Energy Auditing Using Predictive Engineering Techniques

Diane Pemberton
Capital PdM Limited

ABSTRACT

The recent blackout in the northeastern states of the U.S. alerted energy suppliers and end-users of the importance of continuous energy supplies and the devastating impact of power failure. The news media have suggested that power supply grids may be suffering from over-demand, and that consumption must be reduced.

The above situation and fallout are further supported by global summits and conferences, namely, the Montreal Protocol, and Kyoto Agreements. In the UK, which is part of the European Union, agreements have been implemented which set out targets for businesses to reduce energy consumption.

Because of environmental and financial restraints, reduction in the consumption of fossil fuels has taken on a new importance. Fossil fuels are not an unlimited resource, and even their extraction causes harm to environmental and agricultural lands. However, a larger concern is the linking of global climate change to increasing concentrations of greenhouse gases in the atmosphere. The impact scenarios vary starkly across the world, as rising sea levels, adverse weather patterns, and flooding in some regions, and at the same time water shortage and famine increasing in other regions.

THE UK RESPONSE

In the UK, the most impacting law is the “Climate Change Levy”, which is a new tax on energy use in industry, commerce, agriculture and the public sector. It was introduced in April 2001. All UK businesses and public sector organizations pay the levy, via their energy bills.

We understand that the USA do not have similar laws at the moment, however, such measures may now be a topic of interest.

HOW CAN WE HELP LIMIT THE EVENTS DESCRIBED ABOVE?

Once we have access to a client’s premises, whether a commercial property or a private home, we are able to audit the engineering systems, building ergonomics, and building fabric. Other areas of concern include how the building is currently being used, which may have a significant impact on energy consumption.

Capital PdM’s energy audits are designed to facilitate the investigation of current energy consumption within a building structure. We believe that the implementation of an energy audit is an essential activity for any organization or private home owner wishing to:

- Understand their energy use.
- Control energy use.
- Reduce energy use
- Reduce costs.
- Improve working/living environments.
- Improve system efficiency.

- Contribute to global environmental improvement.

TYPICAL "HOME ENERGY" AUDIT

As previously mentioned an energy audit will evaluate what measures can be taken to improve energy efficiency, lets consider the areas where excessive energy maybe present, and steps that maybe taken to rectify energy loss.

Air leaks

The potential energy savings from draft reduction may vary from 5% to 30% per year. Areas of obvious leaks may include gaps along the baseboard or edge of the flooring and at the junctures of the walls and ceiling. Observations to see if air can flow through electrical outlets, switch plates, window frames, baseboards, weather striping around the doors, etc.

Insulation

Heat loss through the ceiling and walls may be very large if the insulation levels are less than the recommended minimum.

Heating/cooling equipment

Inspection of heating and cooling equipment annually or as recommended by the manufacturer will ensure efficient operation

Lighting

Energy for lighting accounts for about 10% of electric bills. Examination of wattage is recommended, and a move to more energy efficient fittings is beneficial, for example, from incandescent to compact fluorescent lamps.

TYPICAL COMMERCIAL ENERGY AUDIT

When carrying out energy audits be sure you understand the task ahead of you. It is important that a thorough log of consumptions is analyzed before the energy audit commences, because excessive energy is sometimes used in the most unlikely places.

The energy audit is the first step in taking control of site energy consumption. It can be viewed as an analysis of current trends and form the basis of a site energy management plan. The site management should consider the following steps that will help achieve this:

- *Consider the solutions detailed in the Full Energy audit.*
- Allocate one hour per week for every $25,000 spent on energy per year.
- Benchmark the consumption and compare against other sites.
- Raise staff awareness of energy and its cost.
- Compare energy costs to company profit.
- Assess the site for investment opportunities for saving energy.
- Carry out regular inspections.
- Introduce monitoring and targeting.
- Intensify monitoring of analyse patterns and trends in consumption.
- Calculate the base or minimum usage required, the rest is waste.
- Compile a plant database noting conditions and best practice for each area.

