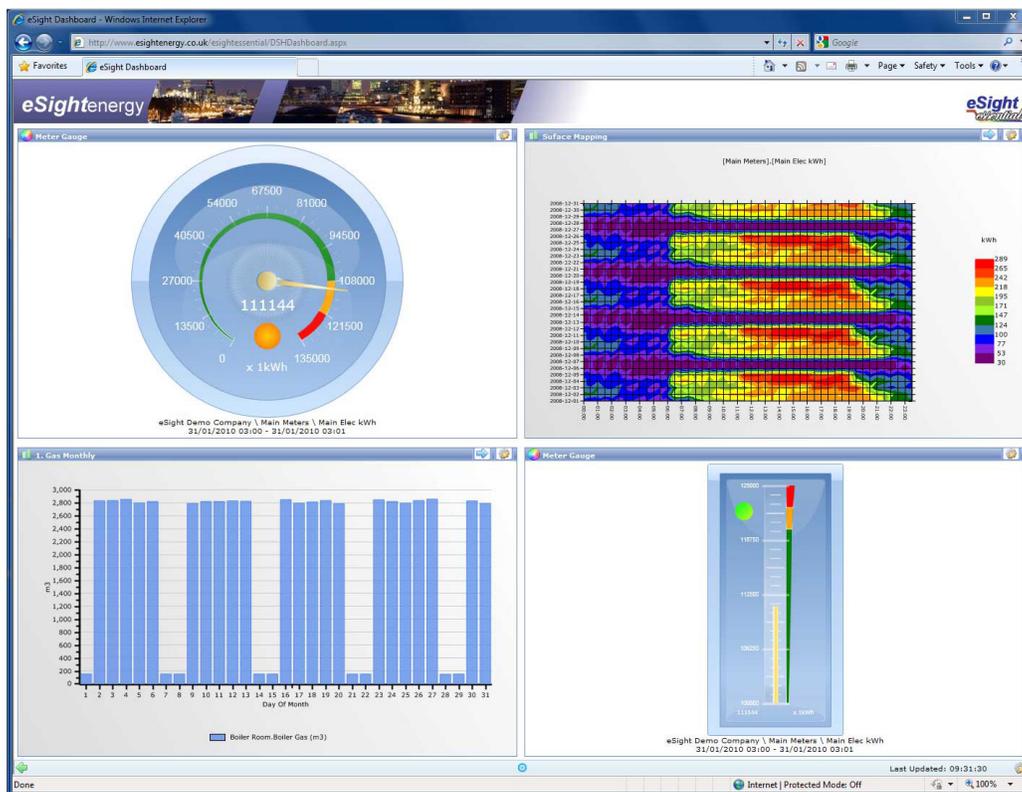
- Anomaly transparency
- Validates energy project investments – a confidence builder
- Documents results
- Equips energy site managers to act
- Fulfills pledge to DOE to implement dashboard

(Lesson 3 continued)

Dashboards can also be equipped with an alarm console to signal when building automation equipment is functioning in an irregular manner and thus leading to a possible demand spike or energy anomaly. The alarms provide site energy managers opportunities to adjust equipment to avoid occasions of high demand. The following are examples:

- Any HVAC unit is operated on both cooling and heating in the past 120 minutes
- Any HVAC unit is operated in one mode (Heat/Cool) while another is operated in a different mode within 60 minutes
- A unit is running in cooling mode below 60 °F outside air temperature (OAT)
- A unit is operating in heating mode above 68 °F
- Lighting power density in any area is above 1.2 watts per foot
- Plug Load density is above 200 watts in any office

Below is an example of a dashboard displaying several different energy use charts that our site energy managers use to monitor energy demand and consumption at their respective sites.



Dashboard Phase 2: Designed for all Legrand Employees

Phase two of the dashboard project is underway at Legrand, with 7 dashboard “kiosks” planned for our highest energy consuming sites. These kiosks will be flat panel screens in high traffic areas that scroll through a number of real-time energy demand charts, energy facts and figures, sustainability announcements, and other relevant information for that location. Legrand believes that with increased visibility into how and where energy is used within facilities, employees will take actions and be our best energy asset.

Reaping the Benefits of the Hawthorne Effect

Inherent in the visibility of energy use is a psychology concept called the Hawthorne Effect, which when applied to submetering, states that the simple presence of monitoring equipment will lead to conservative levels of energy savings of 0 to 2%, as seen in the chart below from a DOE study. Legrand cited the energy savings generated from the Hawthorne Effect as one of the reasons to implement submetering across its sites.

Action	Observed Savings
Installation of meters	0 to 2% (the “Hawthorne effect”)
Bill allocation only	2.5 to 5% (improved awareness)
Building tune-up	5 to 15% (improved awareness, and identification of simple Operation and Maintenance (O&M) improvement)
Continuous Commissioning	15 to 45% (improved awareness ID simple O&M improvements, project accomplishment, and continuing management attention)



Legrand West Hartford, CT sub-meter installation, 2012

Source: Department of Energy (2006)

The introduction of the submeter hardware into Legrand facilities did not measurably affect Legrand’s energy intensity because the majority of employees didn’t know what the small grey boxes mounted under CT and breaker boxes were actually purposed for. Further, most employees had little understanding that the grey boxes were energy monitoring equipment. However, with the addition of the dashboards which will provide a visual depiction of the data the submeters are monitoring, we believe the Hawthorne Effect will come into play.

