Chapter 4

Tools and Solution for Energy Management

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Additional information is available at the end of the chapter

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1. Introduction

Energy efficiency can be defined as utilizing minimum amounts of energy for heating, cooling, lighting and the equipment that is required to maintain conducive conditions in a building [1,2]. An important factor impacting energy efficiency is not only the building envelope but also the management of energy within the premises. The amount of energy consumed varies depending on the design of the building, the available electrical systems and how they operate. The heating and cooling systems consume the most energy in a building; however control system such as programmable thermostats and building energy management systems can significantly reduce the energy use of these systems. Some buildings also use zone heating and cooling systems, which can reduce heating and cooling in the unused areas of the building. In commercial buildings, integrated space and water cooling/ heating systems can provide the best approach to energy-efficient heating [3]. Energy audits can be conducted as a useful way of determining how energy efficient the building is and what improvements can be made to enhance its efficiency. Tests should be undertaken to ensure that the heating and cooling systems as well as equipments and lightings work effectively and efficiently.

Building cooling and heating also produces Carbon Dioxide (CO_2) emissions, but this sector receives less attention compared to other pollution contributors such as the transportation and industry sectors. In addition to energy conservation and energy efficiency approach, a strategic plan to introduce renewable energy resources would be an advantage to any sector as it will reduce the carbon dioxide emissions as well they could be used for heating, cooling, ventilation and lighting systems [4]. As illustrated in Figure 1, the percentage of energy consumed by various type of building is presented. It was shown that the rental and service buildings utilize the highest energy consumption. It is easier to design energy efficient features for energy management of new buildings using available tools; however existing buildings comprise approximately 99% of the building stock. Although energy efficiency initiatives for existing buildings can be demonstrated to be cost effective, there has been limited success in convincing large organizations and building owners to undertake energy efficiency projects such as retrofits, and retro commissions [5].

An important factor that rises while doing a comparison is the use of benchmarks as representative standards against the buildings to be compared and monitored. For example, the comparison of energy consumption with a square meter of floor area to the benchmark will allow the decision maker to observe and assess the amount of energy consumed. Therefore determination for the improvements can be made to minimize the consumption within that specific area. An effective energy management of a buildings do not necessarily cost more to build as compares to normal buildings, provided they are well maintained and manages effectively. Due to the use of energy efficient tools they are set to be very reliable, comfortable and as productive as a normal building. Numerous studies have focused on improving energy efficiency in commercial buildings. As stated by Escriva [6] engineers and researchers have developed complex methods to improve energy efficiency, but buildings are often managed by non-specialized technicians who need understandable and cost-effective actions to implement in their buildings. Therefore basic actions for the base improvements in energy efficiency for commercial buildings had to be stated and implemented.

2. Energy efficiency concept

The simple concept of energy flow can be shown in Figure 2. The whole idea is to minimize the energy loss either from the primary to secondary or from secondary to end use. Implementation of energy practices is part of the solution in reducing the loss from the infrastructure requirement to the energy demand. Energy is essential in increasing productivity and ensuring a high quality of life, thus the relation between energy and economic growth is crucial. However, the proportionality of economic growth and energy demand constitutes the depletion of energy resources. One essential and effective way to manage around the depletion of resources while at the same time fostering economic growth is by applying an energy efficiency concept [7, 8]. Since the late 1970s, a considerable increase in energy efficiency has been achieved in response to energy price hikes, supply uncertainties, government policies, and independent technology improvements [9,10]. Nowadays, the focus of international incentives for people to practice energy efficiency is to inject considerable amounts of awareness concerning climate change into the society. Energy efficiency is a generic term which refers to the usage of less energy to produce the same amount of services or useful output [11, 12].

However, the term energy efficiency depends heavily on its application. Thus there is no defined and clear qualitative measure of it. The input, output, analysis and monitoring parameters are very crucial in executing energy efficiency to the maximum in order to achieve the desired result. In general, the energy efficiency indicators are of the form of

