HALMSTAD UNIVERSITY

Master's Programme in Renewable Energy Systems, 60 credits

MASTER THESIS

PERSPECTIVES OF ENERGY EFFICIENCY IN INDUSTRIES

ENERGY SAVING AND MARKET TRANSFORMATION

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ABSTRACT

Now a days, there is lot of alternatives available, which provides green and renewable energy. Through these alternatives, the consumer's demand for energy is being satisfied. It is important to use the available energy in a systematic and efficient way so that there are many benefits. The purpose of this study is to briefly identify the various prospects, problems, and policies for energy efficiency in industries. Basis of purpose on the negative impacts caused due to the increased use of energy consumption in industries. This literature study is based from practical examples of industries, industrial applications and other new technology. As the electric motor system operates most of the industrial processes, the electricity consumption of motors in industries accounts for two thirds of total energy consumption. Influencing energy efficiency in industries provides substantial advantages. Various motor applications such as pumps, fans, air compressors, cooling compressors, variable speed drives is studied for their operation and working conditions. The utilization of energy efficient technologies to a greater extent can perceive savings to the industries. In spite of being aware of potentials of using energy efficient technologies in industries, energy efficient technologies are not widely used. A barrier to energy efficiency is explained as a practice that inhibits the industrial decision of being efficient in terms of energy and finance. The barriers consent with energy efficiency in industries is fair enough to be considered, while compromising energy for temporary prosperity is not upright.

Influence of increased energy efficiency in market areas need coordination of all industries and commercial area throughout the country. The coordination between the industries and commercial sectors can be closely achieved by raising energy policies and energy regulations. The energy efficient policies are considered as cognizance for market transformation and this can maintain the industry, the environment, and the energy. The options available for market transformation are enormous. It is suggested to implement the energy efficient policies as energy efficiency is important for sustainable future. By adopting the right policy, at right situation can provide enormous benefits to the process, industry, and nation. A basis of energy efficiency in industrial application can provide potential energy savings for the present and future industrial situation. This can provide a balance between INDUSTRY-ENVIRONMENT-ENERGY.

PREFACE

This thesis on 15 credits was conducted during spring 2015 as the last part of the master's program (one year) in Renewable Energy Systems at Halmstad University.

I would like to thank Pernilla Widstam, Energy, and Climate Advisor of Halmstad for her assistance to help me understand the present situation of energy efficiency in industries. I would also like to thank my supervisor Goran Siden, Lecturer, Halmstad University for his assistance in technical questions and constant encouragement throughout this study.

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1. INTRODUCTION

1.1 BACKGROUND

Nowadays, there is lot of alternatives available, which provides green and renewable energy. Through these alternatives the consumer's demand for energy is being satisfied. It is important to use the available energy in a systematic and efficient way so that there are many benefits. The awareness of greenhouse gases, climatic change, and other harmful effects of the environment has led to an increased investment in energy efficient technologies. Energy efficiency is efficient and effective strategy for minimizing the harmful effects causeD to the environment. It also controls the consumer demand for energy and maintains the resource. Efficient use of energy in the present industrial society can improve the industrial standards by lowering the costs and also reduces the environmental impacts caused by the excess consumption of energy. In a small sized industry, the energy efficiency can be improved in all systems. In general these industries use motor drives quite effectively. These motor drives report to use more electricity when compared with other machines in the same industry

When a conventional industrial motor is compared with high efficient motors, it is inferred that 90 percent of the conventional industrial motors cannot adjust their operation to save the power rather uses unsuggested method to save the power (ABB drives and motors for improving energy efficiency, 2012). National Electrical Manufacturers Association (NEMA) has classified three phase induction motors. Each classification has different speed torque characteristics and therefore used in various applications based on its characteristics. The classifications are: DESIGN A (poly phase, squirrel cage induction motor with high torque, high starting current, low slip), DESIGN B (basic motor with normal torque, normal starting current, normal slip), DESIGN C (squirrel cage induction motor with high torque, normal starting current, normal slip), DESIGN D (high locked rotor torque, high slip), WOUND ROTOR (this design performance depends on external resistance) (Emadi, August 2004). The operation of motors can be enhanced by controlling the speed of the motors. There are many technologies developed to control the speed of the motor. The principle of speed control is, on varying the frequency of the power supplied; the speed of the induction motor can be varied (as speed is proportional to frequency). This concept is effectively implemented in adjustable speed drives (ASD) technology, as ASD uses solid-state electronic devices. The solid-state electronic devices used in ASD control the voltage (v) and frequency (f) to maintain a constant v/f ratio. When the speed and torque is reduced, the power utilized by the motor is reduced and therefore the motor uses less energy. (Almeida & Greenberg, 2007) .

In motor drive technology, it is important to consider the cost efficiency analysis of motor drives for a particular period. This cost efficiency analysis includes the cost of purchase, cost of installation, energy,

and maintenance. (ABB drives and motors for improving energy efficiency, 2012). When a high efficient motor is installed in a small sized industry, it is inferred that the operating cost and the energy cost are minimized (energy efficient drives, 2009).

The electricity consumption in industries is approximately 40 percent and most of the consumption is from electric motors (ABB energy efficiency makes a difference, 2008). The electricity consumption by electric motors varies in industrial society and in service society. ”European Energy to 2020” has estimated the annual average growth rate of the electricity consumption on the industrial society is 1.2 percent. In industrial society of the European Union, approximately 69 percent of electricity is consumed by electric motor and on the other hand approximately 38 percent of electricity is consumed by service society of the European Union. (Almeida, et al., 2002). When a high efficient motor is installed in a small sized industry, it enhances the operation, reduces the maintenance, and improves the life of the motor. When high efficiency motor drives are used in the European Union approximately 43 Twh of energy can be saved. This means that this is equal to generated power from 19 power plants. High efficient motor drives are engineered to adapt the flow rate and there by save power at higher percentage (energy efficient drives, 2009). Variable speed drives and energy efficient devices are considered to have potentials in saving electricity. On concerning the technical saving potentials, the application of variable speed drives on large scale can save 96 TWh of electricity and applications of energy efficient drives on large scale can save 36 TWh of electricity (Almeida, et al., 2002). Thus, the ideal idea to save electricity in small sized industries lies in using energy efficient motor system.

1.2 PURPOSE

There is various purpose in this project. The objectives of this study were chosen due to the increasing negative impacts of energy consumption in industries. These results will provide a basis of the energy efficiency in industrial applications at the current period and its prediction for the future. What can be the potential improvements in industrial applications from different aspects for today and tomorrow?

The purpose is to briefly identify the various prospects, problems, and policies for energy efficiency in industrial application. In this study, various motor applications of industry such as pump, fans, air compressor, cooling compressor, variable speed drives are studied for their operation and working condition in each applications.

The questions that this thesis seeks an answer is

- What are the main barriers for energy savings in industries?
- What are the prospects for energy saving in industries?
- What can the alternatives for improving energy efficiency problems be?
- What are the policies that can be implemented for market transformation?

1.3 PROBLEM

A main problem with literature studies is related to practical examples from industries and industrial applications. New and updated data from industries were not available as it may be time consuming and that might limit the study to other parts of the project. Errors in any form such as lost values or loss of great amounts data requires more time to evaluate the data which might limit available time on other parts of the project.

1.4 LIMITATION

This study is limited to know the prospects, policies, and barriers of energy efficiencies in industries. This study is about the industries in general and does not evaluate any particular industry. The discussion regarding energy management programs and policies will not be part of this work, since that is oriented more towards the organization and creation of energy programs rather than perspectives of energy efficiency.

1.5 INTERVIEW

As part of my master thesis work, I wanted to understand the present situation of energy efficiency of industries in Halmstad. I decided to take help by interviewing a well-experienced energy adviser. **Pernilla Widstam, Energy, and Climate Advisor** of Halmstad have answered to the questions.

1. **What kind of customers do you get?**

Usually they are people living in small apartments, houses, and big houses, industries etc. The European Union takes lot of efforts to reach industries for energy efficiency. I give lot of advice to industries, example industries having 20 KW boiler, advice to building and big houses.

I give advice on energy efficiency in general to industries and not to individual equipment.

2. **Do your customers seek permission from you, before starting any new energy operation?**

No, I only give them advice. However, I think it is necessary for the customers to seek permission from environmental officers, as the new operation and its related losses should not interfere with the environment.

