POTENTIAL OF ENERGY EFFICIENCY IN CERAMIC INDUSTRIES

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A project report submitted in partial fulfillment
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ABSTRACT

In year 1994 Asian Development Bank and Ministry of Energy, Telecommunications and Posts Malaysia have produced an economic analysis and recommendation report on Energy Efficiency in Malaysian Industries. By using this report's recommendations as the stepping stone, an effort was made to study the potential of EE in ceramic Industries. A common analysis methodology was suggested to suite the whole industry nation wide. At the end of this work a special focus is given to the Non-Metallic Sector or more specifically ceramic industry as a case study sample in identifying the potential of EE. According to the above mentioned report, ceramic industry falls as one of the highest energy consumer and energy intensive industry. This study is based on identifying the potential of EE in the Malaysian industry sector and ranking the best options available to implement energy efficiency measures. Malaysian Energy Center (Pusat Tenaga Malaysia, PTM), has been very helpful in providing the necessary energy audit data. A thorough understanding of the industrial process flow is necessary in order to plan an energy efficient measure. Literature reviews, plant visits and software based analysis were critical aspects of the methodology used in this project. The data were analyzed using software called Save-X. The priority of available EE options were weighed according to the pay-back period (PBP) and benefit to cost ratio (BCR). As a conclusion, industries with similar facilities as the case study sample (ceramic) can apply the EE measures and analysis technique to view the potential EE. After benchmarking with international frontrunner there seems to be a huge potential of EE even after implementing all the EE measures recommended by the locally conducted energy audit report. More efforts should be taken to take a glance into frontrunners EE operations and try to implement here in Malaysia. Eventually this will lead us to more EE Malaysian Industries and more benefits to the environment in terms of less fuel are burnt to produce inefficient energy use.

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CHAPTER 1

INTRODUCTION TO ENERGY EFFICIENCY IN INDUSTRY

1.1 INTRODUCTION

Energy is vital for sustaining a comfortable modern life. Natural resources such as natural gas, kerosene, diesel and coal are used to generate energy. Energy here refers to electrical or thermal energy produced by both fuel and electricity. Fuel is burnt to produce thermal energy for the process requirement. Where else, electric energy is converted to mechanical energy by electric motors for moving, string, blending, crushing, compressing or any form of displacement activity.

In some end-uses (electrical equipments or appliances) electricity is converted to thermal energy according to industrial process requirements. Electricity is generated by thermal energy and delivered to end-users through a transmission and distribution system. Using electricity to produce thermal energy is not a wise decision. This is because a lot of energy has already been lost during the generation, transmission and distribution. Producing thermal energy using electricity will further increase the losses. More energy can be saved if fuel is used to directly produce thermal energy near to the end-use. This line of thinking relates to the phrase 'energy efficiency' in the title above.

If the term efficiency alone is used in the technical world, then the definition refers to performance of a particular machine or a system. It indicates how much quality output is obtained after deducting the losses in the system. This figure will be normally given in percentage form. When the word 'energy' is added to the word 'efficiency', then the whole perspective changes and a new definition is born.

Generally 'Energy Efficiency (EE) measures', can be defined as steps that can be taken to reduce energy consumption. It includes:

a) encouraging customers on the demand side to invest for capital improvement with attractive return on investment.

b) changing energy consumption behavior without disturbing existing comfort

In some books and reports EE is referred as energy conservation. Handy Manual of Ceramic Industry[4] is produced by 'The Energy Conservation Centre', (ECC), of Japan in the year 1994. The function of ECC is to find new energy saving or energy efficient technologies and provide technical support towards energy conservation in various sectors. The term 'energy conservation' here seems to be similar to the term EE. These terms are interchangeable, and can be combined in to a sentence by saying that "energy conservation can be achieved through EE measures".

Some use much simpler term such as energy savings instead of EE. The term EE seems to be a jargon to people in the non-technical group. The term *Energy Savings* will give a more crystal clear understanding to this group. What ever terms are used, the idea of EE will always remains the same as defined above. The term EE lies in a huge integrated resource platform dealing with people of various backgrounds and schools of studies. Multiple words should be employed to define the same idea to various groups.

