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Georgia Institute of Technology Facilities SMART M&V Process

Statement of Program

Georgia Institute of Technology, as a member of the USGBC with several LEED awards, has submitted its LEED's advanced measurement and verification (M&V) plan for each new building filed under the LEED certification program. Georgia Tech Facilities Division wanted to execute the (M&V) plan to validate the projected savings of the LEED energy conservation measures.

Georgia Tech Facilities discovered a wide variation between projected LEED energy savings and actual energy savings. The School of Mechanical Engineering requested topics for their graduate students to study for their thesis. These two needs came together to develop a true evaluation of the designed energy consumption against the measured performance of the building design, therefore yielding accurate energy savings.

The second objective was to develop a methodology process that would become a standard for an accurate comparison of energy savings as compared to the LEED projected savings. A continuous SMART M&V process would then be in place to revisit the energy savings evaluation on a cycle of every two or three years. This process would also provide an ongoing research platform for the graduate students and provide Facilities with continuous updated benchmarks as to how well the building was performing.

The third objective was to obtain energy usage metrics that passed the rigors of academic review for the Masters and PhD thesis defense yielding defendable energy savings.

Institutional Benefits

The SMART M&V effort has enabled Georgia Tech Facilities to move from non-verified energy savings to a reliable methodology process to evaluate real energy savings of projects of any size, from new buildings and completely renovated buildings, to renovated building zones.

The partnership between Georgia Tech Facilities and the School of Mechanical Engineering Graduate Studies has provided a rich environment for graduate class studies and graduate thesis work. Georgia Tech, like many research campuses, has an ever changing space requirements, and its use of buildings and spaces change approximately every three to five years. Therefore, each re-evaluation of previously studied buildings has the possibility of a completely different set of new problems for the graduate students to address.

To implement the SMART M&V process, effective and accurate metering was required to capture the effects of actual operating conditions. The energy software simulations that will be/has been created will use actual data for the occupancy, weather, and changes in equipment. The metering requirements resulted in Facilities launching a campus wide building metering program. Metering was installed for all electrical, chill water, steam and natural gas lines in every building. The meters installed are SMART meters and have the ability to communicate over the internet to a central ION database. In addition to accurate metering, records of installed systems and verification of building automation controls were required.

The availability of historical building energy usage has been of tremendous benefit to Facilities Operations and Maintenance and the Georgia Tech research community, enabling other units at Georgia Tech to pursue additional research opportunities and to track energy usage.

Innovative, Creativity and Originality

Over the past few years Mechanical Engineering's graduate students have been conducting energy studies for the Georgia Tech Facilities department under the guidance of the Georgia Tech Facilities Institute Engineer. The building energy simulation group has worked together to gain a better understanding and working knowledge of the components necessary to accomplish our goals, namely accurate measurement and verification. The approach of these studies is to integrate the campus wide data network of monitoring, and historical recording ION Database into energy simulations. To capture the effects of real building performance, eQUEST energy simulations use actual data for the occupancy, weather, and changes in equipment based on the recorded meter readings of a specific building.

Georgia Tech, like many large universities, purchases electricity, gas, and produces chill water via central chill water plants. Just as the axiom goes "You cannot manage what you cannot measure", GT Facilities developed a project to install building level metering in all buildings for electricity, chill water, steam, and natural gas. As part of the metering project, an internet based reading and data logging database was implemented, the ION database. The ION database reads all of the meters every 15 minutes and stores the data in an SQL database for later use.

Accurate weather was also required to evaluate the thermal effects of weather on energy usage. A weather station was installed in the central portion of campus and the meter reading database engine was used to record the weather by the hour.

The influences of occupancy have dramatic effects on energy usage. Electronic people counters are being installed on all new projects with the data being recorded by the meter reading database to further gain real data of building usage.

The implementation of the meter reading ION database has proven to be of enormous benefits, other than just providing data for the energy studies. Because the data is web based, Facilities can quickly determine if an implemented energy conservation measure is yielding the planned results. The ION database has provided the opportunity for accurate utility billing of Auxiliary, Athletic, and non-state funded research facilities. The meter database has opened up additional research opportunities. For example, the School of Architecture is using the meter database as part of a research study to evaluate 30 buildings at Georgia Tech for uncertainties in building energy simulation. The School of Aerospace Engineering has won a grant from General Electric to use our campus as a research platform for SMART Grid Studies. Johnson Controls Inc. has funded a campus wide research study to trend operational building data into a centralized database called EnNet.