$$Energy\ \ Efficiency = \frac{output\ power}{input\ power} \tag{1}$$

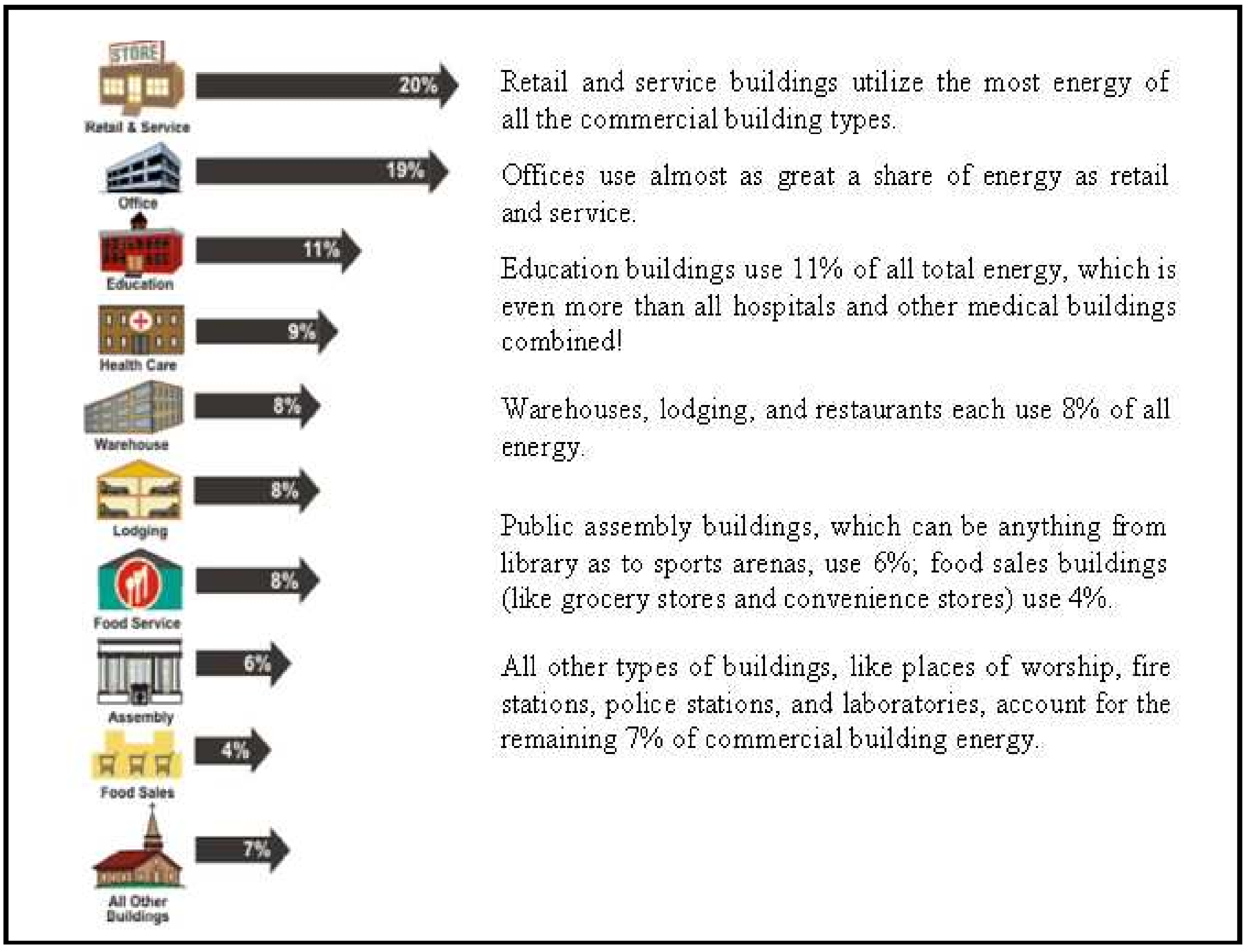

Figure 1. Building energy efficiency (Electric Power Research Institute)

The opposite of energy efficiency is referred to as energy intensity. The output of energy efficiency results can be physically determined, or enumerated in monetary units. The only plausible evaluation of energy efficiency is by looking at its indicators and then evaluating them by observing the results achieved targets, and relative situations among other groups. Energy efficiency number normally gives different interpretations relates to energy processes, programmers, investments, conservation properties, as well as system performances. Comparisons can be made to the past and to the projected future. This is important to ensure that the distribution of energy efficiency technologies and procedures can be systematically promoted. Evaluation and monitoring of energy efficiency practices give beneficial motivation mainly on the financial side. In many factories and buildings, overhead accounts duly increase the energy cost; therefore it saves a lot of money when total energy management is being practiced. Improvements can be adjust and implemented through accounting systems and at the end more accurately allocate energy costs within plants could be shown [8]. Diakaki et all in [9] investigate the feasibility of the application of multi objective optimization techniques to the problem of the improvement of the energy efficiency in buildings, so that the maximum possible number of alternative solutions and energy efficiency measures may be considered

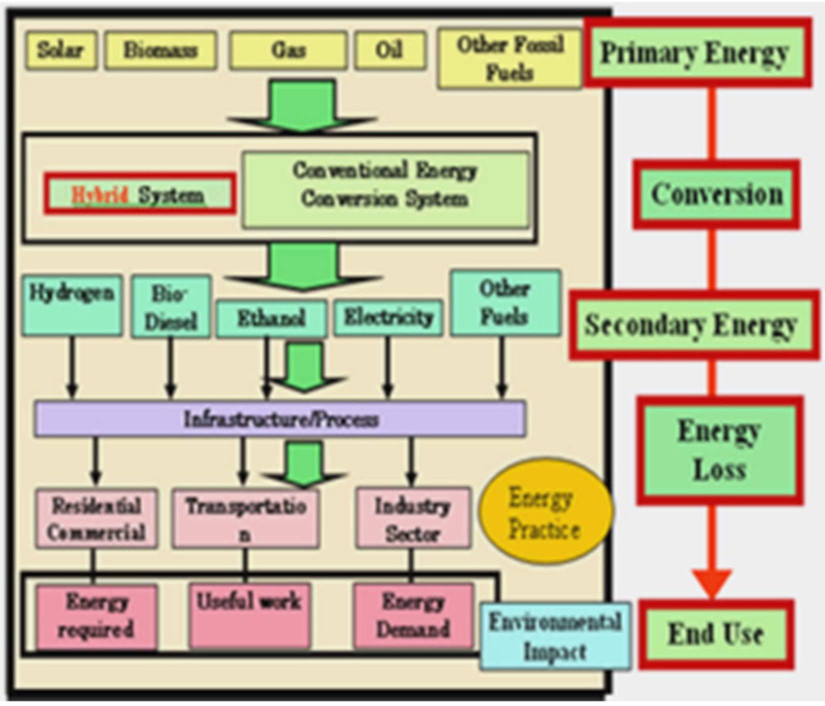

Figure 2. General layout of energy flow

3. Energy efficiency indicators

Analyses of energy efficiency usually include taking several placements of systems indicators and later grouping and evaluating them together. However, their effectiveness is always subject to the stipulation, particularly regarding, data quality and reliability, as well as availability [13]. Placement of indicators shows that there are 4 groups of energy efficiency indicators.

i. Thermodynamic: This group of indicators relies on the measurement of data by thermodynamic science applications while simple ratios and more complicated measures are used to measure the actual energy usage of an ideal process.
ii. Physical-thermodynamic: A much-improved version of thermodynamic units. However, the output is measured as a physical quantity. The purpose of using a physical approach is to measure severing parameters in terms of passenger miles or tones of product.
iii. Economic-thermodynamic: Another hybrid version of energy efficiency indicators where the input is still being measured in terms of thermodynamic units. The output meanwhile is measured according to market prices.
iv. Economic: A measure of this indicator defines changes in energy efficiency by the market values. Both input and output are in terms of the market prices.

Specific energy consumption (SEC) reduction is defined as the improvement of energy efficiency (EE) by industrial players. SEC is one of the EE indicators as it gives a ratio of energy consumption to the beneficial output (physical) of a process. SEC also can serve as an energy intensity indicator, especially for single processes that generate one single product.

The fifth group with addition to Patterson's definition is environmental EE indicators. They are special for measuring energy related specific emission which is direct to environmental issues. However these indicators only allow for the comparison of the efficiency of processes which require the same end use service. It is a very evident that the energy quality problem is a fundamental problem across all energy efficiency indicators when trying to compare process with different quality inputs and outputs [8, 14].