Because our site energy managers were privy to energy demand and consumption data as a small pilot group of employees, Legrand will achieve energy savings through an altered progression of steps, according to the Department of Energy’s chart, shown above. Instead of achieving the Hawthorne Effect first, we achieved the bill allocation (peak demand influencing kWh pricing) and the Building tune-up steps before the Hawthorne Effect can be attributed to the greater employee base. Overall, if Legrand achieves a conservative 1.5% energy intensity reduction, the cost of the dashboard will pay for itself in just 1.5 years with an internal rate of return of 83%; well worth the investment based solely on the Hawthorne Effect and not including the building tune-up or bill allocation savings.

4. Lesson Learned: Assemble the Right Team

Overview:

Assembling the right team of people for a submetering project will speed up the planning, installation and analysis process.

Based on Legrand's experience, we recommend the following team roles and responsibilities:

Project Management: Schedules and tracks progress of each site's installation, from electrical line drawings, hardware order submission, hardware installation, IT alignment and functionality verification.

Electrical Design: An electrical engineer helped each site energy manager draw an electrical map of their facility to determine how many submeters would be necessary to effectively capture all energy use including different sections within each site's facilities.

IT Design: A network systems professional helped local IT representatives and electrical engineers set up the proper pathways between the submeters and Legrand IT infrastructure so data could be safely stored and accessed.

Executive Sponsorship: A member of the executive staff brought significant issues, hurdles and solutions to the attention of the executive staff regarding the submetering project.

The Electrical Design and the IT design roles were filled by more than one person to help speed the implementation process along. Legrand had 2-3 electrical engineers and 2-3 IT professionals acting as subject matter experts after the first several installations were complete.

5. Lesson Learned: Peak Demand Drives Up Costs

Overview:

Submetering highlights two critical factors: 1) how many kWhs of electricity a facility is consuming, and 2) how much electricity is being demanded. The highest level of demand (peak demand) is correlated with the price paid for electricity used. By decreasing the peak demand, the price for electricity is also decreased.

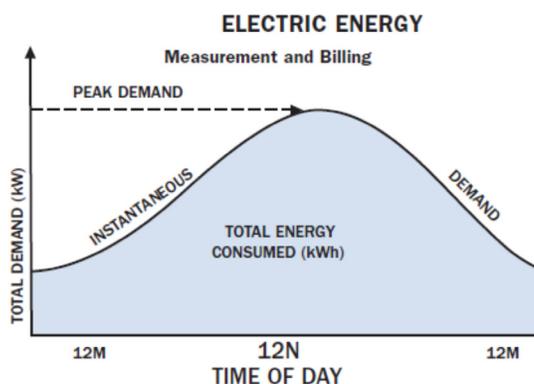


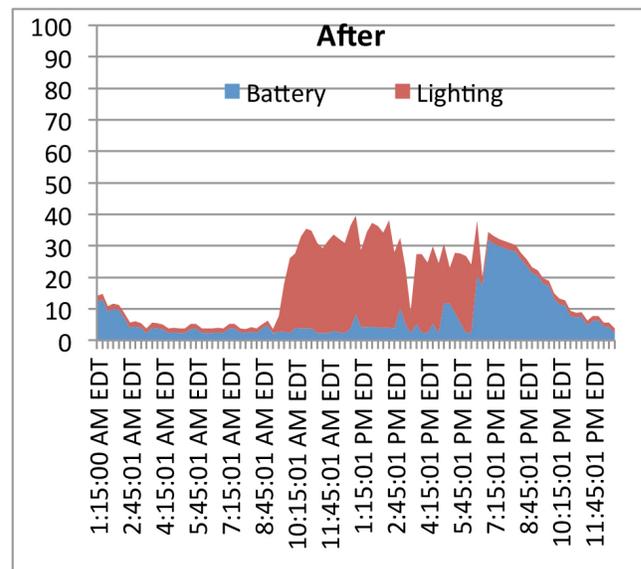
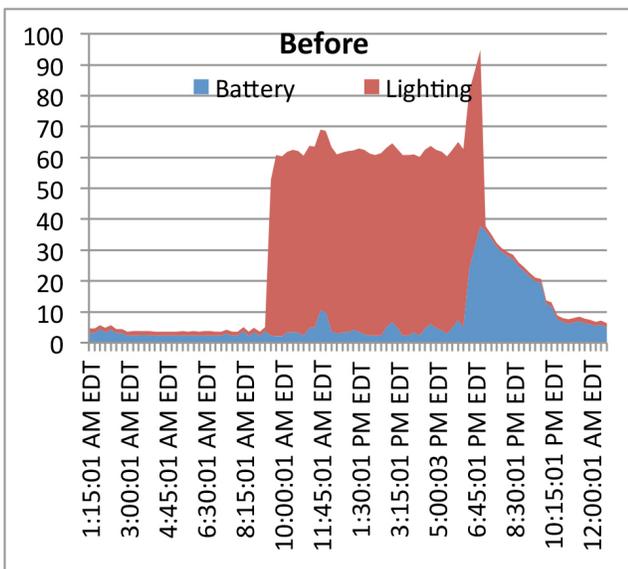
Image Source: www.focusonenergy.com

Utilities commonly measure two things at industrial and commercial facilities: electricity use (kWh) and demand (kW). A facility's electricity meter measures total electricity consumption over time, measured in kilowatt hours, and measures electricity demand in kilowatts, which is the maximum amount of electricity used at one specific time (usually measured every 15 minutes). The demand level indicates to the utility the highest amount of electricity needed by the facility, illustrated as "peak demand" in the graphic on this page.

