Sub-Metering a Hotel for LEED Certification

Energy Systems Measurement and Verification White Paper

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Introduction

This white paper examines LEED® certification at the Proximity™ Hotel in Greensboro, North Carolina. LEED certified buildings must be energy efficient, and they must establish an on-going measurement and verification program to monitor energy consumption. Sub-metering makes detailed measurement and verification possible. The results of measurement and verification through sub-metering include confirmation that buildings are meeting their LEED certification requirements, improved energy efficiency, rapid identification of maintenance problems, and community recognition of responsible environmental stewardship.

LEED Certification

LEED Certification Levels

LEED's rating systems promote green building practices for many different types of buildings.

For the New Construction rating system, which includes major renovations of existing buildings, the LEED certification levels and required points are:

- Certified, 40-49 points
- Silver, 50-59 points
- Gold, 60-79 points
- Platinum, 80 or more points

A total of 110 points can be awarded for New Construction: 100 base points for Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, and Indoor Environmental Quality; six points for Innovation in Design; and four points for Regional Priority.

LEED rating systems are also available for Existing Buildings: Operations & Maintenance, Commercial Interiors, Core & Shell, Schools, Retail, Healthcare, Homes, and Neighborhood Development.

Platinum Certification

An excellent example of sustainability, the Proximity Hotel showcases a wide variety of green building techniques. For a listing, go to http://www.proximityhotel.com/green.htm and click "See a list of our LEED Credits."

LEED (Leadership in Energy and Environmental Design) is a green building certification system developed by the U.S. Green Building Council® (USGBC®). LEED helps building owners and operators implement green building design, construction, operation, and maintenance solutions that are both practical and measurable.

LEED makes good business sense for both building owners and tenants. Green buildings are cost effective. According to the USGBC, "The cost per square foot for buildings seeking LEED certification falls into the existing range of costs for buildings not seeking LEED certification. An upfront investment of 2% in green building design, on average, results in life cycle savings of 20% of the total construction costs – more than ten times the initial investment."[1] With lower operating costs and better indoor environmental quality, green buildings are easier to sell and lease than conventional buildings.

Proximity Hotel

The Proximity Hotel in Greensboro, North Carolina, is the first hotel in the United States to receive LEED certification at the Platinum level from the U.S. Green Building Council. Combining luxury with energy efficiency and environmental sustainability, the hotel places the highest priority on guest comfort. The owner's goal is a sustainable, energy efficient hotel that never compromises guest comfort.

The Proximity Hotel uses 40% less energy than a similar building without green building techniques. Renewable energy provides 35% of the electricity, and a solar thermal system provides 60% of the hot water. The building's HVAC (heating, ventilation, air conditioning) equipment and refrigeration equipment minimize emissions that contribute to ozone depletion and climate change. These energy goals have been achieved at a luxury hotel with eight floors, 147 rooms, 5000 square feet of event space, and a restaurant.

1 "The Business Case for Green Building," U.S. Green Building Council (USGBC). Go to http://www.usgbc.org. select *Intro* on the *LEED* menu, and then click "business sense."

Energy Efficiency

On-Site Renewable Energy at the Proximity Hotel

One hundred solar thermal panels on the hotel's roof provide 60% of the building's hot water. Standing amid the solar panels is Dennis Quaintance, Chief Design Officer of the Proximity Hotel and President of Quaintance-Weaver Restaurants & Hotels.

Energy and Atmosphere (EA) is one of the LEED environmental categories. It involves three prerequisites and six credits:

- Prerequisite 1: Fundamental Commissioning of the Building Energy Systems
- Prerequisite 2: Minimum Energy Performance
- Prerequisite 3: Fundamental Refrigerant Management
- Credit 1: Optimize Energy Performance
- Credit 2: On-Site Renewable Energy
- Credit 3: Enhanced Commissioning
- Credit 4: Enhanced Refrigerant Management
- Credit 5: Measurement & Verification
- Credit 6: Green Power

Prerequisite 2, Credit 1, and Credit 5 focus on energy efficiency. Excessive consumption of energy damages both the environment and the economy.

EA Credit 1 awards from 1 to 19 points for optimizing energy performance. A major renovation of an existing building receives one point if the proposed building energy cost improves on baseline building energy cost by 8%. Additional points are awarded for higher energy cost savings, up to 19 points for a 44% improvement. For new buildings, the percentages for awarding points are slightly higher: 12% for one point up to 48% for 19 points.