3. **How many industries are small companies? How much do these small companies buy?**

There are various industries. I counsel approximately 20 companies a year. The industries are both small and big, they usually range from 50,000 KWh to 25,000 MWh. In addition, every industry is unique by itself.

4. **How good the industries in Sweden energy efficient?**

Not energy efficient!

I think this is because of cheap energy. However, there are companies working to be energy efficient.

5. **What kind of advice do industries seek from energy advisers like you?**

As per the directive of the European Union, we give advice on the requirements of general indoor climate conditions, ventilation, local conditions, building age, lighting, and compressed air. I receive a list of companies from a chimneysweep. I give priority to these industries as they use oil for heating purpose. I generally advise these kinds of companies to use other alternatives such as district heating, wood pellets, or heat pump.

During my visits to companies, I checked on equipment leaks or repairs, unnecessary operation of the equipment's. I advise industries to have regular maintenance so that they can make their industries energy efficient while there are industries that need no energy advice.

6. **Is there any policy available for energy efficiency in industries, are the industries aware of it?**

No policy!

There is a program called PFE. This program was initiated for large industries. It is a survey-based program. Several years ago there were fewer taxes. Later, 0.5 ore/kwh was imposed as tax.

When the industries were into the program called PFE, they were exempted from paying this tax. Money saved on energy saving was more.

7. **From your point of you, how can energy efficiency opportunities are expanded?**

Imposing high taxes is one way, but higher taxes are not good for industries. Scheduled and regular surveys on utilized energy can be a way, but it needs lot of cooperation. Opportunities can differ from industry to industry. We need to think on how much to save.

The European Union has proposed to forbid pumps, and motors which are not energy efficient. Also suggests buying energy efficient technology with high rating.

8. **What can be the reasons for barriers of energy efficiency?**

Industries expect short payoff. In addition, they are very interested in producing quality and quantity of products. If new energy efficient technologies are invested in an industry then production sometimes fails.

2. INDUSTRIAL ENERGY EFFICIENCY

Energy efficiency is defined as an economical way of preventing excessive energy consumption. Consider an industry, consuming power to earn benefits. This Industry is said to be energy efficient when same unit of supplied power provide more benefits or same benefits are obtained by utilizing less unit of supplied power. In general, Industries aim at high profits. The prerequisite idea for high profits is 'lower production cost, less environmental impact, efficient energy use'. Most of the time, energy efficiency is mistook as reduced total energy consumption. Energy efficiency can be obtained in any industry by reducing the energy intensity. Reduced energy intensity is not always energy efficient. Consider a situation, when other resources are too much used to achieve reduced energy intensity. It is not energy efficiency while it is loss of resources. Energy intensity varies among industries to industries. This variation may be due to the factors as explained below (www.rand.org, n.d.)

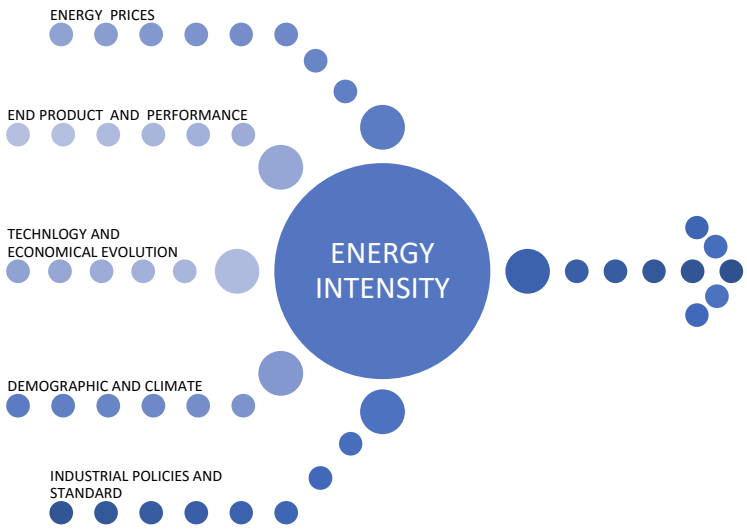

Figure 1 FACTORS AFFECTING VARIATION IN ENERGY INTENSITY AMONG INDUSTRIES

2.1 HISTORY OF ENERGY EFFICIENCY

After the industrial revolution, use of energy has been steadily increased. During which economic conditions of industries has got into shape. Industries having largest economics are also the industries with largest energy consumption. Fig 2. Compares the consumers of electricity. The industrial society is a large consumer of energy and electricity. The industrial sector comprises of manufacturing plants, mines, and

construction firms. Other sectors includes agriculture, commercial and residential sector etc. It is observed from the graph that world electric energy consumption has increased by three times in thirty years.

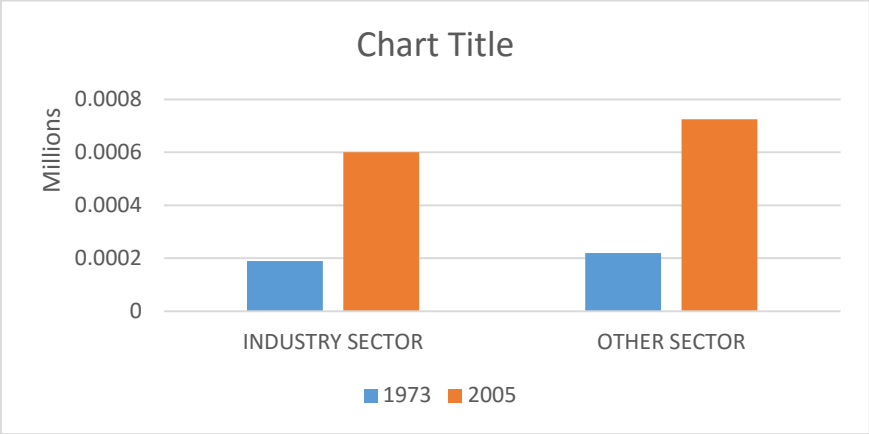

Figure 2 world electricity energy consumption in m ton

Sources: (ABB energy efficiency makes a difference, 2008)

After the 1979 energy crises faced by the major industrial countries of the world. The crises were the reason for efficient and effective use of energy. The fundamental strategy for energy efficiency was emphasized and it was said that, on implementing the strategy the overall energy use would be reduced by 1 percent a year. (Rosenfeld, Arthur H.; Kaarsberg, Tina M.; Romm, Joseph J;, 2001). It was observed that industry showed positive growth towards energy efficiency. The data proved that energy efficiency was increased approximately by 6 percent from 1993 and 2010 and expects 50 percent growth by 2050.

2.2 PROFITS OF ENERGY EFFICIENCY

In industries, the profit of energy efficiency depends on various factors. Figure 3 explains the various factors. The profit in an industry depends on the decisions made by the country council and agency. When their decisions are appropriate, the society in combination with suppliers, energy companies, industries, and industrial customers will be energy efficient. The laws and regulations framed by the international and national firms helps the country to achieve climatic targets, that is the emissions of greenhouse gases will be reduced by large percent encouraging in green, clean and neat atmosphere. On making use of new developed and innovative technologies, energy recovery will be possible. Say for example, pumps, fans, compressors are still working with valves and throttles. On updating the industrial applications with variable speed drives can provide more profits to the industries. Sometimes, longer operation of equipment, over sizing of equipment, age and lifespan of equipment and other operation of industries may not be energy

saving. Such operation has to be avoided to have profits in the system. (IVA Project Energy Efficient Society, 2014)

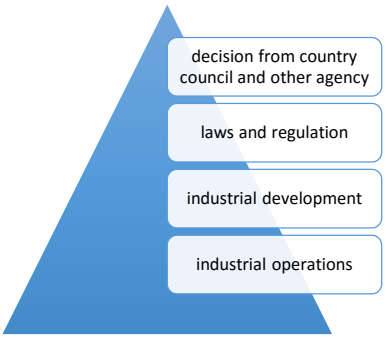

Figure 3 profits of energy efficiency- depending factors

2.3 INDUSTRY- ENVIRONMENT-ENERGY

Now a days, the primary goal of every industry is be environment friendly. On being environmental friendly, we can maintain the sustainable environment for future generations. Therefore it is essential for every industry to satisfy the primary goal first, in order to achieve their long-term objectives. Concern for INDUSTRY-ENVIRONMENT-ENERGY is growing day by day. As the problem associated with environment is increasing due to emissions (combustion of energy) from industry. It is mandatory to reduce the impacts caused by the mentioned relationship.