A realistic assessment of typical energy consumption levels should be carried out to provide a sound base for energy reductions, and proposals for possible capital investment energy schemes will be

formulated on completion of the audit. Understanding where energy is consumed and identifying waste are significant steps towards making reductions in energy costs. A site energy audit should broadly follow these steps:

- Collect site energy utility costs.
- Survey all significant buildings to arrive at a gross area for each functional space.
- Calculate the energy use within the functional spaces and derive a cost/m^2.
- Evaluate the site buildings and identify all features and characteristics that are causing excessive energy consumption.
- Look at the site meters and data acquisition links to check that the level and profile of energy consumption.
- Prioritize energy efficiency measures to provide the best value for the investment.
- Identify and exploit all opportunities to implement cost-effective energy measures.
- Develop energy-saving solutions that provide cost-effective paybacks to the client.

What site issues affect the energy use?

Building factors. As part of the energy audit, it is advisable to visit all populated areas within the site to evaluate current energy use. It may be the case that the current fabric, structures, and systems may have been in place for some time, and hence it could be fair to say that the current site occupancy model may not be a good fit for the utility systems that currently serve the site.

We believe that building characteristics can play an important part in focusing attention on possible energy-saving measures.

People factors. How the site operatives use the office space may have a significant impact on energy consumption. The local operation of space heating controls, air conditioning units, office lighting, computers, printers, and duration/nature of occupancy periods can all affect energy consumption.

Occupied period. The longer the site space is occupied, especially offices, the greater is the potential for energy use and waste. Additional factors affecting office room loads, is the reluctance to shut down computers at the end of room occupancy. Hence, office equipment could be running 24/7, which is energy wasteful. If for operational purposes office equipment needs to remain on, we recommend that "Energy Star" features should be initialized to conserve power and reduce costs.

Control responsibility. Within many sites, occupants control their own environments directly. This includes control of site utilities, such as space heating, air conditioning, lighting, etc. We often observe patterns where room occupants will turn up control levels, but neglect due to the pressure of work to remember to turn them back down.

Theses are just a few areas where energy audits can provide indication of excessive energy use. Capital PdM staffers are frequently amazed at the positive response of clients to the magnitude of energy reductions that can be achieved at relatively small cost. Many of the above energy problems can be identified with thermal imaging and additional techniques.

THE PREDICTIVE ENGINEERING TECHNIQUES

Our energy audits utilize predictive maintenance technologies such as IR thermography, vibration analysis, and building pressure testing to establish a footprint on the condition of the building fabric, heating/cooling plant operation, and power consumption.

Thermographics

We use infrared technology to inspect the integrity of the building's electrical system, pumps for critical plant and generator systems, and the building fabric for heat and cooling losses.

Vibration Analysis

We use vibration readings taken from all rotating plant and machinery. This allows us to ensure that they are being used to their full potential predictive failure, reducing downtime and maximizing energy efficiency. Variable speed drives fitted to pumps and fans are a cost-effective method of reducing electrical energy use, noise levels, and maintenance costs. A 20% reduction in the speed of the pump or fan can reduce electrical consumption by 50%

Oil Analysis

We use oil analysis on mechanical devices, which typically rides on a 10-micrometer film of oil, which is approximately equal to the diameter of a blood cell. Loss or contamination of this film means failure. To ensure smooth running machinery it is critical for the oil to be kept clean and dry.

Control Systems

The building management system (BMS) is the prime means of building control and can be described as an “Energy Information System.” If the BMS is not functioning as it was designed, the client would be operating inefficiently and wasting money

Building Pressure Testing

The urgent need to save energy and reduce global emissions of carbon dioxide demands that buildings are designed and constructed to be more airtight, while maintaining appropriate levels of air exchange to maintain good breathability. This is essential as the air infiltration or ventilation heat loss is proportional to the air tightness of the building. The higher the air infiltration rate, the more the heat loss and energy wastage.

SUMMARY

By educating the people who work within the office environment and people who are responsible for the maintenance and upkeep of a building about energy waste and how to avoid it, significant savings can be achieved in energy consumption and utility bills. In sum, awareness is the key to energy efficiency.