The organization will be charged for this level of demand, even though they may operate at this level for only one 15-minute period during a month's billing cycle. Essentially the peak demand can be thought of as overhead costs incurred for the provision of electrical infrastructure capable of meeting the largest electricity load. By reducing the peak demand, an organization may be able to pay a lesser demand charge, or price paid per kW.

As an example, Legrand lowered its peak demand in one California warehouse facility by redistributing the energy demand throughout a few hours. In this particular distribution facility, the major electrical loads were attributed to lighting and charging the forklift batteries at the end of the day. In the chart below, the energy consumption from the lights is displayed in red, and runs from about 9:15 a.m. to 6:30 p.m. EST. The energy consumed by charging the forklift batteries is shown in blue, and runs from 6:15 p.m. to approximately 1:00 a.m. The chart shows that there is a peak in kW demand from 6:15 p.m. to 7:15 p.m., when the forklift batteries are plugged in to begin recharging. To eliminate this peak, the forklift battery chargers were placed on a timer, so the forklift batteries begin charging after the lights have been shut off in the facility. Without submeters, this level of transparency into the cause behind the peak demand would have been impossible.

This same warehouse facility reduced its demand by 57% by enacting a simple process change. The site energy manager also took the opportunity to retrofit the lighting to more efficient CFLs which reduced overall kWh consumption and demand as seen in the before and after graphs.



Before and After charts of a warehouse facility's energy demand after lowering its peak demand by 57%, and thereby decreasing the price paid per kW.

Distributing energy use to off-peak hours (overnight) can also contribute to the reliability of the local or regional electricity grid. Power generators can sometimes struggle to provide enough reliable energy during hot summer days to meet the kW demand of every constituent during the peak energy-consumption hours of the day (7 a.m. to 6 p.m.), so switching non-critical loads to off-peak hours may help stabilize energy provisions.

In one of Legrand's mixed-use facilities, the peak demand occurred right before lunch time, when the cafeteria was prepping food and warming up cooking equipment for the busy lunch hour. Another demand during this peak was operation of the engineering testing room. The site energy manager realized that by altering the schedule of hours worked in the engineering testing room, the peak demand for the entire site could be lowered. While the electricity demand for the cafeteria was unavoidable, the engineering testing room schedule could be altered.

Understanding a facility's peak demand is critical to energy and cost management. Knowing how much energy a facility demands drives the types of reduction strategies employed, and also affects the price an organization pays for the energy it uses.

6. Lesson Learned: Operate at Optimum Ratios

Overview:

Submeter data has allowed Legrand to use two different metrics to determine how effectively its facilities are using energy. These metrics are considered key performance indicators (KPIs) and help guide the attention of site energy managers in analyzing submetering data.

Opposite of peak demand, site energy managers must also know what drives base demand. The peak is the high point of demand, whereas the base is the low point of demand, often occurring in the late night hours when little to no machinery, lights, computers, and other equipment may be running. On a standard bell curve, the crest is the peak demand while the trough is the base demand. By monitoring these two variables, along with the total number of kWhs consumed, we can define the optimum ratios which are also two useful KPIs. The first ratio is the daily **Minimum kW/Maximum kW ratio (base kW/peak kW ratio)**.

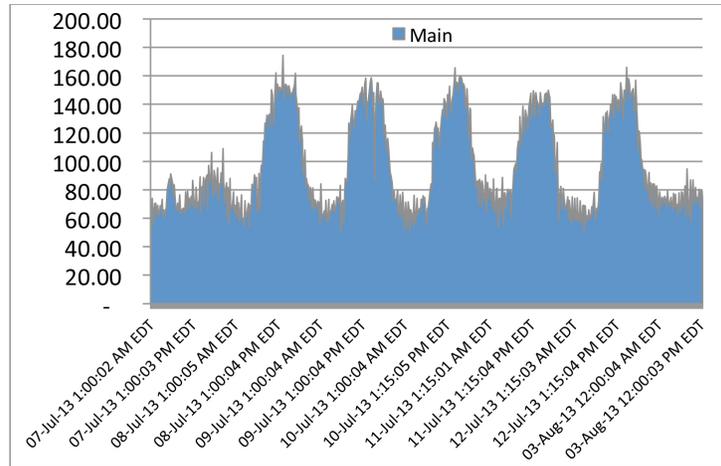
Minimum kW/Maximum kW ratio

In a perfect world, the minimum kW demand of a facility would be zero. A low minimum kW means that everything has been shut down and turned off when employees leave the facility. However in manufacturing facilities, some machinery must remain powered on 24 hours-a-day. By evaluating the minimum, site energy managers can identify and eliminate energy waste by focusing on a building's unoccupied hours. By comparing the minimum to the maximum, site energy managers can understand and strive towards a relatively low minimum/maximum ratio which is indicative of efficiency. This ratio can also be expressed as a percentage, by simply dividing the minimum by the maximum. As a general principle, a 1:5 ratio is considered fairly efficient, and Legrand aims for a ratio of 1:5 (20%) or lower (1:10; 10%) though there may be seasonal changes during different heating and cooling cycles.