From the view point of a plant manager, EE gives him the idea of improvement of profits and significant reduction in manufacturing cost. Industries are more concern in economic point of view. Energy is not an economic term. Thus, this energy term should be discussed in the form of dollar or RM to give a sensible definition to this group of non-technical people. The extract below indicates how EE is promoted to non-technical people.

> *"**Energy efficiency** measures can improve your profits significantly for minimum effort and costs. For a ceramics company with an annual turnover of £10 million and a net profit of £1 million, the average electricity bill will be approximately £200,000 (between 1% and 3% of turnover). Simple no-cost or low-cost **energy efficiency** practices can reduce this by up to 20% and increase profits by up to 4%. This is the equivalent of adding sales of £400,000 to turnover and is a worthwhile investment by any standards."* [1]

In the whole extract no MWh or TOE units are mentioned, the only language employed is money. This kind of briefings on EE enables the plant manager to get a straight forward understanding and take an immediate decision whether to implement or not to implement the particular EE measures in his plant.

There is another non-technical team who is environment conscious. This group defines EE as a method of reduction in emission of harmful gasses to environment and reduction of the depletion rate of natural resources. No one can deny the fact that energy generation process has some side effects of polluting the environment and eventually contributing to the global catastrophes such as global warming and ozone layer depletion. EE methods will be a perfect method to reduce further emission and damage to environment.

Besides the future global environment issues, stubbornness in implementing EE measures will cause a faster depletion of natural resources. Natural resources are vital for sustaining a comfortable life in earth. This is serious problem for countries with less natural resources and a development block for countries without natural resources where much of the nations foreign reserve need to be utilized for purchasing energy which is vital for sustainability and development of any country. Without EE, more natural resource will be used now and future generation will end up in energy crisis.

As it is clear from the above example, an integrated effort should be made to implement EE measures. One may ask who should implement EE, the energy supplier or the energy end-user. In order to answer the question let us embark in the discussion below on implementing EE on the supply side and later demand side (end-user).

Let's say a utility decides to build a new energy efficient plant to cater for the growing needs of energy demand. The utility has to come up with a huge capital investment to realize their goals. Sometimes this will not be cost effective or easy since it is quite difficult to get funding for such mega projects. By considering the complexity of the problem, utilities in some developed countries, are trying to implement demand side energy management. EE is a major component in demand side management.

Furthermore reduction in pollutant gases emission through supply side energy management will not be effective if the energy demand keep on increasing dramatically. So much attention needs to be given to the demand side without neglecting the supply

side EE options. Building more power plants is not the only solution to cater for future energy needs. Implementing Energy Efficiency (EE) options on the demand side seems to be more practical, economical and approachable technique.

To avoid all the unnecessary problems to occur in the very near future 'Energy Efficiency(EE) options' need to be executed to replace further increase in the energy supply and demand.

EE became more prominent after the oils crisis in the 1970's. The developed countries started to seek for alternative energy resources and EE options. Today, they are well established in utilizing their renewable energy options. Whereas, in Malaysia, only recently renewable energy (RE) and energy efficiency (EE) concepts were brought on the mainstream of the national economic agenda under the category of development of energy sector.

Government's enforcement of Energy Efficiency Regulations to support the implementation of demand side management has changed the energy usage pattern. The appliance labeling stipulated in the third Outline Perspective Plan (OPP3) period will further enhance the pattern.

However, the government can only provide relevant infrastructure to support RE and EE activities in the form of legal and financial institutions. Now it's up to the people to reciprocate.

Under the ministry of Energy, Communication and Multimedia, a mega project named 'Malaysian Industry Energy Efficiency Improvement Project ' (MIEEP) have been implemented. The focus is given to only 8 industrial sub sectors, namely; food, iron & steel, rubber, cement, ceramic, pulp & paper, glass and wood to identify the potential of energy savings. Energy audits have been performed in 28 plants. After the preliminary energy audit, some detailed energy audit was done in selected industries. This work is based on the selected non-metallic (ceramic) sectors four audit reports. The reason for ceramic sector selection is discussed briefly below and detailed explanations on ceramic sector and it's process is provided at the end of this work.