3.1. Management of energy efficiency indicators

Energy efficiency indicators, while functioning to provide information about EE consumption and its end results, also function to compare and provide benchmarks for present and future technologies. Benchmarking is quite a tedious process, where external influences that affect economic, financial and other non-includable parameters have to be excluded from the judgment [15]. The influence of external factors tends to dynamically increase which can easily frustrate assessments [13]. According to [8] the main problems with EE indicators are.

i. Inhomogeneous data,
ii. Geographical differences that make the ratios and indicators vary continuously, and
iii. Interpretations of ratios that diverge accordingly

The evaluation of EE indicators heavily depend on the transparency of the data collected and calculation of indicators. In order to reach this 3 targets are identified as follows [9].

i. Progressive harmonization of data and regularity of updated database for data management.
ii. Defining the status of common technology for EE assessment. This can also be applied on the consequences on Carbon dioxide (CO_2) emissions and the related ratios.
iii. Acquiring necessary mechanisms in order to regularize the findings to the real time experiences. Harmonization of interpretations is a necessity to ensure the reliability of indicators produced from common database.

3.2. Energy efficiency labels and standards

Energy efficiency standards and labels usually come together. Standards are technical settings of energy efficiency, while labels provide guidelines to consumers to select more efficient appliances when they make a purchase [16].

3.2.1. Labels

Energy efficiency labels are educational labels that are affixed to explain the energy performance of manufactured products, and to give the consumer the necessary data for making knowledgeable purchases [16]. According to [17] there are three kinds of labels.

i. Endorsement Labels: Fundamentally given according to products that meet specified criteria.

ii. Comparative labels: Allows a customer to evaluate product performance against similar products using discrete categories of performance or a continuous scale.
iii. Information-only labels: Provides data on a product's presentation.

Energy labels can stand alone or balance energy standards [18, 19]. They provide information that allows consumers to select efficient products. The effectiveness of energy labels is very dependent on how they present information to the consumer. The sample of European label is shown in Figure 3a where it will tells you about the energy efficiency of electrical appliances. Grade A++ is now the most efficient, and Grade G is the least efficient. While Figure 3b shows energy label used in Malaysia where the number of star reflect the most efficient.

(a) (b)

Figure 3. Energy Efficiency label (a) European Energy Level and (b) Malaysia energy level

3.2.2. Standards

There are several definitions of energy efficiency standards. According to Greg at all [20] an energy standard is defined as a minimal requirement for efficiency, or the measured energy consumption for the household appliance. Duffy [21] stated that the energy efficiency standards are government mandated standards that define minimum levels of efficiency or maximum levels of energy consumption and that must be met by all products sold in the particular authority.

However definition given by McMahon and Turiel [22] which points out the energy efficiency standard as the prescribed energy performance of a manufactured product, sometimes keeping out the manufacture of products with less energy efficiency than the minimum standards. There are three types of energy-efficiency standards.

i. Prescriptive standards: Requiring that a particular feature or device be installed (e.g., insulation) or not installed (e.g., pilot lights) in all new products;
ii. Minimum energy-performance standards (MEPS) : Prescribing minimum efficiencies (or maximum energy consumption usually as a function of size or capacity) that

manufacturers must achieve in each and every product, specifying the energy performance but not the technology or design details of the product; and

iii. Class-average standards: Specifying the average efficiency of a manufactured product, allowing each manufacturer to select the level of efficiency for each model so that the overall average is achieved.

3.2.3. Products covered by energy efficiency standards

Products covered under National Commission on Energy Policy (NCEP) as shown in Table 1. In normal condition heating and cooling consumed more energy utilization compare to others and in some case it contributed to nearly 80% of energy bill [23]. The standard which was implemented includes those set by the legislation as well as standard adopted by DOE through rulemaking. The impact cover primary energy savings and water saving, net present value of customer benefits and estimated reduction in CO_2.[24]

Heating and Cooling	Residential Central Air Conditioners and Heat Pumps Room Air Conditioners Commercial Unitary Air Conditioners and Heat Pumps Direct Heating Equipment Residential Furnaces, Boilers Mobile Home Furnaces Swimming Pool Heaters
Cleaning & Water	Clothes Washers Clothes Dryers, Dishwashers Water Heaters Faucets, Showerheads Toilets/Water Closets, Urinals
Lighting	Fluorescent Lamps and Ballasts Incandescent Reflector Lamps High-Intensity Discharge Lamps
Food Preservation and Cooking	Refrigerator Freezers Kitchen Ranges and Ovens
Other Products	Distribution Transformers Small Electric Motors Televisions

Table 1. Products covered by energy efficiency standard

3.2.4. Developing labels and standards programs

The steps to developing energy efficiency labels and standards are shown in Figure 4. These steps are described in the following paragraph.

i. First step is to decide whether and how to implement energy labels and standards. A government's decision whether or not to develop an energy-efficiency labeling or standards-setting program is complex and difficult. Many factors determine whether such a program is beneficial in any particular country.

ii. Second step: Develop a testing capability. Testing by manufacturers and private laboratories need to be accredited and recognized. Government costs are reduced and product-marketing delays are avoided if governments rely mainly on private testing and conduct audits themselves.

iii. Third and fourth steps: Design and implement a labeling program, and analyze set standards: label requirements can be established in a variety of ways, usually involving consumer research as important part of the process. A label can provide a single rating or large number of data, and energy performance measurement of competing products.

iv. Standard setting: a standard can be set to eliminate the less efficient models currently on the market. And to encourage importers and local manufacturers to develop the most economically efficient products, several types of analyses should be conducted to ensure that a standard is achieved.

v. Fifth step: Maintain and enforce compliance: After the label design process is mandated or a standard is set, those responsible for the labeling and standard setting must certify, monitor, and enforce compliance.

vi. Sixth step: Evaluate the labeling or standards setting program: If a government is to maintain an energy efficiency labels and standards program over the long run it will have to monitor the programs performance to gather guidance for adapting the program changing circumstance and to clearly demonstrate to funding agencies and the public so that expected benefits are actually being achieved.