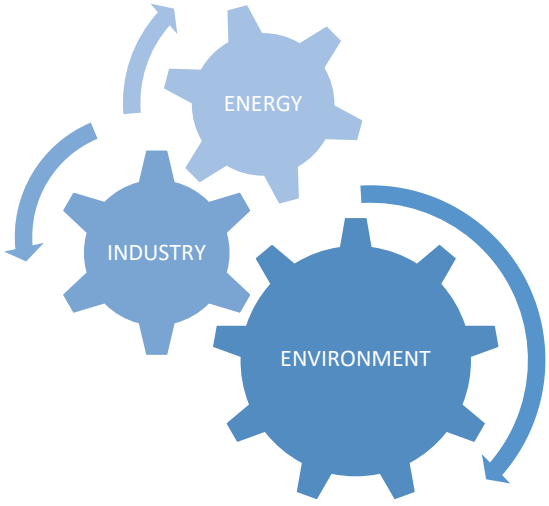

Figure 4 INDUSTRY-ENVIRONMENT-ENERGY

Industrial energy reports for notable release for air pollutants such carbon dioxide, Sulphur dioxide, nitrogen oxides. Chemical industries, metallurgical process industries, mineral transformation industries

are reported to release pollutants in large quantity. The global greenhouse gas (GHG) emissions are shown in figure 5 (Anon., February 2016)

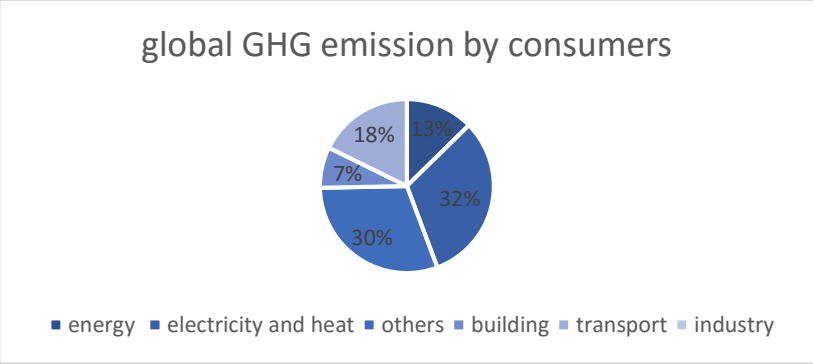

Figure 5 global greenhouse gas emissions

SOURCES: IPCC 2014 (Anon., February 2016)

To answer the above situation, industries must incorporate energy management programs and policies for energy efficiency. Policies to be implemented by industries are explained in the figure 6. On incorporating energy management policies, industry can achieve quality goals for itself and for the environment. This can provide balance between INDUSTRY-ENVIRONMENT-ENERGY.

POLICIES			
ENERGY EFFICIENT DRIVES- upgrade the industrial application to energy efficient drives. when motors are replaced with variable speed drives with inverters , they are controlled accurately and save energy upto 60 percent.	**SUBSTITUTING FUEL-** on substituting fuel , industries can result in less carbondioxide emission by providing some amoutn of energy during combustion. on substituting natural gas for coal can be an ideal example.	**RECYCLING-** utilizing renewable biproducts for manufacturing industrial products say for axample, recycling metal scrap against smelting new metal for manufacturing industrial products .	**ORGANIZING AWARNESS PROGRAM-** organizing awarness programs to the employeers, workers and trainees of particular indstries on how to prevent losses from equipment ,efficient working methods.

Figure 6 Energy Management Policies

3. ENERGY EFFICIENCY IN MOTOR DRIVES

In modern industrial sector, electric motors operate most of the industrial processes. Motor system is used in small power applications like refrigerators to large power applications like pumps, fans. Classification of Motor's electricity consumption in present industrial sector is shown in Figure 6. The electricity consumption of motors in industries accounts to two-third of total energy consumption. Although Industries have different patterns of production, they vary from industry to industry, and country to country, the figures may have slight differences still they are comparable.

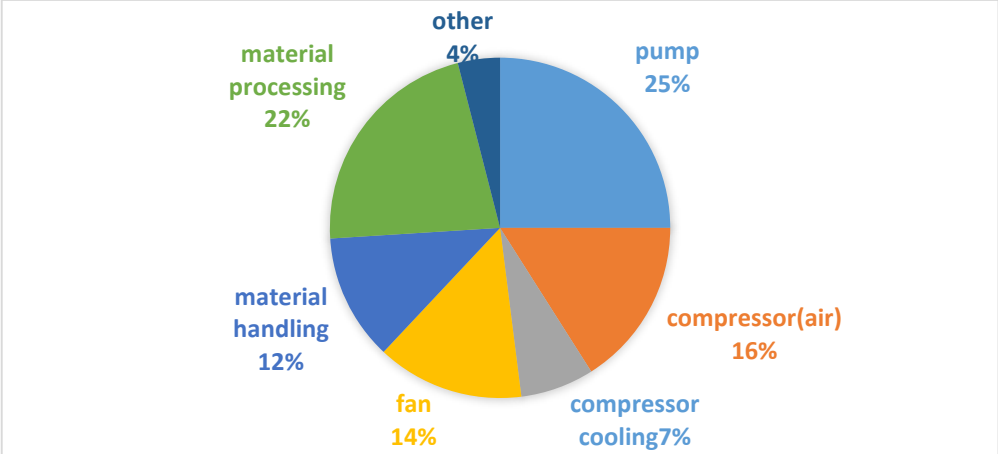

Figure 7 electricity consumption by motors

Sources: International Energy Agency 2007

From the above data, it is understood that fans, pumps, compressor (air) are important type of electric loads accounting to be fifty five percent of total energy consumption. Motors used in material handling and material processing accounts for remaining percent of energy consumption. They are contrary to this study having different loads and consuming large energy.

Industries are concerned with manufacturing and production in sizeable quantity. Because of which low cost, high reliability and better efficiency motors are preferred. Induction motors satisfy the terms of industry and these motors are widely used when compared to other types of ac motors. On studying the important motor system – pumps, fans, compressors, ventilators concerning energy efficiency. They will benefit the industries from energy saving. Energy usage of these motors will be different in various industries and it is inferred from the following data (figure 8). Iron and steel industries uses Fans widely while chemical industry uses air compressors. Therefore the idea of energy saving will vary from industry to industry

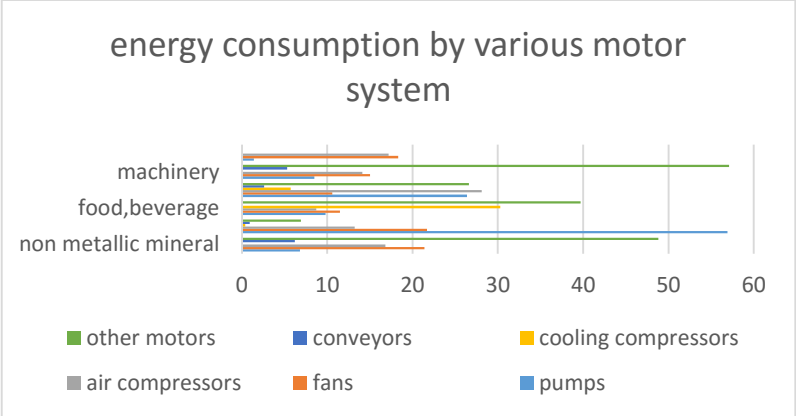

Figure 8 energy consumption by various motor system

Sources: (Almeida, et al., 2002)

3.1 PUMP

On comparing the energy consumption by various motor system in industries in Figure 8. Pump system are extensively used in paper industries, pulp industries, print industries and chemical industries. Electric motor pumps are single motor systems which consumes most electricity in industry. In European Union, pumps consume 160 TWh (NATIONAL RENEWABLE ENERGY LABORATORY, april 2003) per annum of electricity. This accounts for large emission of carbon dioxide. (ETSU AEAT PLC,(UNITED KINGDOM), FEBRUARY 2001). Notable chances are available to improve energy conservation by improved operating principles, and better design.

In general, pump system constitutes of basic components like pump, prime mover, piping valve and end use equipment. Pumps are used in industries to extend the services in processing system, lubrication system, heating ventilating, air-conditioning system (HVAC) etc. As the application for pump system in industries is wide, pumps are available in various sizes from one KW to several hundred KW and also they are available in various types where each motor type satisfies similar application. Energy saving means reliable operation of pump. Reliable operation of pump just not saves energy, but provides improved performance, and reduced life cycle cost. Reliability of pumps is not same in all the system. The factors on which reliability depends on various systems are

1. HVAC SYSTEM- over heating in HVAC system results in catastrophic failures of pump as a result reliability is affected.
2. LUBRICATION SYSTEM- Reliability depends on performance of pump. Performance of the pump depends on process control i.e. Flow control and pressure control.
3. PROCESSING AND OTHER SYSTEMS –reliability depends on operation of pump. Pump spare time affects the production of the industry consequently affecting the reliability.

