DEMAND SIDE MANAGEMENT POTENTIAL FOR ELECTRICITY IN INDUSTRIAL SECTOR IN THAILAND

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ID: 55300700527

A THESIS SUBMITTED AS A PART OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF ENGINEERING
IN ENERGY TECHNOLOGY AND MANAGEMENT

THE JOINT GRADUATE SCHOOL OF ENERGY AND ENVIRONMENT
AT KING MONGKUT'S UNIVERSITY OF TECHNOLOGY THONBURI

2ND SEMESTER 2013

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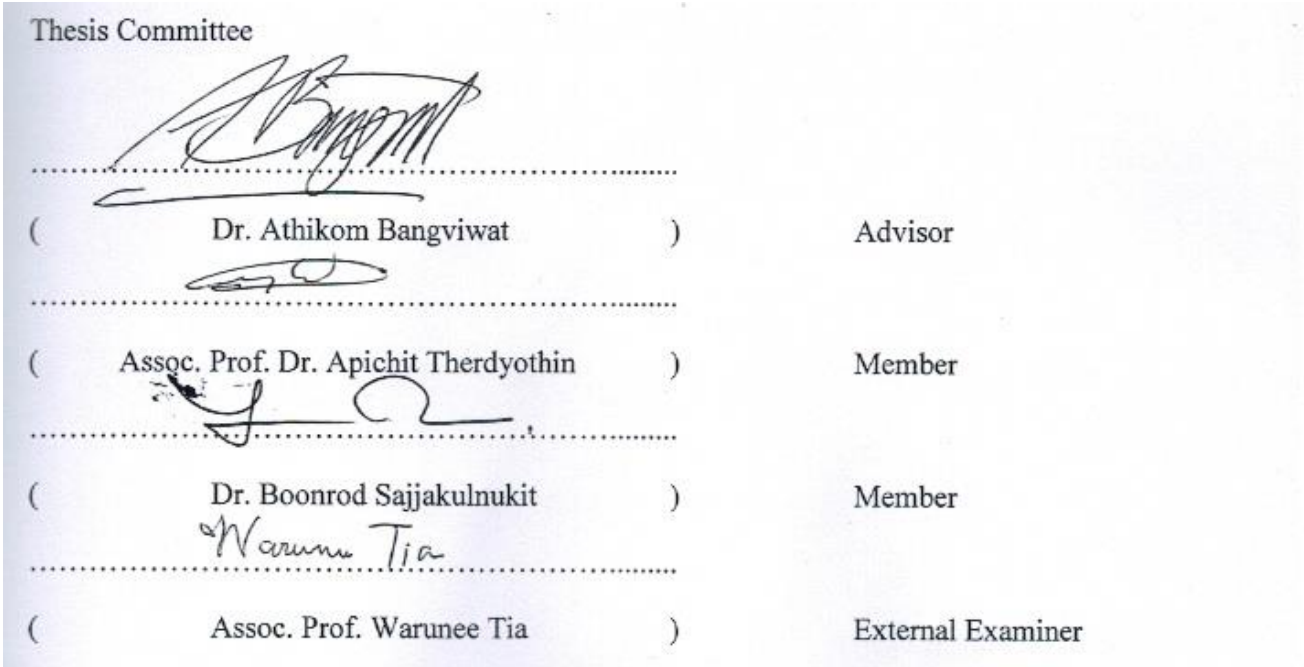

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ABSTRACT

Currently the industrial sector in Thailand consumes 36.7% of the total final energy consumption. The major energy consumed in this sector was electricity, which shared 26.0% of its energy consumption. The industry sector is one of the largest energy-consuming markets in Thailand. In this study, using a core equation, the electric technical savings potential for Thai industrial sector in 2013 is estimated to be 11,500 GWh (17.1% of total base usage). Cost-effectiveness test by using the Benefit-to-Cost ratio represents the electric technical savings potential for Thai industrial sector in 2013, accounted for 9,635 GWh (14.4% of total base usage). According to EPPO informed in 20-year EEDP in 2010, electric technical savings potential in the year of 2030 was estimated accounted for 33,500 GWh, which is lower than our calculation accounted for 41,213GWh. Therefore, our technical potential can be feasible. Nevertheless the achievable estimation results to far from those. The fabricated sector represents the largest electric savings potential, i.e. 2,872GWh, as in technical perspective in based year 2013. The food and beverage sector represents the largest electric savings potential, i.e. 2,325GWh, as in economic perspective. As penetration rate perspective Electric achievable savings potential for Thai industrial sector cumulative 2014 – 2030 is 120,305 GWh. In addition, the cross-cutting electricity efficiency measures inference practically which demonstrate in high sequence of total achievable cumulative savings potential accounted for 98,585 GWh in the period or about 82% of the total achievable cumulative savings potential of all economic measures. Those efficiency measures involving pumps, compressed air, and fans are utility systems supporting production processes able to operate completely which are the highest range to get electric energy saving potential in Thai industrial sector as the same in the global study. Recommendation, to particularly adopt those cross-cutting efficiency measures into energy management in factories enormously obtains electricity savings also meaning cost savings.

Keywords: Energy Efficiency, Demand Side Management Potential, Thai Industrial Sector, The Benefit-to-Cost Ratio,

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CHAPTER 1
INTRODUCTION

1.1 Rational/Problem Statement

In 2012, Thailand's economic growth grew by 6.4% due to both domestic demand and the external sector. This resulted in an increase of final energy consumption by 3.9% and increasing of energy consumption in almost all economic sectors, share of energy consumption in industrial sector was 36.7% of the total final energy consumption, followed by transportation, residential, commercial, and agriculture respectively. Energy consumption in industrial sector increased 8.26% from the previous year. The major energy consumed in this sector were electricity, shared 26.0% of its energy consumption, followed by coal & lignite, renewable energy, petroleum products, natural gas and traditional renewable energy respectively (Figure 1.1) [1].

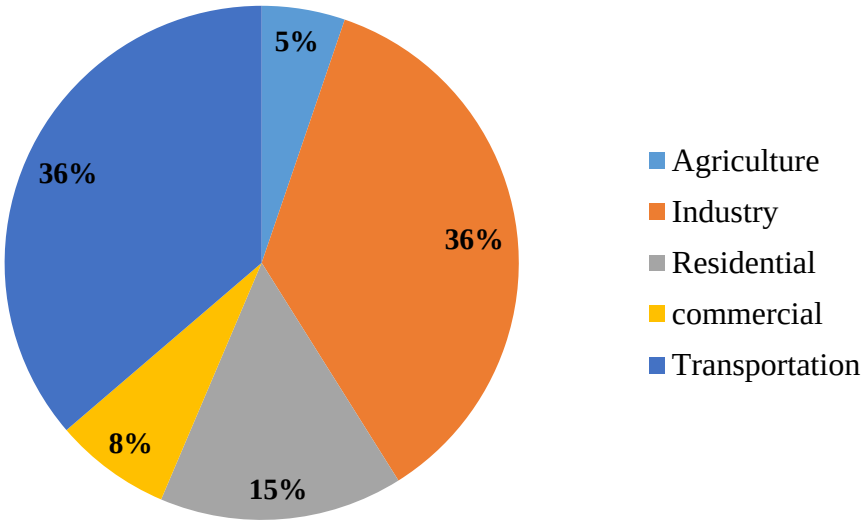


Figure 1 .1 Final energy consumption 2012 [1]

Since 1970, Demand Side Management (DSM) has been used as a management approach that focuses on reducing energy consumption and costs arising from the use of electricity. If DSM is implemented properly and consistently, it will have a positive impact both on consumers in reducing costs and the impact on the electricity industry in the field of power plant construction delayed increase in the future. Included is the ability to forecast the

electricity demand for assured energy management and energy plan for the future. Recently, several utilities and government agencies have set accelerated DSM targets for future years [2]. DSM is one of the best practical tools for balancing environmental protection and economic growth in the industrial sector. It can be improved by integrating into current electricity system reform. DSM objective is the major long-term objectives of a utility's DSM program which are to improve financial performance and customer relations.

In the coming decades, the industrial sector will drive the economy of various countries. Furthermore, this industrial sector always has a central role in developing the Thailand's economy. Since industrial sector is the most various sub-sectors, including food and beverages, textiles, wood and furniture, paper, chemical, non-metallic, basic metal, fabricated metal and other sub-sectors. It is difficult task to model energy efficiency policy for this sector [3]. Nevertheless industrial energy efficiency policies are the one of the main contributors to selection of energy efficient practices and technologies and will affect the degree of energy efficiency improvement that can be completed in Thailand.

This research first develops bottom-up energy conservation supply curves (CSC) model for the Thai industry sector. The cost-effectiveness is evaluated as well as the total technical potentials for energy effective improvement and carbon dioxide emissions reduction potential in this sector.

1.2 Literature Review

1.2.1 Energy situation in Thailand

We would not deny that energy is the key driver of the economy and the technology of the country has grown steadily. So, to the advancement of the country, resulting in the demand for energy is increasing especially in developing countries. This energy is mostly used now as exhaustible energy or cannot be created within a short time, it is also known as fossil fuels. If you had been using these energy sources of fuel, in short next, we would have to meet the energy crisis, or maybe it has already happened without our knowing it because of not know the energy value.

In 2012, Thailand had 73,316 tons of oil equivalent energy use increasing by 3.9% over the same period last year, totaling 1,827 billion baht. Factors that result in increased energy use as a result of the economy of the country. The oil is still the most used energy accounting for 48.0% of the total final energy consumption, followed by the traditional

electrical energy, renewable energy, coal / lignite, and natural gas accounted for 18.9%, 9.5%, 8.7%, 7.9%, and 7.0% respectively [1].

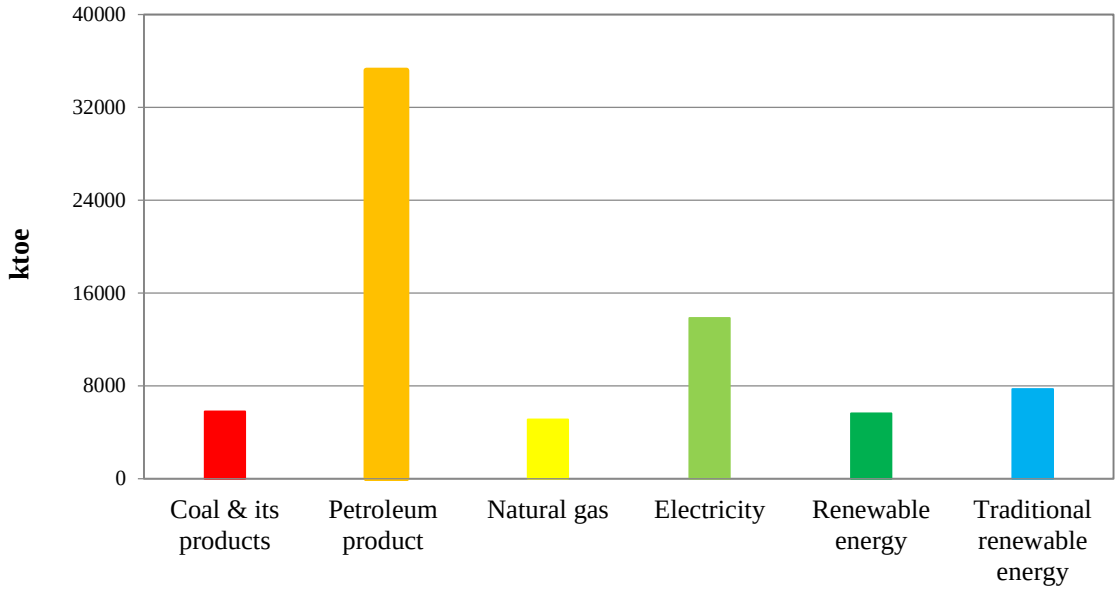


Figure 1.2 Final Energy Consumption by Energy Source in 2012 [1]

In 2012, the overall economic slowed down after growth in the previous period, including the private investment, private consumption, and exports in line with the deceleration in industrial production. However, economic fundamentals are still good by employment growth. Confidence is an upward trend in both the consumers and operators. Overall economic has stability and stable inflation and balance of payments surplus [4]. The concluded Thai economic growth from the accelerated repair of the previous year flood damage and the private sector has been a strong supporter of the government's stimulus package and favorable financial conditions. Although the economy has been affected by the slowdown of the world economy since the mid-year, the impact limited only with exports and industrial production for export -oriented production [1]. All of these factors result in increased energy use in 2012 by almost all economic sectors. From the previous year, energy consumption in the agriculture, industry, residential, and transportation sector increased by 2.82, 8.26, 0.39, and 2.99 respectively. While energy consumption in the commercial sector decreased by 3.77. Industry sector remains a field that has a higher proportion of energy consumption in other sectors, accounting for 36.7% followed by transportation, residential, commercial and agricultural, with 35.8%, 15.1%, 7.2%, and 5.2%, respectively.

Since Thailand energy resources are quite limited, especially oil. In 2012, oil was imported over 1,131 billion baht and the world crude oil average price was $108.3 per barrel. Which the government is promoting the use of renewable energy in the country increased, including increased energy efficiency. From reducing energy consumption per GDP (Energy Intensity), renewable energy was used 7,258 toes increased accounted for 12.5% over the same period. The energy efficiency is declining continuously.

Table 1.1 Final Energy Consumption 2010 - 2012

Economic Sectors	Energy Consumption (ktoe)			Growth (%)
	2010	2011	2012	2012
Agriculture	3,499	3,686	3,790	2.82
Industry*	25,571	24,856	26,910	8.26
Residential	10,963	11,040	11,083	0.39
Commercial	5,621	5,511	5,303	(3.77)
Transportation	24,594	25,469	26,230	2.99
Total	**70,248**	**70,562**	**73,316**	**3.90**

1.2.2 Overview of the 20-Year Energy Efficiency Development Plan (2011-2030)[5]

The 20-Year Energy Efficiency Development Plan (2011-2030) was developed by the Ministry of Energy of Thailand, for providing the policy plan and the energy conservation implementation for the long term. Due to the Thai government has foreseen, in future, the energy price trouble, the international competition for energy resource, environment impact, and climate change resulting from energy production and utilization which will be exacerbated. Hence, the main objective of this project has direct follow; (1) to set the energy conservation targets in the short term (five years) and in the long term (20 years), both at the national level and by energy-intensive economic sectors, i.e. transportation, industry, commercial and residential sector; (2) to lay down strategies and guidelines promoting energy conservation to achieve the targets specified under (1) above, and to lay down measures and work plans to serve as the framework for concerned agencies in formulating their respective action plans for energy conservation promotion.

1.2.2.1 Energy Conservation Targets and Potential in Industrial Sector

In 2007, APEC Leaders reached an agreement an energy conservation target to reduce "energy intensity" by 25% in 2030 with the 2005 base year (energy intensity, 16.2 ktoe per billion baht GDP) for strengthening regional energy security and solving climate change issues. Therefore, Thailand's energy consumption in 2030 must not exceed 12.1 ktoe in the year 2030 by following the mentioned agreement. The technical potential resulting presented that will have approximately energy-saving potential in the three main economic sectors 36,750 ktoe in 2030. The overall energy-saving in the industrial sector will have 13,790 ktoe, accounting for 37.5% of the total energy-saving potential in 2030, whereas, industrial electricity will save 33,500 GWh. In this way, this energy-saving is 22.5% higher than the specified target under the BAU case that can be accomplished by implementing energy conservation measures, as illustrated in Table 1.2. The energy consumption up to 2030 will increase only 3.0% of an annual average rate which will be increased at a lower rate than that of the economic growth.

Table 1.2 Shares of Energy Savings by Economic Sector in 2030

Economic Sector	Technical Potential			Specified Target (ktoe)	Share (%)
	Heat (ktoe)	Electricity (GWh)	Total (ktoe)		
Transportation	16,250	-	16,250	13,300	44.3
Industry	10,950	33,500	13,790	11,300	37.7
Commercial Building & Residential	2,510	52,650	6,710	5,400	18.0
Total	**29,710**	**86,150**	**36,750**	**30,000**	**100.0**

The energy conservation potential in the industrial sector was assessed into five main sub-sectors, i.e. non-metals, food and beverage, basic metals, chemicals, and paper. These clusters are the largest share of energy consumption that account for over 84% of the total energy consumption in industrial sector in 2009, as illustrated in Table 1.3. The roughly assessment of energy conservation technical potential was compared Thailand's current average specific energy consumption (SEC) in each sub-sector with the best SEC or best practice in other countries, in case no comparable foreign best practice, it was compared with

the best practice in Thailand of each sub-sector. Since, the best SEC of each sub-sector was derived to be the target for energy efficiency implementation in the next 20 years. Therefore, the forecast product output in 2030 was considered linkage with this best practice SEC, the assessment of overall energy conservation potential in each year up to 2030 can be made. In Table 1.3, the food and beverage has the highest saving potential accounting for 5,370 ktoe or 28% of the forecast demand followed by non-metal (2,500 ktoe), chemical (2,110 ktoe), paper (1,370 ktoe), and basic metal (300 ktoe).

Table 1.3 Energy Consumption and Energy Savings by Industrial Sub-sector

Industrial Cluster	Energy Consumption in 2009 (ktoe)	Share (%)	Energy Demand in 2030 under BAU Case (ktoe)[1]	Energy Saving Potential in 2030 (ktoe)	Potential Share Compared with the BAU Case (%)
Non-metal	7,406	31	19,510	2,500	13
Food and beverage	7,282	31	19,260	5,370	28
Chemical	2,439	10	4,830	2,110	44
Paper	1,836	8	6,460	1,370	21
Basic metal	1,030	4	2,700	300	11
Others[2]	3,202	16	9,940	2,140	22
Total	**23,195**	**100**	**62,700**	**13,790**	**22**

Remarks: [1]Assuming there is no change in the industrial structure and energy demand shares are constant.

[2]Estimated by using the average percentage of the overall industrial sub-sector potential

1.2.2.2 Strategies and Measures

This plan recommends to use the existing strategies approaches and measures with including the implementation and expansion of measures. Moreover, it will be apply new measures that have proven to be successful in many countries for Thailand. The important topic should be considerable for propelling the energy conservation policy, as follows:

- Combined measure: mandatory via rules, regulations and standards; and promotional and supportive via incentive provision
- Measures that will bring about a wide impact in terms of awareness raising and changes in energy consumption behavior of energy consumers, including decision-making behavior of business operators (market transformation)

- Public-private partnership to promote and implement energy conservation measures
- Propagation of energy conservation to public and private agencies/ organizations which are readily equipped with resources and expertise
- Using professionals as an important tool to provide consultancy involving advanced technologies
- Increase in self-reliance in indigenously developed technologies to reduce technological costs and to increase access to energy-efficiency technology, including promotion of highly energy-efficient product manufacturing processes

Following widely taking counsel with and hearing from business, the general public, academic and government sectors, for the implementation of this plan, five strategic approaches are introduced and applied that require low investment capital while yielding high energy savings. There are three strategic approaches for the industrial sector such as I, II, and IV. Here is shown only measures of strategic approaches involving the industrial sector. The strategic approaches and measures are as follow:

I. Mandatory Requirements via Rules, Regulations and Standards

- Enforcement of minimum energy of processing standard (MEPS)

II. Energy Conservation Promotion and Support

- Benchmarking the amount of energy used per unit of products (SEC)

III. Public Awareness (PA) Creation and Behavior Change

IV. Promotion of Technology Development and Innovation

- Promotion of R&D to improve energy efficiency of the production process

V. Human Resources and Institutional Capability Development

Table 1.4 Annual Targets of Final Energy Saving

Economic Sector	Energy Type	Annual Target of Final Energy Savings					Annual Average Value of Energy Saving Achieved (M Baht)
		2011	**2012**	**2013**	**2014**	**2015**	
Transportation	Electricity (GWh)	-	-	-	-	-	**28,700**
	Heat (ktoe)	433	861	1,293	1,743	2,235	
	Total (ktoe)	**433**	**861**	**1,293**	**1,743**	**2,235**	
Commercial Building & Residential	Electricity (GWh)	1,371	2,661	3,999	5,389	6,909	**17,900**
	Heat (ktoe)	63	123	185	249	319	
	Total (ktoe)	**180**	**349**	**252**	**708**	**908**	
Industry	Electricity (GWh)	915	1,777	2,670	3,597	4,612	**9,100**
	Heat (ktoe)	299	580	872	1,175	1,506	
	Total (ktoe)	**377**	**731**	**1,100**	**1,482**	**1,899**	
Grand Total (ktoe)		**1,000**	**1,942**	**2,913**	**3,932**	**5,041**	**55,700**

The framework of energy conservation measures and work plans by theneconomic sector are divided into three parts as follows:

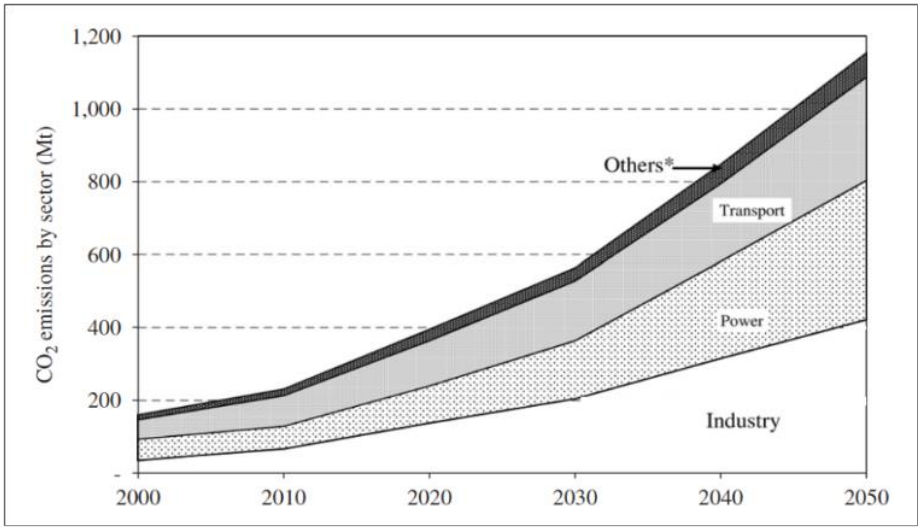
1) Short term (2011-2015)
2) Medium term (2016-2020)
3) Long term (2021-2030)

For the first five years, the energy conservation target details are shown in Table 1.4

1.2.3 Energy and CO_2 intensities of the Thai industry

The log-mean Divisia decomposition technique was used to investigate the energy and CO_2 intensities from the use of energy of Thai industry over a period of 20 years (1981-2000). Their studies indicate that both energy intensities and CO_2 intensity declined to some period that relate to economic situation. In the period of economic boom, intensities increased considerably. An increase in energy intensity and a switchover to a carbon intensive fuel mix were the important factors for the reversal, although structural effects mitigated the overall increase in intensities. However, this analysis reported the sub-sector that played an important role in deciding the intensities were food and beverages, nonmetallic mineral and chemical industries in this period.[6] In 2007, energy system development and its associated

greenhouse gas and local air pollution emission was examined under four scenarios in Thailand through 2050. Their analyses resulted, because of increasing demand for energy and increasing motor vehicles in Thailand, total CO_2 emissions is also estimated to increase in the future. The industry sector would account for the most in total CO_2 emissions in 2050 at 38%, followed by power (33%), transport (23%), and the agriculture, commercial and residential sectors combined (6%) as illustrated in Fig. 1.3. [7]



Note: *Others include agriculture, commercial and residential sectors.