(Lesson 6 continued)

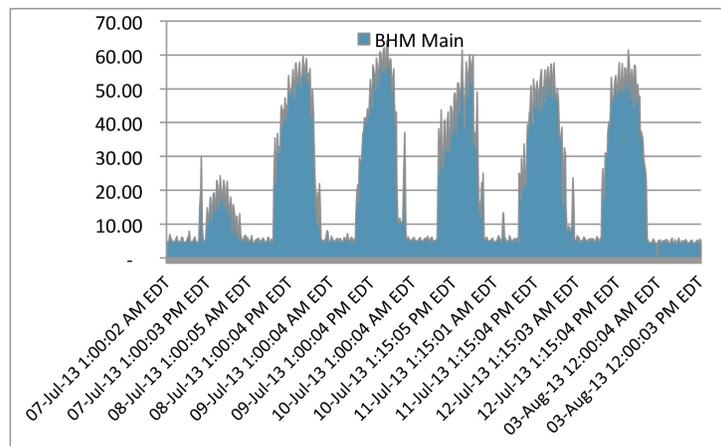
The following charts provide examples of how the kW minimum load/kW maximum load ratio is displayed graphically.

Seen below, this week-long energy use graph shows a facility operating at a ratio of 1:2.5 (40%). This data suggests unnecessarily high overnight and evening base demand. This means that there is unnecessary machinery, lighting, office equipment, and other electrical loads that are idly running when they could be powered down.



A Legrand facility has a high baseload indicating wasteful energy consumption overnight.

Alternatively, one of Legrand's most efficient facilities (graph shown below) has surpassed the goal of a 1:5 ratio (20%) and achieved a low and consistent 1:10 ratio (10%), where peak daytime operations are 10 times the base demand. To achieve this 1:10 ratio, the site energy manager focused on reducing the facility's base demand. This success has been dependent on a combination of factors including employee behavior change, occupancy sensors on lighting and office equipment, and careful attention to the facility's HVAC scheduling and set points overnight.



An efficient Legrand facility with a very low baseload boasting a 1:10 ratio

For Consideration: Impact of a high baseload	
Total hours building is powered	(24 hours/day) x (365 days) = 8760 hours/year
Hours building is occupied	(10 hours/day) x (250 days)* = 2,500 hours/year
Difference (hours building is unoccupied)	8760 - 2500 = 6260 hours/year; 72% of the time
Based on these hour estimates, a building sits unused, consuming energy in the evenings and nights for 72% of the time. If a building is operating with a high minimum kW/maximum kW ratio of 1: 2.5 (40%), as in previous charts above, it is exceeding the optimum ratio (assuming a ratio of 1:5 (20%) is optimal) for 6,260 hours or almost three quarters of the year!	

*Assumes building is occupied 2 hours above the typical 8 hour work day, 5 days a week, 50 weeks of work in a year, accounting for 2 weeks of holidays.

It could be argued that one way to increase the kW minimum/kW maximum ratio would be to simply raise the peak demand – scale up the AC during the summer and turn on all the lights, toaster ovens, coffee makers, and machinery, etc. While this is counter productive to the cause of energy efficiency, a devil’s advocate could make the case that by these actions the minimum kW/maximum kW ratio is a faulty KPI. However, if we evaluate the numbers, we uncover a different conclusion:

For Consideration: Reaffirming the ratio as a KPI		
Different ratio scenarios	min kW/max kW	Ratio as a percent
1. Efficient Ratio	20 kW/100 kW	20.0%
2. Increasing the peak demand	20 kW/105 kW	19.0%
3. Decreasing the base demand	15 kW/100 kW	15.0%
4. Decreasing peak demand and base demand	15 kW/95 kW	15.8%
Let’s assume a building is operating with an efficient ratio, as seen in scenario 1. A site energy manager could lower that ratio by increasing the kW maximum, as seen in scenario 2. However it’s clear that the more effective strategy to achieving a lower ratio is scenario 3, where the kW minimum demand is lowered. Ideally, site energy managers should work to reduce both the kW minimum and kW maximum, as seen in scenario 4, producing a slightly higher ratio of 15.8% but still very admirable. This scenario is optimal because it minimizes wasted energy (minimum kW) and decreases the price of energy through lowering the maximum kW.		