1.2 OBJECTIVE OF THE STUDY

As we have seen the importance of the EE, and the encouragement given by the government in urging private and government institutions towards the realization in Malaysia, it is worth to investigate the potential of implementing EE options in Malaysian Industries. By bearing this in mind the objectives of this work were structured as penned below;

- To **identify the potential** of implementing energy efficiency measures in Malaysian Industries particularly in Ceramic Industry.
- To provide **guidelines** to other industries on how to categorize the no-cost EE measures, low-cost EE measures, medium-cost EE measures and high cost EE measures based on the case study sample.
- To **provide a benchmarking procedure** for energy usage in Malaysian industry. (Case Study Sample : Ceramic Industry)
- To conduct a **case study** on a sample of Malaysian Industry.(Ceramic Industry)

The raw data from energy audits of Pusat Tenaga Malaysia, (PTM) were used in the case study to identify the potential of implementing energy efficiency options in terms statistical and engineering analysis methods.

1.3 EXPECTED BENEFITS OF THE STUDY

These results would be used as general guidelines to the other similar industries while implementing EE measures. These measures can be executed by the industries with their personal technical and economical preference. The up to date state-of-art-technology which have some practicality in implementing has been selected and highlighted in the report as the some of the available options. The industries do not have to spend time in investigating the best technology towards energy efficiency but just spend their time efficiently in planning for the financial support and investment strategy.

The general methodology suggested in Chapter 2 can be used as broad guidelines in determining an analysis scheme to be implemented in Malaysian Industries. The methodology will provide with best tools for statistical, engineering or financial analysis. This analysis is important in selecting the best EE option in terms of benefit and also cost.

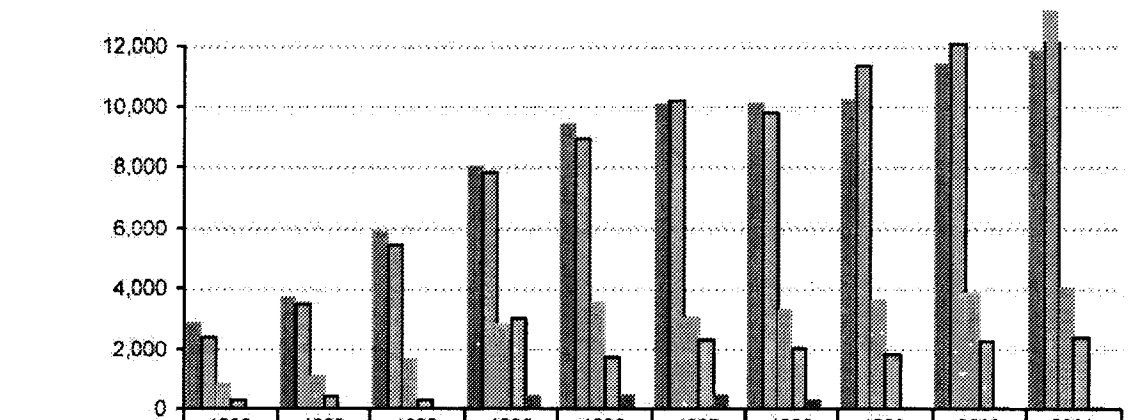
Furthermore the identified measures will be listed in terms of no-cost measures, low-cost measures and high-cost measures. This will enable the industry players to implement them strategically with their own financial model. Financial model here refers to a time-line plans on how to invest the ploughed savings from low level measures of energy efficiency to higher level options. Some tax incentives from government and financial support from international and local organizations such as Malaysian Industrial Development Authority (MIDA), United Nation Industrial Development Organization (UNIDO), Ministry of Energy, Communication and Multimedia, Malaysia (KTKM), and local banks loan plans can be included in the financial model calculation.