Figure 1.3 Sector-wise CO_2 emissions under the dual track scenario during 2000-2050 (Mt) [7]

The cement industry is one of the largest CO_2 emitters in the Thai industry. The bottom-up abatement cost curve model was used to analyze 41 CO_2 abatement technologies and measures for the cement industry during the 15-year (2010-2025) scenario period. The cost-effective annual CO_2 abatement potential over 15 years is equal to 3095 $ktCO_2$/year, this is about 15% of the Thai cement industry's total CO_2 emissions in 2005. The total technical annual CO_2 abatement potential is 3143 $ktCO_2$/year which is about 15.2% of the Thai cement industry's total CO_2 emissions in 2005. And the Iron and steel industry is also one of the most energy-intensive industries. [8] The electricity consumption was indicated that it was a major source of greenhouse gas emission at 58.42%, followed by fuel combustion (33.17%) and chemical reaction (8.41%). Energy and CO_2 intensity of semi-finished steel product was 1.98 GJ/ t product and 0.44 tCO_{2eq}/t product, respectively. While, the energy and CO_2 intensity of finished steel product was 1.63GJ/ t product and 0.17

tCO_{2eq}/t product, respectively. Besides, they recommended that the improvement of electricity consumption efficiency is to be first priority for GHGs mitigation in Thai industry. [9]

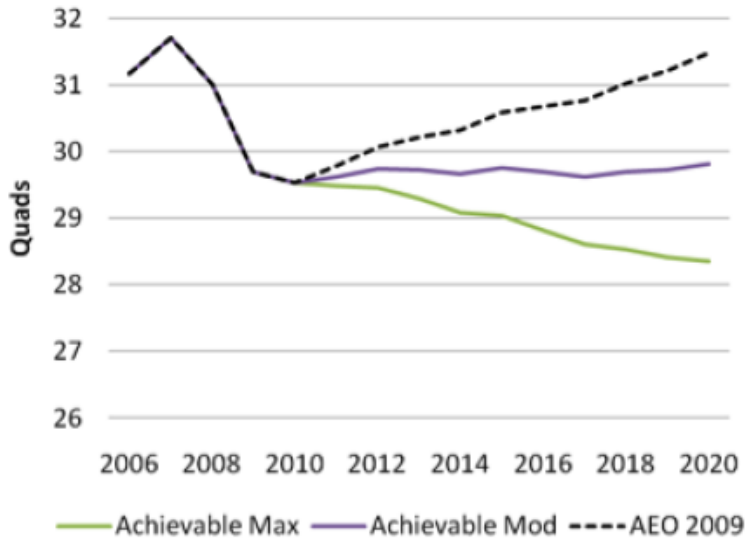


Figure 1.4 Achievable Energy Efficiency Potential in the South Could Bring Energy Consumption in 2020 Down to Below Current Levels [10]

1.2.4 Potential for DSM in the industrial sector

In 2009, more than 250 estimates of the energy efficiency potential were reviewed for different fuels (electricity, natural gas, and all fuels), sectors of the economy (residential buildings, commercial buildings, and industry), and types of potential (technical, economic, maximum achievable, and moderate achievable). This review concluded that the full deployment of energy-efficient technologies could bring energy consumption in 2020 down nine percent below projected levels, which would bring future consumption to slightly less than the present levels, as shown in Figure 1.4By "full deployment" the report means the maximum achievable energy efficiency potential that is also cost-effective. The review concludes that the South has the technical potential to reduce its energy consumption over the next decade by two percent per year, but some of this potential is not cost-effective at current energy prices. The region has the economic potential to reduce its energy consumption by 1.5 percent per year, but some of this potential is not achievable with feasible policy interventions. With vigorous policies, it is possible to reduce energy

consumption in the South by one percent per year, which would more than eliminate the projected growth in energy demand in the region.[10]

Demand Side Management (DSM) involves co-operative action by the utility and the consumer to modify the consumer load curve resulting in savings to the consumer, utility and society. DSM is one of the best and most practical policy tools for balancing environmental protection and economic growth. The method how to fit demand side management (DSM) into current Chinese electricity system reform was discussed. Chinese DSM policy can be upgraded as part of the current round of electricity system reform. The System Benefit Charge (SBC) is a policy tool that is implemented by adding small charges to consumer tariffs. The United States, Norway, Spain, Denmark and including Thailand have adopted this approach in order to support energy efficiency programs. Comparing the advantages and disadvantages of raising electricity price with SBC, he has argued that electricity reform will definitely take a long time. In contract, SBC would much more easily gain support among policymakers and stakeholders in a short time. Furthermore, he has discussed three kind of price discrimination related to the DSM development on China. First, time-based electricity pricing is a special case of price discrimination in which producers charge different rates for given good or service depending on the time, day, month, and so on. This kind of price discrimination can be used as a policy tool to improve the load management level that can temporarily reduce lighting and air conditioning at peak hour. Second, electricity price discrimination for industrial structure adjustment in China aims at reducing power shortage, restraining excessive expansion to upgrade their energy-saving technology and industrial structure. This kind of price discrimination has achieved a significant energy conservation and emission reduction effect. And the last, direct power purchases by large customers and preferential tariff policy can be combined with DSM and energy efficiency policy. [11]

Electricity utility DSM programs attempt to reduce electric loads from the end-user or consumer through energy efficiency and load-shaping measures. DSM programs stimulated by site incentives, requirements, and financial structure could reduce the amount of electricity a utility must provide, thus decreasing the need for new generation sources [12]. The technical and economic potential of energy-intensive industries was investigated to provide demand side management in electricity and balancing market through 2030. Their result showed that integrating wind capacities will lead to an increased demand for balancing power. Moreover, they estimated the impact of DSM stemming from large-scale industrial

processes on utilities. The results show that these processes could be able to provide approximately 50% of capacity reserves but it not used to provide balancing power in real-time due to the high costs of load reduction. [13]

In Thailand, Long-range Energy Alternatives Planning was used to assess the energy efficiency in the industrial sector. They result that the most efficiency option for small industries is the efficiency in boilers and furnaces accounting for 1,112 ktoe of energy demand reduction. Moreover, it helps in the reduction of CO_2 emission approximated 1.35 million tonnes.[14] A bottom-up electricity Conservation Supply Curve (CSC) modal was used to estimate the cost effective and the total technical electricity-efficiency potential for the Thai cement industry in 2008. The fuel CSC model showed that the cost-effective electricity-efficiency potential and the total technical electricity-efficiency potential accounting for 8% and 51% of the total fuel used in cement industry in 2005, respectively. Besides, the cost-effective fuel-efficiency potential and the total technical fuel-efficiency potential accounted for 16% and 19% of the total fuel used in cement industry in 2005, respectively. Moreover, they analyzed energy policy that show the most effective and efficient policy scenario to be the introduction of an energy-related CO_2 tax for the cement industry under the voluntary agreement program. [8]

1.3 Objective

Following the 20-year energy efficiency development plan's (2011-2030) objective to construct a top-down approach, this study aims to show the energy-saving potentials, under the bottom-up approach, for the industrial sector in Thailand. According to DSM potential, the technical potential savings are determined from the implementation of energy efficiency measures by constructing the bottom-up Energy Conservation Supply Curve for the industrial sector. Next the economic potential for the industrial sector are estimated by using the Benefit-to-Cost Ratio. Finally emission-reduction potentials are also estimated from energy-savings. Because the industrial sector has been the one of the most energy intensive sector in Thailand, if the energy use and CO_2 emission of this sector can be really reduced, the overall economic strength and environmental concern can be benefited for our country in a substantial and significant scale.

1.4 Scope and approach

In this study, three basic types of Demand Side Management potential were estimated.

- **Technical potential,** defined as the complete penetration of all measures analyzed in applications where they were deemed technically feasible from an engineering perspective, or the theoretical maximum amount of energy use that could be displaced by the technology being evaluated, disregarding all non-engineering constraints
- **Economic potential,** defined as the subset of technical potential that is economically cost-effective (e.g. as compared to conventional supply-side energy resources). Estimated economic potential does not address market barriers to implementation
- **Achievable potential,** defined as the maximum achievable potential as the amount of economic potential that could be achieved over time under the most aggressive program scenario possible. Maximum achievable potential is really a type of program potential that defines the upper limit of savings from market interventions.

Estimating technical, economic, and maximum achievable potentials are necessary steps in the process from which important information can be obtained; however, the end goal of the process is a better understanding of how much of the remaining potential can be captured, whether it would be cost-effective to increase spending, and how costs may be expected to change in response to measuring adoption over time.

The method used for estimating potential is a "bottom-up" approach in which energy-efficiency costs and savings are assessed at the customer-segment and energy-efficiency measure level. For cost-effective measures (based on the Benefit-to-Cost ratio), savings potential was estimated as a function of measure economics, rebate levels, and marketing efforts.

The key steps of developing a DSM forecast uses in this study maintain the analysis steps identified by KEMA as a three-step process.

Step 1: Develop Initial Input Data

- Develop list of energy efficiency measure opportunities to include in the scope
- Gather and develop technical data (costs and savings) on efficient measure opportunities
- Gather and develop Thai electric price data in 2013

Step 2: Estimate Technical Potential and Develop Supply Curves

- Match and integrate data on efficient measures to data to produce estimates of technical potential and energy efficiency supply curves.

Step 3: Estimate Economic Potential

- Gather economic input data such as current and forecasted retail electric prices and current and forecasted costs of electricity generation, along with estimates of other potential benefits of reducing supply, such as the value of reducing environmental impacts associated with electricity production
- Match and integrate measure and data with economic assumptions to produce indicators of costs from different viewpoints (e.g., utility, societal, and consumer)
- Estimate total economic potential using supply curve approach

Step 4: Estimate Achievable Potential

- Estimate total achievable potential for 2014-2030

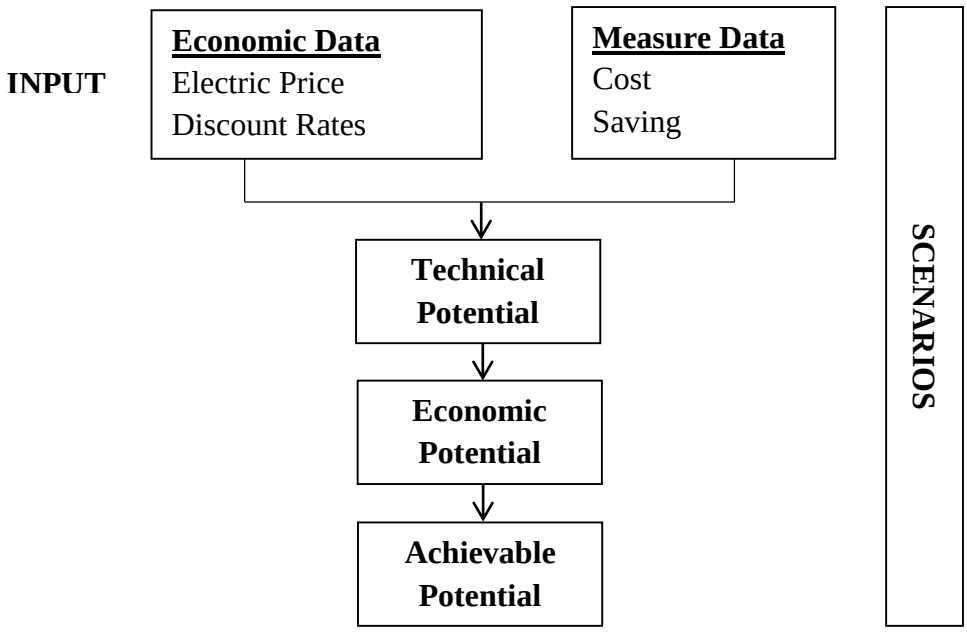


Figure 1.5 Simplified conceptual overview of study process

CHAPTER 2
THEORIES

2.1 Core Equation

The energy technical potential is calculated by using the core equation for each individual efficiency measure as shown below (using a commercial example) in Equation 2.1: [15]

$$\begin{array}{c}\text{Electric}\\ \text{Technical Potential}\\ \text{of Efficient Measure}\end{array} = \begin{array}{c}\text{Total Electric}\\ \text{Consumption}\end{array} \times \begin{array}{c}\text{Applicability}\\ \text{Factor}\end{array} \times \begin{array}{c}\text{Incomplete}\\ \text{Factor}\end{array} \times \begin{array}{c}\text{Feasibility}\\ \text{Factor}\end{array} \times \begin{array}{c}\text{Energy Saving}\\ \text{Factor}\end{array} \quad (2.1)$$

The technical potentials are assumed to be instantaneous replacements of standard-efficiency with high-efficiency measures.

where:

- **Total electric consumption** is the total electric consumption for all industries in the sector.
- **Applicability factor** is the fraction of the industry that is applicable for the efficient technology in a given industry sector.
- **Incomplete factor** is the fraction of applicability that has not yet been converted to the efficient measure.
- **Feasibility factor** is the fraction of the applicability that is technically feasible for conversion to an efficient technology from an engineering perspective.
- **Savings factor** is the reduction in energy consumption resulting from application of the efficient technology.

2.2 The Incomplete Factor

As mentioned above, the core equation was used to calculate the electric technical potential for each individual efficient measure by using effective factors; applicability, incomplete, feasibility, and savings factor. These factors were adopted from the study of California's Industrial Existing Construction Energy Efficiency Potential [42]. Accordingly the incomplete factor that was used in this study wasn't accurate for estimating Thai electric technical potential because this factor is the faction of applicable that has not yet been

converted to the efficient measure. Due to each city has different efficient energy management establishment, the incomplete factor is variant.

2.3 The Concept of Conservation Supply Curve

The conservation supply curve (CSC) is used to describe and compare the different options for energy conservation in a clear way [16]. It captures both the engineering and the economic perspectives of energy conservation and shows the quantity of conserved energy as well as the costs related to specific saving options [3]. Thus provide an indication of which options are to be preferred to ensure cost-effectiveness. According to, CSCs play a key role in many energy policy models that forecast energy demand.

CSC is constructed typically based on the evaluation of a conservation options, uch as the introduction of high- efficiency electric motors. For each of the considered options, the conservation potential and the related specific costs are assessed and the options are ranked according to their costs. The individual options are plotted on the graph in a least-cost order from left to right. As a result, the curve is shaped like a ladder, where each step represents one conservation option. If CSC are used in energy models to determine the decision to invest in conservation techniques, all the options upto this intersection point would be implemented and would reduce the resulting energy demand. [16]

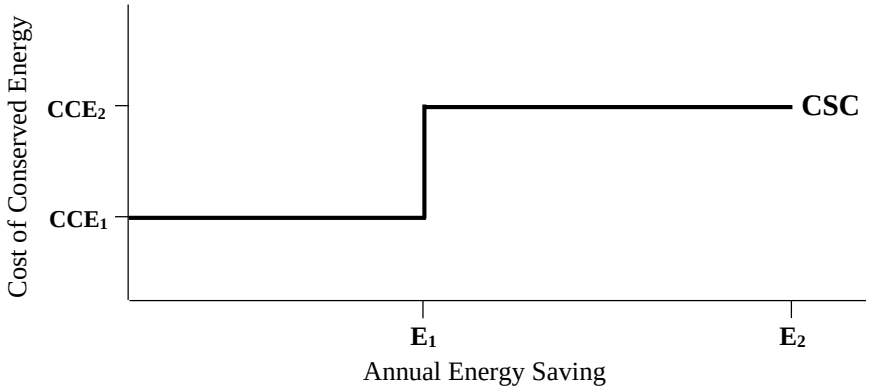


Figure 2.1 Energy Conservation Supply Curve

CSCs show the cumulated annual energy saved by that measure on the x-axis and the marginal cost of conserved energy related to these saving on the y-axis as illustrated in Figure 2.1. Each step in the figure represents an energy saving technique that improves the energy efficiency without changing the level of output. Each technique saves an amount of

the energy per year against certain investment and maintenance costs [17]. The Capital Recovery Rate can be calculated by Equation 2.2. [3]

$$\text{Capital Recovery Rate} = \frac{Annualized\ capital\ cost + Annual\ change\ in\ O\&M\ cost}{Annual\ energy\ saving} \quad (2.2)$$

The costs could be in Thai Baht, U.S. dollar, or any other currency. The energy savings could be in giga Joules (GWh) or any other energy unit. The annualized capital cost can be calculated from Equation 2.3.

$$Levelized\ cost = Capital\ Cost\left(\frac{d}{1-(1+d)^{-n}}\right) \quad (2.3)$$

where: d: Discount rate

n: Lifetime of energy efficiency measure.

The choice of discount rate used for calculating annualized capital costs has significant implications for the cost-effectiveness of energy efficiency measures. Since, measure costs are usually appeared in the first year, measure benefits occur in the life of the energy efficiency measure. [18] In the next section, the content of the discount rate is described.

2.4 Discount Rate

The discount rate is an indicator of a consumer's valuation of their future benefits from current investment. In terms of the investments in energy efficiency, the discount rate indicates how much they are willing to pay for energy efficiency today so that they derive benefits in terms of energy savings in the future. A larger discount rate means the consumer values the benefits in the near term more than the benefits in the future. The present value of any investment can be calculated by discounting the expected benefits at the discount rate. It can then be assumed that a consumer invests for an energy efficient measure if their present value of the benefits exceeds the incremental cost over an average measure. Thus, discount rates can be helpful in estimating the price at which a typical consumer will invest for an energy efficient measure. In the followings sub-sections, we will look at the factors that affect discount rates and the typical discount rates that consumers use while making energy efficiency investments.

There are three commonly accepted reasons for the discount rate [18]:

- Inflation
- Time value of money
- Risk

In this study, the real discount rate is assumed for the base case scenario to indicate the barriers to energy efficiency investment in the Thai industry sector, such as perceived risk, lack of information, management concerns about production and other issues, capital constrains, and preference for short payback periods and high internal rates of return [19], [20].

2.5 Structure of the Cost-Effectiveness Tests [21], [22]

The cost-effectiveness tests are used to evaluate energy efficiency measures and programs. All the cost-effectiveness tests use the same fundamental approach in comparing costs and benefits. However, each test is designed to address different questions regarding the cost-effectiveness of energy efficiency programs.

The basic structure of each cost-effectiveness test involves a calculation of the total benefits and the total costs in dollar terms from a certain vantage point to determine whether or not the overall benefits exceed the costs. A test is positive if the benefit-to-cost ratio is greater than one, and negative if it is less than one. The results are reported either in net present value (NPV) dollars (method by difference) or as a ratio (i.e., benefits/costs). Equation 2.4 outlines the basic approach underlying cost-effectiveness tests.

$$Net\ Benefits_t = \sum NPV\ Benefits_t - \sum NPV\ Costs_t \quad (2.4)$$

$$Benefits - Costs\ Ratio_t = \frac{\sum NPV\ Benefits_t}{\sum NPV\ Costs_t} \quad (2.5)$$

where: NPV: the net present value of the benefits and costs

Cost-effectiveness test results compare relative benefits and costs from different perspectives. A benefit-cost ratio above 1 means the program has positive net benefits. A benefit-cost ratio below 1 has been meaning the costs exceed the benefits. A first step in analyzing programs is to see which cost-effectiveness tests are produce results above or below 1.

CHAPTER 3
METHODOLOGY

3.1 Estimating Technical potential and Developing Energy-Efficiency Supply Curve

Technical potential can be defined as the theoretical maximum amount of energy savings or peak demand reduction which would occur with the complete comprehension of all measures analyzed in applications where they were deemed technically feasible from an engineering perspective. Total technical potential is developed from estimates of the technical potential of individual measures which are calculated on the basis of literature sources.

The Conservation Supply Curve (CSC) is a common tool that captures both the engineering and the economic aspects of energy conservation [3]. The curve shows the potential of energy conservation as a function of marginal cost of the conserved energy. In this study, as mentioned above, the discount rate was assumed in the calculation of cost of conserved energy in CSCs to reflect the barriers to energy efficiency investment in the Thai industrial sector.

3.2 Energy-efficiency technologies and measures for industry sector

This subsection provides descriptions of the industrial measures. The first measure that cuts across industries is described, followed by descriptions of the industrial specific measures.

Table 3.1 Cross-cutting Electricity Efficiency Measures [15], [23]

INDUSTRIAL MEASURES	
Cross-Cutting Electricity Efficiency Measures	
Measures	**Details**
Motors	
Replace motors	To replace existing motors with high-efficiency motors
Adjustable speed drives (ASDs)	To adjust motor speed drives match to load

Table 3.1 Cross-cutting Electricity Efficiency Measures (cont') [15], [23]

INDUSTRIAL MEASURES	
Cross-Cutting Electricity Efficiency Measures	
Measures	**Measures**
Motors	
Motor practices	Proper motor maintenance
Compressed air	
Operation and maintenance (O&M)	Better maintenance to decrease costs
Turn off unnecessary compressed air	To turn off unneeded compressors or delay bringing on additional compressors until needed
Reduce leaks in pipes and equipment	Leak repair and maintenance
Use air at lowest possible pressure	To perform at maximum energy efficiency such as minimizing pressure
Load management	To monitor whether in full operation or not, partial load operation should be avoided
Minimize pressure drop in design of distribution system	To minimize pressure drop to reduce energy loss
Sizing	The proper sizing compressors, regulators, and distribution pipes
Pumps	
Operation and maintenance (O&M)	Better maintenance to decrease cost
Controls	To shut of unneeded pumps, or alternatively, to reduce pump load until needed
System optimization	To perform at maximum energy efficiency such as installing multiple pumps for variable loads
Sizing	To reduce pump size, peak load also
Cooling circulation pump-variation speed drives (VSDs)	To consider the installation of VSDs on cooling circulation pumps
Replace v-belts	To replace v-belt drives with direct couplings

Table 3.1 Cross-cutting Electricity Efficiency Measures (cont') [15], [23]

INDUSTRIAL MEASURES	
Cross-Cutting Electricity Efficiency Measures	
Measures	**Measures**
Building	
Replace T-12	To replace T-12 by T-8 and electronic ballasts
Replace fluorescent	To replace mercury or fluorescent lamps with metal halide lamp
Switch off/O&M	To train personnel to switch off light when not needed
Controls/sensors	To be shut off during non-working hours automatic controls such as occupancy sensors
Super T-8s	To use super T-8 fluorescent system
HVAC management system	
Cooling system improvements	To improve the efficiency of chillers by lowering the temperature of condenser water
Duct/pipe insulation/leakage	To install duct insulation and perform regular duct inspection and maintenance
Window film	To use low-emittance windows for improving window insulation
Programable thermostat	To control temperature settings of space heating, and cooling and optimize settings based on occupancy and use of the building
Setback temperatures (weekend and off duty)	To set back building temperature during period of non-use such as weekends or non-production times

Table 3.2 Sector-specific Efficiency Measures (Electricity) [15]

INDUSTRIAL MEASURES	
Sector-specific Efficiency Measures (Electricity)	
Measures	**Details**
FOOD and BEVERAGES	
Efficiency refrigeration-operations	To improve by applying appropriate setting

Table 3.2 Sector-specific Efficiency Measures (Electricity) (cont') [15]

INDUSTRIAL MEASURES	
Sector-specific Efficiency Measures (Electricity)	
Measures	**Details**
FOOD and BEVERAGES	
Optimization refrigeration	To optimize by improving the operation of compressors, selecting cooling system with high COP values, and etc.
Bakery processes	To reduce electricity consumption through selection of energy-efficiency equipment for the different processes
TEXTILES	
Drying (UV/IR)	To use direct heating methods such as infrared dryers
O&M/drives spinning machines*	To use new high-efficiency motors instead of re-winding, switching off equipment when not in use
Membranes for wastewater	To separate the water from contaminants by using semi-permeable membranes and applied pressure differentials
WOOD and FURNITURE	
Air conveying systems	To optimize the lay-out of the systems, reducing leakages, reducing bend in the system, and etc.
Optimize drying processes	To optimize by controlling heat recovery, insulation, and good maintenance
Heat pumps-drying	To recovery low grade heat from the drying process via a heat pump
PAPER	
Gap forming paper machine	To improve the drying capacity
High consistency forming	To enter the furnish (process pulp) more than double the normal consistency
Optimization control PM	To optimize the paper machine
Efficient practice printing press	To reduce production losses, switching off the press when not in use

Table 3.2 Sector-specific Efficiency Measures (Electricity) (cont') [15]

INDUSTRIAL MEASURES	
Sector-specific Efficiency Measures (Electricity)	
Measures	**Details**
PAPER	
Light cylinders	To reduce the weight of cylinders in the printing machine
CHEMICAL	
Clean room - controls	To reduce recirculation air change rate
Clean room - new designs	To use new design room for improved air filtration and the use of cooling towers in lieu of water chillers
Process control (batch + site)	To implement computer-based process controls for monitoring and optimizing energy consumption
Power recovery	To use recovered power for equipment operated at elevated pressure
Efficient desalter	To use alternative designs for desalting include multi-stage desalters and a combination of AC and DC fields
O&M - extruders/injection molding	To improve and maintenance procedures of extruders
Extruders/injection molding - multipump	To use multiple pumps and an appropriate control system
Direct drive extruders	To use a direct drive instead of a gearbox r belt
Injection molding - impulse cooling	To use impulse cooling for regulating the cooling water to increase cooling rate and reduce productivity
Injection molding - direct drive	To use a direct drive instead of a gearbox r belt
NON-METALLIC	
Efficient grinding	To use efficient grinding technologies including the use of high efficiency classifiers and separators
Process control	To implement computer-based process controls for monitoring and optimizing energy consumption

Table 3.2 Sector-specific Efficiency Measures (Electricity) (cont') [15]

INDUSTRIAL MEASURES	
Sector-specific Efficiency Measures (Electricity)	
Measures	**Details**
NON-METALLIC	
Top - heating (glass)	To use newer design with top-mountd electrodes improving and maintaining product quality and obtaining a higher share of stable glass
Autoclave optimization	To use autoclave for pressing materials
BASIC METALS	
Efficient electric melting	To reduce electricity consumption of the furnace
Process control	To implement computer-based process controls for monitoring and optimizing energy consumption
Near net shape casting	To use the direct casting of the metal into very nearly the final shape
FABRICATED METALS	
Optimization process (M&T)	To optimize the efficiency of painting processes such as reducing the airflow rate in paint booths
Scheduling	To optimize the scheduling of various pieces of equipment for reducing downtime
Efficient curing ovens	Including the optimization of oven insulation, the use of heat recovery techniques, and the use of direct heating methods
Machinery	To use high efficiency motors or speed control for machines
OTHER	
Scheduling	To optimize the scheduling of various pieces of equipment for reducing downtime
Efficient machinery	To use high efficiency motors or speed control for machines
Process control	To implement computer-based process controls for monitoring and optimizing energy consumption

3.3 Considerations for the Application of Some Energy Efficient Technologies

3.3.1 Motors Systems

Motors consume a lot of electricity in various industries and are used in the various systems of a plant, such as HVAC, compressed air, refrigeration and cooling, and some processes, such as stamping. When considering energy efficiency improvements to a facility's motor systems, there are seven important steps to motor system efficiency. These steps approach strives to optimize the energy efficiency of entire motor systems (i.e., motors, drives, driven equipment such as pumps, fans, and compressors, and controls), not just the energy efficiency of motors as individual components. Moreover, the energy supply and energy demand sides of motor systems is analyzed as well as how these sides interact to optimize total system performance, which includes not only energy use but also includes system operating time and productivity. The seven important steps to motor system efficiency include [23], [24]:

- **Identify the problem or objective:** to locate and identify all applications of motors in a facility, whether the problem occurring is infrequent or continuous, when they start to appear and changes to production or plant operation, etc.
- **Gather information:** to document the conditions and specifications of each motor to provide a current systems inventory, including motor system type, operational requirements, motor controls, and nameplate information.
- **Measure system operations:** to prepare a measure plan, evaluate the actual operational needs vs. its driven equipment, and compare measure data with design information.
- **Develop technical options:** to develop alternative solutions, calculate savings and estimate costs to implement and determine financial and operational feasibility, and identify technical options to increase system efficiency and meet production needs.
- **Evaluate proposals:** to collect information on potential repairs and upgrades to the motor systems, including the economic costs and benefits of implementing repairs and upgrades to enable the energy efficiency improvement decision-making process.