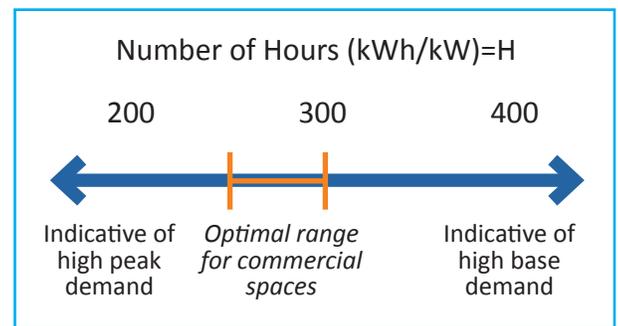
kWh/Maximum kW ratio

The second KPI that Legrand uses is known as the kWh kW ratio. Through our efforts to understand and lower the peak demand, the question arose, “What is an acceptable peak demand?” Obviously a facility’s energy use is going to increase during operating hours and decrease when employees leave and processes are shut down, but what level of peak demand is considered “good?” To answer this question, Legrand uses the kWh/Maximum kW ratio, where kWh is equal to the monthly consumption, and the Maximum kW is the peak demand, or the level of demand that the utility charges for the month.

Dividing kWh by kW leaves the variable “hours” ($\text{kWh}/\text{kW} = \text{h}$). This monthly formula approximates the number of hours the facility operates during a billing period. For most commercial spaces, Legrand expects an hour range of 250-300. For multiple shift operations, it expects higher numbers because the consumption of energy, or the numerator, is greater.

If a facility had an actual ratio of 400, it could indicate excessive loads running at night, because the number of kWhs consumed is large compared to the peak demand. On the other hand, ratios less than 250 could indicate excessively high demand, and higher energy costs to match. A facility with a ratio of 200 most likely is not consuming a high number of kWhs compared to the peak demand. One possible solution to raise the ratio from 200 to 250 is to spread out the building’s operating processes across a longer timeframe. Overall, if the number of hours produced by the ratio changes, the facility manager should understand what is happening in the facility to cause the change.

These two ratios, the Minimum kW/Maximum kW ratio and the kWh/Maximum kW ratio are considered KPIs that can be used to understand how effectively a site is using energy on a daily, weekly, and monthly interval. While it is tempting to set strict numerical parameters for submetering data, these KPIs are meant to be used as guidance and are not the end all-be all of energy management. Furthermore, these ratios should not be used in isolation. Therefore the time spent analyzing these ratios must be balanced with other initiatives that contribute value to energy management.

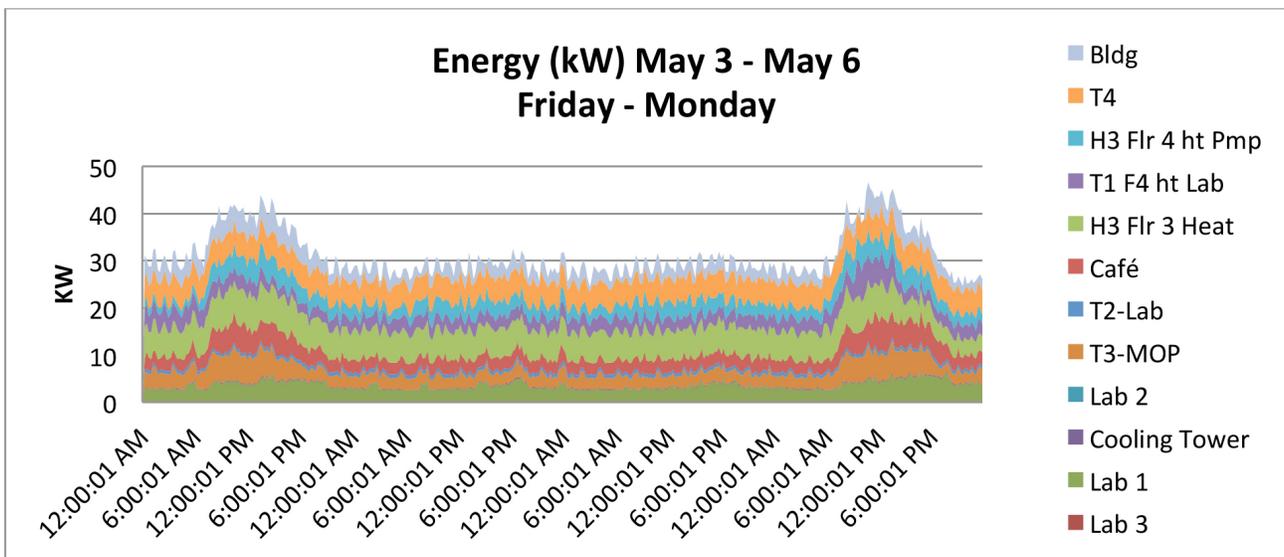


7. Lesson Learned: Break Down the Complex Facility

Overview:

Large facilities often have multiple electrical draws on each submeter point. To gain further visibility into the efficiency of each electrical draw, it may be necessary to utilize portable meters in addition to submeters.

In its larger facilities, Legrand's submeters were tracking numerous electrical loads on each submeter point. In some instances, like the graph shown below, submeters were tracking the energy demand in general locations within a facility. In order to make substantive changes, site energy managers needed further visibility into what process changes, behavior changes and/or technological upgrades were needed to reduce energy demand in those general locations.