Pumping system uses various flow control and pressure control methods for energy efficiency. Various methods used in this regard are throttling valves, bypass lines, speed control. The effective control strategy is speed control. This is because, when a pump speed is reduced, less energy is conveyed to the fluid making the system energy efficient. Variable speed drives are often used for this control. When operating the pump system, conditions like over sizing and flow rate variations has to be given attention. This off design operation of pump may change the system control and if input power is not adjusted to the change in system control, high loss in energy is possible. Industries should identify the various signs of sluggish operations of pumps for energy efficiency. Commonly observed sluggish operations are

1. Pumps demands high requirements for maintenance. If not, Sudden down time causes catastrophic failure.
2. Pumps working on throttled position will affect the flow rate of the system in two ways.
    - Flow rate will increase or decrease
    - System overall back pressure changes
3. Noisy pumps are considered as faulty systems. The operating characteristics will change the system acoustic level and additive operation of pump will cause serious system wear.

Responding to sluggish operation of pump system will save the components from worn outs and common problems like leaking, valve failure, cracks. The life of pump and efficiency deterioration is shown in Figure 9. The figure explains that pump erodes in the early stages of pump. After a decade of service, the pump attains unmaintainable stage. The efficiency of the pump during this stage drops and it is around 10-12.5 percent. After 20 years of service, if the pump is not maintained, the pump will have catastrophic failures and efficiency will drop to lower percent. Scheduled maintenance will maintain the efficiency of new pump. (NSW FARMERS, n.d.)

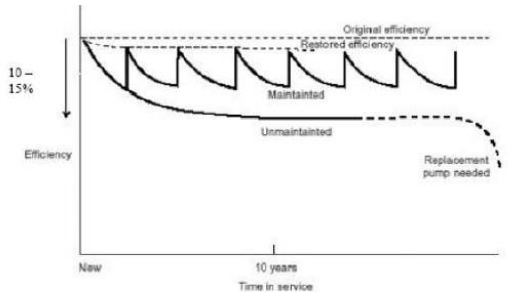

Figure 9 LIFE OF PUMP AND EFFICIENCY DETERIORATION

Sources: UK Department of environment, 1998

3.2 FAN

Fans are second most widely used industrial application after pump system. According to international energy agency (figure 7), fans consume 14 percent of total motor electricity consumption in industries. Fans are used in industries like manufacturing industry, process industry, and used for applications like ventilation application, heating and cooling application.

For efficient energy saving, operation of fan has to be reliable. Malfunctioning of fan system will interrupt the entire processes in industries. In ventilation application, failure in fan system will abandon the process, while in heating and cooling application, failure in fan system aborts the air exchange process. Thereby affecting the overall reliability of fan.

Traditional methods used for airflow control are inlet dampers on box, inlet valve, outlet dampers. Energy is wasted by these traditional airflow control methods. Dampers used in this method, decreases the fan output and shifts the operating point in performance curve. The change in operating point may run the fan in unstable state. Unstable operation of fan may affect the airflow and results in adverse noise, increased wear, and inefficient performance. Performance enhancement is possible through advanced airflow control methods like variable pitch blade and variable fan speed control. Fan law states that fan speed has linear relationship with airflow, pressure, and power. Change in speed in turn changes the fan output, as a result demand can be satisfied in an efficient way. Thus variable fan speed control is an efficient method.

Increase in unstable system and failures, concentration are given to fan design. Researchers have suggested using extra capacity to fans for stabilization in some condition use of extra capacity, technically called as oversizing increases the operating cost and decreases fans reliability. The main disadvantage of oversizing in fan results in increase flow, increased noise and increased stress to the system causing high operating cost. In spite of its disadvantages the application for fan is necessary in today's industry. Thus reliability depends on fan selection.

Selection of fan is important for hushed, efficient, and effective system. In the present time the fan type is not selected based on total efficiency or input power rather selected based on the industrial requirements. During fan selection the preference is given to the type of fan which is large, having low initial and operating cost satisfying requirements with lower operating efficiency. This decision of choosing the fan type is not as good as choosing a large and costly fan satisfying same requirements with better operating efficiency. This selection process works good sometimes and worst at times. A possible way to select an efficient fan can be based on requirements. The requirements of fan such as airflow, external pressure, fan efficiency, grid power, air temperature, and voltage, motor type can specified during fan selection.

With proper selection of fan and without scheduled maintenance expecting energy efficiency is not valid. Evaluating fan system needs and responding to common problems during maintenance can save up to 50 percent of total electricity utilized by fans. (Brelih, Nejc;, 2012)

The ideal approach of energy saving can be achieved by optimizing all the mechanism in fan system.

3.3 AIR COMPRESSOR

Air compressor is important utility in Industries. They are used widely in industries like iron and steel plant, food and beverage industry, chemical industry, tobacco industry etc. Figure 8 shows the energy consumption of air compressors in various industries. Since the application for air compressors are extensive, compressors are available in various sizes from small horsepower to several thousand-horse power.

Air compressor system consists of two units namely supply end unit and demand end unit. Supply end unit consist of compressors and air treatment. Demand end unit consist of storage system, distribution system, end use equipment. When the Supplied end of the compressor system is examined and for its operation, control, and working conditions, energy saving policies can be implemented effectively based on compressor requirement. Similarly examine demand end unit will identify the genuine use of air.

Air compressor is an expensive utility. The extensively used air compressor uses 8-horse power of fuel to generate electricity needed for 1 horsepower of compressed air. (university of Minnesota, 2011) When considering and reviewing energy consumption of a new compressor in an industry, it is indicative that the cost of power would exceed the cost of compressor. Consequently, use of energy is inefficient.

On considering the following techniques can save energy in large percent from air compressor system

- Incorrect use of compressor system may not be economical. Applications like open blowing, aspirating, atomizing, padding can be efficiently executed by alternative equipment. Consider aspirating- aspirating uses air compressors to make another gas (flue gas) flow with compressed air. This process can be efficiently done by a low-pressure power. Also disconnecting the compressor from unused equipment can be energy saving.
- Leaks are the main source of energy misuse in compressed air system. When leaks are not treated immediately, system operation will not be as efficient as it should be. It alters the production and life of the equipment. A well-maintained equipment will have leaks in a range less than 10 percent.
- Variation in pressure affects the performance and energy utilization. Fall in pressure occurs when there are disturbances in airflow. Using air filters with pressure gauze can minimize the airflow

disturbances to the compressor. Ideal range for pressure drops is less than or equal to 10 percent. If fall in pressure deviates the ideal range, the equipment will not be energy efficient.

- When demand unit is supplied with more pressure than necessary, artificial demand is created. This in turn causes leaks and open blowing to the compressors. Significantly energy utilization is more. Use of pressure regulators can regulate artificial demand.
- Compressor size is an important factor to be considered for energy saving. When the compressor used in an industry is over sized, it consumes excesses power during part load operation. Instead several small sized compressors can be used to match the demand.in some cases, it is convenient and nice to use blowers as an alternative to compressors for energy saving. Pipe should fit the compressor system, pipe size should therefore be appropriate in order to prevent excess losses.
- An air compressor unit converts 85 percent of energy to heat. This generated heat can be used productively within the industry for space heating, industrial process heating, water heating, air pre heating, boiler water preheating. Generated heat is not enough for satisfying all the process. However heat recovery system is at hand for air compressors. This can recover 50- 90 percent of heat, leading the system to be energy efficient. (Csanyi, 2015)
- Scheduled maintenance and constant monitoring can lower energy consumption, reduce air leakage, maintain pressure variation, decrease downtime, maintain operating conditions like temperature, moisture, and filter contamination and finally improve the quality and quantity of production.

3.4 COOLING COMPRESSOR

Cooling compressor are widely used in industrial and service sectors assisting industries in food preservation, air and room cooling, process control ,and food production. According to International Energy agency (figure 7), about 7 percent of electricity consumption by motors are used by cooling compressors.