- **Implement the project:** if upgrades are pursued, to corroborate the savings with measurements and calculate savings compare actual savings with calculated saving.
- **Communicate:** to manage communicate progress for supporting further steps.

The motor system energy efficiency measures below indicate significant aspects of these important steps for motor efficiency, including replacing motors, matching motor speeds and loads, proper motor sizing, upgrading system components, etc.

Replace motors, when selecting a motor, it has various important factors including motor speed, horsepower, enclosure type, temperature rating, efficiency level, and quality of power supply. The choice of installation greatly depends on efficient motors with the conditions of motor working and the life cycle costs related to the investment. An efficient motor is typically the most economically attractive when replacing motors with annual operations or fines not exceeding 2,000 hours/year [23]. When selecting and purchasing a motor, it is also important to know up to 95% of a motor's costs can be attributed to the energy it consumes over its lifetime, while only around 5% of a motor's costs are typically attributed to its purchase, installation, and maintenance [25].

Motors that are oversized for the requirement of equipment can cause unnecessary energy losses. In this case, motor size should be reduced then peak loads on driven equipment can be reduced. On average for the U.S. industry, replacing oversized motors with properly sized motors saves 1.2% of total motor system electricity consumption [26]. Higher savings can often be realized for smaller motors and individual motor systems. When determining the proper motor size, the following data are needed: load on the motor, operating efficiency of the motor at that load point, the full-load speed of the motor to be replaced, and the full-load speed of the replacement motor [23].

Choosing a high efficiency motor has rules of thumb that are showed as follows [24]:

- Specify high-efficiency motors for new installations operating more than 3,500 hours/year
- Select high-efficiency motors for motors that are loaded greater than 75% of full load
- By new high-efficiency motors instead of rewinding old, standard-efficiency motors
- Specify high-efficiency motors when purchasing equipment packages

- Use high-efficiency motors as part of preventive maintenance

In some cases, to rewind an existing energy efficient motor may be cost-effective instead of purchasing a new motor. As a rule of thumb, when rewinding costs exceed 60% of the costs of a new motor, purchasing the new motor may be a better choice [25]. When rewinding a motor, it is important to choose a motor service center that follows best practice standards for motor rewinding, to reduce the loss that may occur efficiently. When best rewinding practices are implemented, efficiency losses are normally less than 0.5% to 1% [27]. However, the poor quality rewind motor may cause larger efficiency losses. It is therefore important to inquire whether the motor service center follows the Electric Apparatus Service Association (EASA) best practice standards [28].

Maintenance, the purposes of motor maintenance are to keep motor and motorfa. Motor maintenance measures can be classified as either preventative or predictive. Preventative measures, the purpose of which is to prevent unexpected downtime of motors, include electrical consideration, voltage imbalance minimization, load consideration, and motor ventilation, alignment, and lubrication. The purpose of predictive motor maintenance is to continuously observe motor temperature, vibration and other operating data to identify when it became necessary to update or change the motor before failure occurs [29]. The following sections show the major maintenance of the motor and make recommendations about services and testing [24].

- **Cleaning:** when a motor has dirt, it assaulted the insulation through attrition and/or absorption, and can be contaminated the lubricant and bearing damage. Dirt build up on the motor housing and fan openings increase the temperature of the motor, which will reduce performance and shorten the life of the motor.
- **Lubrication:** large motors periodically have problem is excess grease, which causes increased friction and leads to failure. Excess greasing is forced down on their windings to cause failure. Clean equipment before grease injection to avoid contamination.
- **Vibration:** A noticeable increase, or change in the vibration of a motor is an indication of bearing problems, load imbalances, bent shafts or electrical malfunctions. Incorrect belt tension and alignment can increase energy consumption and make shorter motor life.

- **Voltage Testing:** motor design work is outside the range of ±10% of working voltage with reduced motor life. Unbalanced phase voltage will cause very large rotor currents at higher temperatures and significantly increased motor losses. Measure and log the voltage at the terminals of the motor while it loads. Compare measurements with established norms can help identify the problem.
- **Insulation Testing:** The resistance test of the motor in normal life is to test the predictions that could reveal the deterioration of insulation. Reading should be given only once or twice per year.

The savings associated with an ongoing motor maintenance program are significant, and could range from 2% to 30% of total motor system energy use [30].

Adjustable speed drives (ASDs). Many systems almost operate with varying load requirements by using throttling methods to control flow. These traditional approaches that require the device to operate at a constant speed nearly full load. Energy lost from the decomposition, crosses the control mechanism. Energy is wasted by keeping a constant rate of energy consumption while the system does not to work and is not useful in the process. Speed control is a great opportunity to save energy by matching the speed of the equipment to the requirements of the actual process. ASDs is a great opportunity to save energy by matching the speed of the equipment to the requirements of the actual process. ASDs systems are offered by many suppliers and are available worldwide. An overview of savings achieved with ASDs was provided in a wide array of applications; typical energy savings are shown to wide vary between 7% and 60%.Many fans, pumps and compressor power requirements vary with the cube of the flow. Flow varies directly with the speed, so the 20% reduction in speed would result in a saving of about 50% in energy consumption [24].

Power factor correction: inductive loads such as transformers, electric motors, and HID lighting can cause a low power factor. Both real and reactive power are required for an induction motor to operate. The real power (kW) produces work and heat while the reactive power (kVAR) establishes the magnetic field in the motor. The 70% of power factor indicate that the electrical system is being used to produce useful work. Power factor can vary depending on the design and loading. A low power factor can cause the increasing of power consumption, and hence increased electricity costs. The low power factor can be solved by:

- Minimizing idling of electric motors (a motor that is turned off consumes no energy)
- Replacing motors with high-efficient motors (see above)
- Installing capacitors in the AC circuit to reduce the magnitude of reactive power in the system.

Minimizing voltage unbalances: unbalanced voltage decreases performance and shortens the life of three-phase motors. Voltage unbalance causes an unbalance in the current, which will result in torque pulsations, vibration and increased mechanical stress, loss are rising and motor overheating, which can reduce the life of the winding insulation motors. Voltage unbalances may be caused by the function of power factor correction device, an unbalance transformer banks or an open circuit. The voltage unbalance at the motor terminals should not exceed 1% as a rule of thumb. Even a 1% unbalance will reduce motor efficiency at part load operation, while an unbalance of 2.5% will decrease the performance of the motor at full load. For a 100 hp motor operating 8,000 hours per year, a correction of the voltage unbalance from 2.5% to 1% will result in electricity savings of 9,500 kWh [31].

3.3.2 Compressed Air Systems

Compressed air is probably the most expensive form of energy used in industry due to low efficiency. Typically, effective from the beginning to the end, with about 10% for compressed air systems [32]. Due to this inefficiency, if compressed air is used, it should be of minimum quantity for the shortest possible time, constantly monitored and reweighed against alternatives. In addition to the measures detailed below, many other motor-directed measures can also be applied to the compressors (see sections on motors and HVAC). Many opportunities to reduce energy in the compressed air systems are not prohibitively expensive. Payback periods for some options are extremely short-less than one year.

Operation and Maintenance: inadequate maintenance can lower compression efficiency and increase air leakage or pressure variability, and lead to increased operating temperatures, poor moisture control and excessive contamination. Better maintenance will reduce these problems and save energy.

Proper monitoring (and maintenance) can save a lot of energy and money in compressed air systems. Proper monitoring includes [33]:

- Pressure gauges on each receiver or main branch line and differential gauges across dryers, filters, etc.

- Temperature gauges across the compressor and its cooling system to detect fouling and blockages.
- Flow meters to measure the quantity of air used.
- Dew point temperature gauges to monitor the effectiveness of air dryers.
- kWh meters and hours run meters on the compressor drive.

Proper maintenance includes the following [32]:

- Blocked pipeline filters increase pressure drop. Keep the compressor and intercooling surfaces clean and foul-free by inspecting and periodically cleaning filters.
- Poor motor cooling can increase motor temperature and winding resistance, shortening motor life, in addition to increasing energy consumption. Keep motors and compressors properly lubricated and cleaned.
- Inspect fans and water pumps for peak performance.
- Inspect drain traps periodically to ensure they are not stuck in either the opened or closed position, and are clean. Some users leave automatic condensate traps partially open at all times to allow for constant draining. This practice wastes substantial amounts of energy and should never be undertaken. Instead, install simple pressure-driven valves. Malfunctioning traps should be cleaned and repaired instead of left open
- Maintain the coolers on the compressor and the aftercooler to ensure that the dryer gets the lowest possible inlet temperature [34].
- If using compressors with belt, check the belts for wear and adjust them. A good rule of thumb is to adjust them every 400 hours of operation.
- Check water cooling systems for water quality (pH and total dissolved solids), flow and temperature. Clean and replace filters and heat exchangers per manufacturer's specifications.
- Minimize leaks (see also Leaks section, below).
- Specify pressure regulators when close to failing.

Applications requiring compressed air should be checked for excessive pressure, duration or volume. They should be regulated, either by production line sectioning or by pressure regulators on the equipment itself. Tools not required to operate at maximum system pressure should use a quality pressure regulator. Poor quality regulators tend to drift and lose more air. Otherwise, the unregulated tools operate at maximum system pressure at

all times and waste excess energy. System pressures operating too high also result in shorter tool life and higher maintenance costs.

Turn off unnecessary compressed air: equipment that is no longer using compressed air should have the air turned off completely. This can be done using a simple solenoid valve. Compressed air distribution systems should be checked when the equipment has been reconfigured to be sure no air is flowing to unused equipment or obsolete parts of the compressed air distribution system.

Reduce leaks in pipes and equipment: leaks can be a significant source of wasted energy. A typical plant that has not been well maintained could have a leak rate between 20 to 50% of total compressed air production capacity [34], [35]. Leak repair and maintenance can reduce this number to less than 10%. Overall, a 20% reduction of annual energy consumption in compressed air systems is projected for fixing leaks [36].

The magnitude of a leak varies with the size of the hole in the pipes or equipment. A compressor operating 2,500 hours per year at 6 bar (87 psi) with a leak diameter of 0.02 inches (½ mm) is estimated to lose 250 kWh/year; 0.04 in. (1 mm) to lose 1100 kWh/year; 0.08 in. (2 mm) to lose 4,500 kWh/year; and 0.16 in. (4 mm) to lose 11,250 kWh/year [33]. The most common areas for leaks are couplings, hoses, tubes, fittings, pressure regulators, open condensate traps and shut-off valves, pipe joints, disconnect and thread sealants. A simple way to detect large leaks is to apply soapy water to suspect areas, or to use a bag to monitor the velocity of the air filling the bag, although this may be time-consuming. The best way to detect leaks is to use an ultrasonic acoustic detector, which can recognize the high frequency hissing sounds associated with air leaks. After identification, leaks should be tracked, repaired and verified. Leak detection and correction programs should be ongoing efforts. The General Motors Power train Group's Metal Casting Operations in Michigan has reduced energy consumption by over 21 million kWh/year by reducing compressed air leaks [37], [38].

Load management: due to the large amount of energy consumed by compressors, whether in full operation or not, partial load operation should be avoided. For example, unloaded rotary screw compressors still consume 15 to 35% of full-load power while delivering no useful work [32]. Centrifugal compressors are cost effective when operated at high loads [39].

Air receivers can be employed near high demand areas to provide a supply buffer to meet short-term demand spikes that could exceed normal compressor capacity. In this way,

required online compressors may be reduced. Multiple stage compressors theoretically operate more efficiently than single stage compressors. Many multi-stage compressors save energy by cooling the air between stages, reducing the volume and work required to compress the air [32]. Replacing single stage compressors with two-stage compressors typically provides a payback period of 2 years or less [34]. Using multiple smaller compressors instead of one large compressor can save energy as well. Large compressors consume more electricity when they are unloaded than do multiple smaller compressors with similar overall capacity. An analysis of U.S. case studies shows an average payback period for optimally sizing compressors of about 1.2 years [41].

Use air at lowest possible pressure: although system pressure may be higher, air used for a particular application should be at the lowest pressure needed.

Minimize pressure drop in design of distribution system. An excessive pressure drop will result in poor system performance and excessive energy consumption. Flow restrictions of any type in a system, such as an obstruction or roughness, require higher operating pressures than are needed. Pressure rise resulting from resistance to flow increases the drive energy on positive displacement compressors by 1% of connected power for each 2 psi of differential [32], [34]. Highest pressure drops are usually found at the points of use, including undersized or leaking hoses, tubes, disconnects, filters, regulators, valves, nozzles and lubricators (demand side), as well as air/lubricant separators on lubricated rotary compressors and aftercoolers, moisture separators, dryers and filters (supply side). A pressure reduction of 0.14 bar (2 psi) on a centrifugal air compressor results in savings of about 1% in electrical demand [39]. Typical pressure for an industrial plant system is 6.89 bar (100 psi).

Minimizing pressure drop requires a systems approach in design and maintenance. Air treatment components should be selected with the lowest possible pressure drop at specified maximum operating conditions and best performance. Manufacturers' recommendations for maintenance should be followed, particularly in air filtering and drying equipment, which can have damaging moisture effects like pipe corrosion. Finally, the distance the air travels through the distribution system should be minimized.

Sizing: regulators can provide the largest energy savings in compressed air systems. By properly sizing regulators, compressed air will be saved that is otherwise wasted as excess air. Also, it is advisable to specify pressure regulators that are close to failing. Inadequate pipe sizing can cause pressure losses, increase leaks and increase generating

costs. Pipes must be sized correctly for optimal performance or resized to fit the current compressor system. Increasing pipe diameter typically reduces annual energy consumption by 3% [36]. In a model developed in the Netherlands for a system of three compressors, increasing distribution pipe diameters from 3 to 4 inches (80 to 100 mm) was projected to save 37,000 kWh/year or 2.4% [33].

3.3.3 Heating, Ventilation and Air Conditioning (HVAC)

HVAC comprises a significant amount of the energy used. It is estimated that HVAC uses 11 to 20% of the electricity used in vehicle assembly plants, and fuel is mainly used for space heating and drying in painting. Many of the measures applicable to HVAC systems have been discussed under motors, compressed air, and heat and steam distribution. A few additional measures are discussed below.

Electronic controls can be as simple as on/off switches to be switched off during non-operating hours. Several industrial U.S. case studies have indicated an average payback period for computer controls for HVAC of about 1.3 years [40].

Weekend setback temperatures, setting building temperatures lower during the winter or higher during the summer over the weekend and during non-production times can save energy by reducing heating or cooling needs.

Ventilation and cooling system design improvements. New local ventilation and cooling systems and controls respond to current conditions in their plant, better matching ventilation or cooling output to demand. Three types of cooling systems exist: intermittent air supply systems where air is chilled only when workers are present; variable air volume (VAV) systems with constant temperature for local cooling; or variable air temperature (VAT) with constant volume for local cooling.

Recover cooling water from other sources to use in cooling chillers: the Boeing Company in Washington partnered with Puget Sound Power and Light and King County Department of Metropolitan Services (Metro) to recycle secondary treated cool water into its chiller system. By using this treated water from Metro, Boeing reduced its water use by 48 million gallons per year and projected savings of 20% in cooling energy [41]. They will also save on refrigerant and treatment chemicals for the cooling tower water.

Solar heating (Solarwall), Solarwall heating systems use conventional steel siding painted black to absorb solar radiation for insulation. Fresh air enters the bottom of the panels where it is heated as it passes over the warm absorber. Fans distribute the air.

Modifying fans, changing the size or shape of the sheaves of a fan can save energy by controlling the airflow and running at the design speed. Toyota cut the sheaves of its fans instead of installing ASDs, and found better savings and payback periods than they had anticipated from ASDs.

In the next subsection, economic potential is discussed and how to estimate as a subset of the technical potential.

3.4 Estimation of Economic Potential

Economic potential is typically used to refer to the technical potential of those energy conservation measures that are cost effective when compared to either supply-side alternatives or the price of energy. Economic potential takes into account the fact that many EE measures cost more to purchase initially than do their standard-efficiency counterparts. The incremental costs of each efficiency measure are compared to the savings delivered by the measure to produce estimates of energy savings per unit of additional cost. These estimates of EE resource costs can then be compared to estimates of other resources such as building and operating new power plants.

Cost effectiveness is used to estimate economic potential. It is necessary to develop a method by which it can be determined that a measure or program is economic. Moreover, cost-effectiveness test results compare relative benefits and costs from different perspectives. A benefit-cost ratio above 1 means the program has positive net benefits. A Benefit-to-Cost ratio below 1 means the costs exceed the benefits. A first step in analyzing programs is to see which cost-effectiveness tests are produce results above or below 1. [21] The costs and benefits of energy efficiency are qualitatively from those of supply-side resources in that they can have different implications for different communities. As a result, five cost-effectiveness tests have been developed to consider efficiency costs and benefits from different perspectives. Each of these tests combines the various costs and benefits of energy efficiency programs in different ways, depending on which costs and which benefits are appropriate to the different communities.

The somewhat simplified benefit and cost formulas for the Benefit-to-Cost ratio are presented in Equations 3.1 and 3.2 below:

$$Benefits = \sum_{t=1}^{N} \frac{Electric\ Bill\ Saving_t}{(1-d)^{t-1}} \quad (3.1)$$

$$Costs = \sum_{t=1}^{N} \frac{Implementation\ Cost_t}{(1-d)^{t-1}} \quad (3.2)$$

The first summation in Equation 3.1 should be used for conservation and load management programs.

3.5 Estimation of Achievable Potential

In contrast to technical and economic potential estimates, achievable potential estimates take into account market and other factors that affect adoption of efficiency measures. In this study, the primary curve shown in Figure 3-1 is considerably utilized. The effect of a financial incentive on the penetration of more energy-efficient devices can then be estimated to be proportional to the effect that increasing the benefit-to-cost ratio of the equipment would have in a market represented by the selected reference curve.

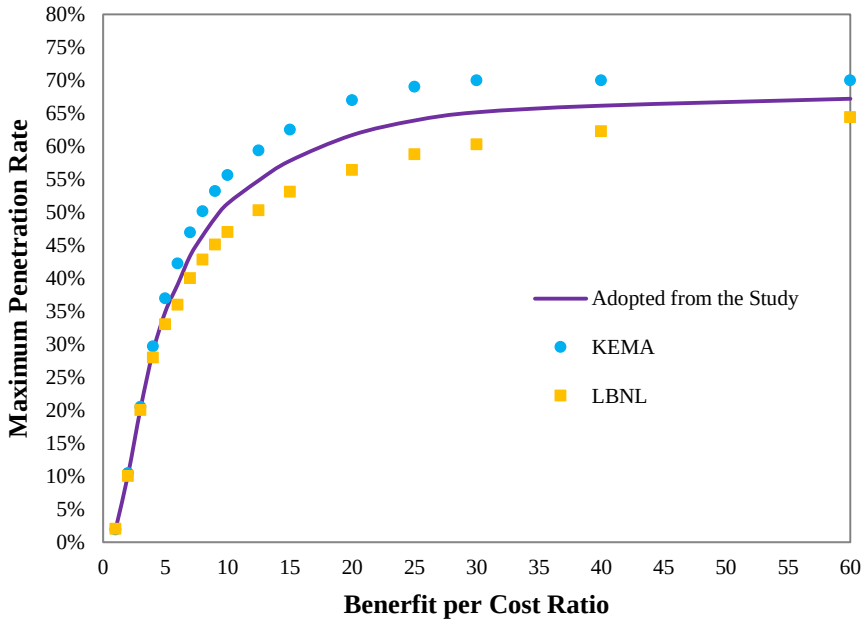


Figure 3.1 Market implementation curves for the Moderate Market Barrier levels [42, 43]

In Figure 3.1, the maximum penetration rate curves for the Thai industrial sector are plotted against the benefit-to-cost ratio. To build this curve, moderate market barriers are relied on to generate the penetration rate for Thailand. Therefore, the Thai maximum penetration rate was calculated by averaging KEMA and LBNL penetration rates at each

benefit-to-cost ratio. The benefit-to-cost ratio, sometimes refer to as payback simple which is calculated from participants perspective as energy bill savings over the life of the measure.

Achievable potential represents the amount of energy usage that efficiency can realistically be expected to displace assuming the most aggressive program scenario possible (e.g. providing end-users with payments for the entire incremental cost of more efficient equipment). This is often referred to as maximum achievable potential. Achievable potential takes into account real-world barriers to convince end-users to adopt efficiency measures.

CHAPTER 4
RESULTS AND DISCUSSION

This chapter presents estimates of electric technical, economic, and achievable energy efficiency potential for the industrial sector of Thailand.

4.1 Introduction

A total of 125 industrial electric measures were included in the analyses (see Appendix B) following KEMA. Since, we assumed that the set of measures in all Thai industrial sectors are same presently commercially available to provide a realistic assessment of potential. In this research, measure analysis was distinguished into 9 industrial sectors based on 2-digit Thailand Standard Industrial Code (TSIC-xx), as shown in Table 4.1.

Table 4.1 Mapping of Two-Digit SIC Codes to Two-Digit TSIC Codes for Manufacturing

2-digit Tsic	Industry
TSIC-31	Food and Beverages
TSIC-32	Textiles
TSIC-33	Wood and Furniture
TSIC-34	Paper*
TSIC-35	Chemical*
TSIC-36	Non-metallic
TSIC-37	Basic Metals
TSIC-38	Fabricated Metals*
TSIC-39	Other (Unclassified)

*: In calculation of electric savings potential for paper, chemical, and fabricated metal sector, the applicability, incomplete, feasibility factor and energy saving of these sector is averaged by electric usage ratio in each sub-sector.

As a result, these analyses were conducted for 1,125 measure-market sector applications. (Not all measures applied to every industrial sector) The technical, economic, and achievable potential results are presented in both absolute and percentage terms. The total electric database in 2013 for the whole country classified by 2 and 3 digits TSIC was

obtained from the Energy Policy and Planning Office (EPPO), Ministry of Energy, Thailand. In this study, the total electric usage in the whole Thai industry is roughly 67,000 GWh [44], which was estimated by the sum of measure applicable to each industrial sector.

It should be noted that, in this study, the methodology has a weakness involving inaccuracy of the applicability, incomplete, feasibility factor and energy saving of each industry. Those factors are used in foreign country not in Thailand. Therefore, in future work, the applicability, incomplete, feasibility factor and energy saving for Thai industrial sector should be study to accurately estimate electric savings potential.

4.2 Electric Technical and Economic Potential

Estimates of overall energy efficiency technical and economic potential and more details on these potentials are discussed in this section.

4.2.1 Electric Technical Savings Potential

The technical potential represents the savings that do not take into account the cost-effectiveness of the measure or the rate of the market acceptance of those measures (i.e. 100% customer acceptance assumed) that are deemed to be technically feasible. The evaluation of energy saving potential in the industrial sector is shown in Table 4.2. Total technical potential savings in 2030 for the whole Thai industry are 41,213 GWh, or approximately 28% of forecast Thai industry GWh sales in 2030 under no DSM case. The fabricated metal industry has the highest technical saving potential, i.e. 16,234 GWh, or 31% of the forecast demand. Next to it are food and beverage, chemical, basic metals, and non-metallic industry, with electric technical saving potential of 12,697 GWh, 4,385 GWh, 2,855 GWh, and 1,493 GWh respectively. The other (unclassified) industry has the least potential, i.e. 999 GWh.

In the past 12 years (2002-2013), electrical consumption in Thailand continuously increased at an annual average rate about 4.0%. In the year 2013, electric energy consumption was 1.46 times the amount it was in 2002.

In the next 17 years (2014-2030), if there is no bottom up approach or energy efficiency improvement measures, the energy unconstructed Demand Side Management will increase from 67,070 GWh in 2013, to 146,924 GWh in 2030, or about 2.19 times the present amount by using an average annual growth rate of 4.0% as mentioned above.