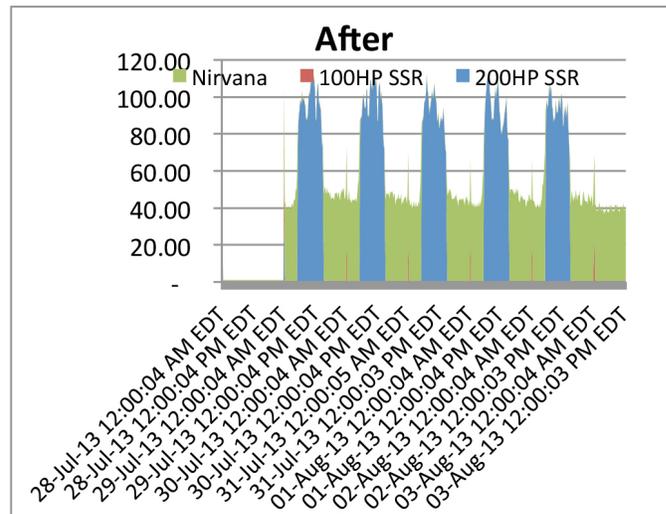
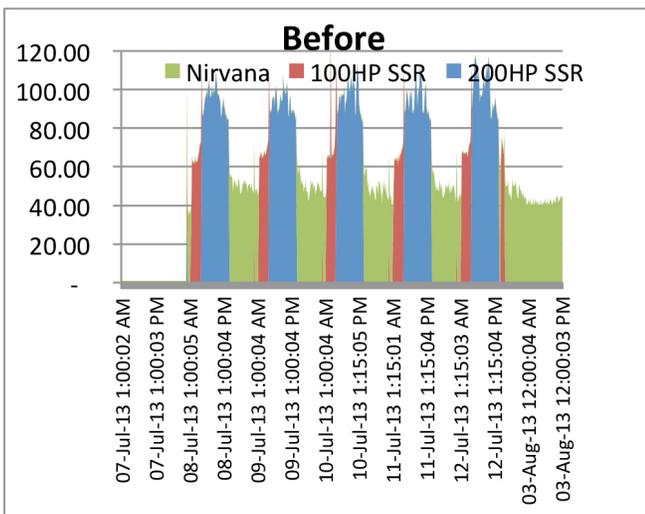


A large facility needing further visibility into the causes behind its high and multi-faceted energy demand

The Impact of Portable Meters

To gain the needed visibility into specific machinery or processes, Legrand purchased portable meters, different from submeters, that can be attached to specific machinery to determine demand and consumption. At Legrand's headquarters site, these portable meters provided comparison data on three different air compressors used in the facility.

In the graphs below, there are three air compressors. Two of them are 100 horse power compressors, the first named "Nirvana" and the second named "SSR 100HP." The third air compressor, "SSR 200HP" is a 200 horse power unit. SSR 200HP is needed during the day when the heaviest shifts are running. During the night, the two smaller 100HP air compressors are run to power the machinery that cannot be shut down. In the graph labeled, "Before," it's evident that all three air compressors were used in a cycle. However, once portable meters were plugged into each of the air compressor units and the site energy manager was able to visually see the energy demand, it was discovered that the 100HP SSR air compressor demanded more energy than Nirvana, while offering the same amount of horsepower. Therefore, the change was made to exclusively use the Nirvana air compressor until the main shift arrives, when the 200HP SSR air compressor is utilized. The SSR 100HP is now kept as a backup. This small change saved the facility 7% in air compressor electricity use, or roughly \$4,600 annually. Without portable meters, the 7% savings in air compressor electricity would not have been realized, because it was invisible. The use of portable meters helps break down the uncertainty of what processes and machinery are drawing energy on a single submeter point.



Before and After graphs depicting the process change to a lesser energy demanding air compressor rotation.

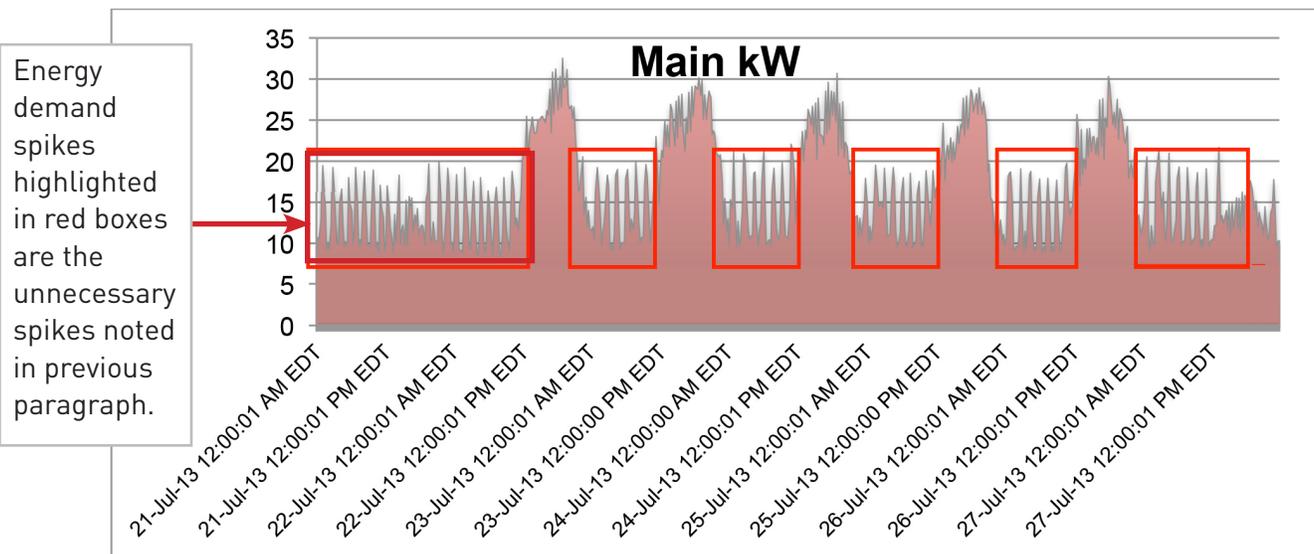
8. Lesson Learned: Detect the Basic Anomalies