CHAPTER 2

BACKGROUND OF MALAYSIAN INDUSTRIAL SECTORS AND ENERGY AUDIT

2.1 MALAYSIAN INDUSTRIAL SECTORS

Since early 80's Malaysia have been focusing its' attention on industrial sector development. The countries economic growth was mainly contributed by this sector. Parallel to this growth, other infrastructures such as transportation facilities have been



	1980	1985	1990	1995	1996	1997	1998	1999	2000	2001
Industrial	2,870	3,726	5,685	8,060	9,443	10,106	10,121	10,277	11,406	11,852
Transport	2,398	3,477	5,387	7,827	8,951	10,201	9,793	11,393	12,071	13,137
Resid. & Comm.	826	1,123	1,646	2,837	3,557	3,073	3,314	3,653	3,868	4,048
Non-energy	291	386	299	2,994	1,744	2,298	2,023	1,799	2,250	2,378
Agriculture	0	0	0	446	472	490	307	106	104	98
Total	6,385	8,712	13,217	22,164	24,167	26,168	25,558	27,228	29,699	31,515

Figure 2.1 Final Energy Use by Sectors (kTOE)

developed to enhance further economic development. This can be clearly seen from Figure 2.1[2]. In the early 80's industrial sector was the major energy user until mid of 1990's. Later transportation sector was leading industrial sector in energy usage. However industrial sector still remains as one of the major energy user comparatively to other sectors. This indicates the importance given to Malaysian industrial sector by the government. For the next decade, we can predict that industrial sector will still remain in the top list of energy user. This prediction makes industrial sector to be attractive for EE program implementation.

Since industrial sector is one of the highest energy consumer of nearly 11,852 kTOE, (kilo tonnes of oil equivalent) it is wise to consider an EE program in this sector.

2.2 ENERGY BILL AND ENERGY INTENSITY IN MALAYSIAN INDUSTRY SECTORS

Malaysian Industrial sector energy consumption can be obtained from National Energy Balance report by Ministry of Energy, Communications and Multimedia, (KTKM). The energy consumption data represents the whole industrial sector. For case study or energy analysis, industrial sub-sectors data are required. The industrial sub-sectors data can be obtained from Department of Statistics of Malaysia, DOS Malaysia.

EE indicators such as energy bill and energy intensity (EI) data are used to give a rough guide on the potential of energy efficiency in the particular industrial sector. Energy bill refers to the amount of money that the particular sector consumes within any physical year in RM or percentage. Energy intensity refers to the energy used per unit of output or activity. Unit for EI may differ from one analysis to another but the information are required for giving an indication on how much energy is consumed. For more information on EI please refer to section 3.5.

A very high energy bill or EI indicates a huge potential of EE. For an example, let's take a look at Figure 2.2. This figure illustrates the energy consumption in percentage of total industrial consumption of 5809 thousand tonnes of oil equivalent (TOE) in the year 1991. The energy bill shows that food sector has the highest energy bill (790 kTOE) followed by the non-metallic (673.8 kTOE) sector. The smallest energy bill comes from the foot wear sector with 5.81 kTOE. The energy bill is not indicated in currency since the currency and oil prices fluctuate. This will not give an accurate comparison from year to year.

One percent savings in the food sector will result in 7.9 kTOE. This value is higher than the total energy consumption in the foot wear industry (5.81 kTOE). Even though, some amount of savings could be achieved in foot wear industry by implementing EE measures, the amount of energy saved compared to the efforts made to implement EE options is small. Making plans to implement EE in food sector or non-metallic sector seems to be more beneficial comparatively. Based on the above logical explanation a very high energy bill can be used to indicate the potential of EE. A priority list can be made to select which are the industries having huge potential of energy savings according to the sectors energy consumption.