Table 4.2 Electric Technical Savings Potential by Industrial Sector

Industrial Sector	Energy Demand in 2030 (No DSM Case) (GWh)	Electric Technical Savings in 2030 (GWh)	Potential Share Compared with No DSM Case (%)	Cumulative Technical Savings (2014-2030) (GWh)
Food & Beverages	39,511	12,697	32	113,517
Textiles	5,955	749	13	14,638
Wood & Furniture	3,474	798	23	8,905
Paper	3,917	1,003	26	12,189
Chemicals	18,551	4,385	24	51,358
Non-metallic	7,903	1,493	19	22,511
Basic Metals	11,881	2,855	24	33,673
Fabricated Metals	52,520	16,234	31	140,669
Other (Unclassified)	3,213	999	31	8,397
Total	146,924	41,213	28	405,856

According to EPPO informed in 20-year EEDP in 2010, electric technical savings potential in the year of 2030 was estimated accounting for 33,500 GWh, which is lower than the calculation accounting for 41,213 GWh in 2030. Therefore, our technical potential can be feasible, but vigorous procedures in all measures would be required because the gap between 20-year EEDP's estimation and our potential is not too wide.

Table 4.3 Electric Economic Savings Potential by Industrial Sector

Industrial Sector	Economic Savings in 2030 (GWh)	Cumulative Economic Savings (2014-2030) (GWh)
Food & Beverages	11,900	106,384
Textiles	624	12,190
Wood & Furniture	722	8,065
Paper	910	11,053
Chemicals	3,495	40,932
Non-metallic	1,296	19,537
Basic Metals	3,363	36,535
Fabricated Metals	11,567	100,233
Other (Unclassified)	649	5,457
Total	34,526	340,385

4.2.2 Electric Economic Savings Potential

The economic potential represents the subset of the technical potential that is economically cost-effective. This potential considers only the cost of efficiency measures, ignoring program costs (e.g., marketing, analysis, administration). As shown below in Table 4.3, the result of our calculations for economic potential that obtained from the cost-effectiveness test involving benefit-to-cost ratio (e.g. a benefit-cost ratio above 1 means that is so called cost effectiveness of an energy efficiency measure). Total economic potential savings in 2030 for the whole Thai industry are 34,526 GWh, or approximately 23% of forecast Thai industry GWh sales in 2030.

4.2.3 Electric Technical and Economic Savings Potential by industrial Sector

Figure 4.1 is presents the estimates of technical and economic savings potential by industrial sector. The fabricated sector represents the largest electric savings potential, i.e. 2,872 GWh in 2013, as in technical perspective. It should be noted that, detail on technical and economic potential for electricity savings is presented in Appendix C. This appendix shows results by end-use and industrial sector. As shown in Figure 4.1, electric technical and economic saving potential are so close that are different equal to about 2% of forecast Thai industry GWh sales in 2030 because almost all measures are energy efficiency measures.

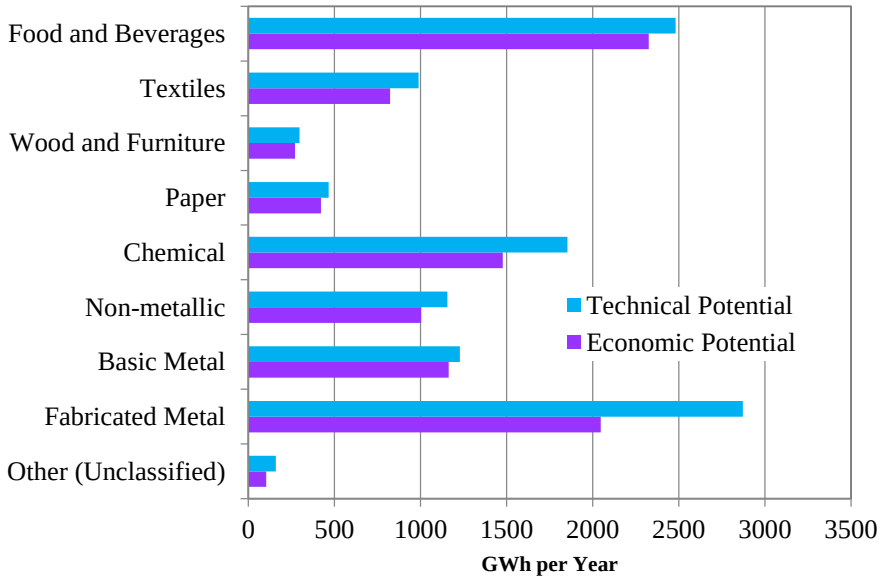


Figure 4.1 Industrial Electric Savings Potential by Industrial Sector, 2013 (Base Year)

4.2.4 Electric Technical and Economic Savings Potential by End Use and Industry

Estimates of energy savings potential is provided by end use in Figure 4.2. The left of the figure provides savings in absolute terms; the right, in term of the percentage of base case end-use energy. Pumping represents the largest end-use savings potential, followed by compressed air and lighting. While at the right of Figure 4.2, compressed air systems have the largest percentage of base case end-use energy that followed by pumping and lighting, both in technical and economic perspective. Therefore, the pump, compressed air, and lighting are the highest range to get electric energy saving potential in Thai industrial sector as the same in the global study.

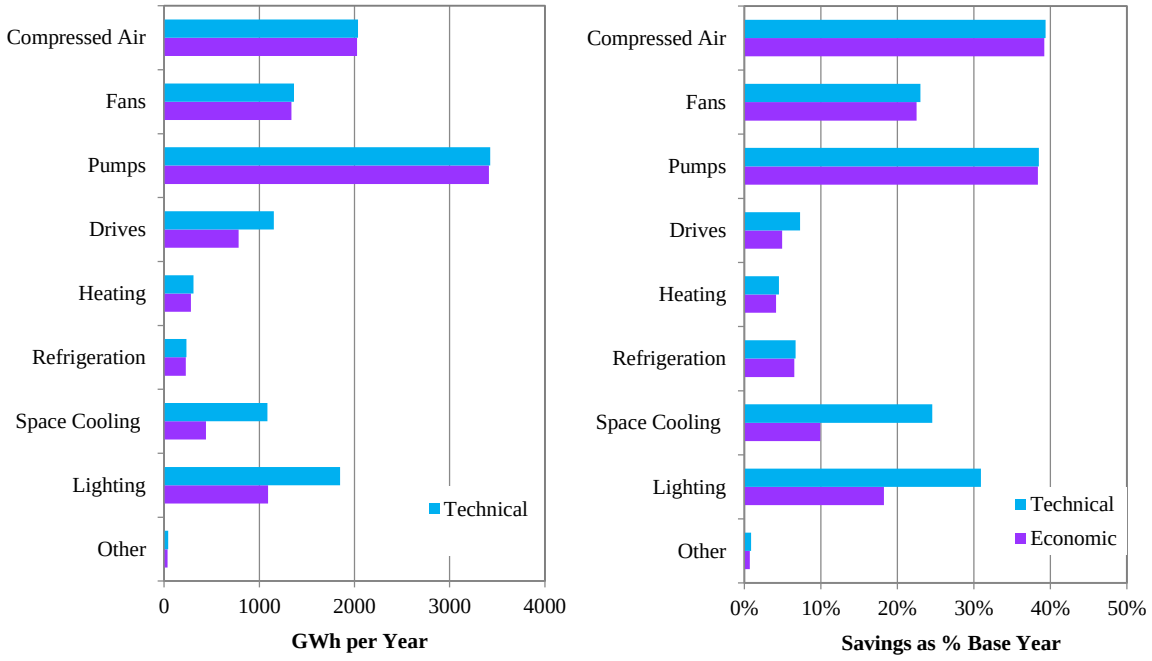


Figure 4.2 Industrial Electric Savings Potential by End Use, 2013

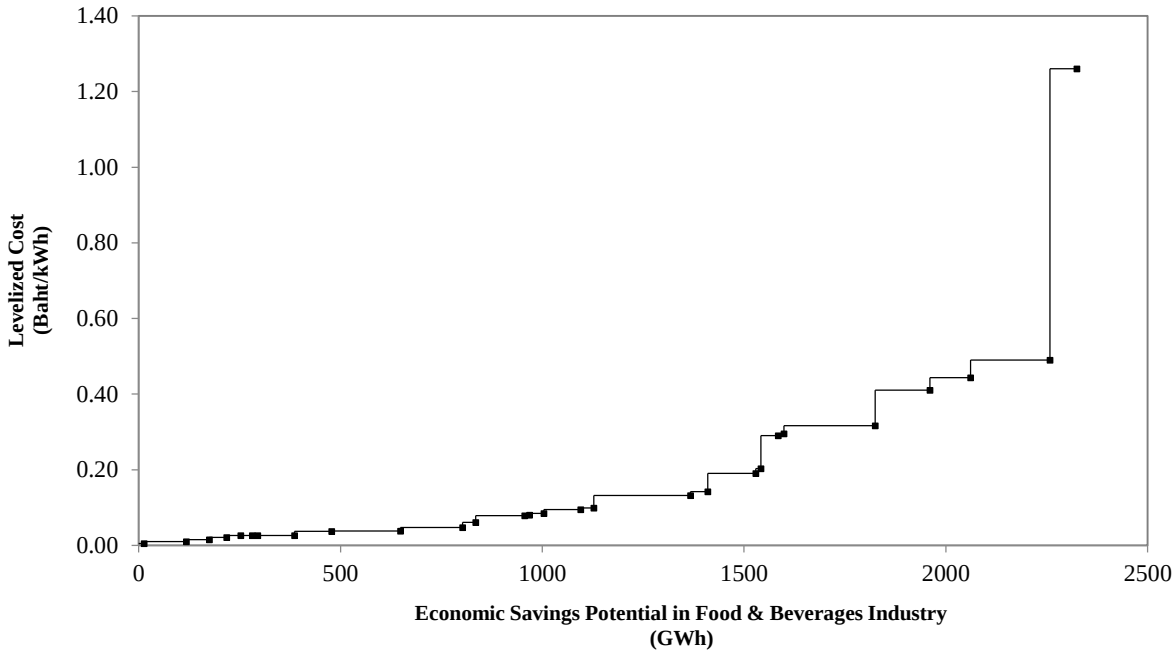
4.2.5 Electric Energy-Efficiency Supply Curves

Each industrial sector energy-efficiency supply curve is included in this section,

4.2.3.1 Food and Beverages Sector

In Figure 4.3, the curves are shown in terms of savings as GWh per year. It should be noted that, the economic savings potential figures presented previously are based on the Benefit-to-Cost ratio. Figure 4.4 presentes 28 economic electric energy efficiency measures for food and beverages, based on the Benefit-to-Cost ratio, for food and beverages sector. This is so-called “cost effectiveness” of an energy efficiency measure. In other words, the cost of investing in the economic energy efficiency measures to save one kWh of

electricity is less than purchasing one kWh of electricity at electricity price in 2013 (4.21 Baht/kWh, [45]).



Note; the electric energy efficiency supply curves do not include O&M cost savings that might be associated with some measures. It is not clear that industrial customers fully acknowledge these O&M savings when deciding to adopt these measures.

Figure 4.3 Industrial Electric Energy-Efficiency Supply Curve for Food and Beverages, 2013

Figure 4.3, shows all of the economic electricity efficiency measures which are ranked by their levelized costs. The economic electric savings potential for Thai food and beverages industry in 2013 was estimated to be 2,325 GWh. This is about 17.3% of the food and beverage's total electric usage in 2013. This potential obtained when applying all of the electric efficiency measures, as shown in Figure 4.4, to the Thai food and beverages industry in a way described above in the methodology section. The Figure clearly shows that fans operation and maintenance is the most cost effective measure with the least levelized energy cost, followed by installing adjustable speed drive of compressed air, pumps, and fans system. Therefore, proper monitoring and maintenance can save a lot of energy as well as money in this industrial sector. Moreover, operation and maintenance of other systems also obtain high electric savings potential which remain low levelized energy cost (e.g. Compressed Air – Operation and Maintenance, 154 GWh savings in 2013).

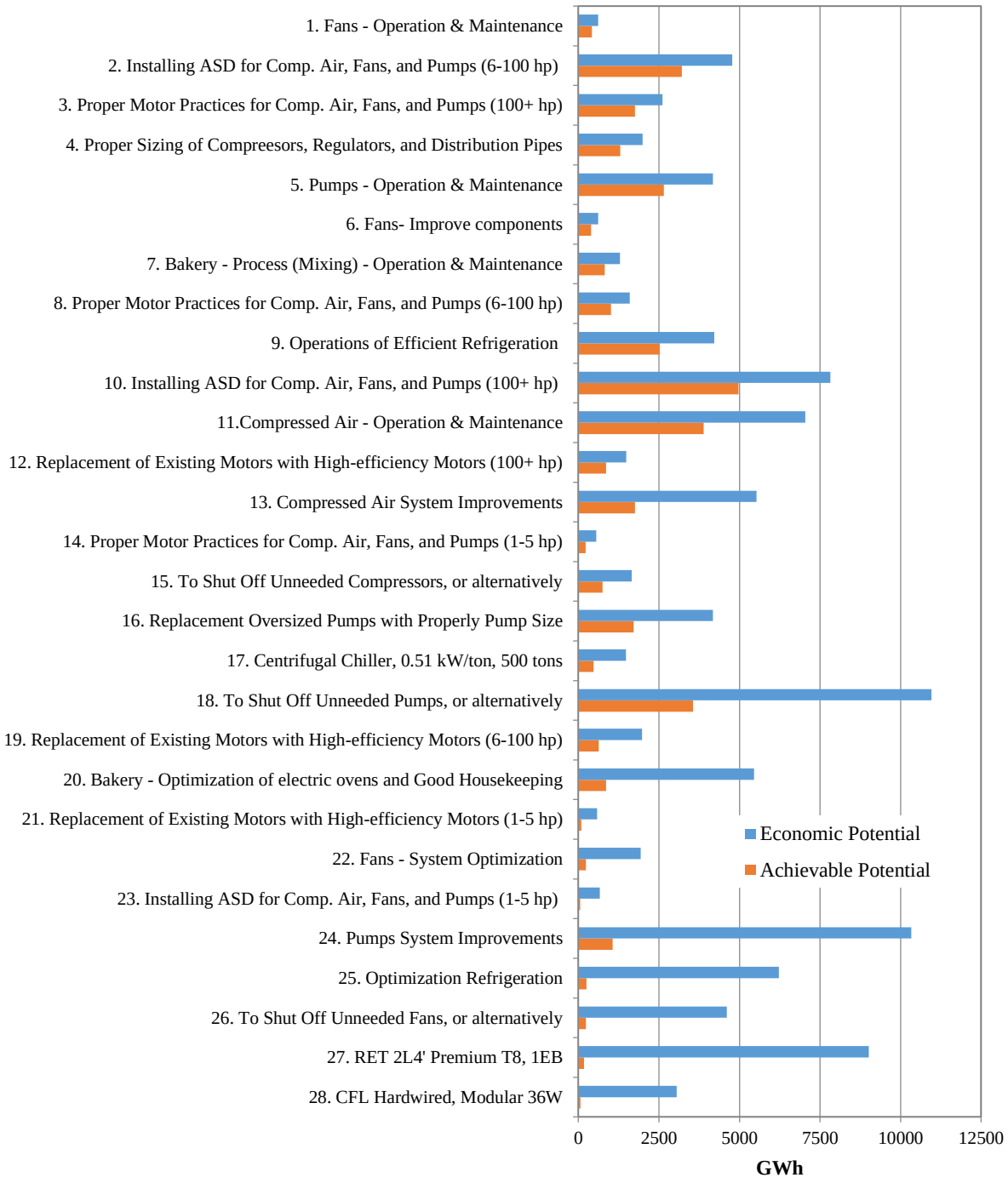


Figure 4.4 Food & Beverages Net Economic and Achievable Electric Savings Potential by Measures – Cumulative 2014 to 2030

Figure 4.4, shows all of the electricity efficiency measures economically to Thai food and beverage industry which are ranked by their levelized cost from least to farthest. The net achievable potential which compared to the net economic potential tends to decrease, as shown in this figure, due to increased levelized cost. The increasing of levelized cost is the important factor to decision to investment in any measures. Although, measure 10 has higher opportunity to decision than measure 9 to investment this measure as it much cost. Therefore money does not only one barrier that affect to the decision.

As shown in Figure 4.4, Measure number 18, to shut off unneeded pumps represents the highest net electric economic potential, followed by pumps system improvement, RET 2L4' premium T8, 1EB, installing ASD for compressed air, fans, and pumps system (100+ hp), and operation and maintenance in compressed air system, accounting for 10,958 GWh. Resulting of net electric achievable potential, installing ASD for compressed air, fans, and pumps system (100+ hp) is the highest accounting for 4,968 GWh, followed by operation and maintenance in compressors, to shut off unneeded pumps, installing ASD for compressed air, fans, and pumps system (6-100 hp), and operation and maintenance of pumps.

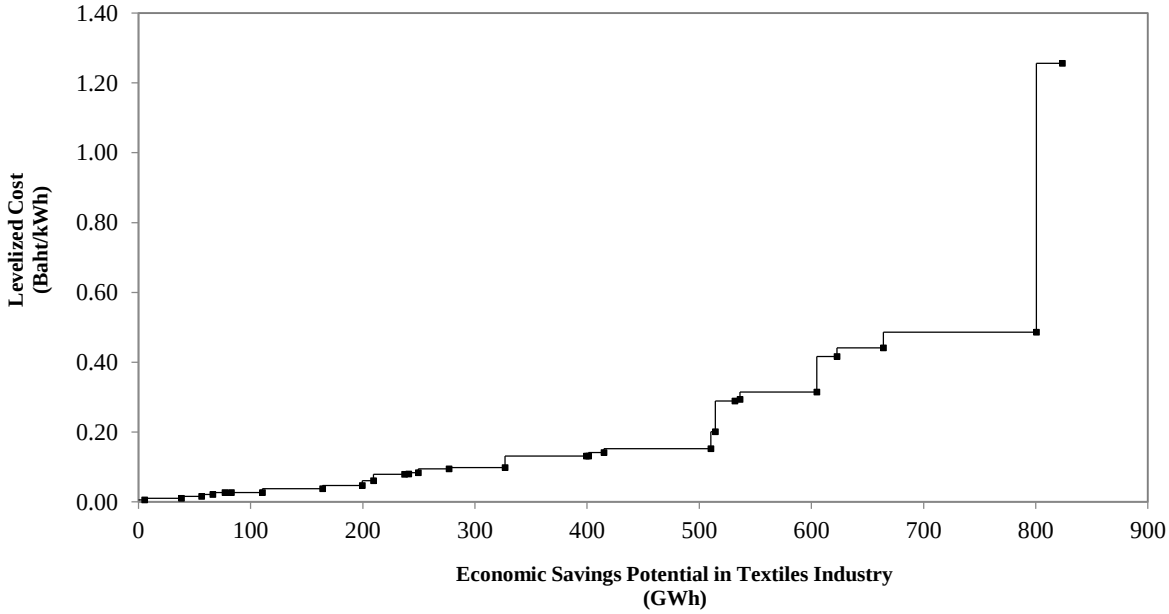
According to the resulting, to shut off unneeded pumps and install ASD for compressed air, fans, and pumps (100+ hp) are one of the highest potential both in economic and achievable potential. Therefore, we suggest that you do not let the pump drive run empty for a long time. When the system is driven with high performance and proper usage, it can help to increase energy saving. However, whether any given drive system, the motor can work efficiently only when electric motors and drive system related to work properly. The motor which is used in the drive system must be suitable related to the speed drive of this motor, not too large to fit the required load. Using such a motor driving a pump or fan flow rates change over time should be selected to adjust the speed.

On the other hand, measure number 14, proper motor practices for compressed air, fans, and pumps system (1-5 hp), with the lowest net economic savings potential, is 553 GWh. Following this measure, the replacement of existing motors with high efficiency motors (1-5 hp), and installing ASD for compressed air, fans, and pumps system (1-5 hp). Showing that, the measures involving 1-5 hp motor have obviously small economic savings potential. Thus, this measure should be implemented after other higher energy efficiency measures. Consideration of net achievable potential, measure number 23, installing ASD for compressed air, fans, and pumps system (1-5 hp) represents the lowest savings potential

accounting for 53 GWh. CFL hardwires, modular 36W, replacement of existing motors with high efficiency motors (1-5 hp), RET 2L4' premium T8, 1EB, and properly motor practices for compressed air, fans, and pumps system (1-5 hp) followed. Those results emphasize 1-5 hp motor measure received small interest to decision implementation, significantly, in Thai food and Beverages industrial sector, because, small size motor costs are high and related to receiving benefits.

4.2.3.2 Textiles Sector

In Figure 4.5, the curves are shown in terms of savings as GWh per year. It should be noted that the economic savings potential figures presented previously are based on the Benefit-to-Cost ratio. Figure 4.6is presented in 27 economic electric energy efficiency measures Benefit-to-Cost ratio, for textiles sector. This is so-called "cost effectiveness" of an energy efficiency measure. In another words, the cost of investing on the economic energy efficiency measures to save one kWh of electricity is less than purchasing one kWh of electricity with electricity price in 2013 (4.21 Baht/kWh, [45]).



Note; the electric energy efficiency supply curves do not include O&M cost savings that might be associated with some measures. It is not clear that industrial customers fully acknowledge these O&M savings when deciding to adopt these measures.

Figure 4.5 Industrial Electric Energy-Efficiency Supply Curve for Textiles, 2013

Figure 4.5 shows the economic electric savings potential for Thai textiles industry in 2013 is estimated to be 824 GWh. This is about 11.9% of the textile's total

electric usage in 2013. This potential obtained when applying all of the electric efficiency measures, as shown in Figure 4.6, to the Thai textiles industry in a way described above in the methodology section. The figure also clearly shows that fans operation and maintenance is the most cost effective measure with the least levelized energy cost, followed by installing adjustable speed drive of compressed air system and fans system. Therefore, proper monitoring and maintenance can save a lot of energy as well as money in this industrial sector. Moreover, operation and maintenance of other systems also obtain high electric savings potential which remain low levelized energy cost.

In Figure 4.6, the measures are ranked by levelized cost from least to vast. Net achievable potential which compared to net economic potential tend to decrease, as shown in this figure, due to increased levelized cost. The increasing of levelized cost is the important factor to decision to investment in any measures. Although, measure 10 has higher opportunity to decision than measure 9 to investment this measure as it much cost. Therefore money still does not only one barrier that affect to the decision.

Measure number 26, RET 2L4' premium T8, 1EB represents the highest net electric economic potential, followed by optimization of motor use in spinning mills, to shut off unneeded pumps, pumps system improvement, and installing ASD for compressed air, fans, and pumps system (100+ hp), accounting for 2,018 GWh but it has scanty net achievable potential. Resulting of net electric achievable potential, measure 8, installing ASD for compressed air, fans, and pumps system (100+ hp) is the highest accounting for 506 GWh, followed by optimization of motor use in spinning mills,to shut off unneeded pumps.

To shut off unneeded pumps and installs ASD for compressed air, fans, and pumps (100+ hp) are one of the highest potentials both in economic and achievable potential. Therefore, we suggest that do not let the pump drive run empty for a long time. When the system is driven with high performance and proper usage, it can help to increase energy saving. However, whether any given drive system, the motor can work efficiently only when electric motors and drive system related to work properly. The motor which is used in the drive system must be suitable related to the speed drive of this motor, not too large to fit the required load. Using such a motor driving a pump or fan flow rates change over time should be selected to adjust the speed.