EA Credit 5 awards up to three points for measurement and verification (M&V) of energy consumption to make sure the actual consumption meets proposed consumption guidelines established during the LEED certification process.

Through energy simulation or engineering analysis, actual energy consumption can be compared to a baseline model of standard energy consumption by building and by each room within the building. The model shows the cost of conventional equipment versus energy efficient equipment and the payback period through reduced energy consumption. Using the model of standard energy consumption, the building's designers can project the amount of energy efficiency gained through energy saving equipment and building construction.

Metering equipment should be installed to measure energy use by heating, cooling, ventilation, lighting, and other important energy subsystems. Once the metering system is in place, operating data can be collected by subsystem.

Measurement and Verification

To meet LEED energy requirements and verify performance, the Proximity Hotel modeled the building's standard and projected green energy consumption. The final design model predicted an annual energy consumption 30% lower than a similar building designed to meet minimum building code requirements. The hotel then implemented a measurement and verification program as part of their overall energy efficiency solution, and the M&V process further reduced utility costs by USD 40,000 per year.

"Energy management is an ongoing, continuous improvement process. Not only must existing equipment be maintained in peak operating condition, but opportunities to incorporate new technologies must be considered in a timely manner. Energy efficiency is an ever-advancing field, and building owners who wish to continue to be leaders in the Green world must adopt a philosophy of continuous improvement in energy management."

Dr. Peter Rojeski, Measurement & Verification Services

Program Design

Dr. Peter Rojeski, the owner of Measurement & Verification Services, developed the hotel's M&V program. Dr. Rojeski, an energy efficiency consultant with extensive teaching and research experience in building energy management and energy conservation, specified the energy usage points to monitor, the data to be captured, the frequency of the data collection, and the data analysis plan.

Capturing energy-use data is the first part of Dr. Rojeski's energy efficiency solution implemented at the hotel. Figure 1 shows the solution's basic components.

The hotel's energy efficiency expert analyzes the data in light of constantly changing energy efficiency technologies, quantifies the analysis based on the hotel's energy models, and prepares reports that describe recommended operational tune-ups and opportunities for new efficiencies in financial terms.

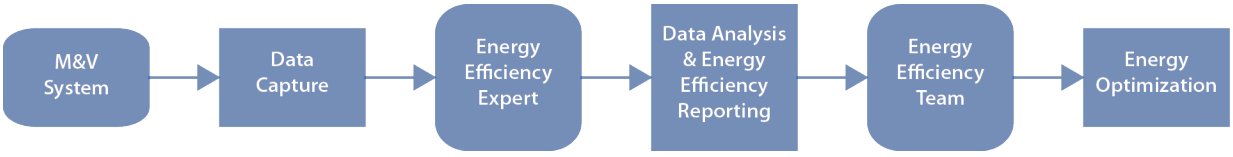


Figure 1. Optimizing energy use based on data from an M&V system

Optimizing energy based on measurement and verification data is a team effort. The Proximity Hotel has a dedicated energy efficiency team that reviews energy use data and recommendations, evaluates new technologies, and chooses cost-effective energy improvements and tune-ups. The team members comprise the owner, the chief financial officer, the energy efficiency expert, the mechanical contractor, the electrical contractor, the building Information Technology administrator, the maintenance supervisor, and the equipment vendors. The team meets regularly to discuss current operation and plans for future improvements.

Systems Integration

"The Proximity Hotel has a state-of-the art Measurement and Verification system that monitors the efficiency of its energy systems real-time, 24 hours a day, 7 days a week."

David Adams, president of Adams Environmental Systems

Adams Environmental Systems, specialists in building weather and M&V monitoring systems, performed the M&V systems integration work. At the start of the project, the Proximity Hotel had one gas meter and one electric meter. Adams Environmental Services built the sensors that monitor outdoor air temperature, humidity, and solar as well as indoor air temperature, humidity, and carbon dioxide levels. The company specified the systems components needed to implement the data capture and inspection plan including the sub-metering system, the device network to transmit the data, and the data acquisition system. The company installed the components, set up the network, and programmed the components' data capture, analysis, and display software. Adams Environmental Systems also maintains the data acquisition system.

