

ENERGY AUDITS FOR BUILDINGS: AN OVERVIEW OF METHODS USED TO PREDICT AND ENHANCE PERFORMANCE

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Many significant influences – both inside buildings as well as in the external environment – contribute to energy consumption. How much energy a building needs is affected by its shape and size, for instance, and also by the kinds of materials used in its construction. Equipment loads, lighting systems, insulation values, and the routine usage patterns of those who live or work in the building also play critical roles. Taken together these various components and their unique interrelationships create the building's energy use outcome.

But those multiple factors are not easy to pinpoint or calculate because they are in a state of continual flux. During the life of a building, for example, the floor plan will change. The number of tenants will vary, and so will the ways that those people use the building's energy. The performance of HVAC systems improves or deteriorates, for example, depending upon how old or new they are. The price of energy fluctuates. Redecorate one floor of a building with a different thickness of window shades and the demands for lighting will shift. Convert a vacancy into a restaurant and water usage can skyrocket.

Because of the obvious challenges that all of these interdependent energy factors present, insightful audits are virtually impossible to do without the aid of computerized building models and technically advanced simulation software.

COMPUTERIZED BUILDING MODELING AND VIRTUAL SIMULATION

Traditional energy audits derive information from a variety of different sources including building specs, photographs, architectural blueprints and drawings, lists of construction materials, and other relevant data. The information is manually entered into the energy audit software program database, and once it has been compiled the auditor combines it to create an energy model. Simulation then attempts to mimic the energy behavior of the actual building – and by performing a creative simulation the auditor can make observations, predictions, and recommendations.

But the process of gathering hundreds or thousands of pieces of pertinent information and entering them by hand is labor intensive and prone to human error, which is why another method evolved that uses statistical information. The simulated models generated in this way are not exactly the same but are statistically similar and comparable to the building being studied. So the model of an existing building can be created and an energy audit can be conducted in considerably less time with much greater ease.

Misinterpretations of building geometry are not uncommon, however, as AutoCAD formatted data is transferred to the energy model software. (As a simple example, a computer may not recognize the difference between a window and a rectangular shaped black fabric banner hanging against the wall.) Another problem frequently encountered is that with multiple contractors, designers, and engineers contributing to a project there may be several different versions of the same building plan. Once all the discrepancies are added together – however minor they may be on their own – they can have a major impact that compromises accuracy and reliability and skews the audit results.

Statistical averages can be used in an attempt to even out this kind of inconsistency and make the inputting process more manageable. The average lighting schedule for a building might be used, for example, instead of attempting a more customized model based on the unique usage patterns of each floor of a building or each individual office or apartment unit on a floor.

While statistical modeling offers benefits not found in earlier modeling techniques, the main drawback of this approach is that the audit results may be too generic and unrealistic. Another common complaint is that once the baseline statistics are input and the parameters are set, revisions to the energy model are cumbersome, labor intensive, and sometimes impossible to satisfactorily achieve without starting over with a fresh model of the updated structure.

RECENT TECHNOLOGICAL IMPROVEMENTS

Addressing the issues encountered with previous methods, parametric or interactive Building Information Modeling (BIM) technology was recently adapted to energy audit software applications. With the BIM energy model the user can simulate a building in an interactive and updatable manner that provides greater simplicity, flexibility, and longevity.

Energy audits are most needed on existing buildings that now need to be updated in order to save energy. But instead of relying upon old plans and drawings the BIM model can be created on site in a matter of hours with a handheld electronic tablet in order to give a precise “as-built” rendition. The model offers the same perspective and view that one gets when walking through a real building – with effects that are visual, realistic, and immediate. Because the model operates on a parametric platform, it is possible to

easily and conveniently try various layouts and configurations or update design and construction changes without human intervention.

Green retrofits under consideration can be pre-tested in a virtual environment capable of simulating everything from occupant energy usage patterns to fluctuations in local energy prices. View the impact of reconfigured floor plans, various construction materials, alternative energy sources, or changes in equipment, occupancy, and infrastructure.

Various options can be toggled on and off in the model for visualization, quantification, and analysis. Develop and study multiple design alternatives – both green and conventional – and do it all simultaneously within a single model. Look at options for varying levels of LEED certification while showing before and after and side-by-side comparisons. The versatility of BIM technology also allows an auditor to integrate any combination of changes or strategies and apply them within a single test or analysis. By contrast, conventional energy audits can only show the result of modifying one component at a time.

Meanwhile users can more closely match the unique characteristics of a particular building. The thermal zones can be closely matched to the mechanically designed HVAC zones, for example, rather than relying upon theoretical thermal zone statistics typical of less sophisticated energy modeling programs.

Once a BIM model has been created, architects, engineers and contractors can add their work to the same database and model file, eliminating design conflicts between groups while tracking an unlimited number of changes. When changes are made in one part of the BIM model, the implications are visible throughout and interrelated changes are made everywhere else in the model. All data and drawing information is associated and linked, virtually ensuring flawless coordination. The model also becomes a “living document” that updates as the building changes, making it useful for the entire life of a building.

The importance of understanding, monitoring, and managing energy usage in buildings has taken on a greater importance within recent years as the cost of energy continues to rise and the incentives for conserving energy become more tangible and compelling. Fortunately the technology to ensure cost effective energy management has kept pace with the demands of the building industry to provide sophisticated and affordable energy audit tools. ♦

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