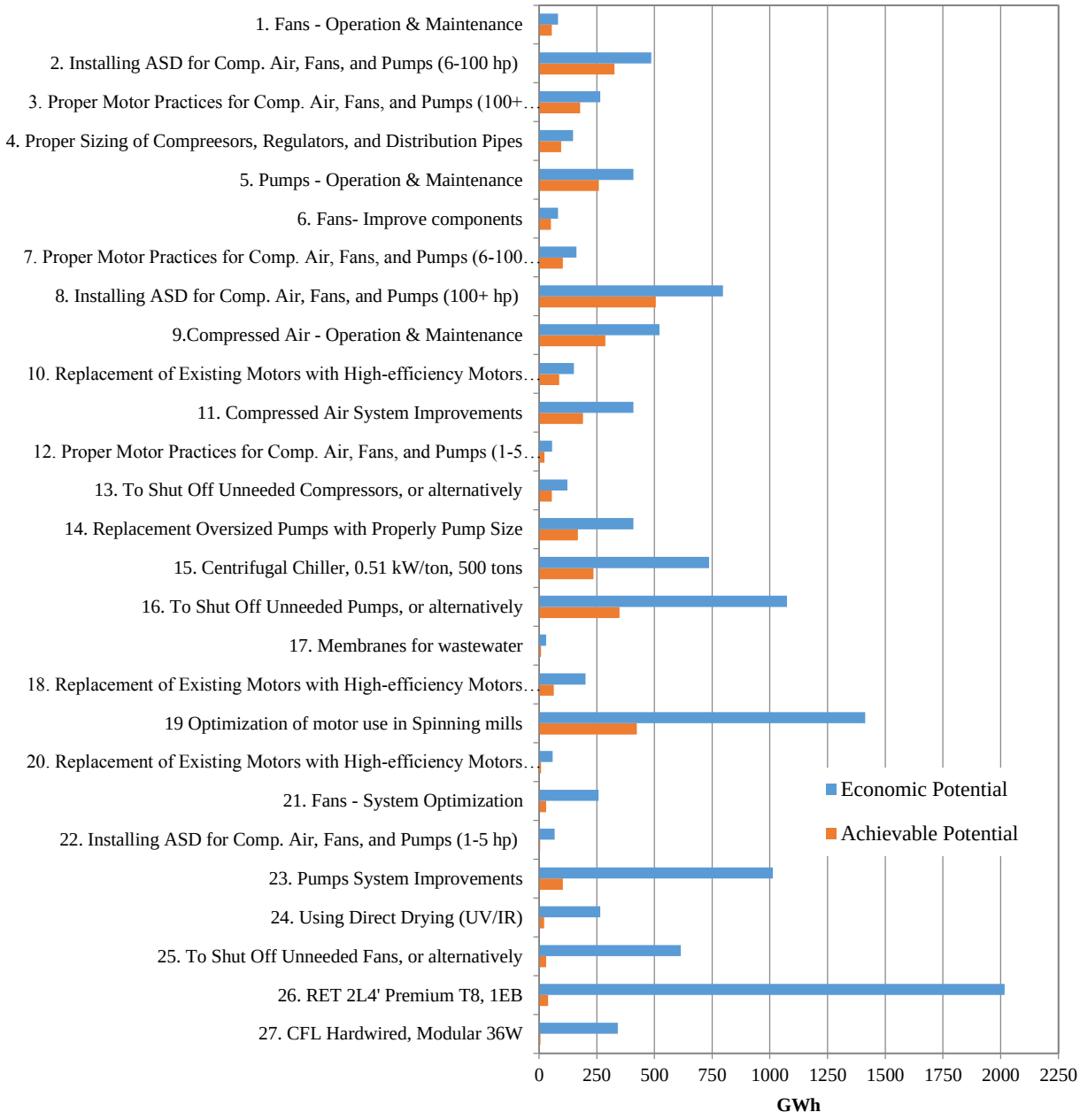


Figure 4.6 Textiles Net Economic and Achievable Electric Savings Potential by Measures – Cumulative 2014 to 2030

On the other hand, measure number 17, membrane for waste water, with the lowest net economic savings potential, is 31 GWh, Following this measure, proper motor practices for compressed air, fans, and pumps system (1-5 hp), replacement of existing motors with high efficiency motors (1-5 hp), and installing ASD for compressed air, fans, and pumps system (1-5 hp). Showing that, the measures involving 1-5 hp motor have obviously small economic savings potential. Thus, this measure should be implemented after

other higher energy efficiency measures. Consideration of net achievable potential, measure number 22, installing ASD for compressed air, fans, and pumps system (1-5 hp) represents the lowest savings potential accounting for 5 GWh. CFL hardwires, modular 36W, membrane for wastewater, replacement of existing motors with high efficiency motors (1-5 hp), 1EB, and properly motor practices for compressed air, fans, and pumps system (1-5 hp) followed.

Those results emphasize 1-5 hp motor measure that have received small interest to decision implementation, significantly, in Thai textiles industrial sector. Because, small size motor cost is high that related to receiving benefits.

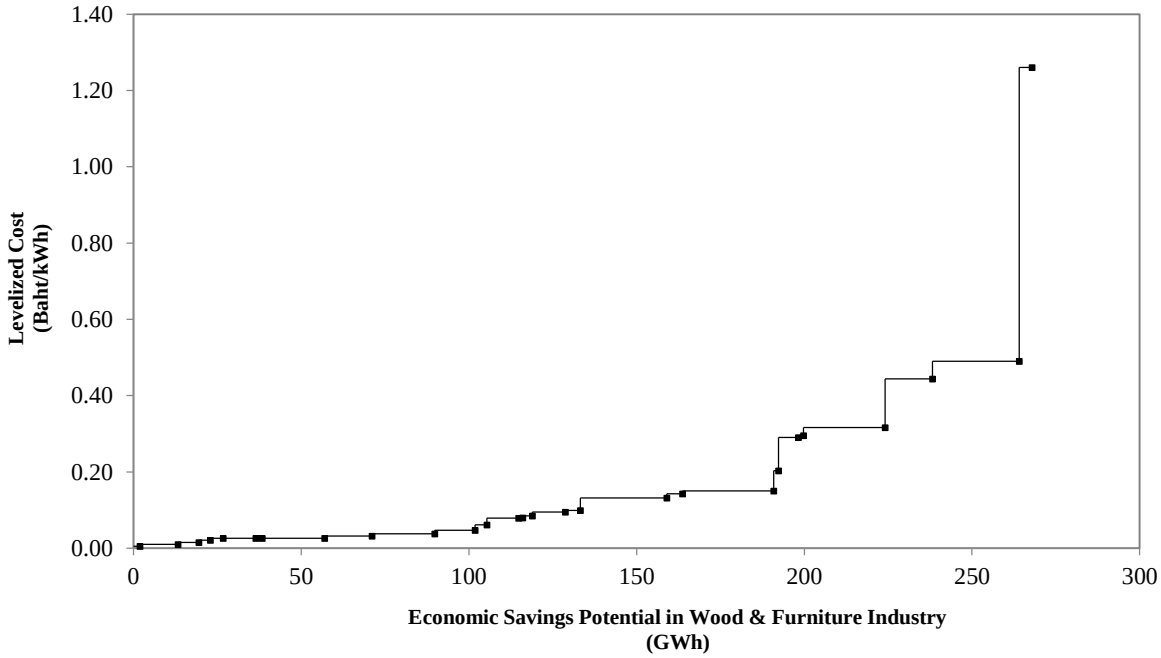
Moreover, membrane technologies that are typically more energy efficient than evaporation methods and can lead to significant reductions in facility freshwater intake have a little both in net economic and achievable potential. Since, money still does not only one barrier that affect to the decision for applying membrane for wastewater. Performance uncertainty which is the difficulties consumers face in evaluating claims about future benefits may be the major reason why inadequate of its penetration rate (i.e., reflected to market barriers).

4.2.3.3 Wood and Furniture Sector

In Figure 4.7, the curves are shown in terms of savings as GWh per year. It should be noted that the economic savings potential figures presented previously are based on the Benefit-to-Cost ratio. Figure 4.8 presents 27 economic electric energy efficiency measures, based on the Benefit-to-Cost ratio, for wood and furniture sector. This is so-called "cost effectiveness" of an energy efficiency measure. In another words, the cost of investing on the economic energy efficiency measures to save one kWh of electricity is less than purchasing one kWh of electricity with electricity price in 2013 (4.21 Baht/kWh, [45]).

In Figure 4.7, the economic electric savings potential for Thai wood and furniture industry in 2013 is estimated to be 268 GWh. This is about 14.2% of the wood and furniture's total electric usage in 2013. This potential is obtained when applying all of the electric efficiency measures, as shown in Figure 4.8, to the Thai wood and furniture industry in a way described above in the methodology section. The figure clearly shows that fans operation and maintenance is the most cost effective measure with the least levelized energy cost, followed by installing adjustable speed drive of compressed air system and fans system. Therefore, proper monitoring and maintenance can save a lot of energy as well as money in this industrial sector. Moreover, operation and maintenance of other systems also obtain high

electric savings potential which remain low levelized energy costs (e.g. Pumps – Operation and Maintenance, 10 GWh saving in 2013).



Note; the electric energy efficiency supply curves do not include O&M cost savings that might be associated with some measures. It is not clear that industrial customers fully acknowledge these O&M savings when deciding to adopt these measures.

Figure 4.7 Industrial Electric Energy-Efficiency Supply Curve for Wood and Furniture, 2013

In Figure 4.8, measures are ranked by levelized cost from least to farthest. Net achievable potential compared to net economic potential tends to decrease, as shown in this figure, due to increased levelized cost. The increasing of levelized cost is the important factor to decision to investment in any measures. Although, measure 12 has higher opportunity to decision than measure 11 to investment this measure as it much cost. Therefore money still does not only one barrier that affect to the decision.

As shown in Figure 4.8, measure number 20, air conveying systems which are used to transport material in the wood industry represent the highest net electric economic potential, followed by RET 2L4' premium T8, 1EB,to shut off unneeded pumps, pumps system optimization, and installing ASD for compressed air, fans, and pumps system (100+ hp), accountings for 816 GWh. The resulting of net electric achievable potential, measure 23, installing ASD for compressed air, fans, and pumps system (100+ hp), is the highest

accounting for 355 GWh, followed by replacing V-belt in pumps system, driving energy efficiency motors, and to shut off unneeded pumps.

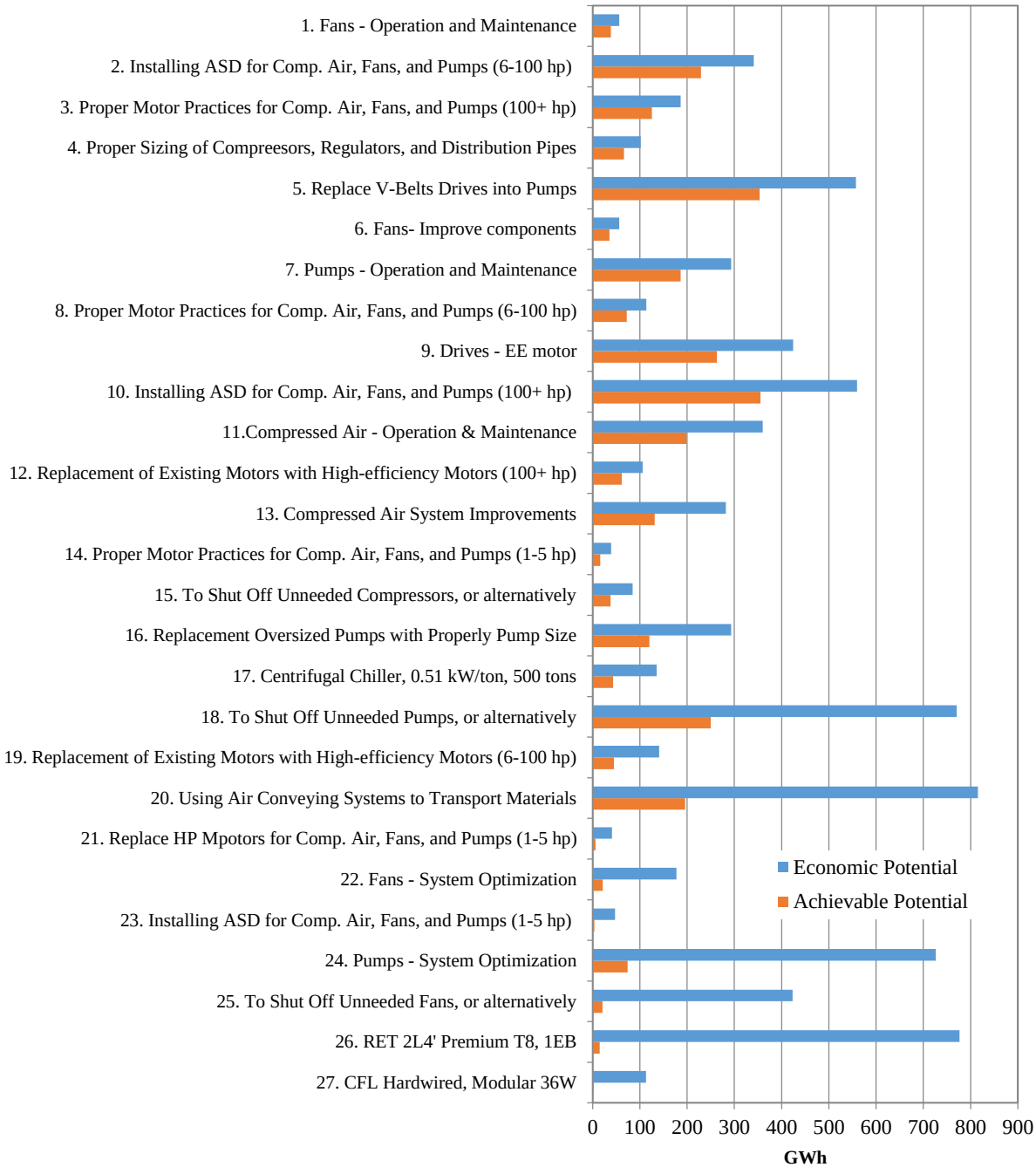


Figure 4.8 Wood & Furniture Net Economic and Achievable Electric Savings Potential by Measures – Cumulative 2014 to 2030

To shut off unneeded pumps and install ASD for compressed air, fans, and pumps (100+ hp) are one of the highest potentials both in economic and achievable potential. Therefore, we suggest that do not let the pump drive run empty for a long time. When the system is driven with high performance and proper usage, it can help to increase energy saving. However, whether any given drive system, the motor can work efficiently only when electric motors and drive system related to work properly. The motor which is used in the drive system must be suitable related to the speed drive of this motor, not too large to fit the required load. Using such a motor driving a pump or fan flow rates change over time should be selected to adjust the speed.

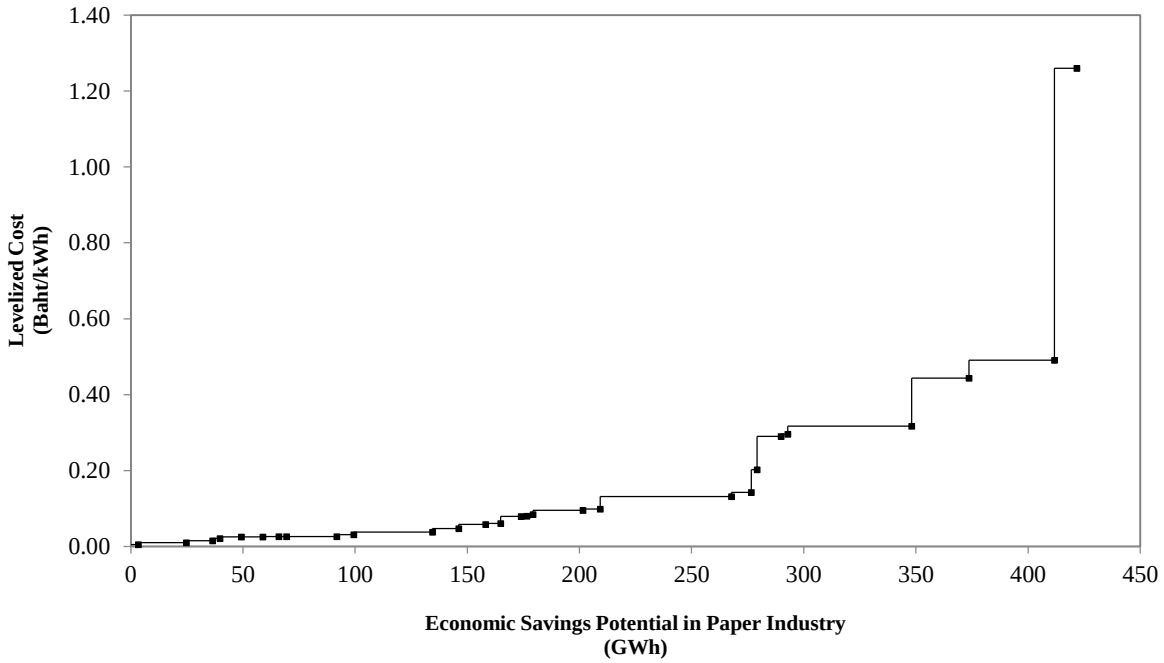
On the other hand, measure number 14, proper motor practices for compressed air, fans, and pumps system (1-5 hp), with the lowest net economic savings potential, is 40 GWh, Following this measure, replacement of existing motors with high efficiency motors (1-5 hp), and installing ASD for compressed air, fans, and pumps system (1-5 hp). Showing that, the measures involving 1-5 hp motor have obviously small economic savings potential. Thus, this measure should be implemented after other higher energy efficiency measures. Consideration of net achievable potential, measure number 27, CFL hardwires, modular 36W represents the lowest savings potential accounting for 2 GWh. Installing ASD for compressed air, fans, and pumps system (1-5 hp), replacement of existing motors with high efficiency motors (1-5 hp), RET 2L4' premium T8, 1EB, and properly motor practices for compressed air, fans, and pumps system (1-5 hp) followed. Those results emphasize 1-5 hp motor measure received small interest to decision implementation, significantly, in Thai wood and furniture industrial sector. Because, small size motor cost is high that related to receiving benefits.

4.2.3.4 Paper Sector

In Figure 4.9, the curves are shown in terms of savings as GWh per year. It should be noted that, the economic savings potential figures presented previously are based on the Benefit-to-Cost ratio. Figure 4.10 presents 28 economic electric energy efficiency measures, based on the Benefit-to-Cost ratio, for paper sector. This is so-called "cost effectiveness" of an energy efficiency measure. In another words, the cost of investing on the economic energy efficiency measures to save one kWh of electricity is less than purchasing one kWh of electricity with electricity price in 2013 (4.21 Baht/kWh, [45]).

In Figure 4.9, the economic electric savings potential for Thai paper industry in 2013 is estimated to be 422 GWh. This is about 17.3% of the paper's total electric usage in

2013. This potential obtained when applying all of the electric efficiency measures, as shown in Figure 4.10, to the Thai paper industry in a way described above in the methodology section. The figure clearly shows that fan operation and maintenance is the most cost effective measure with the least levelized energy cost, followed by adjustable speed drive of and pumps system compressed air system. Therefore, proper monitoring and maintenance can save a lot of energy as well as money in this industrial sector. Moreover, the operation and maintenance of other systems also obtains high electric savings potential that remain low levelized energy cost (e.g. Pumps – Operation and Maintenance, 17 GWh saving in 2013).



Note; the electric energy efficiency supply curves do not include O&M cost savings that might be associated with some measures. It is not clear that industrial customers fully acknowledge these O&M savings when deciding to adopt these measures.

Figure 4.9 Industrial Electric Energy-Efficiency Supply Curve for Paper, 2013

In Figure 4.10, the measures are ranked by levelized cost from least to vast. Net achievable potential which compared to net economic potential tend to decrease, as shown in this figure, due to increased levelized cost. The increasing of levelized cost is the important factor to decision to investment in any measures. Although, measure 7 has higher opportunity to decision than measure 6 to investment this measure as it much cost. Therefore, money is still not the only one barrier that affects the decision.

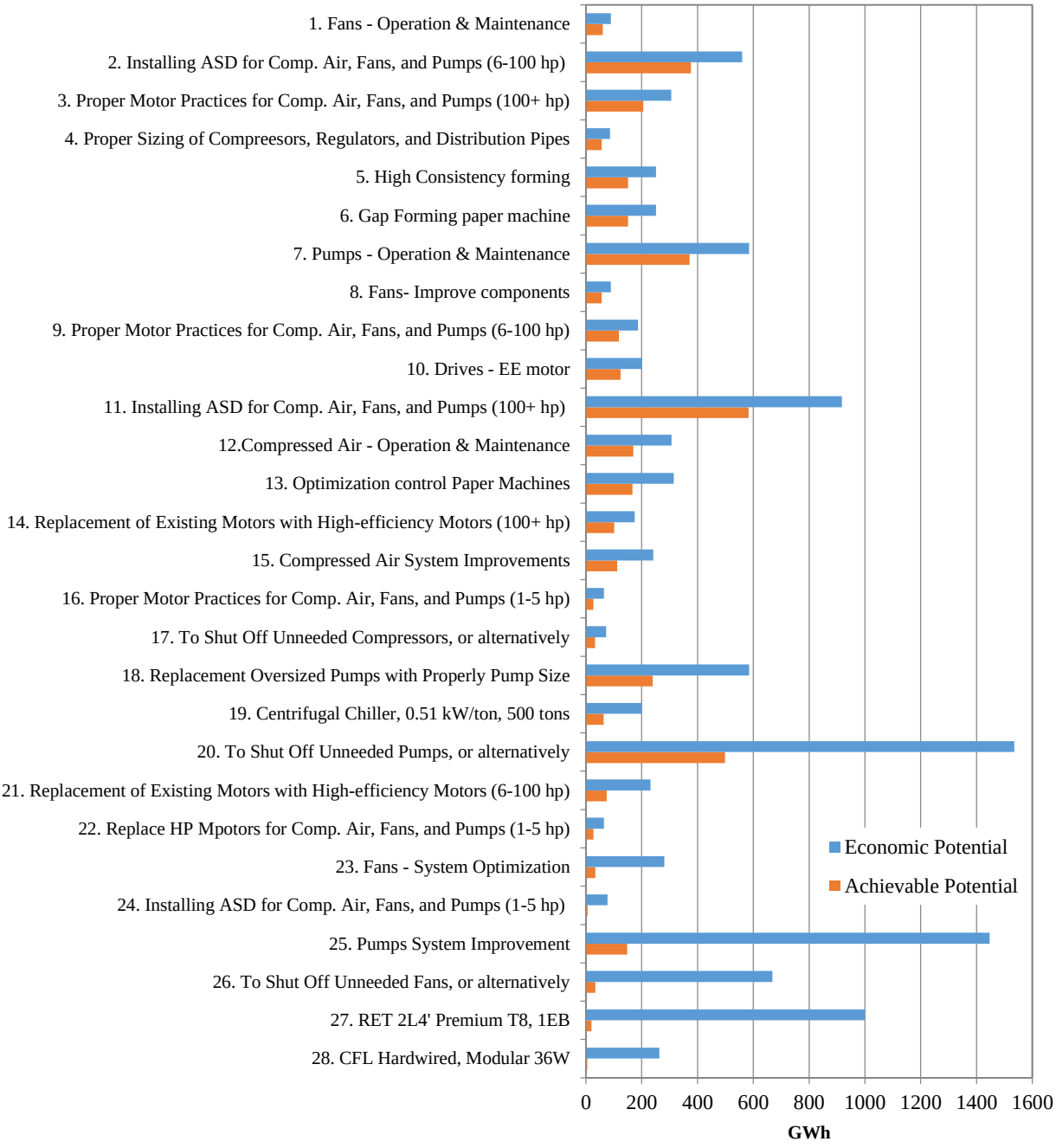


Figure 4.10 Paper Net Economic and Achievable Electric Savings Potential by Measures – Cumulative 2014 to 2030

Measure number 20, to shut off unneeded pumps represents the highest net electric economic potential, followed by pumps system improvement, RET 2L4' premium T8, 1EB, and installing ASD for compressed air, fans, and pumps system (100+ hp), accounts for 1,535 GWh. Resulting of net electric achievable potential, measure number 24, installing ASD for compressed air, fans, and pumps system (100+ hp) is the highest

accounting for 583 GWh, followed by shutting off unneeded pumps, installing ASD for compressed air, fans, and pumps system (6-100 hp), and pumps – operation and maintenance.

The results show that to shut off unneeded pumps and install ASD for compressed air, fans, and pumps (100+ hp) have the highest potential in economic and achievable potential. Therefore, we suggest that do not let the pump drive run empty for a long time. When the system is driven with high performance and proper usage, it can help to increase energy saving. However, whether any given drive system, the motor can work efficiently only when electric motors and drive system related to work properly. The motor which is used in the drive system must be suitable related to the speed drive of this motor, not too large to fit the required load. Using such a motor driving a pump or fan flow rates change over time should be selected to adjust the speed.

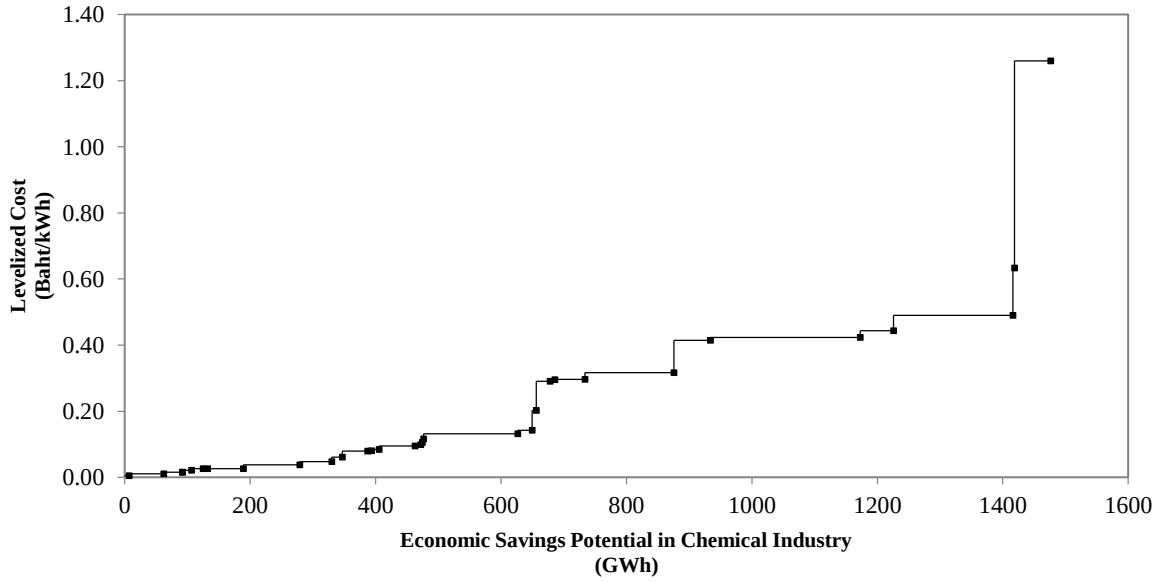
On the other hand, measure number 16, proper motor practices for compressed air, fans, and pumps system (1-5 hp), with the lowest net economic savings potential, is 65 GWh, Following this measure, to shut off unneeded compressors, and install ASD for compressed air, fans, and pumps system (1-5 hp). Showing that, the measures involving 1-5 hp motor have obviously small economic savings potential. Thus, this measure should be implemented after other higher energy efficiency measures. Consideration of net achievable potential, measure number 28CFL hardwires, modular 36W represents the lowest savings potential accounting for 5 GWh. Installing ASD for compressed air, fans, and pumps system (1-5 hp), replacement of existing motors with high efficiency motors (1-5 hp), RET 2L4' premium T8, 1EB, and properly motor practices for compressed air, fans, and pumps system (1-5 hp) followed. Those results emphasize 1-5 hp motor measure received small interest to decision implementation, significantly, in Thai paper industrial sector. Because, small size motor cost is high that related to receiving benefits.