Portability and Sustainability

The process and methodology is completely portable and adaptable to other Colleges and Universities. This process provides the means to evaluate the LEEDs energy submittal and to provide accurate documentation of energy savings. Proposed designs of LEED buildings use theoretical assumptions of occupancy, plug loads and weather . This yields an approximation or best guess of what the energy savings of the final design is, as compared to meeting the minimum energy code. Comparing actual meter readings to these theoretical assumptions will yield faults, energy savings or over usage. For a true comparison of energy savings, the eQUEST simulation model has to be adjusted to the actual conditions for occupancy, weather, and plug loads during the same time period as the meter readings.

The following procedure is used to substantiate energy performance of new or refurbished buildings:

- Step 1: Develop eQUEST energy simulations to estimate performance of new and refurbished GT buildings using design and generic data.
- Step 2: Correct the estimated performance (e.g. LEED submitted) energy models for:
  - Validated equipment installed in buildings.
  - Occupancy and Internal Loads
  - Local Weather conditions (including solar inputs: SHG, sol-air temp)
- Step 3: Compare corrected model with actual performance (verify performance, test cost effectiveness)

These steps can be developed by consultants or in-house staff and students depending on the capabilities of the College/University Facilities.

Metering data can be obtained by installing new metering and/or adding metering to the campus's building automation system. Building automation systems are very effective in collecting data and trending for later usage.

The methodology and practice is extremely sustainable and follows prescribed procedures of the International Performance Measurement and Verification Protocol (IPMVP2007), www.evo-world.org, The Association of Energy Engineers, and Certified Energy Manager energy audits practices. The SMART M&V process not only provides educational opportunities for students on building design and operation but a sustainable way of ensuring GT buildings are operating as expected.

As other LEED property owners attempt the accurately quantify energy savings, this process or a similar process may be adopted as accepted standard practice.

Management Commitment and Employee Involvement.

Georgia Tech has demonstrated its commitment to the SMART M&V process by adding this requirement of the additional metering in the campus design standards (GT-Yellow Book) for all projects.

Georgia Tech Facilities Division has committed funding for energy metering which support the SMART M&V process as well as other Facilities operational requirements. The Office of the Senior Vice President provides funding to the Georgia Tech School of Mechanical Engineering Graduates Studies Programs to support graduate students research opportunities. Graduate students perform the fundamental analytical analysis required for the energy simulation comparisons and the academic requirements for their thesis.

The School of Mechanical Engineering continually involves new candidates and other disciplines for studies of GT buildings through a wide variety of research projects. GT facilities engineers support Mechanical Engineering graduate students by providing guidance and wisdom on the implementation of new research projects related to building operation. An example of how the SMART M&V process has affected involvement of GT employees and students is the implementation of a continuously updated building dashboard. The development process for building dashboards involves the direct interaction of Mechanical Engineering graduate students, GT facilities engineers and the student body. Building dashboards present the currently trended data of energy consumption to the building occupants. Building dashboards provide an outlet for discussion on how a particular building is performing or will perform. Many students have expressed and interest in seeing the buildings energy consumption via the dynamic display of the Dashboards. The Dashboard will also provide information to the Researchers to determine if they can reschedule their research to reduce energy. Energy reduction strategies can be witnessed and implemented on a person by person basis by simply tracking how the building performed when their energy consumption is minimized.

Documentation, Analysis, Customer Input, and Benchmarking

The following two documents are presented as background, define objectives, and provide results of the process. The first document is a presentation to the Senior Vice President of Georgia Tech, documenting the achievements and to lay out the future of the program. The second document is a detailed report of a major renovation to a 1928 building that once housed the School of Civil Engineering for approximately 40 years. The building is on the National Historic Register. Recently, Georgia Tech renovated the entire building, renovating all of the electrical, HVAC, and communications systems. The remodeling provided new, advanced, classroom resources and offices. The renovations rejuvenated and kept the classic charter of the building and won a LEED Gold Certificate.

The Gold Certificate ratifies Georgia Tech's Design Standards as striving to achieve excellence. The performance of the SMART M&V process, confirms that savings can be achieved above and beyond the potential savings of the buildings LEED submitted savings.

1- "SMART M& V Research Conducted with GT Facilities Update"
2- "Research Conducted with Georgia Tech Facilities Department and Analysis of Old Civil Engineering Building"

Copies of the full study are available at:
http://www.facilities.gatech.edu/dc/smart-m-v/research-and-activities-conducted-with-georgia-tech-facili.pdf
http://www.facilities.gatech.edu/dc/smart-m-v/appa-award-submission-jan-2011revised-2.pdf
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