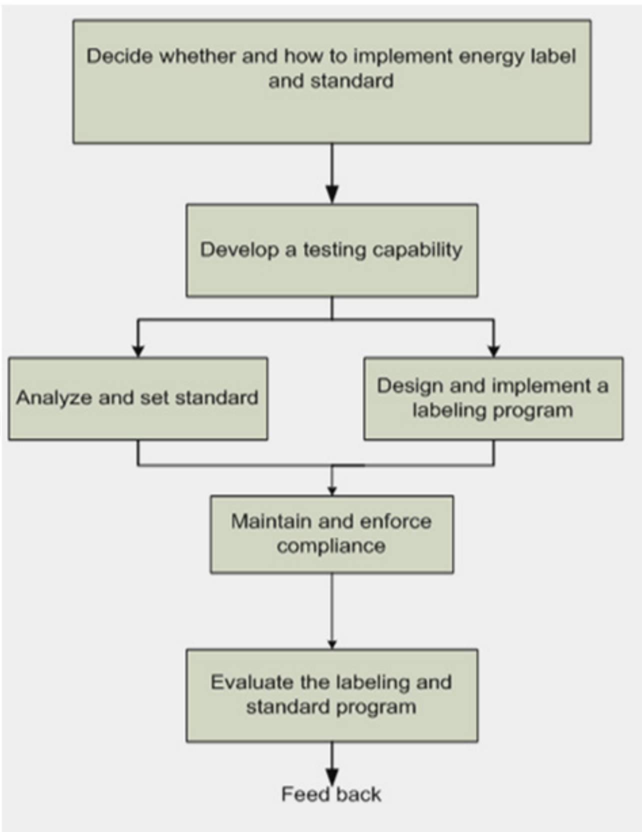

Figure 4. Steps in developing energy efficiency labels and standards

For developing policy-relevant indicators in the residential sector, the following data are required [25]:

i. Energy consumption by major end-uses and by energy sources;
ii. Main activity variables for the sector, including number of households and residential floor area;
iii. Information on the stock and efficiency not only of large appliances, but also of small appliances given their growing importance; and
iv. Information on heating and cooling degree-days to adjust for weather conditions

3.2.5. Labels and standards relationship to another energy program

Energy efficiency labels and standards work best in combination with other energy policies designed to shift the market toward better energy efficiency. It is important that consumers receive a consistent message on energy efficiency. Collective efforts from everyone, including government policy makes an energy efficient economy together with an array of policy instruments that can influence manufacturing, supply, distribution product purchases, and operation maintenance of energy consuming products in our society. When working effectively, these policy instruments accelerate the penetration of energy efficiency technology throughout the market. Energy efficiency labels and standards are considered by many researchers such as Mahlia [17] to become the main of a country's energy efficiency portfolio.

3.2.6. Labels and standards of energy efficiency scope

Energy efficiency label and standards can be applied to any product that consumes energy. The national benefits of labels and standards applied to the most prevalent and energy intensive appliances. The benefits from labels and standards for less common or less energy intensive products are often too small to justify the cost [27].

The first mandatory minimum energy efficiency standards were introduced as early as 1962 in Poland, for a range of industrial appliances. The French government set standards in 1966 and 1978 and other European countries introduced legislation mandating efficiency information labels and standards through the 1960s and 1970s. Mandatory labeling programs have developed in parallel with standards. In 1976 France introduced mandatory labeling followed by Japan, Canada, and USA. A report by [23] show that the ENERGY STAR program of the USA Department of Energy was able to verify product performance and also could identify product that do not meet these standard. In China when the Ministry of Constructions issued a revised energy design standard for new heating JGJ 26-95, an increase of 50% of energy saving was achieved [26]. The labels and standard are being updated continuously worldwide [27-29]

4. Constraints in implementation the energy management practice

The administrative personnel may feel that finding previous energy bills and equipment manuals is extra work. If the future data (bill) on electricity and oil is obtained from normal administrative work (reporting), this would not be the case. The need for energy efficiency, both for economic and environmental reasons, has never been greater. The International Energy Outlook 2000 [30], predicts that energy consumption will increase by 60% over period 1997 to 2020. Energy use worldwide will continue to grow at an average annual rate of 1.1%, and by 2020 the world consumption will rise from (380) quadrillion British thermal units (Btu) in 1997 to (608) quadrillion Btu in 2020, as shown in Figure 5.

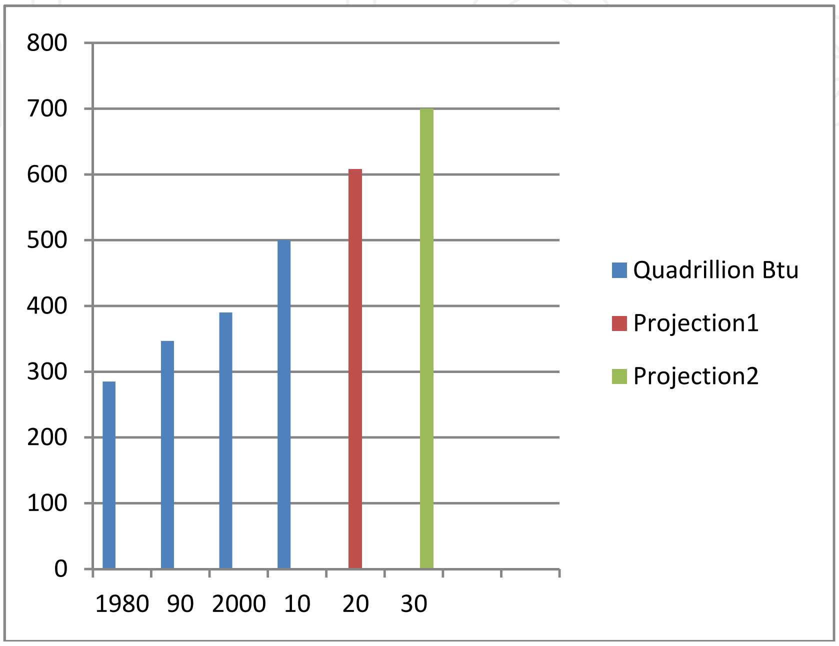

Figure 5. Energy use world wide

The main factor responsible for the increase in energy demand especially in the developing countries is the economic growth. Confronting the growing world energy demand raises two questions. Will there be enough energy available, and in what forms. Reassuringly, there appears to be no prospect of absolute shortage, at least for the next twenty or thirty years and probably beyond. Fossil energy resources are still abundant: for example, the cumulative production of natural gas has used only one sixth of the 325 trillion cubic meters of known reserves. Coal reserves are even larger, providing a basis for continuous production for hundreds of years. Known uranium resources, even on the basis of present knowledge, could meet the current level of demand for a period of 8000 years if advanced nuclear technology is developed [31].

Consideration of energy in relation to the building environment throughout the world's developed countries reveals that 20 – 55% of all delivered energy can be directly associated with buildings and industry. Consequently, new technologies applied to the built environment and industry may be expected to make a significant contribution to a reduction in energy consumption. By raising the efficiency of energy utilization, it is possible to reduce energy consumption by 10 – 30%, representing a savings of around 3Mtce per year. Some progress has been made in recent years as building energy management (sensors, HVAC control equipment) and information technology (IT) systems have evolved to a point where they can support and integrate the activities involved in energy management. With respect to environmental impact and economics, the ability to make well founded decisions regarding energy consumption and supply is of the utmost importance. This requires some means to assess the current performance and agreed targets against which to judge performance [32-34].