4.2.3.5 Chemical Sector

In Figure 4.11, the curves are shown in terms of savings as GWh per year. It should be noted that, the economic savings potential figures presented previously are based on the Benefit-to-Cost ratio. Figure 4.12 presents 31 economic electric energy efficiency measures based on the Benefit-to-Cost ratio for the chemical sector. This is so-called "cost effectiveness" of an energy efficiency measure. In another words, the cost of investing on the economic energy efficiency measures to save one kWh of electricity is less than purchasing one kWh of electricity with electricity price in 2013 (4.21 Baht/kWh, [45]).

In Figure 4.11, the economic electric savings potential for the Thai chemical industry in 2013 is estimated to be 1,476 GWh. This is about 13.5% of the chemical's total electric usage in 2013. This potential obtained when applying all of the electric efficiency measures, as shown in Figure 4.12, to the Thai chemical industry in a way described above in the methodology section. The figure clearly shows that fan operation and maintenance are the most cost effective measure with the least levelized energy costs, followed by adjustable speed drive and pumps system compressed air system. Therefore, proper monitoring and maintenance can save a lot of energy as well as money in this industrial sector. Moreover, operation and maintenance of other systems also obtain high electric savings potential which remain low levelized energy cost (e.g. Pumps – O&M, 57 GWh savings in 2013).

In Figure 4.12, measures are ranked by levelized cost from least to vast. Net achievable potential which compared to net economic potential tend to decrease, as shown in this figure, due to increased levelized cost. The increasing of levelized cost is the important factor to decision to investment in any measures. Although, measure 5 has higher opportunity to decision than measure 4 to investment this measure as it much cost. Therefore money still does not only one barrier that affect to the decision.



Note; the electric energy efficiency supply curves do not include O&M cost savings that might be associated with some measures. It is not clear that industrial customers fully acknowledge these O&M savings when deciding to adopt these measures.

Figure 4.11 Industrial Electric Energy-Efficiency Supply Curve for Chemical, 2013

Measure number 27, the use of multiple pumps which reduce energy use of the extruder represents the highest net electric economic potential, followed by RET 2L4' premium T8, 1EB, replacement high efficiency motors, pumps system improvement, and installing ASD for compressed air, fans, and pumps system (100+ hp), accounting for 7,515 GWh. Resulting of net electric achievable potential, installing ASD for compressed air, fans, and pumps system (100+ hp) is the highest accounting for 1,795 GWh, followed by replacement high efficiency motors, and installing ASD for compressed air, fans, and pumps system (6-100 hp). From the resulting, installing ASD for compressed air, fans, and pumps (100+ hp) is one of the highest potential both in economic and achievable potential. Therefore we suggest that, whether any given drive system, the motor can work efficiently only when electric motors and drive system related to work properly. The motor which is used in the drive system must be suitable related to the speed drive of this motor, not too large to fit the required load. Using such a motor driving a pump or fan flow rates change over time should be selected to adjust the speed.

On the other hand, measure number 4, power recovery in the petroleum refinery, with the lowest net economic savings potential, is 4 GWh, Following this measure, the implementation of computer-based in Process, clean room – new design, clean room controls, properly motor practices for compressed air, fans, and pumps system (1-5 hp), and replacement of existing motors with high efficiency motors (1-5 hp). Showing that, the measures involving 1-5 hp motor have obviously small economic savings potential. Thus, this measure should be implemented after other higher energy efficiency measures. Consideration of net achievable potential, measure number 30, clean room – new design represents the lowest savings potential accounting for 6 GWh. Power recovery in the petroleum refinery, installing ASD for compressed air, fans, and pumps system (1-5 hp), implementation computer-based in Process, replacement of existing motors with high efficiency motors (1-5 hp), clean room controls, and CFL hardwires, modular 36W followed. Those results emphasize 1-5 hp motor measure received small interest to decision implementation, significantly, in Thai paper industrial sector, because, small size motor cost is high that related to receiving benefits.

The chemical sector has a lot of kind filed or various products therefore the energy savings potential have diverse rankings. Power recovery in refinery is also small net economic and achievable energy potential because the measure is a part of the sector. Various processes in the petroleum refinery run at elevated pressures, enabling the

opportunity for power recovery from the pressure in the flue gas. The major application for power recovery in the petroleum refinery is the fluid catalytic cracker (FCC). However, power recovery can also be applied to hydrocrackers or other equipment operated at elevated pressures. However, heat recovery has high B-C ratio representing effectiveness to implementation.

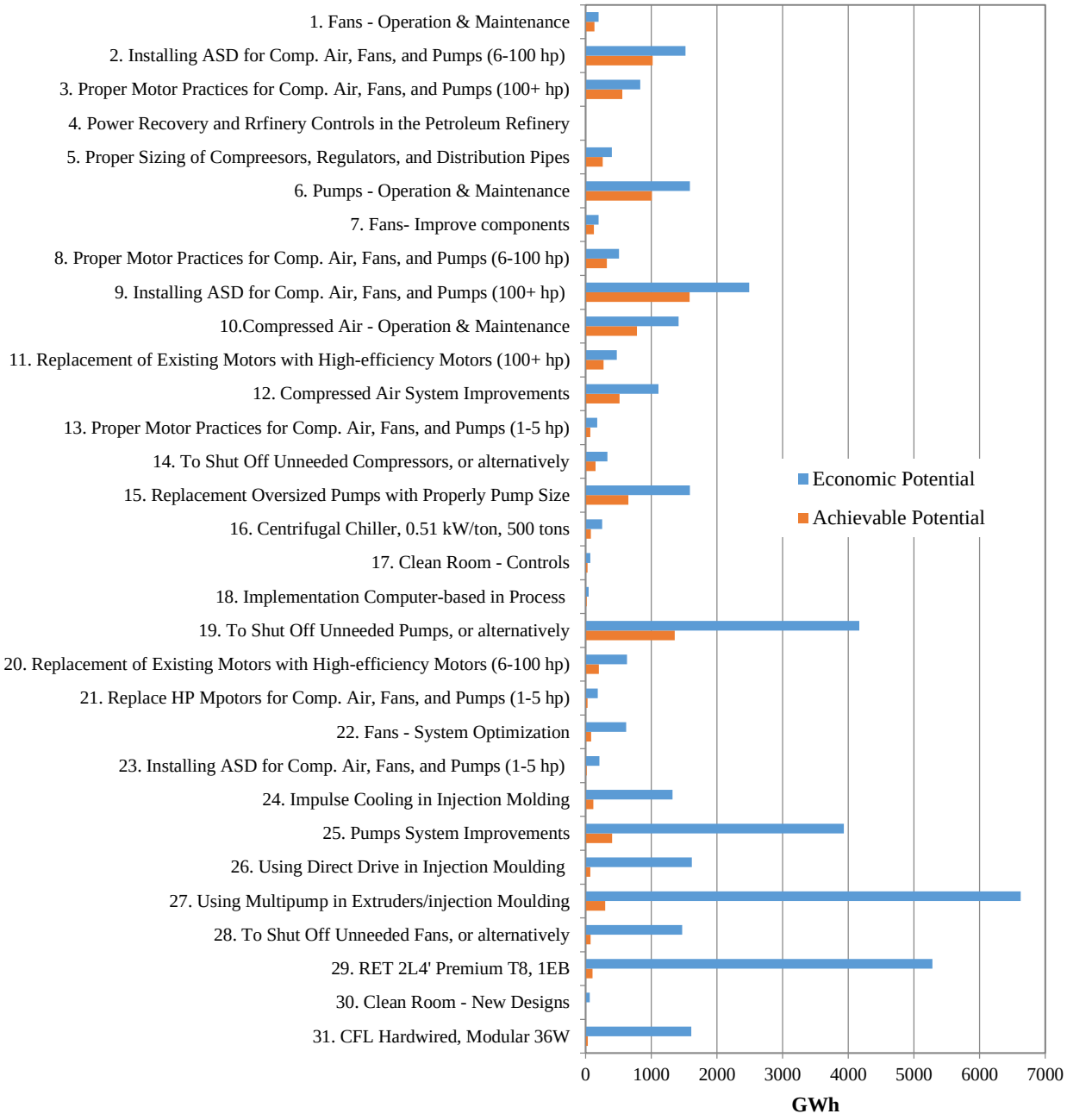
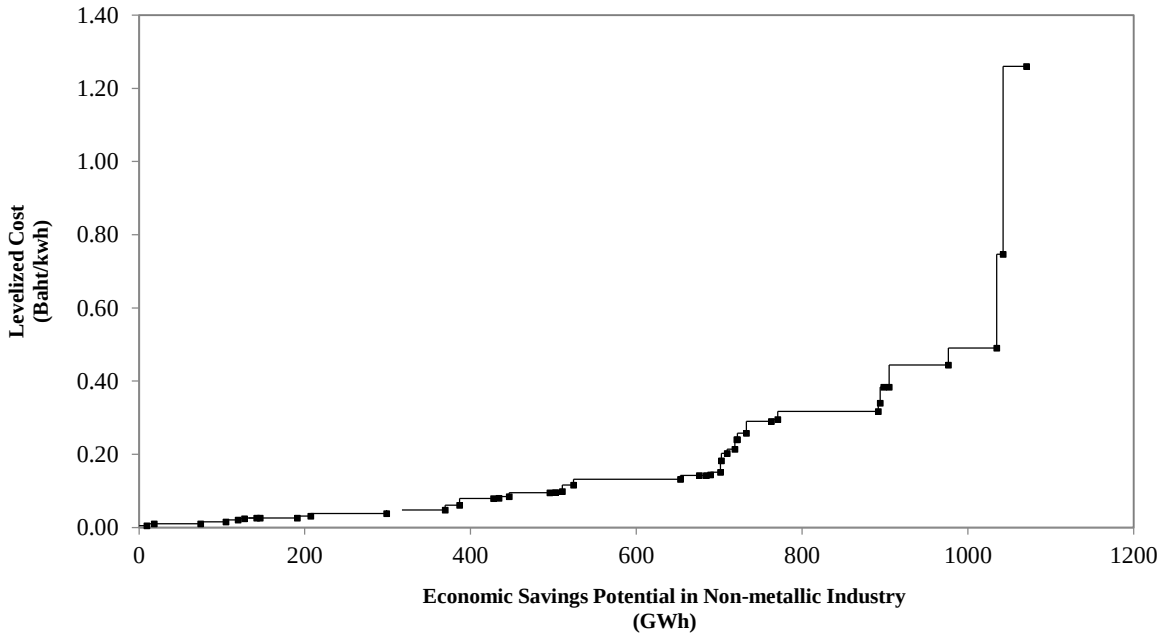


Figure 4.12 Chemical Net Economic and Achievable Electric Savings Potential by Measures – Cumulative 2014 to 2030

4.2.3.6 Non-metallic Sector

In Figure 4.13, the curves are shown in terms of savings as GWh per year. It should be noted that the economic savings potential figures presented previously are based on the Benefit-to-Cost ratio. Figure 4.14 presents 29 economic electric energy efficiency measures, based on the Benefit-to-Cost ratio, for non-metallic sector. This is so-called "cost effectiveness" of an energy efficiency measure. In another words, the cost of investing on the economic energy efficiency measures to save one kWh of electricity is less than purchasing one kWh of electricity with electricity price in 2013 (4.21 Baht/kWh, [45]).



Note; the electric energy efficiency supply curves do not include O&M cost savings that might be associated with some measures. It is not clear that industrial customers fully acknowledge these O&M savings when deciding to adopt these measures.

Figure 4.13 Industrial Electric Energy-Efficiency Supply Curve for Non-metallic, 2013

In Figure 4.13, the economic electric savings potential for the Thai non-metallic industry in 2013 was estimated to be 1,002 GWh. This is about 14.7% of the non-metallic's total electric usage in 2013. This potential obtained when applying all of the electric efficiency measures, as shown in Figure 4.14, to the Thai non-metallic industry in a way described above in the methodology section. The figure clearly shows that fans operation and maintenance is the most cost effective measure with the least levelized energy cost,

followed by adjustable speed drive of and pumps system compressed air system. Therefore, proper monitoring and maintenance can save a lot of energy as well as money in this industrial sector. Moreover, operation and maintenance of other systems also obtain high electric savings potential which remain low levelized energy cost (e.g. Pumps – Operation and Maintenance, 49 GWh saving in 2013).

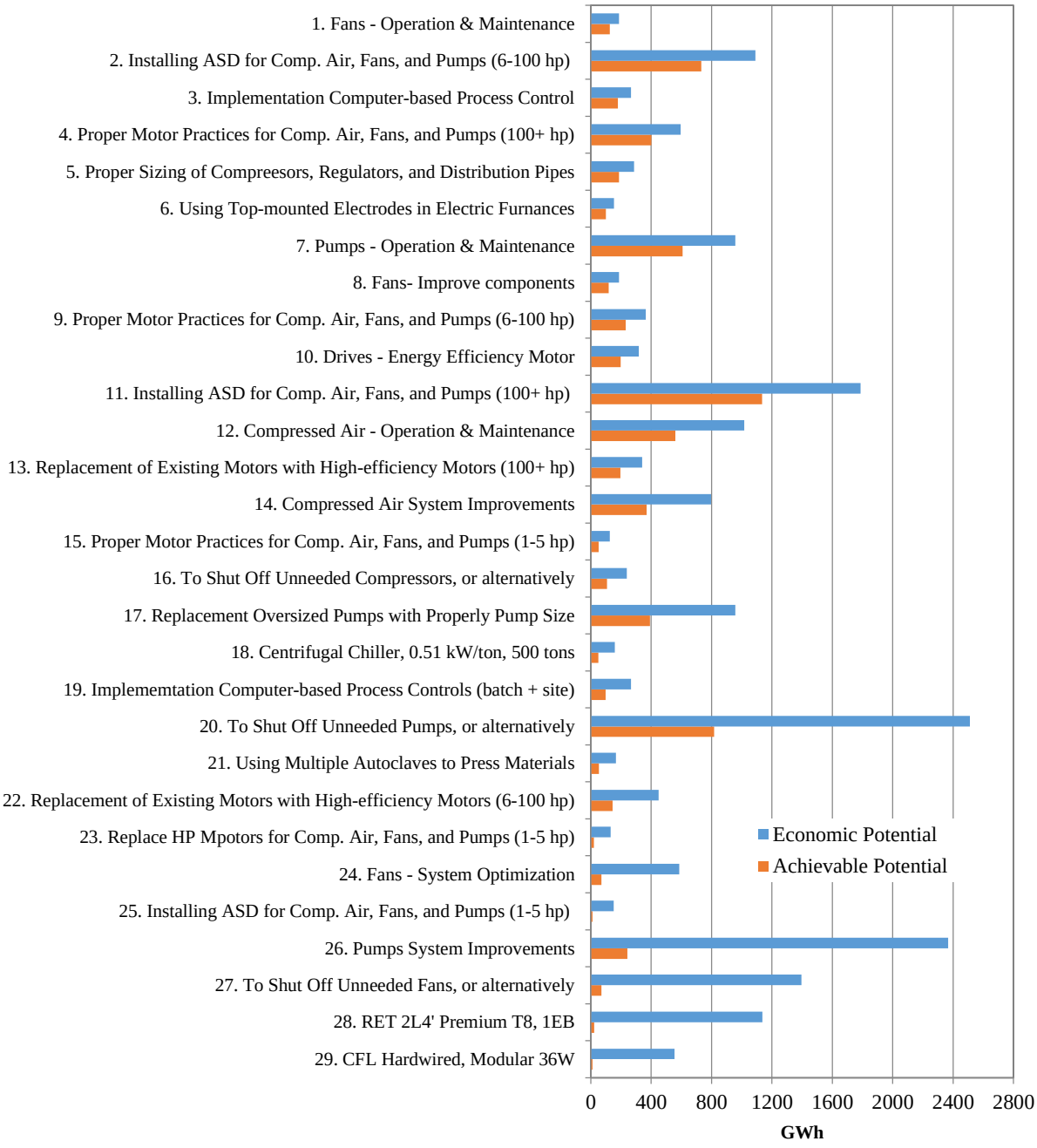


Figure 4.14 Non-metallic Net Economic and Achievable Electric Savings Potential by Measures – Cumulative 2014 to 2030

In Figure 4.14, measures are ranked by levelized cost from least to vast. Net achievable potential which compared to net economic potential tend to decrease, as shown in this figure, due to increased levelized cost. The increasing of levelized cost is the important factor to decision to investment in any measures. Although, measure 11 has higher opportunity to decision than measure 10 to investment this measure as it much cost. Therefore money still does not only one barrier that affect the decision.

Measure number 20, to shut off unneeded pumps represents the highest net electric economic potential, followed by pumps system improvement, installing ASD for compressed air, fans, and pumps system (100+ hp), to shut off unneeded fans, and RET 2L4' premium T8, 1EB, accounts for 2,511 GWh. Resulting of net electric achievable potential, installing ASD for compressed air, fans, and pumps system (100+ hp) is the highest accounting for 1,135 GWh, followed by shutting off unneeded pumps, and installing ASD for compressed air, fans, and pumps system (6-100 hp).

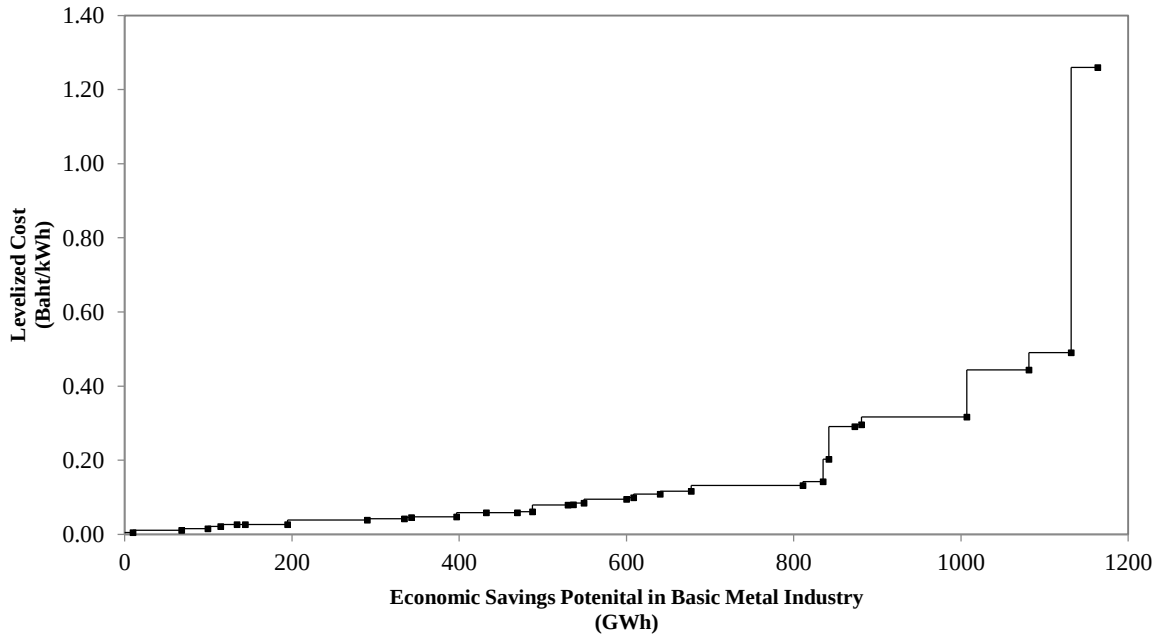
From the results, to shut off unneeded pumps and install ASD for compressed air, fans, and pumps (100+ hp) have the highest potentials both in economic and achievable potential. Therefore, we suggest that do not let the pump drive run empty for a long time. When the system is driven with high performance and proper usage, it can help to increase energy saving. However, whether any given drive system, the motor can work efficiently only when electric motors and drive system related to work properly. The motor which is used in the drive system must be suitable related to the speed drive of this motor, not too large to fit the required load. Using such a motor driving a pump or fan flow rates change over time should be selected to adjust the speed.

On the other hand, measure number 15, proper motor practices for compressed air, fans, and pumps system (1-5 hp), with the lowest net economic savings potential, is 126 GWh, Following this measure, the replacement of existing motors with high efficiency motors (1-5 hp), and installing ASD for compressed air, fans, and pumps system (1-5 hp). This shows that, the measures involving 1-5 hp motor have obviously small economic savings potential. Thus, this measure should be implemented after other higher energy efficiency measures. Consideration of net achievable potential, measure number 27,CFL hardwires, modular 36W represents the lowest savings potential accounting for 11 GWh. Installing ASD for compressed air, fans, and pumps system (1-5 hp), replacement of existing motors with high efficiency motors (1-5 hp), RET 2L4' premium T8, 1EB, and properly motor practices for compressed air, fans, and pumps system (1-5 hp) followed. Those results

emphasize 1-5 hp motor measure received small interest to decision implementation, significantly, in Thai non-metallic industrial sector. Because, small size motor cost is high that related to receiving benefits.

4.2.3.7 Basic Metal Sector

In Figure 4.15, the curves are shown in terms of savings as GWh per year. It should be noted that the economic savings potential figures presented previously are based on the Benefit-to-Cost ratio. Figure 4.16 presents 30 economic electric energy efficiency measures, based on the Benefit-to-Cost ratio, for basic metal sector. This is so-called "cost effectiveness" of an energy efficiency measure. In another words, the cost of investing on the economic energy efficiency measures to save one kWh of electricity is less than purchasing one kWh of electricity with electricity price in 2013 (4.21 Baht/kWh, [45]).



Note; the electric energy efficiency supply curves do not include O&M cost savings that might be associated with some measures. It is not clear that industrial customers fully acknowledge these O&M savings when deciding to adopt these measures.

Figure 4.15 Industrial Electric Energy-Efficiency Supply Curve for Basic Metal, 2013

In Figure 4.15, the economic electric savings potential for Thai basic metal industry in 2013 is estimated to be 1,163 GWh. This is about 16.5% of the basic metal's total electric usage in 2013. This potential obtained when applying all of the electric efficiency measures, as shown in Figure 4.16, to the Thai basic metal industry in a way described above in the methodology section. The figure clearly shows that fans operation and maintenance is

the most cost effective measure with the least levelized energy cost, followed by adjustable speed drive of and pumps system compressed air system. Therefore, proper monitoring and maintenance can save a lot of energy as well as money in this industrial sector. Moreover, operation and maintenance of other systems also obtain high electric savings potential which remain low levelized energy cost (e.g. Pumps – O&M, 51 GWh saving in 2013).

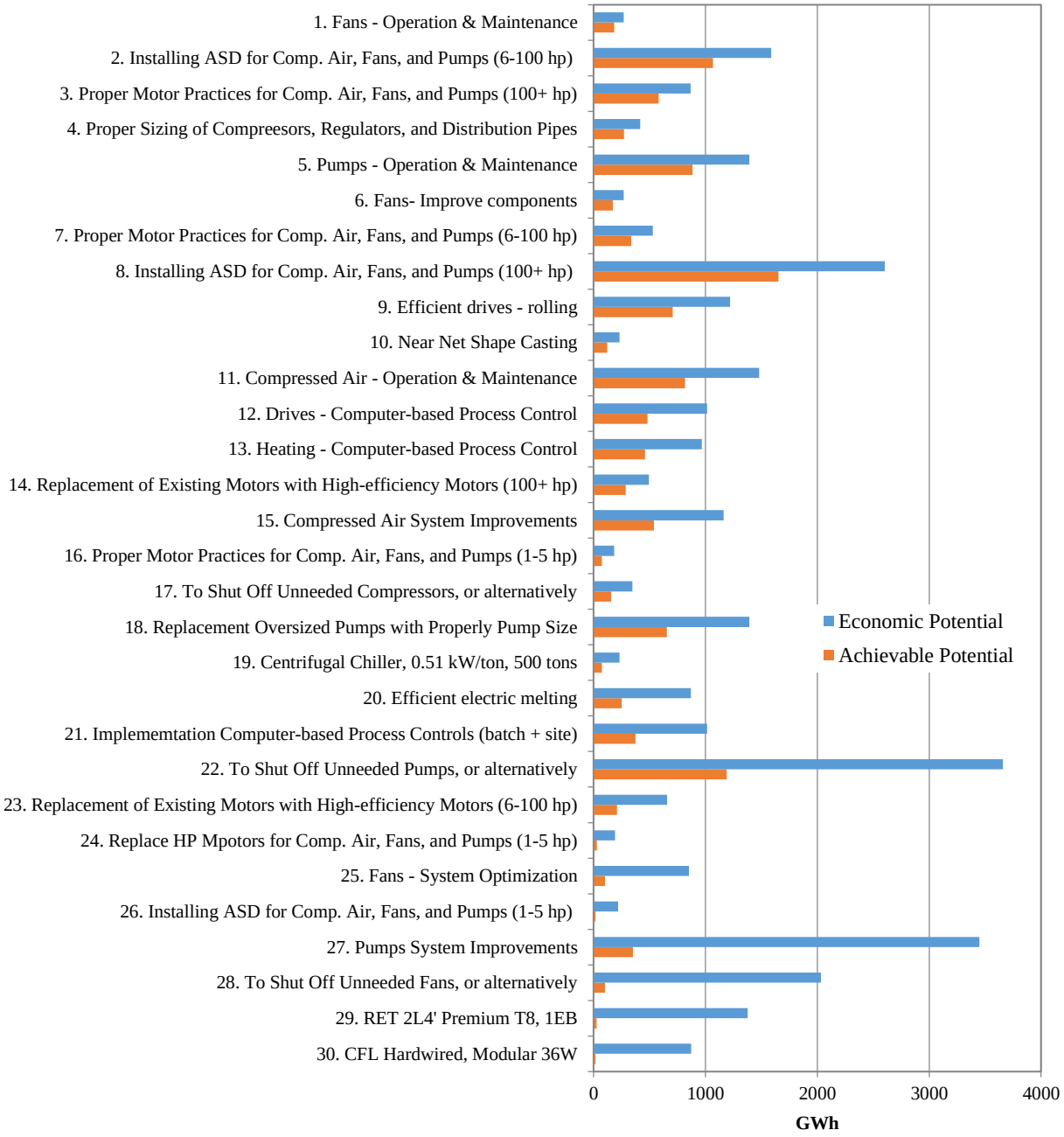


Figure 4.16 Basic Metals Net Economic and Achievable Electric Savings Potential by Measures – Cumulative 2014 to 2030

In Figure 4.16, measures are ranked by levelized cost from least to vast. Net achievable potential as compared to net economic potential tend to decrease, as shown in this figure, due to increased levelized cost. The increasing of levelized cost is the important factor to decision to investment in any measures. Although, measure 13 has higher opportunity to decision than measure 12 to investment this measure as it much cost. Therefore, money is still not the only barrier that affects the decision.

