Winn Energy Controls, Inc.

Energy Audit: Definition and Purpose

The energy audit, as the name implies, is a process to perform an energy balance on a facility. A facility can be a total building or plant or it can be a major process or subset whose energy supply can be clearly identified. The energy audit will first identify and quantify every source supplying energy to a facility usually, but not necessarily, on an annual basis. Then every user of energy in the facility is independently identified and the energy consumption of each system, device, or process is determined, based on measurements, engineering models and interviews. The audit team then compares the sum of the sources with the sum of the energy consumptions to balance the energy use in the facility. This compilation provides the baseline energy use in the facility.

The purpose of an energy audit done on a facility or plant is to identify and define energy load flows associated with utilities (gas, electricity, water, etc), quantifying delivery and consumption at the terminal points. Once load flows are defined and rates of consumption at terminal devices (motors, chillers, boilers, pumps, etc) are determined, the next part of the effort is to determine efficiencies of various systems and subsystems in the facility through measurements and / or analysis. Once the technical information is found, the next step is to analyze the information to develop a set of findings to meet the goals of the facility owner. These goals may be to reduce energy costs, reduce energy use or to make the facility “greener”. While these goals have similarities, recommendations resulting from the study may and will likely be different against each of these different goals. Choice of a particular optimization goal is for an owner’s management team to make.

Recommended improvements should comply with accepted standards such as ASHRAE or NAIES, or the NEC. Therefore improvements considered cannot negatively impact guideline performance such as, for example, occupied space temperature reset outside acceptable human comfort limits.

Economic Evaluations as a Part of an Energy Audit

Once load and rate flow information is developed and improvement opportunities identified, the concluding part of the Energy Audit is concerned with evaluation of first cost and savings payback associated with each potential element or system identified. The proper metric for evaluation of potential changes or improvement are then created on the basis of Present Value and Future Value costs and dollars. Typically the ultimate objective associated with an Energy Audit is concerned with retrofit to reduce operating costs and subject to sufficient saving to recover first and interest costs so that simple payback is achieved in a 5, 10, or 15 year period.

Reporting

An energy audit report is prepared by the team that discusses methodology, data taken, consumption profiles, findings and recommendations. If it is anticipated that if private sector or third party financing is desired to cover retrofit costs, especially with governmental entities, an “Investment Grade Audit Report” is required. This type audit report is very detailed so as to permit the financing entity to determine the risk

associated with accepting cash flow from energy cost savings as a means of amortizing the loan. The financing entity will usually require the report to be stamped by a professional engineer.

Conducting the Energy Audit

Usually a preliminary or simple scope audit is done before an engineering team begins a more comprehensive audit. The purpose of a scope audit is to quantify the level of saving opportunities that might be available for a facility without incurring a great deal of time or expense. This type audit would look at the facility energy bills, facility size and type of use. A simple "walk thru" by an audit team member would also be a part of the preliminary audit. We recommend that all energy savings / retrofit efforts start with a simple scope energy audit done as a means of determining what if any potential saving might exist.

The time and effort required for execution of the audit process is always greatly reduced when an owner can supply the audit team up to date building and facility drawings and all submittal information as it relates to the equipment devices and elements of the systems installed. When such information is not available from an owner, the first task that an audit team must complete is to generate the information normally found on such drawings and obtain equipment and systems product and design information before proceeding into analysis. Availability of such information reduces time and cost associated with audit efforts, especially the field portions of such efforts.

Engineering Staffing and Qualifications necessary for Audits

Facility auditing entails a comprehensive analysis of a building or plant, its facilities, the systems contained in or a part of the facility, the equipment and systems the equipment serves, and a comprehensive review of facility and systems operations and maintenance. Accordingly, the engineering staff doing the energy audit must involve experienced and seasoned engineering professionals with fundamental knowledge of:

- Electrical machines
- Thermodynamics
- Fluid mechanics
- Engineering Economics

And experience with:

- EMCS and SCADA Top Level Controls
- Instrumentation, measurement and automation
- Boilers and Heaters
- Steam and Condensate Systems
- Dryers and Heat Exchangers
- Fans, Pumps and Compressors
- Chillers and HVAC systems
- Industrial Electrical Equipment
- Lighting
- Building related energy use

- Industrial insulation, selection and cost
- Heat recovery systems
- Steam and Condensate Systems
- Boiler Plant
- Weatherization
- Energy Recovery Systems
- Renewable Energy Systems
- Solar
- Wind
- Biomass
- Facility Energy Improvements
- Water Conservation

Implementation of Saving Opportunities, Owner risk, retrofit expenses and energy performance service contracts (ESCo contracts)

The up-front engineering cost for producing an effective energy audit can be significant. An audit is useless and a waste of expenses if energy and cost saving opportunities identified in the audit are not implemented. Implementation is expensive and most owners want some assurance that if the measures identified are implemented, the saving return will cover the cost of the energy audit as well as the implementation cost within a payback time frame typically set by corporate policy.