5. Energy efficiency targets

Energy efficiency practices could the solution to ensure energy is available to satisfy all demands, to ensure energy is used and supplied with minimal cost/ environmental impact and to ensure energy is not wasted. The challenge of achieving these targets is the driving force for the development of computer-based energy management tools that enable users to understand how energy is consumed within their properties and how they can improve the use of energy resources for effective task processing [34-40]. The Energy Efficiency Initiative, a report published by the IEA, Danish Energy Agency and the Energy Charter 1999, identified four most essential elements of a normal framework for effective energy policies.

i. Focus market interest on energy efficiency Actions include: Fostering voluntary agreements, establishing and enforcing building codes, minimum energy performance standards, integrating energy efficiency in procurement practices and using government purchasing to stimulate the market for advanced technology.
ii. Ensure access to good technology Actions include: Encouraging the development, adaptation and diffusion of energy efficient technology, improving district heating systems and expanding the use of combined heat and power.
iii. Develop and maintain a supportive institutional framework: Actions include: Integrating energy efficiency in sectoral policies and ensuring the availability of impartial expertise.
iv. Act to ensure continuity: Actions include: Establishing policy clarity, demonstrating leadership, implementing effective evaluation, monitoring techniques and strengthening international collaboration

Other outcomes of the implementation of energy efficiency in industries can be given as [41]:

a. Industries become aware of the actual and rational energy utilization performance, as well as Energy Efficiency and Energy Conservation measures that can be applied to improve energy utilization efficiency through the establishment of energy use norms for industrial sub-sectors and processes.
b. Industries comply with regulations / guidelines designed to encourage the use of energy efficient equipment and practices.
c. Awareness about, and attitude towards, energy efficiency and environmental improvement by industries widespread.
d. Industries are using and benefiting the local energy support services (ESCOs) in the implementation of their energy efficiency projects.

e. Industries are implementing proven and cost-effective energy efficiency technology projects.
f. Industries utilize locally manufactured equipment with comparable efficiencies to imported quality industrial equipment.
g. The energy authorities is able to increase its capacity and capability in providing energy advisory services to the public and the private sectors

A proposal by Escriva to impose seven actions of the base improvement in energy efficiency in commercial building had shown a considerable financial saving is being made. These actions include an accurate operational data measurement, a proper schedule, automatically monitored of the consumption of electricity, individual responsibility for energy use in each building, proactive action to increase energy efficiency, facilities modification to enable easier energy management and an excellent communication between user and the building managers. Even many national governments and international organization have developed new regulations, what is lacking today is the universal energy efficiency index for building. In order to address this issue Gonzalez et all [42] had proposed an energy efficiency index for buildings that relates the energy consumption within a building to reference consumption. The proposed energy index can be obtained in a simple manner by combination standard measurement, simulation and public data base; furthermore the index is upgradable whenever new data are available.

6. Benefit of energy efficiency

The benefits resulting from the implementation of energy efficiency in management systems are numerous and can be grouped as direct and indirect. Direct benefits are the current benefits, while indirect benefits are the expected short or long term benefits. Some of the direct and indirect benefits are given in the following section [30, 31].

6.1. Direct or short term benefit

Some of the direct benefit can be states as follow.

a. Reduction of fuel and electricity bills
b. Identification of energy saving opportunities and environmental compatibility concerning the building
c. Energetic retrofitting of the buildings
d. Reduction of operation and maintenance costs
e. Improved public image

6.2. Indirect or long term benefits

6.2.1. Environmental benefits

Greenhouse gases include carbon dioxide which is produced every time we use energy from fossil fuels - oil, coal and natural gas. With businesses producing almost half of the world's carbon emissions their impact is huge [32]. The increase in our planet's temperature has already caused sea levels to rise, making floods more frequent and severe. And as the temperature gets hotter, it's predicted that we shall see more extreme weather. It is found that the businesses are currently responsible for about half of all the world's carbon emissions. Even one small office can produce 3-5 tons of carbon dioxide (CO_2) in a year. Unless they reduce their carbon emissions, businesses will start paying the price of climate change through more expensive energy supplies and higher insurance premiums [32].

6.2.2. Business benefits

Many companies think of energy as a fixed overhead but saving energy is actually one of the easiest ways to reduce costs and improve your standing. The following are some of the benefits from the practices discussed [41].

i. Save money simply by switching machines off after use, or turning the heating down in warm weather or switching off the air conditioning system when not occupying a room, the owner can make real savings on energy bills.
ii. You can offer better value to your customers by cutting your overheads as production costs will go down, making your products and services more competitive.
iii. Enhance your reputation. Increasing numbers of consumers and business customers will now only buy from, or invest in, companies with environmentally friendly policies and production methods. By demonstrating a commitment to saving energy, you will increase your appeal in the market and attract a wider customer base.
iv. Encourage more people to come and works for you. People do not just want to buy from socially responsible businesses; they also want to work for them. So you will also increase your appeal in the recruitment market, and stay an employer of choice.
v. Stay ahead of government regulation. With climate change so high on the political agenda, there are likely to be more initiatives like the government levy and scheme, as well as tighter building regulations from the government. Being prepared for these changes will save time and money when they are introduced [36].

6.2.3. Home benefits

Home energy is responsible for carbon dioxide emissions which contribute to climate change. By following the best practice standards, new buildings and refurbished housing will be more energy efficient and will reduce these emissions. New buildings or home extensions can provide new, energy efficiency accommodations and also improved the overall efficiency of the houses that are extended [35]. For the homeowner, specifying an energy efficient extension is a cost effective approach because the additional cost will be recovered in reduced fuel costs. Payback period is less than 10 years, but fuel cost is entirely reduced for the entire life of the building.

6.2.4. Transport benefits

By running the fleet more energy efficiently the following benefits will be withdrawn.

i. Reducing your maintenance, operation costs and cutting your vehicle emissions.
ii. Improving your social and environmental reputation.
iii. Minimizing traffic and parking problems where you work.