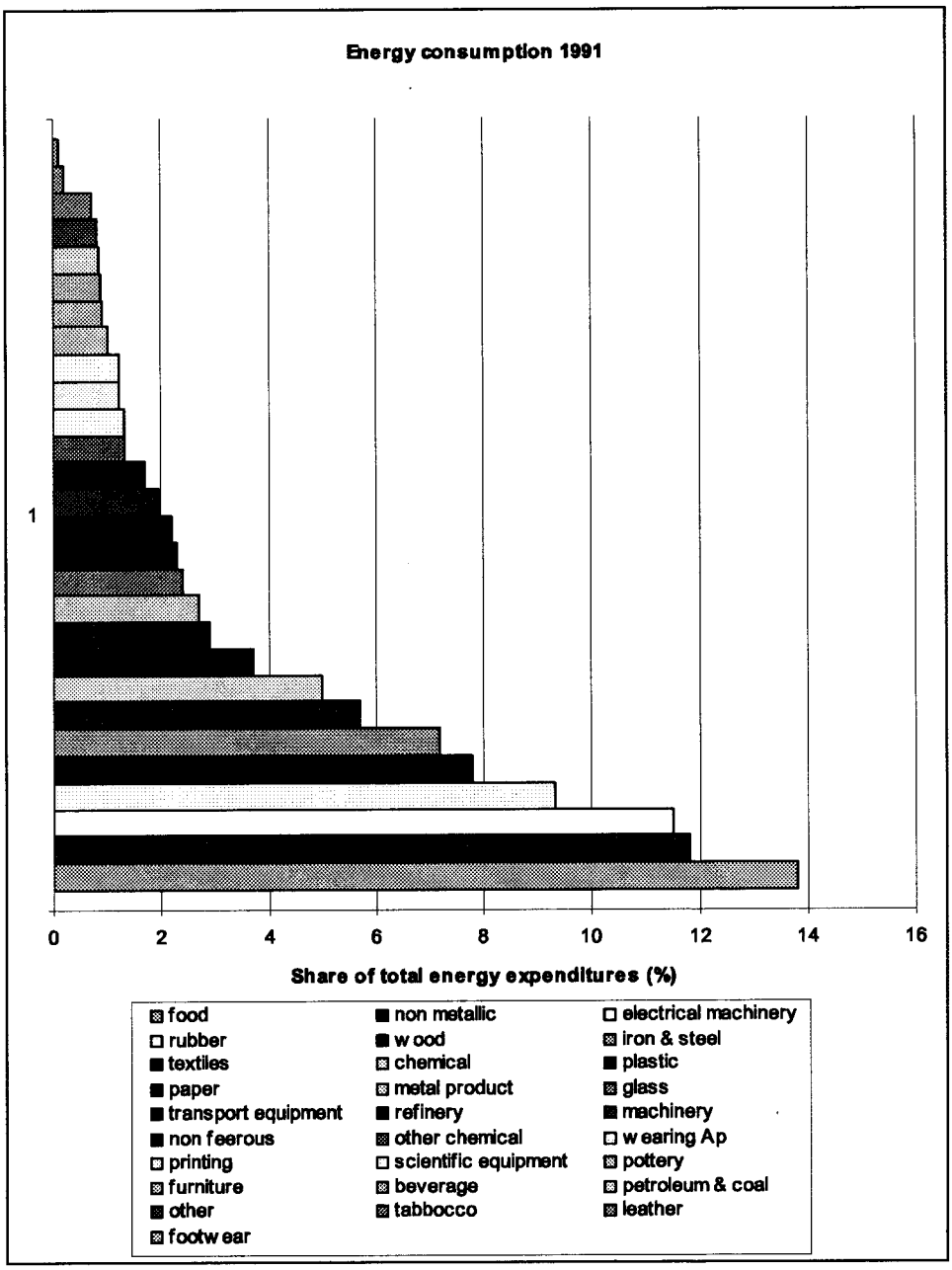


Figure 2.2 Energy Consumption by Industrial Sectors in year 1991.

Figure 2.3 illustrates energy intensity of Malaysian industrial sectors to indicate the potential of EE. The highest potential is seen in the glass sector followed by the non-metallic sector. Electrical machinery industry seems to have the lowest EI in the whole sector. This indicates electrical machinery is the best sector which uses energy efficiently.