Energy efficiency in industries varies based on load. Analyzing the load for the system cooling will recognize the requirements. Cooling process has two main steps, cooling the load and heat gain. Heat gains are observed in heat exchangers, walls, floors, ceilings of the room, air infiltration, motors used for internal process, lights, and other handling equipment. Heat gains in the system are considered through energy balance calculation. Heat gains in the system can be reduced by following the steps discussed below. This may differ in different industries and various process.

- Air leakage- the leakage of room air into cooled space has to be minimized.
- Recheck for cooling in the room. Increase or decrease based on requirement to reduce heat gain

- Checking and frequent monitoring of spaces for over heating
- Proper insulation on pipe works will reduce heat gains.
- Fix internal fan for efficiency improvement.
- Turn of the system when not required
- Installing cooling equipment in a position far from other heat source equipment can prevent heat gains. Suitable shading is also important.
- Proper maintenance of other process equipment will prevent heat gains in individual system and process.

Cooling compressors uses coolants. The greenhouse gases and global warming effects are caused by improper use of energy in cooling systems and only small percent is caused by release of refrigerants used in compressors. (INTERNATIONAL INSTITUTE OF REFRIGERATION, NOVEMBER 2003).When flow of coolant is more, more energy is utilized for pumping. The pump system should be adjustable to respond to different cooling loads. Proper insulation of pipes and large pipe diameter (reduces pressure) will increase the performance of the system. This will save lot of energy.

Like air compressors, cooling compressors consume excesses power during part load conditions. It is an efficient practice to use several small size compressors to match the load demand. Cooling load has issues caused due to temperature variation, inadequate power, excessive cooling, and improper control. These issues can be rectified by proper compressor control. Cooling compressors are operated by manual control, semi-automatic control, automatic control, and by combination of these control. It is a known fact that, manual control and semi-automatic control needs assistance for control and operation. Upgrading to automatic control will operate the system with optimum efficiency. Following advantages will be observed in automatic/semi-automatic control of compressors:

- Automatic on/off switching will increase the drive efficiency and increased life.
- Automatic/semiautomatic Regulation of temperature difference i.e. between evaporating temperature and condensing temperature can improve plant efficiency by 4 percent. (Anon., 2009)
- Automatic/semiautomatic regulation of head pressure maintains optimum heat rejection temperature to provide cooling on hottest seasons. This is a better practice than maintaining a constant maximum value. This practice should be done when necessary

Generated heat from the cooling compressors can be used productively within the industry for water heating, air preheating, boiler preheating. Heat recovery is a good industrial practice, even though it does not help in energy efficiency.

Scheduled maintenance and testing of the system can maintain efficiency like a new system. In manual control of cooling compressors, installing alarms on equipment, filters, and valves can give warning when there are changes in process or malfunctioning of equipment. On providing immediate service to damaged, faulty, or worn equipment's can deliver following range of savings to industries:

- Minimum energy cost
- Increased process reliability
- Improved production
- Enhanced working environment
- Lower operational and maintenance cost
- Better safety
- Lower emission of greenhouse gases and its effects.

3.5 VARIABLE SPEED DRIVES (VSD)

Earlier topics has discussed about various motors used in industrial sector and their inefficiencies. Variable speed drives are considered to have potentials to save energy. Replacing the unproductive motor system with variable speed drive has a possibility to improve motor efficiency. Electronic variable speed drives are commonly used motor speed drives in industries for today and forthcoming tomorrow.

A variable speed drive is a power electronic equipment to regulate the speed in order to vary the output of an electric motor. Speed of the motor can be varied by varying the input frequency of that motor, Control on frequency (F) and voltage (V) maintains the V/F ratio. Thus the three phase ac input is converted to dc supply and then to variable frequency- variable voltage by that able to vary the speed of the AC motor. Variable speed drives are available as three main types, and they differ by their rectification processes. They are: variable voltage input (VVI), current source input (CSI), pulse width modulation (PWM). This working mechanism provides increased efficiency and reliability options with inexpensive maintenance. Variable speed drives uses Power semiconductor switches, which are used for motor protection, soft start, and remote control. Usually the power semiconductor switches used during the motor start limits the inrush current, this reduced voltage start makes the system advantageous. VSD are also available in different sizes and different controls, these are chosen based on the industrial requirement.

Cube law states, power increases when speed increases by cube. Therefore, variable speed drives have potential to run the motor in half speed to make the system advantageous. Like other electronic equipment's, Variable speed drives also has an efficiency ratings. Efficiency rating depends on nominal output and partial load losses. Losses are at 2-5 percent for nominal speed and nominal torque and losses increases for higher speed and higher torque rate. In common, Loads are of two types: variable torque loads and constant torque

loads. Axial pumps, fans, blowers are loads which have variable torque .these loads require lower torque at lower speed than higher speed. Here torque varies as square of speed and power varies as cube of speed. Compressors, reciprocating pump are loads which have constant torque. These loads requires constant load at lower speed than higher speed. Here torque is constant and power is directly proportional to speed.

In Pumps and fans applications, throttling valves and fan vanes works at full speed during normal operation. This design might be simple and cost effective, but as long as they are used they are energy wasters. Speed control makes it certain that the motor type does not run at speed more than required concurrently the load demand is matched with less energy consumption. Air compressors and cooling compressors have advantageous of variable speed drives as similar to pumps and fans. Variable speed drives used in compressors can avoid frequent ON/OFF switching and throttling. In cooling compressors, airflow can be controlled effectively by varying the temperature, humidity and other requirements needed through variable speed drives. The controls provided by variable speed drives add lot of benefits by not only saving energy and increased life. They commit to enhance process control, production and contribute to decreased reactive power, maintenance cost. Furthermore they add the following benefits:

- Drives help in maintaining motor efficiency at reduced load by improving power factor.
- Drives provide considerable ranges for speed, torque, and power. Enabling them for quality process control and quality product.
- Variable speed control shows upturn production
- Low cost maintenance
- Drives provide fault protection to motors.
- Drives provide smooth starting and stopping. This prevents mechanical damages to motors
- Drives give protection from interferences.

4. BARRIERS FOR ENERGY EFFICIENCY

Influencing energy efficiency in industries provides Substantial advantages. Utilization of energy efficient technologies to a greater extent can perceive savings to the industries. In spite of being aware of potentials of using energy efficient technologies there are number of barriers to manipulate energy efficient technologies in industries. Barriers to energy efficiency can be explained as a practice that inhibits the industrial decision of being energy efficient by energy and finance.

Some of the barriers are easy to realize. The barriers to industrial energy efficiency may be analyzed from economics, technical, and organization perspectives. The reason of barriers differs in different perspectives. Improving energy efficiency often involves in equipping the industry with energy efficient drives. These technologies are concern with savings and risky pay back. Sometimes the industry might expect a higher return of investment. When there is no significant approach to overcome the barriers of adopting energy efficiency drives. The policy options can help them in overcoming the barriers. Industrial sector consumes energy directly in production processes otherwise in application such as Heating, ventilating, air conditioning, lighting, and computer.

Efficient use of energy is achieved by an initial investment essential to (not always) financial constraint. This factor can be measured by benefit to cost ratio. Benefit to cost ratio evaluates energy system in industries and give solution to the available benefits in terms of cost. Benefit to cost ratio has two perspectives. Measure of benefit to cost ratio has two aspects:

- Total energy saved during the operative period to the total expenditure (machine investment, machine operation, and machine maintenance).
- Net energy conservation i.e. the variation between energy conserved to energy utilized for operation and maintenance.

Therefore on estimating the economic performance and cost of energy through benefit to cost ratio can give assistance in determining preliminary payback period.

Understanding barriers is important as it can be the only possible solution to bridge the gap in industries to be energy efficient. The focus upon energy efficiency in industrial sector evaluates the various barriers like uncertainty, inadequate awareness, and Concealed disadvantage, depreciates funding, denied target, and innovation. (sorell, et al., 2011)

Figure 10 BARRIERS OF ENERGY EFFICIENCY

4.1 UNCERTAINTY

Industries investing on energy efficiency technologies have to take a chance. Payback on energy efficiency technologies is not as short payback like other types of investment and it involves financial threat. Necessary investment on energy efficiency will be a barrier to companies who prefer business more than energy. Industries implement stringent investment idea for energy efficiency is due to

- Financial trend- an instance to this, is variation in prices and interest rates
- Inflation- an instance to this, inflation in fuel and electricity prices
- Financial threat – sudden fall of profits.
- Technological failure- technological equipment is being unreliable.