Two schemes are available to mitigate owner risk associated with funding. With an investment grade audit, the ESCo contractors doing work for a governmental agency must provide a 100% performance bond that is carried through length of the payback period. The difficulty with this, however, is that the up-front engineering audit and upgrade design cost have to be rolled into the funding after an ESCo contract is funded. This means that engineering cost and effort is at risk until funding is guaranteed and even with this scenario most third party financial entities do not want to provide funds to cover the engineering efforts that are a necessary part of the process.

The second scheme is most often used by private sector companies and financial entities. With this scenario the initial audit costs are paid by the owner and if an ESCo contracts result from this, ESCo savings projections are purposely reduced to permit the owner to recover his up-front costs. Regardless of scheme or scenario, the owner ultimately pays the engineering costs.

Proof of Savings Performance

As owners are concerned not only with reducing energy consumption but with saving money, it is necessary to have measurement and validation systems in place starting before implementation measures are installed, initiated and needed for baseline comparison and then for metering and recording data that is then used to prove results. Metering and Validation (M&V) is the process referred to for proving results.

Our M&V efforts center around and utilize a open protocol IT based system, which we install, to implement automated M&V systems acquisition of data offering the following:

- No need for replacement of properly functioning BAS/EMS.
- Interfaces to current controls and sub-meters installed.
- User friendly graphical interface quickly allows user to access desired information and data from “dash board”.
- Automatically collects and reports data to develop life cycle costing analysis.
- Measures and Validates Energy Performance Contracts.
- Meets the Utility M&V requirements to receive rebates and subsidy funds.
- Automatic Data formatting, No data entry.
- Continuously benchmark performance.

We also find that to sustain our M&V efforts we must provide operations and maintenance training with the owners staff or in some cases provide this service to an owner on a contract basis, especially where it may not have existed or existed at a substandard industry level. Since the technician knowledge level required often is not present, i.e., technician knowledge with electrical, HVAC, refrigeration, BAS and IT systems, we most often have to provide training to the individuals with remote and sometimes on-site support. The results of having a trained O&M service team on site or on a consulting basis when needed are:

- Avoided unscheduled service calls with remote monitoring and control.
- Better upkeep of facility.
- Reduce replacement part costs.
- Reduce diagnostic/ trouble shooting time.
- Minimize length of time during outage.
- Recognize potential faults before failure or detection by BAS.
- Increase machine life.

Implementation of Energy Conservation Plans

Often and as a necessary part of implementation of an energy conservation plan, one must start by correcting pre-existing problems, replace inefficient equipment, and install basic supervisory controls in the facility to adjust machine set points while maintaining a device’s factory furnished OEM controller which has built-in safety features. Supervisory control reset for instance of a chiller through the device’s factory furnished OEM controller, which has built-in safety features, eliminates warranty disputes and other problems when faults or problems occur. Often with major pieces of equipment, such as for example a chiller, it is desirable to install a Programmable Automation Controller (PAC) which is used as a monitoring and secondary controlling device. As several quality manufacturers of low cost high performance PACs exist, these devices are used more and more as secondary controlling devices for the following reasons:

- Stability of a PLC with flexibility of a PC.
- Existing Proprietary and new Non-proprietary BAS / EMS systems and communication protocols will in integrated to common HMI.

    - TCP/IP
    - ModBus
    - LonWorks
    - BACnet
- Report machine performance through the existing IT networks.
- Expand I/O as needed due to changing environment conditions without replacement of base processors.
- Eliminates need for special software / hardware.

As the controls industry, especially the building controls industry evolves and expands more into supervisory controls, PACs implementation into systems will find application in: Automatic Fault Detection, Diagnostics, and evaluation in a predictive way using the M&V data collected, stored and analyzed for:

- Continuously monitoring machine performance by M&V.
- Compare M&V to previously recoded data and simulated performance for anomalies.
- Alert O&M of likely faults, causes, and corrective actions.

- Global Optimization across a facility to include its entire HVAC system with:
    - Chilled Water Reset based on returning water temperature and BTU requirements.
    - VFD and fan speed reset based on load.
    - Load allocation of machines based on performance curves to achieve maximum efficiency.

- Global Optimization for monitoring, diagnostics, and alarm integration of:
    - Fire Protection & Security.
    - Manufacturing and Process Control.
    - Predicting performance of system for time of day optimum opeation.
    - Continuous on-line cost analysis and cost accumulation to include life cycle for every piece of equipment and system.

- Fully Automated Control with multiple facility monitoring via data recorded and stored in a data center:
    - Chiller Plant
    - Power/Co-Gen Plant
    - Boiler Plant
    - Automated Maintenance

Costs Associated with a Building or Facility Audit

An energy audit recently done for a simple three-story 100,000 sq ft office building in Houston, Texas that contained a data center on part of one floor was quoted at $17,000, not to include travel and per diem expenses. A simple scope audit is done preliminary to pricing of a more extensive audit indicated annual operating cost pers square foot per year of $13.26. This facility has an annual possible potential saving on the order of $240K per year. If it is possible to achieve only half of this potential savings, then the

owner could spend $600K for retrofit expenses based on a 5 year simple payback. An audit price of $30,000 ± $5,000 plus expenses was recently provided for a 100,000 sq. ft chemical blending plant in Ohio.

Audit prices for facilities should be provided on an individual basis that reflects availability of owner's documents and submittal information, systems and process and equipment in the facility and the use of the facility.