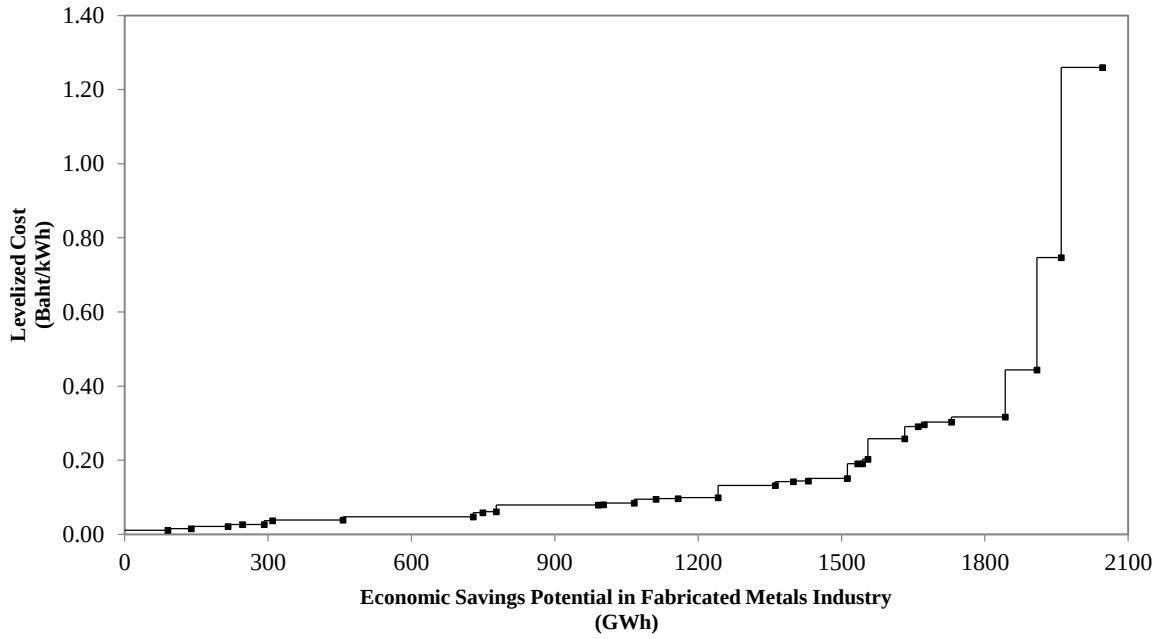
Measure number 22, to shut off unneeded pumps represents the highest net electric economic potential, followed by pumps system improvement, and installing ASD for compressed air, fans, and pumps system (100+ hp) accounting for 3,659 GWh. Resulting of net electric achievable potential, measure number 8, installing ASD for compressed air, fans, and pumps system (100+ hp) is the highest accounting for 1,654 GWh, followed by to shut off unneeded pumps, and installing ASD for compressed air, fans, and pumps system (6-100 hp). From the results, installing ASD for compressed air, fans, and pumps (100+ hp) and to shut off unneeded pumps have the highest potential both in economic and achievable potentials. Therefore, we suggest that do not let the pump drive run empty for a long time. When the system is driven with high performance and proper usage, it can help to increase energy saving. However, whether any given drive system, the motor can work efficiently only when electric motors and drive system related to work properly. The motor which is used in the drive system must be suitable related to the speed drive of this motor, not too large to fit the required load. Using such a motor driving a pump or fan flow rates change over time should be selected to adjust the speed.

On the other hand, measure number 16, proper motor practices for compressed air, fans, and pumps system (1-5 hp), with the lowest net economic savings potential, is 184 GWh, Following this measure, the replacement of existing motors with high efficiency motors (1-5 hp), and installing ASD for compressed air, fans, and pumps system (1-5 hp). Showing that, the measures involving 1-5 hp motor have obviously small economic savings potential. Thus, this measure should be implemented after other higher energy efficiency measures. Consideration of net achievable potential, measure number 30CFL hardwires, modular 36W represents the lowest savings potential accounting for 17 GWh. Installing ASD for compressed air, fans, and pumps system (1-5 hp), RET 2L4’ premium T8, 1EB, replacement of existing motors with high efficiency motors (1-5 hp), and properly motor practices for compressed air, fans, and pumps system (1-5 hp)followed. Those results emphasize 1-5 hp motor measure received small interest to decision implementation,

significantly, in Thai basic metals industrial sector. Because, small size motor cost is high that related to receiving benefits.

4.2.3.8 Fabricated Metal Sector

In Figure 4.17, the curves are shown in terms of savings as GWh per year. It should be noted that, the economic savings potential figures presented previously are based on the Benefit-to-Cost ratio. Figure 4.18presents 31 economic electric energy efficiency measures, based on the Benefit-to-Cost ratio, for fabricated metal sector. This is so-called "cost effectiveness" of an energy efficiency measure. In another words, the cost of investing on the economic energy efficiency measures to save one kWh of electricity is less than purchasing one kWh of electricity with electricity price in 2013 (4.21 Baht/kWh, [45]).



Note; the electric energy efficiency supply curves do not include O&M cost savings that might be associated with some measures. It is not clear that industrial customers fully acknowledge these O&M savings when deciding to adopt these measures.

Figure 4.17 Industrial Electric Energy-Efficiency Supply Curve for Fabricated Metal, 2013

In Figure 4.17, the economic electric savings potential for Thai fabricated metal industry in 2013 is estimated to be 2,047 GWh. This is about 12.3% of the fabricated metal's total electric usage in 2013. This potential obtained when applying all of the electric efficiency measures, as shown in Figure 4.18, to the Thai fabricated metal industry in a way

described above in the methodology section. The figure clearly shows that installing ASD for compressed air, fans, and pumps system (6-100 hp) is the most cost effective measure with the least levelized energy cost, followed by adjustable speed drive of and pumps system compressed air system. Therefore, the motor which is used in the drive system must be suitable related to the speed drive of this motor, not too large to fit the required load. Moreover, operation and maintenance of other systems also obtain high electric savings potential which remain low levelized energy cost (e.g. Pumps – O&M, 46 GWh saving in 2013).

In Figure 4.18, measures are ranked by levelized cost from least to vast. Net achievable potential which compared to net economic potential tend to decrease, as shown in this figure, due to increased levelized cost. The increasing of levelized cost is the important factor to decision to investment in any measures. Although, measure 9 has higher opportunity to decision than measure 8 to investment this measure as it much cost. Therefore money still does not only one barrier that affect to the decision.

Measure number 8, operation and maintenance in compressors represents the highest net electric economic potential, followed by compressed air system improvement, installing ASD for compressed air, fans, and pumps system (100+ hp), and to shut off unneeded pumps, accounting for 13,374 GWh. Resulting of net electric achievable potential, measure number 8, operation and maintenance in compressed air system is the highest accounting for 7,382 GWh, followed by compressed air system improvement, installing ASD for compressed air, fans, and pumps system (100+ hp), proper sizing compressors, and to shut off unneeded pumps.

From the resulting, to shut off unneeded pumps and installing ASD for compressed air, fans, and pumps (100+ hp) are both of the highest potential both in economic and achievable potential. Therefore, we suggest not to let the pump drive run empty for a long time. When the system is driven with high performance and proper usage, it can help to increase energy savings. However, whether any given drive system, the motor can work efficiently only when electric motors and drive system related to work properly. The motor which is used in the drive system, must be suitably related to the speed drive of this motor, not too large to fit the required load. Using such a motor driving a pump or fan flow rates change over time should be selected to adjust the speed.

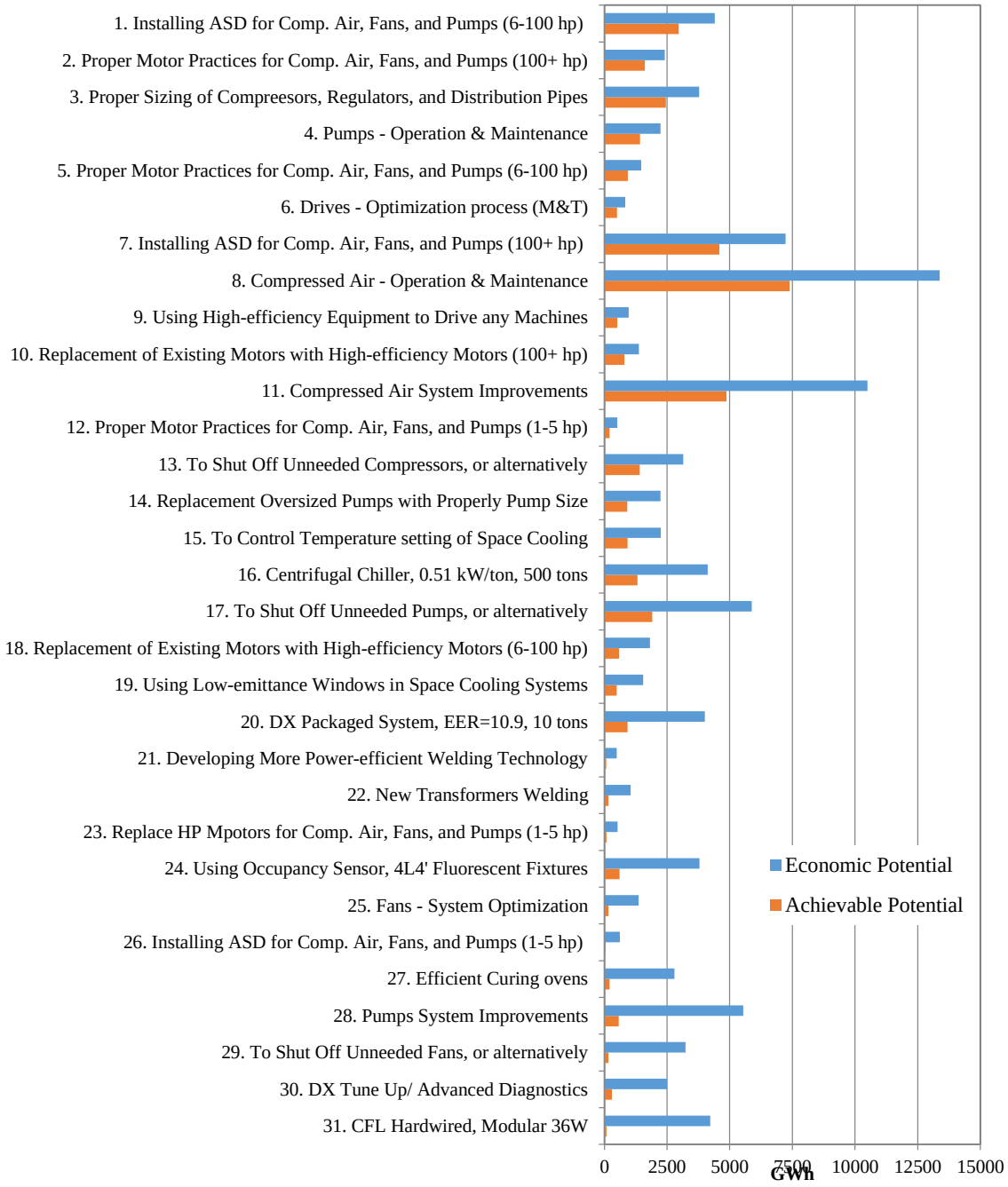


Figure 4.18 Fabricated Metals Net Economic and Achievable Electric Savings Potential by Measures – Cumulative 2014 to 2030

In the fabricated metals industry, compressed air systems are used in many machines to drive the equipment. Figure 4.18, therefore, clearly shows the measure involving compressors have high economic energy savings potential. Furthermore, the achievable energy savings potential are also high because of high of their B-C ratio, significantly.

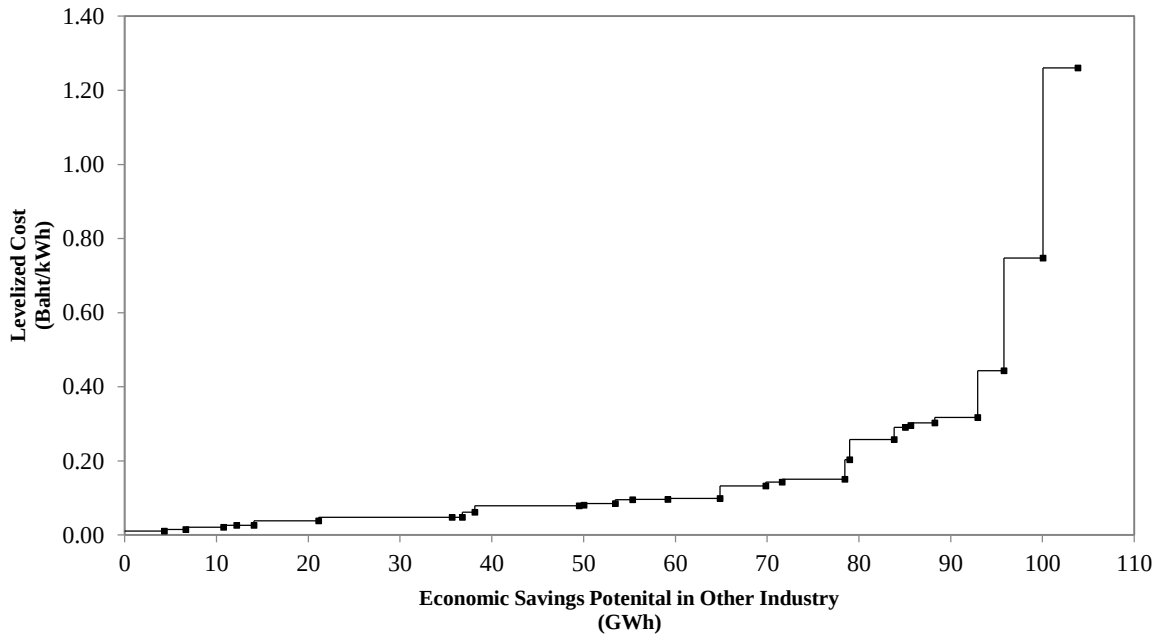
On the other hand, measure number 21, developing more power-efficient welding technology, with the lowest net economic savings potential, is 496 GWh, Following this measure, proper motor practices for compressed air, fans, and pumps system (1-5 hp), replacement of existing motors with high efficient motors (1-5 hp), and installing ASD for compressed air, fans, and pumps system (1-5 hp). Showing that, the measures involving 1-5 hp motor have obviously small economic savings potential. Thus, this measure should be implemented after other higher energy efficiency measures.

Consideration of net achievable potential, measure number 26,installing ASD for compressed air, fans, and pumps system (1-5 hp) represents the lowest savings potential accounting for 49 GWh. Developing more power-efficient welding technology, replacement of existing motors with high efficient motors (1-5 hp), and CFL hardwires, modular 36W followed. Those results emphasize 1-5 hp motor measure received small interest to decision implementation, significantly, in Thai basic metals industrial sector, because, small size motor cost is high that related to receiving benefits.

4.2.3.9 Other Sector

In Figure 4.19, the curves are shown in terms of savings as GWh per year. It should be noted that the economic savings potential figures presented previously are based on the Benefit-to-Cost ratio. Figure 4.20 presents 27 economic electric energy efficiency measures, based on the Benefit-to-Cost ratio, for other sectors. This is so-called "cost effectiveness" of an energy efficiency measure. In another words, the cost of investing on the economic energy efficiency measures to save one kWh of electricity is less than purchasing one kWh of electricity with electricity price in 2013 (4.21 Baht/kWh, [45]).

In Figure 4.19, the economic electric savings potential for Thai other industry in 2013 is estimated to be 104 GWh. This is about 10.9 % of the other's total electric usage in 2013. This potential obtained when applying all of the electric efficiency measures, as shown in Figure 4.20, to the Thai other industry in a way described above in the methodology section. The figure clearly shows that installing ASD for compressed air, fans, and pumps system (6-100 hp) is the most cost effective measure with the least levelized energy cost, followed by adjustable speed drive of and pumps system compressed air system. Therefore, the motor which is used in the drive system must be suitable related to the speed drive of this motor, not too large to fit the required load. Moreover, operation and maintenance of other systems also obtain high electric savings potential which remain low levelized energy cost (e.g. Compressed Air – O&M, 15 GWh saving in 2013).



Note; the electric energy efficiency supply curves do not include O&M cost savings that might be associated with some measures. It is not clear that industrial customers fully acknowledge these O&M savings when deciding to adopt these measures.

Figure 4.19 Industrial Electric Energy-Efficiency Supply Curve for Other, 2013

In Figure 4.20, measures are ranked by levelized cost from least to farthest. Net achievable potential which compared to net economic potential tend to decrease, as shown in this figure, due to increased levelized cost. The increasing of levelized cost is the important factor to decision to investment in any measures. Although, measure 12 has higher opportunity to decision than measure 11 to investment this measure as it much cost. Therefore money still does not only one barrier that affect to the decision.

Measure number 8, operation and maintenance in compressors represents the highest net electric economic potential, followed by compressed air system improvement, installing ASD for compressed air, fans, and pumps system (100+ hp), and to shut off unneeded pumps, accounting for 762 GWh. Resulting of net electric achievable potential, measure number 8, operation and maintenance in compressed air system is the highest accounting for 421 GWh, followed by compressed air system improvement, and installing ASD for compressed air, fans, and pumps system (100+ hp).

From the resulting, operation and maintenance in compressors have the highest potential both in economic and achievable potentials. Therefore, compressed air system which consists of air supply, air quality improvement, and air requirement segment should

management of the great air supply segment. The good management can get dry clean air, regularly air supply at appropriate pressure, consequentially, has cost-effectiveness. Moreover, other industry, compressed air systems are used many in their machines to drive the equipment. Figure 4.20, therefore, clearly shows the measure involving compressors have high economic energy savings potential. Furthermore, the achievable energy savings potential are also high because of high of their B-C ratio, significantly.

On the other hand, measure number 11, proper motor practices for compressed air, fans, and pumps system (1-5 hp), with the lowest net economic savings potential, is 26 GWh, Following this measure, replacement of existing motors with high efficient motors (1-5 hp),and installing ASD for compressed air, fans, and pumps system (1-5 hp). Showing that, the measures involving 1-5 hp motor have obviously small economic savings potential. Thus, this measure should be implemented after other higher energy efficiency measures.

Consideration of net achievable potential, measure number 22,installing ASD for compressed air, fans, and pumps system (1-5 hp) represents the lowest savings potential accounting for 2.5 GWh. CFL hardwires, modular 36W, and replacement of existing motors with high efficient motors (1-5 hp) followed. Those results emphasize 1-5 hp motor measure received small interest to decision implementation, significantly, in Thai basic metals industrial sector, because, small size motor cost is high and related to receiving benefits.

It should be noted that the details on economic results for individual measures by the industrial sector are provided in Appendix C. Supply curve data by the industry are provided in Appendix D.

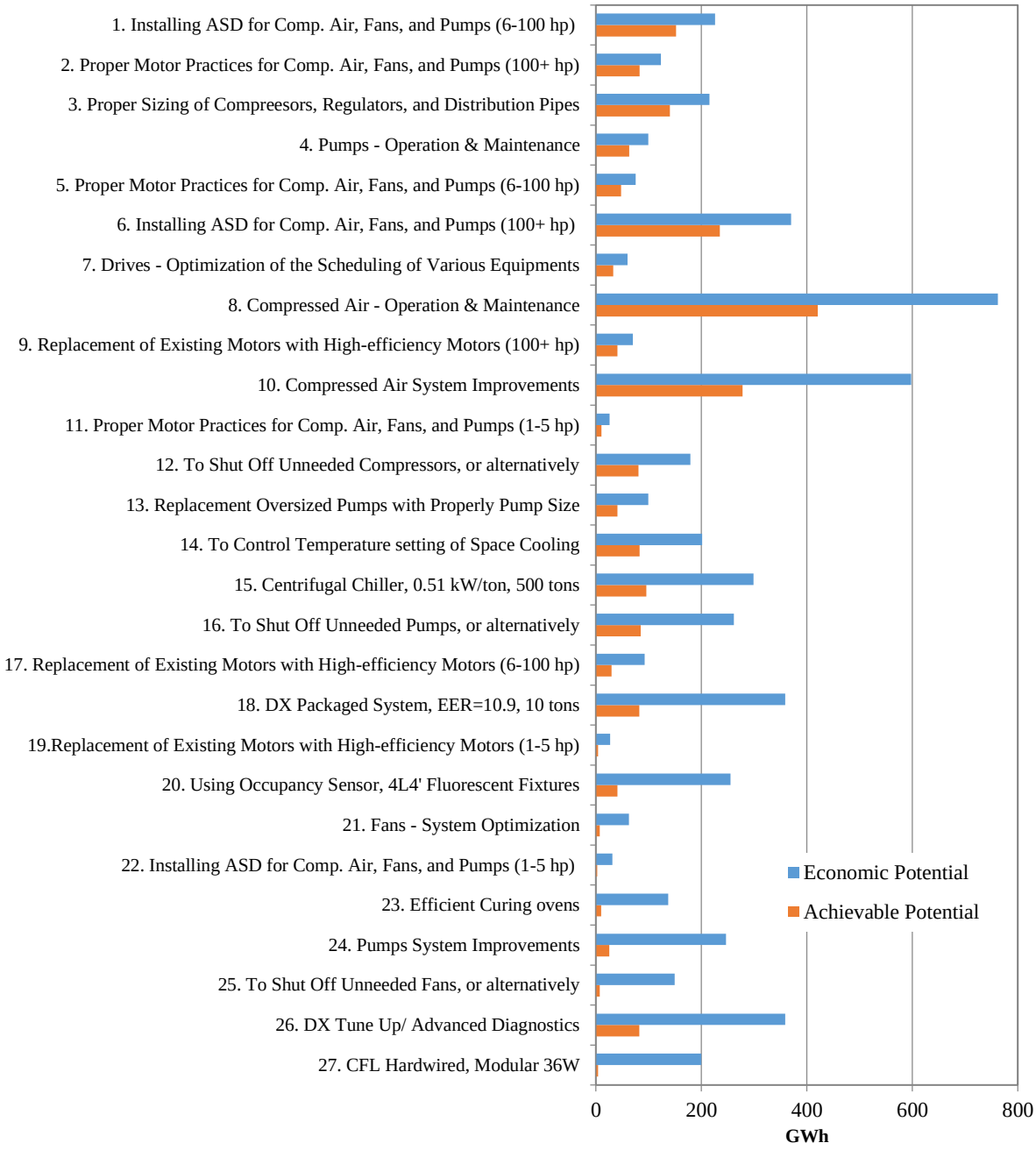


Figure 4.20 Other Net Economic and Achievable Electric Savings Potential by Measures – Cumulative 2014 to 2030

4.3 Electric Achievable Potential

In contrast to technical and economic potential estimates, achievable potential estimates take into account market and other factors that affect the adoption of efficiency measures. In this study, the primary curve shown in Figure 3.1 considerably utilized. The

effect of a financial incentive on the penetration of more energy-efficient devices can then be estimated to be proportional to the effect that increasing the benefit-to-cost ratio of the equipment would have in a market represented by the selected reference curve.

Achievable potential represents the amount of energy usage that efficiency can realistically be expected to displace assuming the most aggressive program scenario possible (e.g., providing end-users with payments for the entire incremental cost of more efficient equipment). This is often referred to as maximum achievabl e potential. Achievable potential takes into account real-world barriers to convincing end-users to adopt efficiency measures.