Uncertainty will vary from industry to industry and technology to technology. The uncertainties related to technology are dealt with higher risks. This can be explained in this way, consider an industry installed with new VSD technology, if the technology installed is unreliable and does not provide any benefits as hoped. This kind of situation is mostly arise with technology which are recent and unknown. In order to avoid such uncertainty, technologies which are highly recommended by energy standards and publications should be preferred. Thereby able to limit the risk associated.

4.2 INADEQUATE AWARNESS

Inadequate awareness on energy efficiency drives may lead to inefficient use of energy because of which the options for cost effective productivity are overlooked. In a particular industry, it is important to have knowledge on performance of different technologies and its energy consumption. If not, this will lead to make substandard investment on energy efficient technologies in an industry. This unproductive or uncertain decision will lead to market failure, Because of the barriers existing between the markets and consumers. The markets related to energy lacks to provide information to consumers. The supplier in the market holds enough information about the new and updated technologies, but lacks to provide all the information to the buyers. Therefore it is important for industries who are interested in investment on energy efficiency to compare the various products and utilities to buy an optimum energy efficient equipment.

Adequate knowledge is necessary in three main areas i.e. knowledge on present energy use, knowledge on investment opportunities for energy efficiency, knowledge on energy efficient technologies and their application. Knowledge on present energy use means knowledge on utility, energy consumption, control system, process and so on. This knowledge is basic to the barrier study and they are mostly related to the present situation of the industries.

Knowledge on energy efficient technologies will update about the technologies available in the present market. Factors such as Cost, quality, performance, accuracy, and other related factors in relation to energy efficiency have to be known for different technologies. They can be available for new and unfamiliar technology. These factors may vary from technology to technology

The Knowledge on the energy efficiency investment can help the organization to evaluate the cost and, performance of energy efficient technologies. Knowledge on this area can be determined through energy audits. This will give an idea for the regular transaction of industry. It is important to know about the subsidies available from the government or other funded program to have profitable investment. There are three different situation existing in today's market.

1. Understanding the performance and characteristics of the equipment before investment- Usually equipment used in the industry will have a life span of fifteen years (i.e. long life span) and price investing will also be high. Hence, highlighted concept towards such investment is to have low purchase cost while conveying same services with energy efficiency.
2. Understanding the performance and characteristics of the equipment after investment- sometimes only after investment (test run of the equipment), the efficiency can be determined. During which the rating scheme of the equipment will not be the correct guide as the energy efficiency of the

equipment is better described with experience. This kind of situation is largely seen in industries operating their equipment in part load operation.

3. Rarely performance and characteristics of the utility cannot be determined even after the investment. Various motors, variable speed drives and other similar technology can be difficult to evaluate their energy performance in industries where their operating patterns are different each time. Careful evaluation of consumption pattern should be done to have feedback on the purchase decision.

Energy efficiency is not same to all the industries. It is different for different industries with same level of energy consumption. This can be advantageous sometimes or not. This is because there considerable relation between the inadequate awareness and concealed advantage.

4.3. CONCEALED DISADVANTAGES

The Organization neglect energy efficiency and cost effective alternative when making broader investment, this is because energy efficiency investments are probably correlated with concealed disadvantages. This can probable be the reason for energy efficiency barriers. Sometimes the management of the industry fails to estimate the concealed disadvantage of using energy efficient technology. Instead they might overestimate the advantage associated with technologies. Nevertheless, this is not real. There can be additional cost that will be estimated for training staff, equipment maintenance, and nonsuccess production.

A known disadvantage is the unknown cost or hidden cost. This can be a dominant reason for not using energy efficient technologies in smaller industries. One of the disadvantage associated with investment in energy efficient technology is the energy management within the industries. It is important to employ trained professional to work in the industries for energy management. The trained professional has to maintain records of energy consumption data, identify faults, evaluate performance and characteristics of the equipment. For this kind of energy auditing there require additional cost.

Concealed disadvantage associated with investment in individual equipment is lot more than the previous case. There can be lot of expenses associated in the initial stages. It takes a lot of time and money in identifying the right design and configuration for the investment. There can be lot of hidden difficulties while seeking approval for buying the decided technology. Sometimes individual equipment can cost more for maintenance. There are possibilities to have disadvantages during replacement and retaining of staff. The chosen equipment might need special assistance for secondary performance. For example, an energy efficient process may be a reason for increased noise, an energy efficient drives may need extra services. Sometimes may not be as reliable as it should. All these are the possibilities for demanding more cost and can be considered as concealed disadvantage.

4.4. DEPRECIATE FUNDING

If the management of the industry faces depreciating funds mainly because of insufficient internal capital, share issues and other similar issues, may prevent the industry on investing on energy efficiency drives. In industries there can be various reasons to raise up such situation. However, the two main reasons are

- Insufficient funds within the organization
- Difficulties in raising the funds through indirect means or external sources.

In additional to the early payback period, depreciating funds can be a reason for neglecting the organization to be energy efficient. In large companies, the investment for energy efficiency will require relatively smaller finance when compared to other investment for development within industries. When taking help from external sources for finance, the risk associated will be appraisal for the entire industry and not just the individual equipment. Therefore, this can be a reason for barrier to prevent large industries to invest on energy efficient technologies. Smaller industries, have possibilities to have indirect access to funds, such as to borrow funds for higher interest rates. This is one kind of barriers to prevent smaller industries to invest on energy efficiency technologies. Government providing subsidy for such projects having good return will benefit industries facing depreciate funding.

An Organization of the industry will pay attentional to utility equipment under two criteria's i.e. higher priority maintenance and lower priority maintenance. Higher priority maintenance, Such as replacing a failed pump, servicing a drive for higher reliability, or sometimes upgrading the plant for higher productivity. Lower priority investment like investment in maintenance of energy efficient technologies. Smaller cost benefitting allowances from energy efficient technologies are being ignored. This kind of situation will change only when energy is a critical issues or when cost of energy increases due to carbon dioxide emissions.

We can say that, it can be profitable for industries in investing on energy efficiency programs which can contribute to lot of advantages and higher rate of return. While it can also be good if the management does not take additional finance in form of debt in order to make an industry profitable. There are possibilities for it to be profitable. Sometimes not. There is no right decision to follow and the result is hard to understand.

4.5 DENIED TARGET

When the target of the industry is not achieved on time, due to production failure, funds, finance or various other minor operational issues. There will be an urgency to accomplish the target, consequently attention, and decision on industry will be denied, and practice of savings will also be affected. This can be the reason for the management of the industry to disregard in enhancing technologies as energy efficient, because of

which there will be loss of benefits in energy efficiency. Denied target will be considered as barrier itself when other barriers are satisfied. When an organization has enough funds, adequate awareness to invest in energy efficiency while there is sudden market failure or failed target. The organization will fail to attempt in investing rather try to concentrate on achieving the missed target. It is essential to favor energy efficiency instead of favoring energy acquisition. As the latter is considered to be an inefficient use of resources.

4.6 INNOVATION

Many industries pay much attention to production, profit, product design, quality, and quantity of production rather than innovation to utility or equipment. Industries prefer proven technology rather than new technology. Barriers may differ from one energy application to another while elemental reasons for those barriers remain same. Apart from the topics discussed earlier, Barriers to innovation can be due to two elements of industry. They are managerial decision and scientific decision. (ETSU AEAT PLC,(UNITED KINGDOM), FEBRUARY 2001)

4.6.1 MANAGERIAL DECISION

Energy equipment and drives are sold at lower cost to customers by agents such as other equipment manufacturers (OEM) and distributors. The department in charge of the equipment, and functioning of the equipment is different and the department in charge for administration is different. Because of which there is fifty-fifty chances that there will not be consideration for energy efficiency. Certainly, the administration department will not have much clarity on the equipment's such as motor system, drives and their prices, their advancement, for making the industry energy efficient.

This is considered to be a major barriers.

4.6.2 SCIENTIFIC DECISION

Using improved efficiency equipment is as important as system efficiency. The former is not implemented due to the barriers discussed above .On considering the long-term goal of industry i.e. plant expansion. The decision of buying over- sized equipment is a barrier. This affects the efficiency of individual equipment and the industry itself. Therefore, it is important to adopt the right equipment. There is no technical clarity between efficiency, maintenance, and services. There is always compromise in efficiency, when it comes to maintenance, services and efficiency. When regular maintenance for the equipment is not practice and energy saving will be just an idea and not a fact.

5. PROSPECTS FOR ENERGY EFFICIENCY

Energy efficiency can be anticipated to provide much more improvement in the industries. This can be précised as prospects of energy efficiency. Prospects can be determined through the knowledge about potentials of energy efficiency and alternatives of energy efficiency.