M&V Implementation

Figure 2 shows the measurement and verification system at the Proximity Hotel.

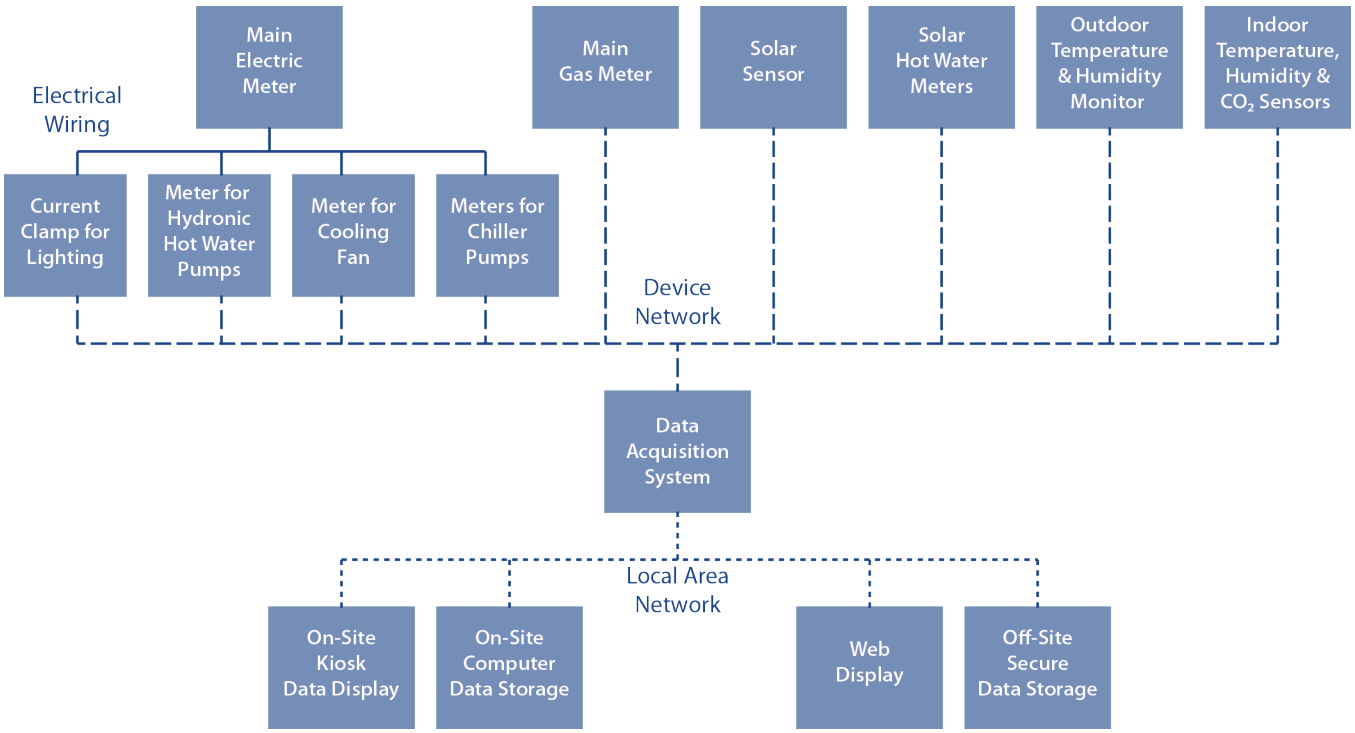


Figure 2. Measurement and verification system for Proximity Hotel

The M&V system monitors energy consumption at the main electric meter and by the hotel's lighting, chiller pumps, cooling fan, and hydronic hot water pumps. Gas consumption is monitored at the main gas meter. Solar hot water production is monitored with British thermal unit (BTU) meters. A weather station monitors

the outdoor air temperature, humidity, and solar. Sensors monitor the indoor air temperature, humidity, and carbon dioxide levels at four locations in the hotel.

The sensors, meters, and sub-meters send data over a device network to a data acquisition system. The device network supports up to 256 discrete devices on a single pair of wires for over 4000 feet. Additional range is possible with the addition of repeaters.

The data acquisition system sends the data over the hotel's local area network (LAN) to an on-site computer that stores the data and to a kiosk that displays the data. The data is also displayed on the Proximity Hotel's website and securely stored off-site.