On average, every time you use up to a 400 liter tank of fuel, you produce: "1.04 tons of carbon dioxide, 1.38 kilos of carbon monoxide, 0.67 kilo of hydrocarbon, 6.15 kilo of nitrogen oxide and 0.14 kilo of particulates" (UK Road Transport Emission Projection 1997). Bio fuel use has cut carbon dioxide emissions by 40,000 tons in the first quarter of 2006. Independently evaluated by the Edinburgh Centre for Carbon Management, the reductions were said to be the equivalent of 50,000 family vehicles taken off British roads [36].

6.2.5. Community benefits

Community Action for Energy is one of the energy efficiency programs that are designed to promote and facilitate local community-based energy projects. Community action for energy can help to improve the quality of life in community by providing new opportunities to improve the comfort, health and well-being of people in community, combat fuel poverty and help the local economy. Example of community activities are community heating or cooling, ground source pump, renewable energy, solar PV, wind, and community energy project [37].

6.2.6. School benefits

Energy efficiency for schools promotes energy management and efficiency for the whole school community. It encourages schools to make links between the school curriculum and the management of energy efficiency and learn about how to make a difference to climate change. Schools can save themselves money on their energy bills, reduce their carbon dioxide emissions and improve their working environment.

7. Barriers to energy efficiency

Theoretically it is easy to define and put measures on energy efficiency parameter, although in practice, the same cannot be said, as there are quite a number of challenges to be faced. However for overall success, there is an urgent need to implement the solution of energy efficiency in a large scale in developing and developed countries [38]. Various barriers that may be giving hindrances to implementation of energy efficiency initiatives have been studied. For instance Reddy [39] has investigated a typology for energy efficiency barriers that related to consumers, manufactures, financial institutions and the government. While DeCanio [40] has investigated that there are a few problems regarding energy efficiency barriers in firms. Painuly and Reddly have identified 6 important factors that need to be addressed to effectively deal with those barriers.

i. Technical – availability of reliable knowledge of energy efficiency technology.
ii. Institutional – availability of right technical input and proper execution of programmers.

iii. Financial – convenient mechanism of finance.
iv. Managerial – training and management.
v. Pricing – proper rationalization of pricing on electricity and fuels.
vi. Information – appropriate level of information.

In Malaysia for example there are several barriers which could hamper the smooth implementation of Industrial energy efficiency improvement project [41]. These are as follows:

a. Limited knowledge/awareness about Energy Efficiency and Energy Conservation techniques/technologies in industries and the lifecycle economic benefits.
b. Limited access to information on energy efficiency techniques as well as energy benchmark.
c. Industries are unwilling to incur what are perceived as "high cost, high risk" transactions.
d. Industries generally focus on investments on production-related improvements.
e. Lack of financiers ready to finance energy efficiency investments.
f. Limited/not stringent regulations on energy efficient standards and implementation.
g. Few or limited energy efficiency technology demonstration projects implemented.
h. Weak local energy support service

An energy gap is a term that points to a phenomenon where a firm is not utilizing the feasibility of technically and economically viable efficiency measures. Weber [43] pointed them to its institutional, market, organizational and behavioral barriers. While Sorrel, et.al [44] grouped the barriers of energy efficiency as neo-classical (economical), behavioral and organizational

The need for border framework to tackle barriers to energy efficiency for significant improvement has been intensified. But literature reviews reveal that there are qualitative issues on the barriers. And a creation of suitable topologies is a must to tackle them. There is currently not enough attention when considering relevant influential factors to the qualifications of the barriers levels, especially industry specific barriers related studies that are very scarcely found [44]. Various definitions of energy efficiency barriers that have been introduced by previous researchers include environmental, economical, and technology related aspects. This prevents a whole implementation of an energy efficient based practice blueprint. Governments as well as private sectors need to churn out more effort with the intention to practice energy efficient so that the longevity of a healthy world can be achieved for future generations [45]. A recent work by Escriva [46] could be an excellent approach to overcome part of the problem. This research work proposes the continuous assessment of energy efficiency in building using different energy rating factor for assessing energy performance and identifying wasted energy.

8. Software tools

For the last four decades there have been many energy software had been developed and most of the energy tools can be run using a simple text-based input. The simple algorithms that were used can calculate energy performance for the specific requirement. Such tools that have been developed are capable of predicting the daily, monthly and also annual energy performance of the proposed or existing building. The software had been tested and shows tolerable results compare to normal practical measurement. Most of the developed commercial software provides the users information of building performance such as energy demand, temperature, operating costs and humidity [47]. Additional information regarding energy analytics, policy management, billing system, meter data management, Green House Gas tracking, continuous benchmarking and commissioning also available. Some of the software currently available are Energy-10, EnergyPlus, Energy Manager AutoStartTM , IES VE, Ecotect, HAP, Trace, eQUEST, PowerDomus, eSight Energy and iEnergyIQ. The list of the software developed but not being commercialized was uncountable and normally they were being used for authorized personnel.