5.1 POTENTIALS FOR ENERGY EFFICIENCY

To prevail over the industrial barriers of energy efficiency needs support from the industries. The prosperity of the industries depends on intact, protected, sustainable energy. Over the next few years, investments on energy efficient technologies have to be enhanced tremendously in order to diversify existing resources and provide resources for challenging and changing energy requirement. An energy efficient technology uses minimum energy than the other technology which is used currently. As many countries are dependent on non-renewable energy sources like petroleum, coal, and natural gas to produce energy and if, the energy efficient technologies are not used excessively, then energy will not be feasible leading it to ruin the natural environment and causes enormous emission of carbon dioxide.

Energy is supposed to be life of industries. Prospects of energy efficient technologies can satisfy the new energy demand in an economical way. The associated impacts caused by the conventional methods can be minimized. These prospects of energy efficiency can be improved by the policies made by various directives. Nowadays, there are realistic, proved technologies which are available in the market to help the industries energy efficient. As discussed in earlier chapter, the energy efficient technology can provide needed prospects in applications such as cooling, heating, ventilation, compressed air, pumps and also in other industrial applications.

On being energy efficient, the industry can provide the same or higher level of utility with the prospects of using lower energy. It is very much important to improve the use of energy as it is vital for the future generations to be benefitted with power and energy. It is therefore mandatory to make necessary modification for energy efficiency, So that it directs the industries to be more sustained for decades. From figure 8, the most energy- intensive industries are non- metallic mineral industries, iron and steel industries, food industries, chemical industries, metallic industries, paper and print industries. These industries have various business with increased production, processes, and energy usage. On improving energy, the use of energy can be reduced by 14 to 22 percent, with returns at least 10 percent by twenty-twenty (2020). (Lave, 2009) However these can be achieved by overcoming the barriers that has been discussed in previous chapter. As per figure 11, The prospects for energy efficiency covers four main objectives

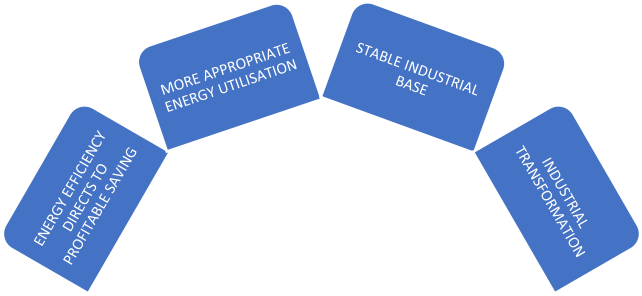

Figure 11 prospects of energy efficiency- objectives

5.1.1 ENERGY EFFICIENCY DIRECTS TO PROFITABLE SAVING

As industries have higher potential to make energy efficient profits, the demand for energy intensive products like variable speed drives, energy efficient drives will be more. It is now time to implement the decisive plans to action. On improving energy efficiency in all the industries in their respective countries, energy intensity will be dropped. If the energy intensity rates are dropped in good percent, the use of energy will be increased, thereby investing less burden on the environment in some way or the other. With higher percentage drops of energy intensity can provide energy security. This prospects can be realized on implementing good policies and also by adopting policies.

An another important prospects for energy efficiency would help the industries to save energy and would also help in low carbon emission and would also help in exploring a lot of renewables and produce energy from those renewables. Employment opportunities will be created if efforts are taken to pay attention on energy from generation – transmission- distribution and finally consumption. It requires consent for monitoring, inspection of energy usage and energy audits. These effort directs to energy saving. When industries become more energy efficient it strengthen the competition among industries for this comprehensive labeling should be accessible in the industries, in order to make extensive comparison.

5.1.2 MORE APPROPRIATE ENERGY UTILISATION

With continuous and vigorous efforts of making a country energy efficient will initiate a unified and integrated energy market. In a long term biases, If there is efficient use of energy there can be a prospect that, there will be a balance in energy usage between the authorized consumer's and economic gain from energy use. For more appropriate energy utilization, large investment will be essential to replace the out of date, less efficient equipment to well suited advanced, modernized and equipment to satisfy the demand and quality products. As a result of using energy efficient technologies the overall electricity bill will be reduced since Industries pay for the energy they utilize. Promotions over energy related research and development could contribute to better opportunities for implementing energy efficient technologies.

5.1.3 STABLE INDUSTRIAL BASE

Investing on energy efficiency will not only provide a platform for intact, protected and sustainable energy but encourages in active, stable, diversified and ambitious industrial base. Technologies can influence the production in that particular industry. When there is higher production, the industries profit will also be increased leading to stable industrial base. This industrial base can cater a service with best novelty in their product. An industries who is energy efficient can cater an assured trust to protect the environment and consumer. An individual responsible for investment in energy efficiency technologies and the success of the project aids to the individual career boost. This can be a boost to consent industry too

5.1.4 INDUSTRIAL TRANSFORMATION

It would always be prospective if all equipment used in an industries were energy efficient rather from one single applications. In short, it would be greater if an integrated whole industry- office approach were adopted. Fifty percent of energy can be saved in heating, cooling, and hot water of an industries. (Lave, 2009). Also on choosing an alternative for being energy efficiently, it would be greater to choose a more efficient alternative than least efficient alternative when making a decision to change the equipment, after many years. It would be a right choice to replace it with more efficient and effective model. If the opportunity were missed it would take decades to change one. Energy efficient technologies can be a reason to advanced level of peration.it would help the technician to analyze a plant on its working every point. These technologies provide a platform for system integration for achieving high improvements in energy efficiency. If the potential of energy efficiency are understood and when a particular country becomes substantially energy efficient. It would nominate the country to lead the energy technology and innovation and be sustainable.

5.2. ALTERNATIVES FOR ENERGY EFFICIENCY

Prospects of energy efficiency discussed in earlier topics intensify industrial efficiency and achieve long-term goals of industries. To add an extra advantage in terms of energy efficiency in industries, the alternatives for energy efficiency in the industrial application can help. Alternatives in energy efficiency in industries is a general term and this can focus on two things

- Energy Efficiency from existing equipment
- Energy Efficiency from new replaced equipment

5.2.1 ENERGY EFFICIENCY FROM EXISTING EQUIPMENT

Improving efficiency using existing equipment is the economical way to stop inefficient use of energy. The measures to improve efficiency are:

i. Firstly, the operator working in the industry has to be instructed about the exact operation, process, and settings of the equipment. Therefore, that erroneous operation may consume higher energy.
ii. It is advantageous to shut down the existing equipment when the operation of the equipment is unnecessary. Usually motors are not visible among the other equipment and often they are unattended. Shut down of such operated equipment in an industry can save energy. Installation of sensors, time clocks, alarms, and other control techniques for start stop operation will be beneficial.
iii. Monitoring the production output in an industry will assist to spot the errors and will give opportunities to save energy. This will also solve mechanical issues of the equipment at earlier stage.
iv. Production of industries may vary based on consumer demand. Managing the production during lower energy prices is logical way to save energy.
v. Having organized schedule for maintenance, repair, and service will be positive idea to save money and time (during motor failure). This measure will give answers when there is a confusion whether to replace the equipment or to repair the existing equipment.

5.2.2 ENERGY EFFICIENCY FROM NEW REPLACED EQUIPMENT

This type of alternative is associated with replacing the old equipment's like old pumps, fans and drives to new motor system and drives. Energy efficiency in new equipment's is immense as discussed earlier, it may not an economical method to stop inefficient use of energy. To make sure an energy efficient technology to be cost-effective the following measures are to be considered are

i. The most efficient technology needs to be checked for its installation and investment cost and compared with other similar equipment's with similar level of services. The economic performance of the equipment's can be done through economic-evaluation methods like life-cycle costs, legalized cost of energy, benefit- cost ratio method, etc. Life cycle cost can help in cost-effectiveness as the analysis will determine if the energy efficiency investment will be profitable to the industry. This economic evaluation method can compare the other equipment that provides the same service level.
ii. Ratings of the equipment have to be checked as the equipment consumes energy.
iii. They are various tools available to compute energy use in the equipment. The various tools used are motor master[+,] Euro DEEM, can MOST. These compute tools support the equipment in planning for repair or renewable decision, savings decisions and replacement of better energy efficient equipment, low operation cost can also be determined.
iv. The major maintenance requisite should also be known.

v. The consequential problems such as power factor, harmonics, interference, prone to the equipment has to be known for its cost effectives. While the problems are known, the benefits associated with the equipment's should also be known. The various benefits provided by new advanced equipment's are - the automatic protection, equipment control, soft start, wear and tear protection, etc.