The M&V system software graphs energy use data from the monitoring and sub-metering equipment. Figure 3 shows daily electrical energy totals over a four-month period for main power and sub-metered chiller and hydronic hot water pumps.

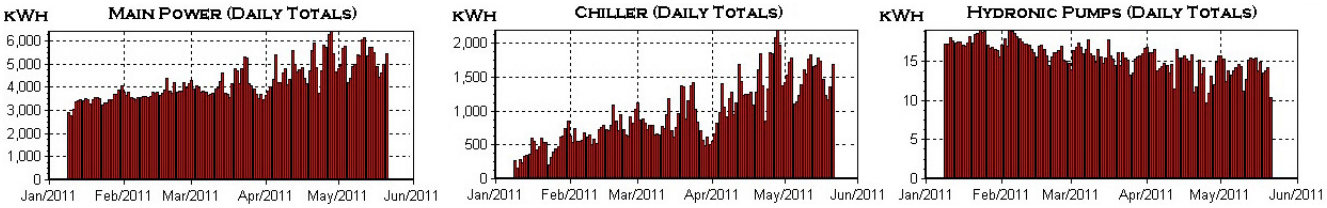


Figure 3. Daily energy totals for main power, chiller, and hydronic pumps

The software also computes energy savings. It updates energy consumption and savings figures every hour and displays the information on an educational kiosk in a lobby hallway, on guest-room television sets, and on the hotel's website. Figure 4 shows an example.

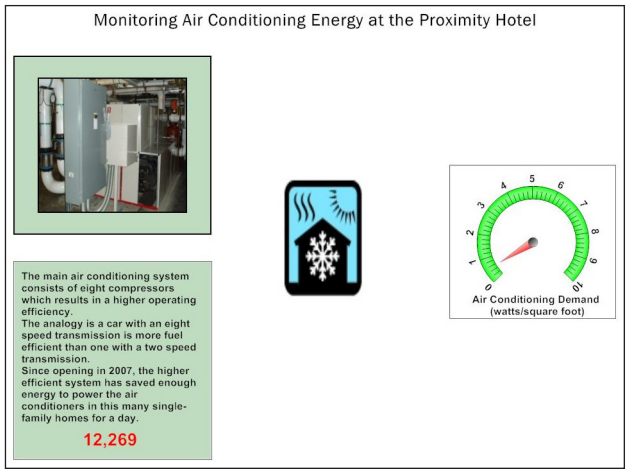
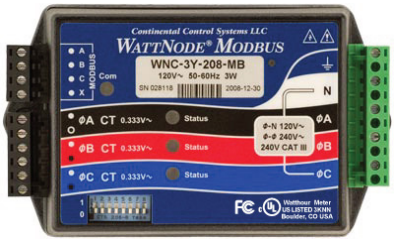


Figure 4. Data display for air conditioning energy

Sub-Metering

WattNode Modbus Meters



Benefits:

- Efficient communications
- Support for three-phase variable frequency drive (VFD) motors
- Economical solution for monitoring multiple motors
- Compact size
- Support for wide range of current transformers (from 5 to 6,000 amps)
- Support for voltages from 120 to 600 AC

Sub-metering is an important part of the M&V implementation. Individual electrical energy meters isolate the performance of the air conditioning system's two high-current chiller pumps. A third meter monitors the performance of the cooling fan, and a fourth meter monitors the performance of the two low-current hydronic hot water pumps. Figure 5 shows the sub-metering portion of the M&V system.

Variable speed motors for heating and air conditioning pumps and fans provide large gains in energy efficiency. At the Proximity Hotel, three-phase variable-frequency drive (VFD) motors enable the chiller pumps and hydronic hot water pumps to save energy by running at slower speeds when full power is not required.

To support VFD motors, to economically sub-meter the chiller pumps, cooling fan, and hydronic hot water pumps, and to efficiently send power consumption data over the device network to a data acquisition system, Adams Environmental Systems chose WattNode® Modbus® electrical energy meters.