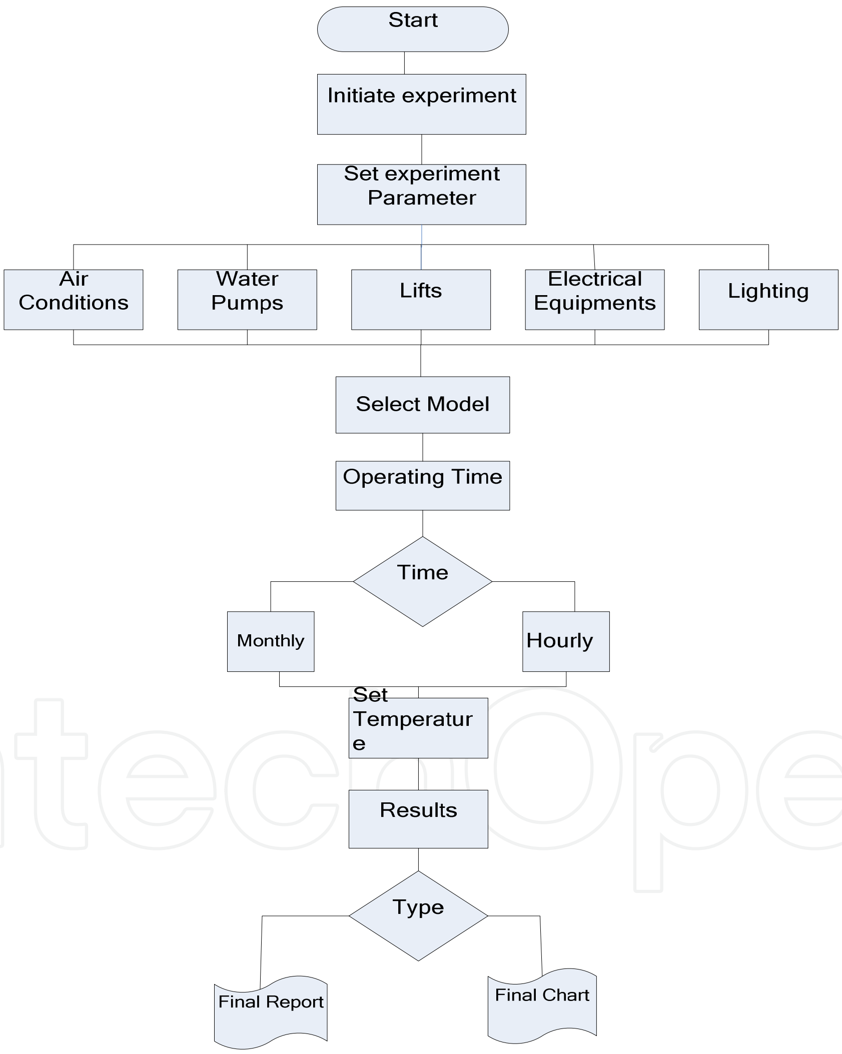

Figure 6. Layout for Smart Energy Evaluation System

One of the software developed at the School of Electrical Engineering, University Science Malaysia was the Smart Energy Evaluation System [48]. Based on Microsoft Visual Basic, a smart interface media is developed to give users ample opportunity to browse and observed energy consumption, bills, temperature, humidity control and its operation hours. The built in intelligent enables the user to obtain analysis regarding energy related issue. The simple layout of the system is shown in Figure 6 and the manager window is shown in Figure 7. Figure 8 shows the results of energy consumption in a particular seminar hall.

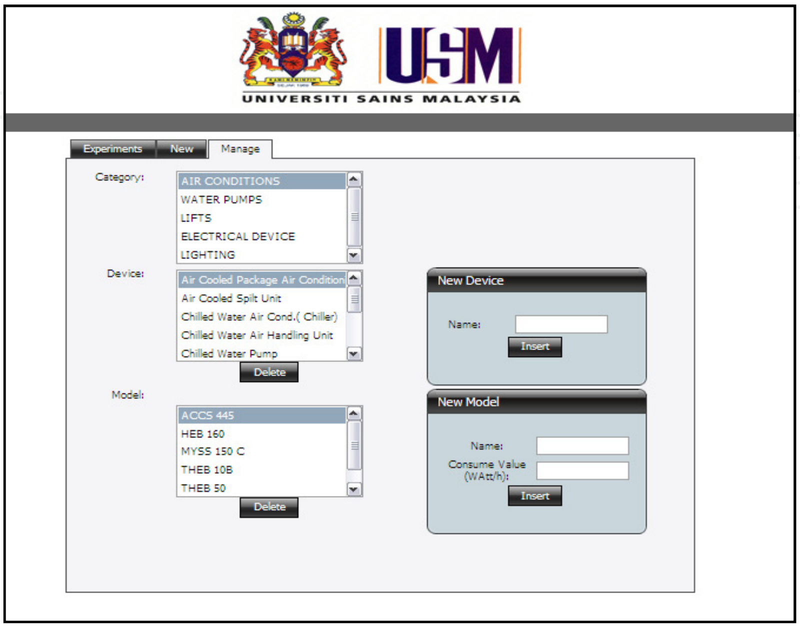

Figure 7. The manager window for Smart Energy Evaluation System

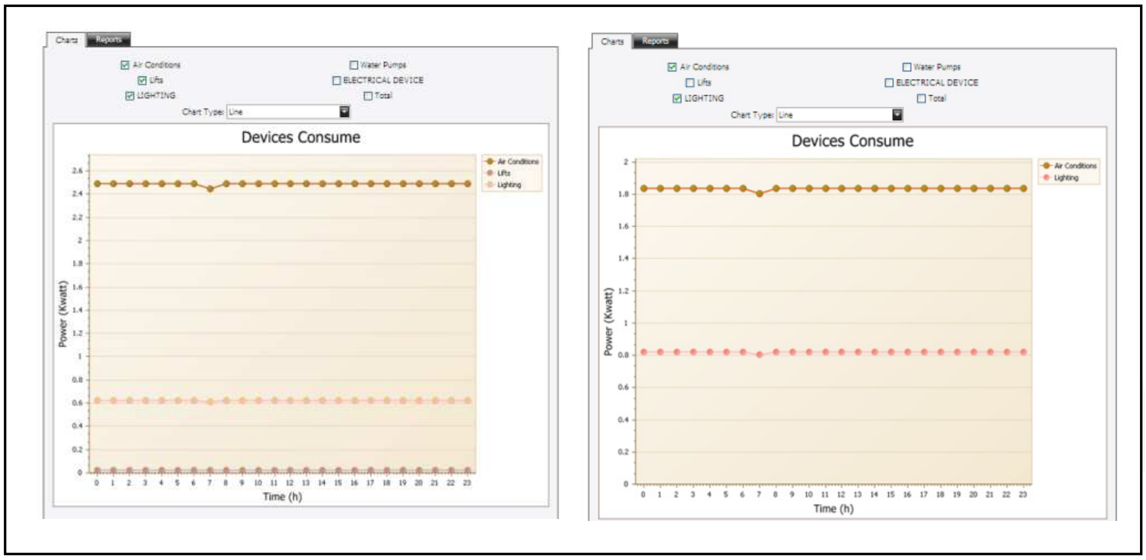

Figure 8. Energy consumption in a seminar room using Energy Evaluation System.

It is quite difficult to select the appropriate software for general purpose because each of them is set to a specific function. Energy software development normally depends on the user's requirements and demands, where the designer had to identify their energy analysis algorithm, model and results presentation. A few of these software solutions are consider expensive, costing more than US $10,000/year for example, but the majority of the commercial product are offered either for a reasonable price or free. The requirement for the designers is to design the software using accurate measurement tools and a proper automated reporting system within an acceptable price. This should include the report of data either hourly or monthly basis so that the verification of the software could be check and in line with historical data. The other important feature that had to be considered in future is the data sharing within the software. Based on the experience it is worth to use the appropriate energy efficient tools as part of energy management for our future sustainability plan. Not only it preserves our environment by reducing the GHG emission but also save unnecessary funding for energy.