6. POLICIES FOR MARKET TRANSFORMATION

Market transformation can be explained as intervention that can alter the structure, function, behavior of the market to influence in increased energy efficiency practice for better market services and practices.

Influence of increased energy efficiency in markets needs coordination of all the industrial and commercial sectors throughout the country. The coordination between the industries, and commercial sector can be closely achieved by raising energy policies and energy regulations. The time has come to implement policies, as energy efficiency is important for sustainable future.

There are few companies which set as good example by being energy efficient by following their own standards and policies while there are many companies waiting for the government to implement standards and policies to make the market energy efficient**.** Energy regulations can bring in new innovative opportunities such as incentives, energy services, monetary institution, training companies, and certification bodies such as energy saving certifications (ESC's) (Petrick & Sinha, 2015)

6.1 ENERGY REGULATION AND DIRECTIVES

Governments influence energy efficiency in markets by deciding the standards and guidelines. There are different government boards deciding the standards of energy efficiency in different country. It is a long process for the government to set rules and to implement these rules. The marketer to the government agencies needs to be capable enough to implement all the rules and be accredited. When an industries save more energy than expected by the government boards, receive energy saving certificates.

Energy efficiency is given a concern in the European Union and the Sweden. The positive results for increased energy efficiency is reduced climatic change, increased adequacy, increased efficiency of natural resources. The policy objective of Sweden in terms of Energy efficiency at the national level is measured as energy input (primary energy) per GDP. The National targets for energy efficiency in Sweden should be 20 percent more energy efficient in 2020 compared with 2008. For the industrial sector, there is no specific goal. Not setting sectoral targets for energy efficiency has aimed to create degrees of freedom. Increase in energy efficiency has to be achieved to maximize the economic benefits. (IVA Project Energy Efiicient Society, 2013)

To achieve the main aim of the European Union, the European Union has endorse various directives. One such directive is EUROPEAN UNION ENERGY EFFICIENCY DIRECTIVES.

The European Union adopted a directive for energy efficiency improvement in 2012. This directive will achieve twenty percent increase in energy efficiency by 2020. The directive concentrated on large industries (i.e. industries having employees more than 250) to perform energy audits. The Swedish industry implements various incentives for increased energy efficiency, depending on how Sweden chose to implement the directives.

Various country administrators of the European Union takes help from energy auditors, about the local and regional level of energy usage. Thereby, offering different networking and supporting projects to small and medium sized companies. In addition, there is energy agency which takes responsibilities to share knowledge on energy efficiency for energy intensive industries. Industries who are actively interested of being energy efficient takes lot of actions with the help of certain policy measures, these are discussed below:

The Industrial and technology agency launched a project called ECO –ENERGY during 1995. The project was later taken over by the Swedish energy board which was formed in 1998. This project had a goal of improving energy efficiency by reduced need for power generation. In addition, contributed to reduced carbon dioxide emission under the guidelines from 'established environmental act ISO 14001'. This project attempts to conduct an energy flow analysis with the support of energy consultants to cater proper policies, train staff under the guidelines from ENEU-94 directives 'the procurement of energy efficient equipment machines in industries'

A program called PFE was administered for energy efficiency in European Union. PFE in a large company with a purchase cost of energy greater than 3 percent of the value added. It can get relief from electricity tax 0.5 (cents/ kWh) for certain types of industrial activities if industries join the program. The industries registered under this program were exempted from electricity tax in deal of promoting efficiency. In return must work on energy efficiency carried on manner by certified energy management. Measures with short payback of notice (under 3 years) will be carried out on the reasonable. However, this program is not continued as it opposed the regulations of European Union. (IVA Project Energy Efficient Society, 2014)

6.1.1 ENERGY SERVICES

The training companies provide professional certificates empowering the industry to work with trained staff. This can promote energy efficiency by making use of industrial applications in a correct way. These companies organize training programs to develop the markets. They are typically involved in training individuals in engineering and technical fields, this will help the individuals to work for industries in trained

manner. The training companies train students and professionals in energy efficiency, supervise research, aid in technology, advertise and promote about energy saving.

Government funds such programs in order improve the growth for energy efficiency. Government funded programs provides practical advices to energy-intensive and non-intensive industries. They also instigate consumers to highly efficient technologies.

6.1.2 MONETARY INSTITUTION

Funds are available from government and governmental agencies for energy efficiency. Investments made from these fund can provide additional boon like tax relaxation, energy replacement of older inefficient equipment's to newer energy efficient technologies. Monetary institution provides deals based on equipment's performance. This can profit the industry with reduced payments. This kind of contracts guarantees energy savings while the customers are responsible for the loan. Monetary institution aims in providing financial support to industries, so that there are interventions made for market transformation. They help the industries to overcome barriers such as lack of funds, lack of potentials for organizing programs for energy efficiency implementation.

Establishing 'energy loan board' in a particular industry will be a cooperative and helpful idea that increases energy efficiency opportunities by craving an understanding between various actors and parties. Establishing 'energy credit guarantee board' can help the industries during risky times. Moreover, support the industries during losses.

6.1.3 ENERGY SAVING CERTIFICATES

An energy saving certificate is regarded as an identity for energy saving that can be recognized using measurements and verifications in a market. Energy saving certificate can be an encouragement for more energy efficiency conception. If the potentials of energy saving in private industries are to a greater extent, then it is sure that it would benefit the markets and the nation. (Friedman, et al., july 2009)

An example for energy saving certificate is white certificates. According to the policies related to environment. A white certificate is a document which validates that there is certain amount of decrease in energy utilization in a particular industry. In short energy savings are recognized by the certification so called 'white certificates'. Certifications are given based on the instruction from the certification body. Certification body will verify the energy saving target achieved by the industry and also verify the minimized transaction cost calculation. When the performance of the industry is verified, the industry is awarded with 'white certificate'. (Bertoldi, December 2011)

7. CONCLUSION

The increasing negative impacts of energy consumption in industries are still prevailing. The emissions from industries are partly responsible for climate change, acid rain, smog, energy security and other environment related consequences. Perspectives to energy efficiency can minimize the impacts caused due to increased energy consumption. The core idea of this literature review study is from practical examples from industries, industrial application, and new technology. A basis of energy efficiency in industrial applications provides potential energy savings for the present and future industrial situation. This basis will provide a balance between INDUSTRY- ENVIRONMENT-ENERGY, thereby providing higher profits. The potential improvements in industrial application can influence the energy prices, performance of industry, quality of end product, evolution of technology and sustainability of environment.

These improvements clarify the purpose of the study. By enforcing the new advancement in technology can boost the energy efficiency in motor drives. Enforcement of new advanced technology is not as easy as it sounds. There are barriers akin to the investment of energy efficient technologies. Understanding barriers is important as it can be the only possible solutions to bridge the gap in industries to be energy efficient. It is accepted that energy is required for industries. Therefore, this study suggests evaluating the reasons for the barriers so that the future of industries is energy efficient. All industries, whether an energy intensive or non-intensive should evaluate the current situation. They should understand their industry and make the possibilities to achieve savings through energy. However, there are many policies for energy efficiency and directives initiated by the government of each country, to increase energy savings in the industries. The initiative has to be made by the management of the industries to experience the possible benefit of energy efficiency. Barriers should not be a reason to compromise the benefits associated with energy efficiency and also not be a reason to compromise the prosperity of sustainable environment. Energy efficiency is anticipated to provide improvements in the industries. This is likely due to potential and alternative aspects of energy efficiency. However, the research in past years has proved the importance of being energy efficient. The enforcement of energy efficiency is not complete.

Every barrier has a possible way to overcome. The prospects of energy efficiency are highly advantageous and alternatives are also very simple to be contemplate. The barriers consent with energy efficiency in industries is fair enough to be considered. While compromising energy for temporary prosperity of the market is not upright. It is the responsibility of the industrial market to plan for future generations. The various policy options that are available to develop energy efficiency practice are considered as cognizance for market transformation. Market transformation is achieved when there are positive interventions in standards of equipment and standards of entire system. The options available for market transformation are enormous. The adoption of right policy, in the right situation can provide enormous benefits to the process,

industry, market, and nation. Most importantly, being energy efficient can save INDUSTRY, ENVIRONMENT, and ENERGY.

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