Overview:

There are a few common energy-saving opportunities that become apparent after analyzing submetering data, most of which are concerned with HVAC controls.

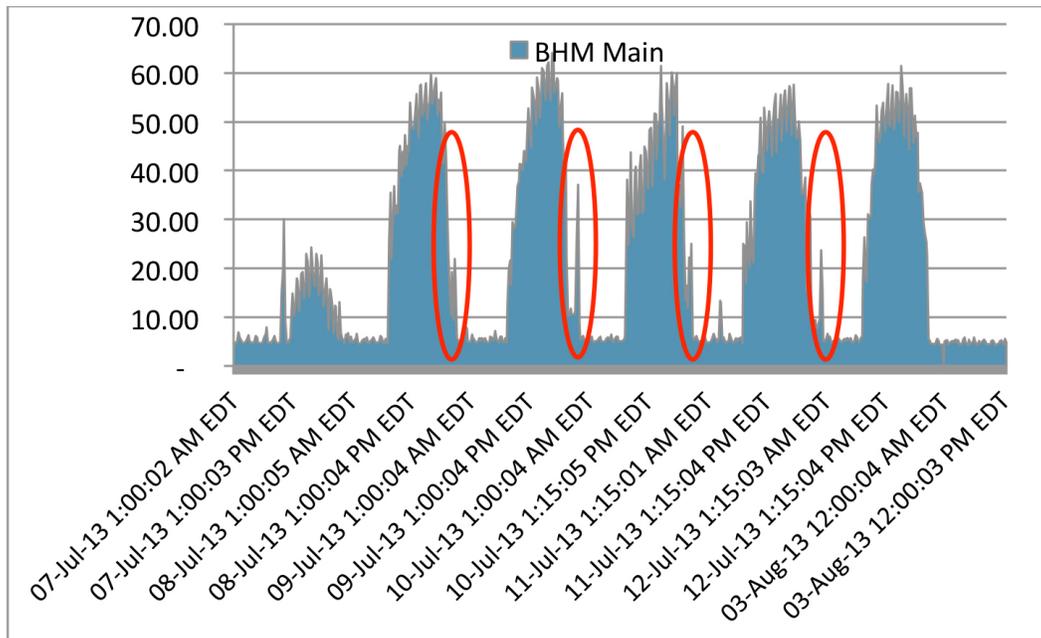
While acclimating to the new submetering technology, many of our site energy managers expressed the frustration of logging into the submetering graphing tool, pulling up their site's submeter graphs, but not knowing what to look for. In the beginning stages, Legrand's project manager helped site energy managers identify some common anomalies including spikes in energy use and unnecessary overnight and weekend loads, attributable to a lack of weekend settings for HVAC systems, a lack of holiday settings for HVAC systems, and elongated HVAC run time on weekday evenings.

The graph below displays submetering data in an office location from Sunday to Saturday. On the first day in the graph, it's evident that the HVAC system is turning on and off frequently, trying to keep the building cool, even though the building is empty. The HVAC is also running unnecessarily overnight during the weekdays, as demonstrated by the many short spikes during off hours. The simple solution in this case was to install a setback thermostat and program it for nights and weekends so that higher temperatures could be maintained after 6:30 p.m. on weeknights and during weekends.



The facility's HVAC system is not programmed on a set back thermostat and data here displays unnecessary running during nights and weekends.

One interesting finding from a Legrand office, as seen in the below graph, revealed that the night time cleaning crew was inadvertently triggering the HVAC system via occupancy sensors, creating a spike in electricity demand in the evenings. As a result, the site energy manager looked into how to program the HVAC occupancy sensors for work hours only, as the office naturally cools down in the evenings.



Night time cleaning crews triggered HVAC system causing small peak in off-hour operation.

Empowered by these overnight and weekend savings, site energy managers gain confidence to dig a little deeper into submetering data and endeavor to find explanations for peaks in energy use and high baseloads. If there are still numerous unknown causes for peaks or high baseloads, sites have been increasingly requesting the portable meters available for use across all the sites.

9. Lesson Learned: Employee Engagement is Key

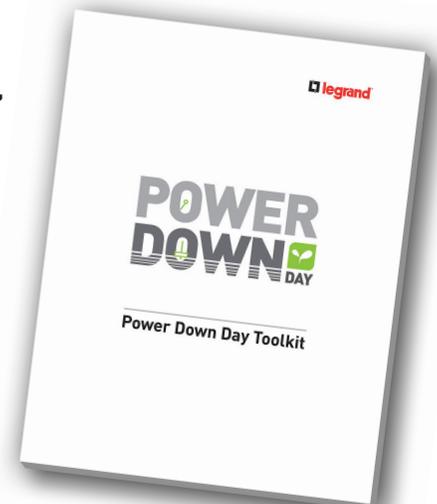
Overview:

Technologies, while important, do not deploy themselves. The support and engagement of employees is critical to reducing energy intensity.