9. Case study in Malaysia

The Malaysia Industrial Energy Efficiency Improvement Project (MIEEIP) was developed to remove barriers to efficient industrial energy use. The project is also designed to facilitate the reduction in greenhouse gas emission by the industrial sector [41]. The following programmers were implemented:

a. Energy used bench marking

The overall objective of this component is to establish and develop energy use benchmark for the eight industrial sectors that can be used by the industries as a guide in their energy efficient and energy conservation efforts.

b. Energy Audit

The overall objective of this component is to improve the energy efficiency levels in industries by promoting the practices of energy auditing.

c. Energy Rating

The overall objective of this component is to introduce activities that will inform industries about energy efficient equipment energy rating programmers including cost technical specification, economic and energy performance.

d. Energy Efficiency Promotion

The main objective of this component is to disseminate information on energy efficient practices and technology application to the industries

e. Energy Services Companies (ESCO) Support

The overall objectives of this component are to provide engineering services or consultancies, providing financial solution as well as risk mitigation for energy efficiency activities to industries/client.

Case study 1: Tritex Containers Sdn Bhd (Malaysia)

For more than 20 years the management thought that it was okay to have big boiler for its production process. Little did they realize that oversized boiler was causing inefficient use of energy which eventually meant the company was losing money? Initial finding by the audit team showed that the company had the potential for energy saving as high as

USD50,000 a year. The MIEEIP team discovered that most of the energy losses occurred because of uninsulated pipes in the boiler and leakage in the compressed air system and main distribution loops [41].

Energy Efficiency Activities:

The measures that were recommended involving no-cost and low cost investment included:

a. Fine tuning boiler operations
b. Repairing leaks in distribution pipes and consumption points
c. Recycling leakages in compressed air system
d. Shutting-off compressor and dryer during non-production hours
e. Using smaller compressor during low production period
f. Switching off all nonessential equipment

With an initial investment of only USD15,000 the company put in place a more efficient system that resulted in an annual energy saving of USD30,000. Table 3 shows the estimated annual savings from the measures implemented practices.

No	Energy saving measure	Invesment (USD)	Annual Saving (USD)
1	Fixing air compressor leaks	0	2000
2	Compressor and dyer Shut Off	0	1500
3	Boiler readjustment	0	1200
4	Reduce Boiler Breakdown	0	500
5	Repair Steam Leak	6500	14000
6	Replace Pneumatic Pumps	500	800
7	Insulate Boiler and Condensate	3700	3800
8	Relocat WTP Closer to Boiler	4000	1700
9	Pump Condensate from WTP	6000	4200
	TOTAL	14800	30000

Table 2. Estimated annual saving

Case Study 2: Pan Century Edible Oil (PCEO) Sdn Bhd (Malaysia)

It's total manufacturing capacity of oil refinery product and special product is about one million tones. The factory recorded an annual turnover of USD250 million in 2002. More than 550 tones of steam are generated daily for physical refining, making soap noodles, tank farm heating and fractionation.

During the audit, the team identified significant steam leakages and analyzed the respective losses. With an investment on USD343,000 on the steam optimization programmed, resulted in an annual energy saving of USD229,300. Modification to the factory's cooling towers, replacement of standard high efficient motor, steam conversation scheme, heat recovery scheme and monitoring, which produce another total energy saving of USD100,000. Table 4 shows the estimate annual saving from the implemented measure practices.

	Energy Cost Measure	Investment	Saving GJ/yr	Investment (USD)	Saving (USD
1	Use of low pressure steam	Low cost	2665	21000	27000
2	Pressure reduction valve for distillation	Low cost	6504	9300	40800
3	Insulation improvement	Low cost	10789	16000	68000
4	Steam trap maintenance	Low cost	4395	25000	26000
5	Condensate recovery	Low cost	2943	39000	24000
6	Temperature Control	Low cost	1896	8000	11500
7	Steam ejector replacement	Low cost	5188	15000	32000
	TOTAL		34380	133300	229300

Table 3. Estimate annual energy saving

Case Study 3: JG Container Sdn Bhd

This company had commenced operation in Malaysia since1970 and total energy costs representing 20% of it turnover. By applying energy efficiency practices 57,300 GJ annual energy saves from the new furnace and 2,800 GJ/annum from improvements in two annealing lehr, saving in fuel cost of more than 33% from heat recovery system for the glass furnace. It is found that by total investment of USD2.5 million made a saving of USD0.6 million per year. Table 6 shows the energy efficient measure and the saving affected.

	Energy saving measure	Investment (USD)	Fuel Saving (%)	Payback (year)
1	Rebuilding furnace	2.3 million	33	4
2	Modification of one annealing lehr	17000	42	1
3	Natural gas-powered lehr	133000	67	6.5
4	Water recycle	6000	25	1
	Total	2.5 miilion		

Table 4. Investment and saving for JG Container Sdn Bhd (Malaysia)

Case Study 4: HeveaBoard Bhd (Malaysia)

Saves USD180,000 on annual energy costs, saves 37,000 GJ in fossil fuels and decreases CO2 emissions by nearly 3,000 tonnes each year. Following an energy audit, HeveaBoard, a particleboard manufacturer, replaced its fuel oil fired thermal heater with a wood dust fired thermal oil heater. This allowed the company to capitalize on a cheap source of energy, namely the excessive wood waste left over from production. HeveaBoard also engaged the services of an Energy Service Company (ESCO) to install the system which guarantees results and payment based on energy savings achieved.

Case Study 5: Globalmas Sdn. Bhd. (Malaysia)

A manufacturer of canned food based in Sarawak recorded an annual turnover of USD1.4 million in 2002 and found ways to slash its operating costs. The company identified the best use of energy consumption during various plant processes by reanalyzing electric, gas, and fuel or steam resources. Globalmas discovered that with a total capital expenditure of USD42,000, the factory could reduce its energy costs by nearly half and recover the investment within a period of 18 months.

10. Conclusions

Energy efficiency has become one of the main tasks in energy management. Technical systems and solutions that can save energy and keep the costs down gain an importance decision. At present in buildings, equipment like air-condition, pumps and lighting had consumed high amounts of energy. A small adjustment through energy practices and energy audit can lead to a significant reduced of energy used. It is found that the available commercial tool for analyzing energy consumption and implements energy conserving measures could be a solution to minimize energy utilization. Practices of energy audit and energy efficiency activities in industries had shown a potential saving. An improvement of energy efficiency in building will be among the top priorities in the energy management worldwide together with the implementation of ISO and related standard.

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