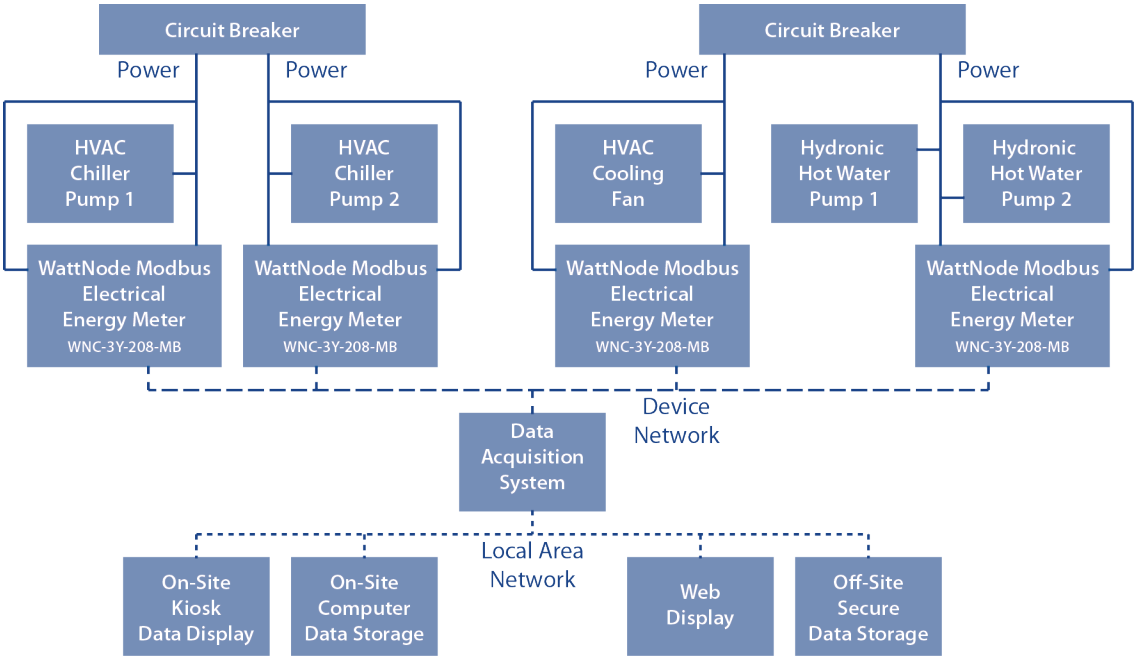


Figure 5. Sub-metering implementation in the M&V system

Results

For More Information

Proximity Hotel: visit www.proximityhotel.com

Proximity Hotel's energy efficiency website: visit www.proximityhotel.com/energy/one.htm

LEED certification: visit www.usgbc.org

Measurement & Verification Services: visit www.mandvservices.com

Adams Environmental Systems Inc.: visit www.adamsenvsys.com

WattNode AC power and energy meters: visit www.ccontrolsys.com

The results of implementing a measurement and verification program for energy consumption at the LEED-Platinum Proximity Hotel include capture and storage of accurate energy-use information, verification of energy compliance, annual summaries of results for each system, and identification of energy problems, areas for improvement, and operational tune-ups.

Analyzing the data leads to many improvements in energy efficiency. If the chiller motors are consuming energy when cooling is not required, the system automatically sends an alert, and the data shows the source of the problem. When changes are made to energy systems, the results of the changes can be quantified. For example, changes to the solar hot water system 's flow characteristics, air vents, and heat exchangers increased the system's BTU output by 20 percent. Energy improvements recommended by the energy effiency team based on M&V data have saved the Proximity Hotel USD 40,000 per year.

Together with LEED green building techniques, a comprehensive measurement and verification program with sub-metering to isolate energy consumption by subsystem makes environmental and economic sustainability cost effective.

WattNode Power and Energy Meters

CONTINENTAL CONTROL SYSTEMS, Boulder, Colorado, USA, specializes in the design and manufacture of the WattNode AC (kW) power and (kWh) energy meters. Available products include **MODBUS,** standard **PULSE-OUTPUT,** and **LONWORKS®** Watt/hour **WATTNODE** transducers that offer interoperable power, energy, and energy demand metering. Low cost, low voltage current transformers in split core, solid core, bus bar, and custom configurations can be selected, measuring current up to 6000A. Applications include LEED Certification, Net Metering, Utility and Facility Sub-Metering, Equipment Operation and Performance Monitoring, Measurement / Verification of Power and Energy Production and Consumption, and Building Automation and Control.

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