Legrand uses a strategy of “People, Process, and Technology” to achieve its energy management goals. Employees are the best asset in energy management because they interact with their environment every day and can be a valuable source for energy efficiency ideas and process changes. Some of the engagement activities that Legrand has used include:

- In 2011, Legrand put on an “Eco-Challenge” which challenged and rewarded employees to take sustainable actions at work and at home. By tallying up points for actions, employees could buy prizes or be entered into drawings for prizes.
- As an ongoing engagement strategy Legrand shares relevant facts and figures from the DOE, the Energy Information Administration and the Environmental Protection Agency to raise the “energy IQ” of employees.
- Every month Legrand publishes a Sustainability Bulletin, featuring operational success stories from a specific site in North America. The majority of success stories cover energy saving projects including employee energy competitions, process changes, and new technology adoptions.
- In 2012, Legrand held an employee engagement event called Power Down Day which was a competition between facilities to see which facility could reduce their energy intensity the most within a 24-hour period. At locations where submeters were already installed, site energy managers were able to utilize submeters to provide instantaneous energy consumption reports. Learn more about [Power Down Day](#), by downloading our free toolkit.

While still undergoing the implementation of energy dashboards at all sites, Legrand is hopeful that the visualization of energy consumption will lead to other easily quantifiable competitions for employee engagement around energy consumption.



10. Lesson Learned: Communicate Results

Overview:

An important factor in continuously improving energy intensity is to communicate findings and results across all sites so employees know goals, progress and success stories.

Every employee has a role to play in energy management. Communicating Legrand's progress on its energy intensity journey equips employees with the information needed to perform their jobs to the best of their abilities. Legrand has identified several different audiences to communicate progress and success:

- all employees
- the Sustainability Steering Committee – Legrand Executive staff who meet 3-4 times each year to review Sustainability initiatives and goals
- the Operations team – site energy managers and continuous operational improvement staff meets monthly to share best practices and work together to achieve Operational Sustainability goals
- a focused submetering team

Legrand has an established practice of communicating operational success stories each month. These stories are shared with all employees via email, posters, and on TV slides mounted in common areas such as break rooms, lobbies, and cafeterias. Kiosks at seven sites will be available to further reinforce the corporate emphasis on strong energy management.

Most employees also attend a quarterly webcast delivered by Legrand's CEO. This webcast provides insight into the direction and achievement of the business. Within the webcast there is time allotted specifically to sustainability achievements, where submetering has been a featured topic.

The Operations team discusses current energy and resource projects each site is pursuing. The team shares the successes and pitfalls of projects so all Legrand sites can benefit from implementing similar projects. Submetering questions and findings have been incorporated into these monthly meetings.

The Sustainability Steering Committee has acted as a sounding board for the entire submetering process from proposal through data mining to dashboard development. The Steering Committee has been integral in identifying needed resources to drive progress for the submetering initiative.

The small focused submetering team consisting of Legrand's CEO, the submetering project manager, the Vice President of Sustainability, and rotating site energy managers began to meet together during the installation process to troubleshoot issues including installation delays, needed additional hardware, and other issues. After the installation phase, this small team continues to meet to review findings and document best practices and discuss KPIs.



Conclusion

Legrand has learned a great deal through its submetering initiative, and will continue to uncover more valuable lessons about energy demand and consumption within its different facilities. Submetering is an involved energy management exercise that can provide unparalleled visibility into how to control energy demand, consumption and energy costs. This submetering journey has increased Legrand's knowledge, competitiveness, and hunger to learn about its energy landscape, surpass its energy intensity goals, and improve its overall sustainability.

Learn more about Legrand Sustainability and our other tools and resources at our website: www.legrand.us/sustainability. Questions regarding this publication can be directed to Susan Rochford, VP Energy Efficiency, Sustainability, Public Policy for Legrand.

Sources:

Department of Energy, Energy Efficiency and Renewable Energy (2006).

Guidance for Electric Metering in Federal Buildings.

Retrieved Feb 2012 from http://www1.eere.energy.gov/femp/pdfs/adv_metering.pdf

Department of Energy, Energy Efficiency and Renewable Energy (2011).

Better Buildings Challenge Overview. Retrieved Sep 2013 from http://www4.eere.energy.gov/challenge/sites/default/files/docs/BB_Challenge_Program_Overview.pdf

Department of Energy, Energy Efficiency and Renewable Energy (2012).

Legrand Implementation Model: Submetering Initiative and Energy Dashboards.

Retrieved Sep 2013 from <http://www4.eere.energy.gov/challenge/implementation-model/Legrand>



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60 Woodlawn Street
West Hartford, CT 06110
1.877.BY.LEGRAND (295.3472)
www.legrand.us

570 Applewood Crescent
Vaughan, Ontario L4K 4B4
905.738.9195
www.legrand.ca

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