Table 4.4 Electric Achievable Savings Potential by Industrial Sector – cumulative 2014-2030

Industrial Sector	Total achievable cumulative savings (GWh)
Food & Beverages	36,708
Textiles	3,718
Wood & Furniture	2,984
Paper	3,996
Chemicals	10,364
Non-metallic	7,302
Basic Metals	13,895
Fabricated Metals	39,206
Other (Unclassified)	2,132
Total	120,305

Because achievable potential depends on the type and degree of intervention applied, we used maximum penetration rate to estimate achievable saving potential for industrial sector in Thailand. As shown in Table 4.4, the result of our calculations for achievable potential, total achievable cumulative saving potential savings, 2014-2030 for the whole Thai industryis120,305 GWh, or approximately 6.3% of forecast total Thai industry GWh sales in the period. Besides, fabricated metals, food and beverages, and basic metals show the highest net achievable saving potentials.

Table 4.5 Achievable Savings Potentials by Cross-cutting Electricity Efficiency Measures – cumulative 2014-2030

Electricity Efficiency Measures	Total achievable cumulative savings (GWh)
Installing ASD for Comp. Air, Fans, and Pumps (100+ hp)	15,605
Proper Motor Practices for Comp. Air, Fans, and Pumps (100+ hp)	5,505
Replacement of Existing Motors with High-efficiency Motors (100+ hp)	2,708
Installing ASD for Comp. Air, Fans, and Pumps (6-100 hp)	10,077
Proper Motor Practices for Comp. Air, Fans, and Pumps (6-100 hp)	3,184
Replacement of Existing Motors with High-efficiency Motors (6-100 hp)	1,982
To Shut Off Unneeded Pumps, or alternatively	10,015
To Shut Off Unneeded Compressors, or alternatively	2,783
To Shut Off Unneeded Fans, or alternatively	729
Compressed Air - Operation & Maintenance	14,508
Pumps - Operation & Maintenance	7,454
Fans - Operation & Maintenance	1,323
Compressed Air System Improvements	8,769
Pumps System Improvements	2,975
Fan System Improvements	1,236
Replacement Oversized Pumps with Properly Pump Size	4,897
Proper Sizing of Compressors, Regulators, and Distribution Pipes	4,835
Total	**98,585**

4.3.1 Achievable Savings Potential by Cross-cutting Electricity Efficiency Measures

In this section, the cross-cutting electricity efficiency because they are measures having high achievable savings potential in each industrial sector are gathered necessary to apply in commercial industry. As shown in Table 4.5, the management of compressed air, pumps, and fans system represented in high sequence of total achievable cumulative savings potential.

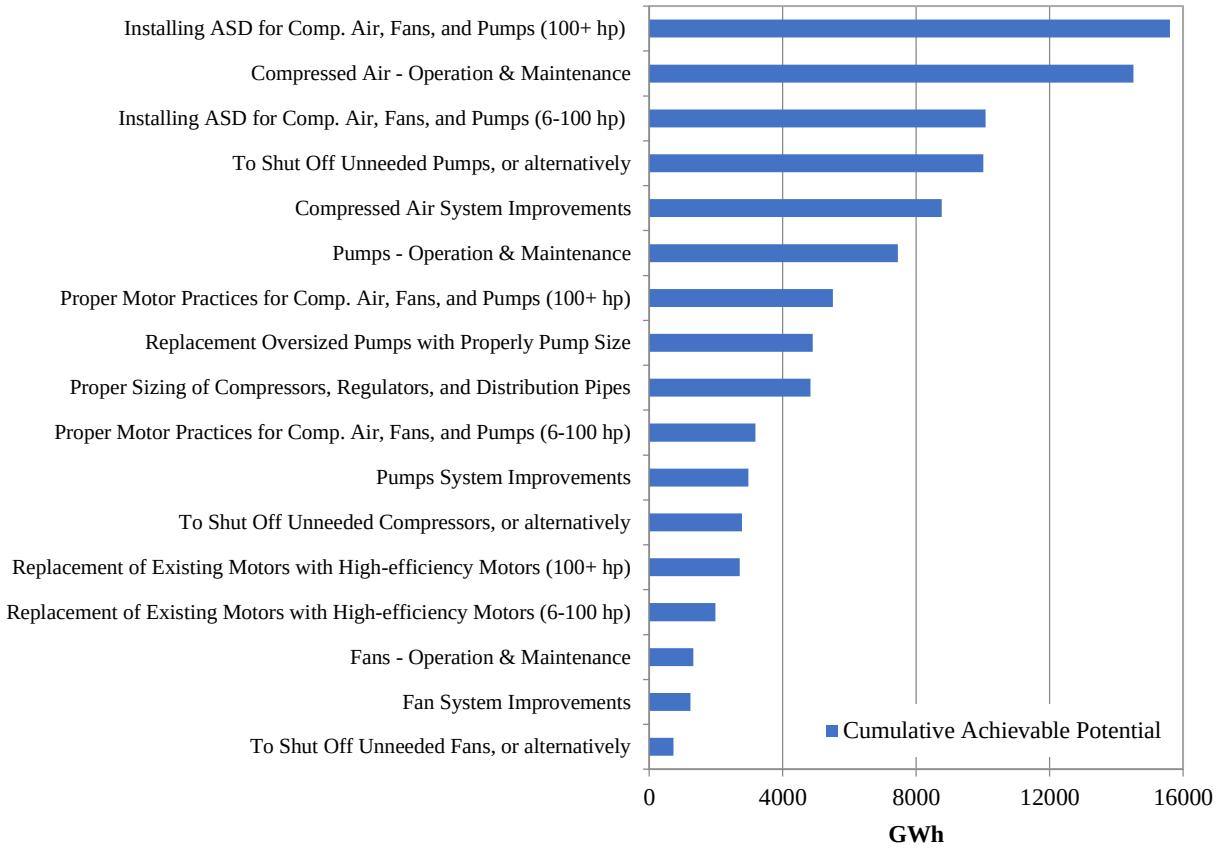


Figure 4.21 Achievable Savings Potentials by Cross-cutting Electricity Efficiency Measures – cumulative 2014-2030

The cross-cutting electricity efficiency measures inference practically accounted for 98,585 GWh in the period or about 82% of the total achievable cumulative savings potential of all economic measures. Those measures are utility systems which support production process able to operate completely. Therefore, those electricity efficiency measures are recommended to particularly apply into energy management in factories in order to enormously obtain electricity savings which also means cost savings.

Figure 4.21 demonstrates the cross-cutting efficiency measures of achievable savings potential, in the period of 2014-2030, ranked by the highest potential to the lowest. Installation of ASD in pumps, fans, and compressed air system (100+ hp) has the highest achievable savings potential, accounted for 15,605 GWh as shown in Table 4.5 and followed by Operation and maintenance in the compressor. Factories can be used to decide what efficiency measures that appropriate to adopt in own and obtain the highest benefits.

4.4 Key Discussion for Power DSM Potential in Industrial Sector in Thailand Study

- According to EPPO informed in 20-year EEDP in 2010, electric technical savings potential in the year of 2030 was estimated accounting for 33,500 GWh, which is lower than the calculation accounted for 41,213 GWh in 2030. Therefore, our technical potential can be feasible. Nevertheless the achievable estimation results are far from those.
- As shown in Figure 4.3, electric technical and economic savings potential are so close that are different equal to about 2% of forecast Thai industry GWh sales in 2030 because almost all of measures are energy efficiency measures. Moreover, the pump, compressed air, and lighting are the highest range to get electric energy saving potential in Thai industrial sector as the same in the global study.
- As mentioned in section 2.1, the core equation was used to calculate the electric technical potential for each individual efficient measure by using effective factors; applicability, incomplete, feasibility, and savings factor. These factors were adopted from the study of California Industrial Existing Construction Energy Efficiency Potential [42]. Accordingly the incomplete factor that was used in this study wasn't accurate for estimating Thai electricity savings potential because this factor is the faction of applicable that has not yet been converted to the efficient measure. Furthermore the defect incessantly affects to Thai economic and achievable potential. Due to each city has different efficient energy management establishment, the incomplete factor is variant. Therefore, the next study, the incomplete factor should be researched for Thailand in order to accurately electric potential estimation.
- Another weakness in this study, the limitation of productivity in each product was not mentioned, owning to Benefit-to-Cost ratio qualification. The productivity of one output has same nature in all products. S-curve technique which is used to predict the nature of product indicates status by using previous information. Therefore, in the next occasion, the S-curve should be applied to estimate electric energy savings potential in Thailand for accuracy.
- Almost an industrial sector in Thailand clearly show that fans operation and maintenance is the most cost effective measure with the least levelized energy cost, followed by adjustable speed drive of compressed air system and fans system. Therefore, proper monitoring and maintenance can save a lot of energy as well as

money in this industrial sector. Moreover, operation and maintenance of other systems also obtain high electricity savings potential which remain low levelized energy cost.

- Improved process controls, system optimization, and O&M measures are key components of potential savings. These measures are likely to be more difficult to implement than strict equipment efficiency improvements as customers will require more education to effect improvement.
- Net achievable potential, compared to net economic potential, tend to decrease due to increased levelized costs. The increasing of levelized cost is the important factor to decision to investment in any measures. Although, any measures havehigh opportunity to decision to investment this measure as it much cost. Therefore money does not only one barrier that affect to the decision.
- Almost all of industrial the sectors in Thailand, to shut off unneeded pumps and installing ASD for compressed air, fans, and pumps (100+ hp) is one of the highest potential both in net electric economic and achievable potential. Therefore, we suggest that do not let the pump drive run empty for a long time. When the system is driven with high performance and proper usage, it can help to increase energy saving. However, whether any given drive system, the motor can work efficiently only when electric motors and drive system related to work properly. The motor which is used in the drive system must be suitable related to the speed drive of this motor, not too large to fit the required load. Using such a motor driving a pump or fan flow rates change over time should be selected to adjust the speed. But, those results emphasize 1-5 hp motor measure received small interest to decision implementation, significantly. Because, small size motor cost is high that related to receiving benefits.
- In the basic metals, fabricated metals, and other industries, compressed air systems are used many in their machines to drive the equipment. Therefore, the results clearly show the measure involving compressors have high economic energy savings potential. Furthermore, the achievable energy savings potential are also high because of high of their B-C ratio, significantly.
- In our estimation, operation and maintenance of compressors is both the highest potential in net electric economic and achievable potentials in many sectors. Therefore, compressed air system which consists of air supply, air quality improvement, and air requirement segment should management of the great air

supply segment. The good management can obtain dry clean air, regularly air supply at appropriate pressure, consequentially, has cost-effectiveness. Moreover, Thai industry, compressed air systems are used many in their machines to drive the equipment.

- Achievable potential takes into account real-world barriers to convince in end-user to adopt efficiency measures. Because the achievable potential depends on an actual adoption which correlates with several market barriers. In any case, the achievable potential is adjusted based on the incentives.
- In the industrial sector, there are many individual measures that can be applied to processes throughout the population of industrial facilities in a service region. However, analyzing each of these opportunities, though possible, is impractical within a resource and time-constrained study.
- Figure 4-21 shows the results of achievable potential estimation as compared to technical and economic potential. Fabricated metals industry has the highest technical and economic savings potential. In achievable potential is very different from both of technical and economic potential, because the B-C ratio of high savings potential measures is low.

CHAPTER 5
CONCLUSSION

This chapter presents estimates of electric technical, economic, and achievable energy efficiency potential for the industrial sector of Thailand

5.1 Aggregate Electric Technical and Economic Savings Potential

Figure 5.1 presents the estimates of total electric technical and economic potentials for energy. Overall, technical energy savings potential is estimated to be 11,500 GWh, accounted for 17.1% of total industrial electric usage (i.e., 11,500 GWh Savings ÷ 67,070 GWh of base consumption). The economic potential is estimated to be 9,635 GWh, accounted for 14.4% of total base usage.

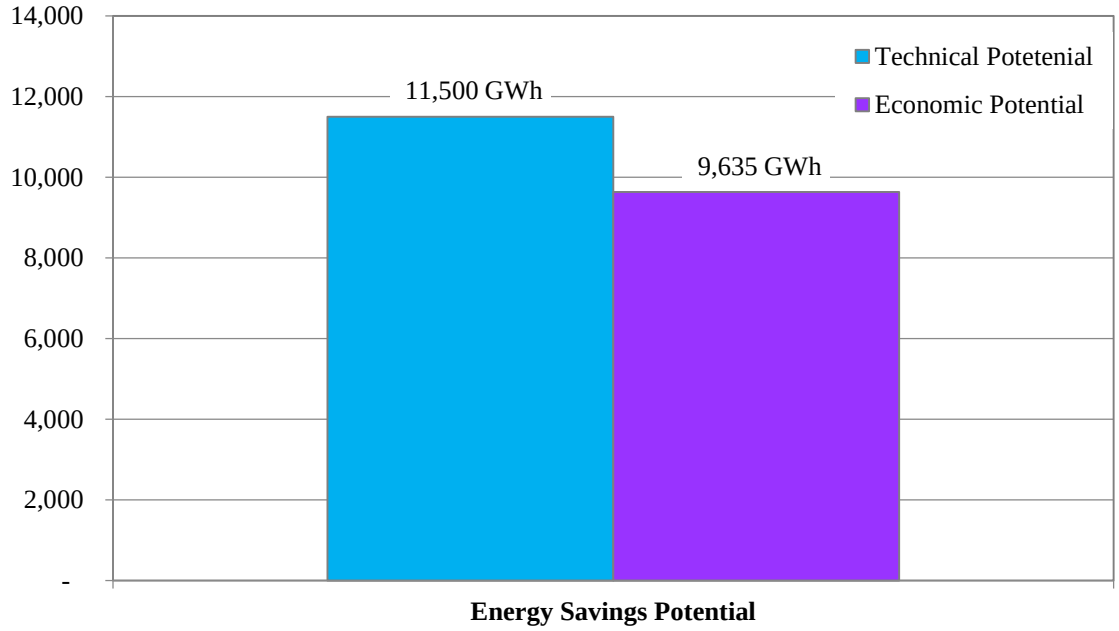


Figure 5.1 Estimated Electric Technical and Economic Potential in Industrial Sector

5.2 Electric Technical and Economic Savings Potential by End Use and Industry

Estimates of energy savings potential is provided by the end user in Figure 5.2. The left of the figure provides savings in absolute terms; the right, in term of the percentage of base case end-use energy. Pumping represents the largest end-use savings potential, followed

by compressed air and lighting. While at the right of Figure 5.2, the compressed air system has the largest percentage of base case end-use energy followed by pumping and lighting, both in technical and economic perspectives. Therefore, the pump, compressed air, and lighting are the highest range to get electric energy saving potential in Thai industrial sector as the same in the global study.

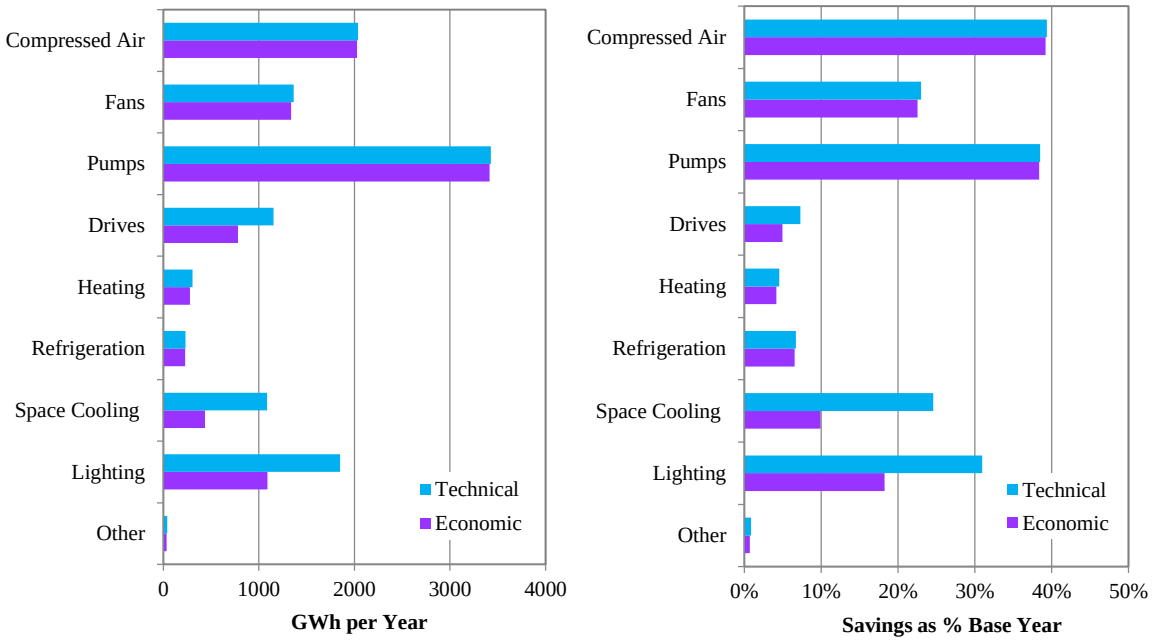


Figure 5.2 Industrial Electric Savings Potential by End Use, 2013

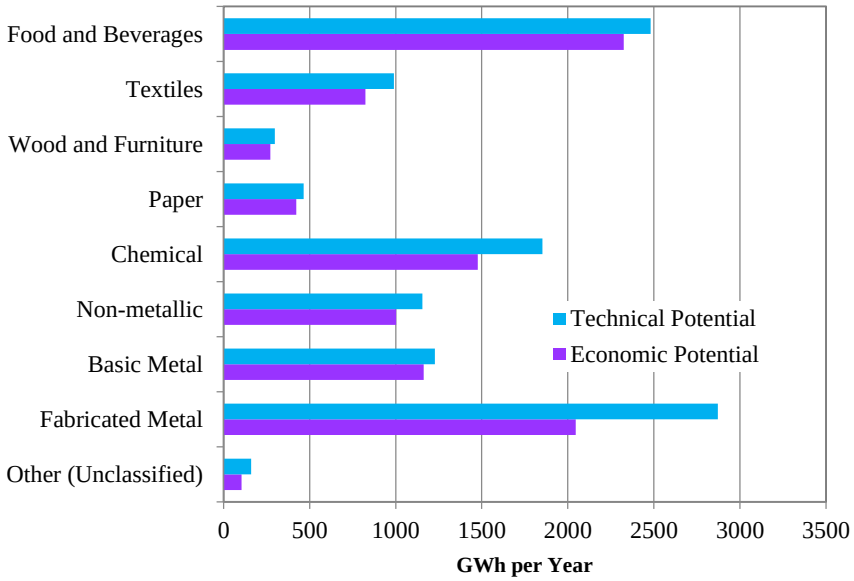


Figure 5.3 Industrial Electric Savings Potential by Industrial Sector, 2013 (Base Year)

Figure 5.3 presents estimates of technical and economic savings potential by the industrial sector. The fabricated sector represents the largest electric savings potential, i.e. 8,153 GWh, as in technical perspective. It should be noted that, detail on technical and economic potential for electricity savings is presented in Appendix C. This appendix shows results by end-use and industrial sector. As shown in Figure 5.3, electric technical and economic saving potential are so close that are different equal to about 2% of forecast Thai industry GWh sales in 2030 because almost all of measures are energy efficiency measures.

5.3 Electric Achievable Savings Potential

Since achievable potential depends on the type and degree of intervention applied, we used maximum penetration rate to estimate achievable saving potential for industrial sector in Thailand. As a result in Table 4.4, the result of our calculations for achievable potential, total achievable cumulative saving potential savings, 2014-2030 for the whole Thai industryis120,305 GWh, or approximately 6.3% of forecast total Thai industry GWh sales in the period. Besides, fabricated metal, food and beverages, and basic metal show the highest net achievable saving potential. Figure 5.3 shows the results achievable potential estimation compared to technical and economic potential.

According to EPPO informed in 20-year EEDP in 2010, electric technical savings potential in the year of 2030 was estimated accounting for 33,500 GWh, which is lower than the calculation accounting for 41,213 GWh in 2030. Therefore, our technical potential can be feasible, but vigorous procedure in all measures would be required because the gap between 20-year EEDP's estimation and our potential is not too wide. Nevertheless the achievable estimation results are too far from those.

As shown in Figure 5.4, electric technical and economic saving potentials are so close that their difference is about 2% of forecast Thai industry GWh sales in 2030 because almost all of measures are energy efficiency measures. Moreover, the pump, compressed air, and lighting are the highest range to get electric energy saving potential in Thai industrial sector as the same in the global study.

Achievable potential takes into account real-world barriers to convince the end-users to adopt efficiency measures, because the achievable potential depends on an actual adoption which correlates with several market barriers. In any case, the achievable potential is adjusted based on the incentives.

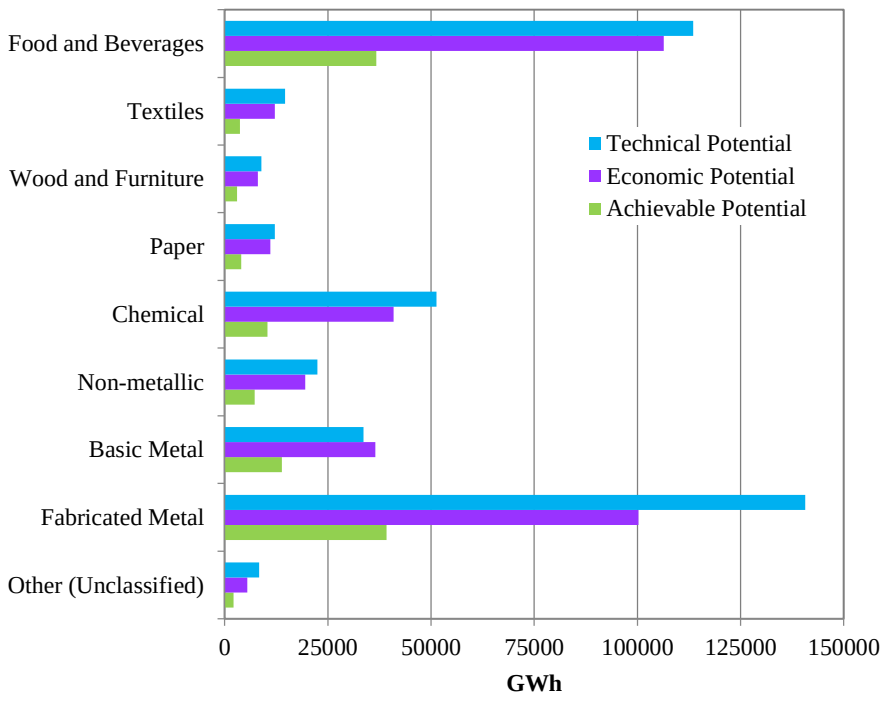


Figure 5.4 Industrial Electric Savings Potential by Industrial Sector, Cumulative 2014-2030

In almost all industrial sectors in Thailand, to shut off unneeded pumps and installing ASD for compressed air, fans, and pumps (100+ hp) is one of the highest potential both in net electric economic and achievable potential. Therefore, we suggest that do not let the pump drive run empty for a long time. When the system is driven with high performance and proper usage, it can help to increase energy savings. However, for any given drive system, the motor can work efficiently only when the electric motors and drive system work properly. The motor which is used in the drive system must be suitable related to the speed drive of this motor, not too large to fit the required load. Using such a motor driving a pump or fan flow rates change over time should be selected to adjust the speed. But, those results emphasize 1-5 hp motor measure received small interest to decision implementation, significantly. Because, small size motor cost is high that related to receiving benefits.

It should be noted that in this study, the methodology has a weakness involving the inaccuracy of the incomplete factors of individual effective measures in each industry. Those factors are used in California not in Thailand. Therefore, in future work, the incomplete factor for Thai industrial sector should be study to accurately estimate electric savings potential. Moreover, the penetration rate adopted in this work was estimated from KEMA

and LBNL. In Thailand, a study of penetration rate should be constructed for energy efficiency assessment. Another weakness in this study, the limitation of productivity in each product was not mentioned, owning to Benefit-to-Cost ratio qualification. The productivity of one output has same nature in all products. S-curve technique which is used to predict the nature of product indicates status by using previous information. Therefore, in the next occasion, the S-curve should be applied to estimate electric energy savings potential in Thailand for accurately.

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Appendix A: Economic Inputs

Thailand Industrial Sector

Discount Rate	0.08	
Currency Chang	32	Baht/$
General Inflation Rate	0.03	
Base Year	2013	
The normalized year life	17	
Electricity Price - 2013	4.208	Baht/kWh

Table A.1 Thai Electricity Price in the year of 2013 [45]

Month	Whole Sale Price of Thai Industry	ft	Electric Price (including ft and vat 7%)
1	3.4145	0.5204	4.2103
2	3.4347	0.5204	4.2320
3	3.4047	0.5204	4.1999
4	3.4703	0.5204	4.2700
5	3.4327	0.4692	4.1750
6	3.4186	0.4692	4.1599
7	3.4136	0.4692	4.1546
8	3.4130	0.4692	4.1540
9	3.4284	0.5400	4.2462
10	3.4247	0.5400	4.2422
11	3.4192	0.5400	4.2363
12	3.3967	0.5400	4.2123
Thai Electricity Price			**4.2077**

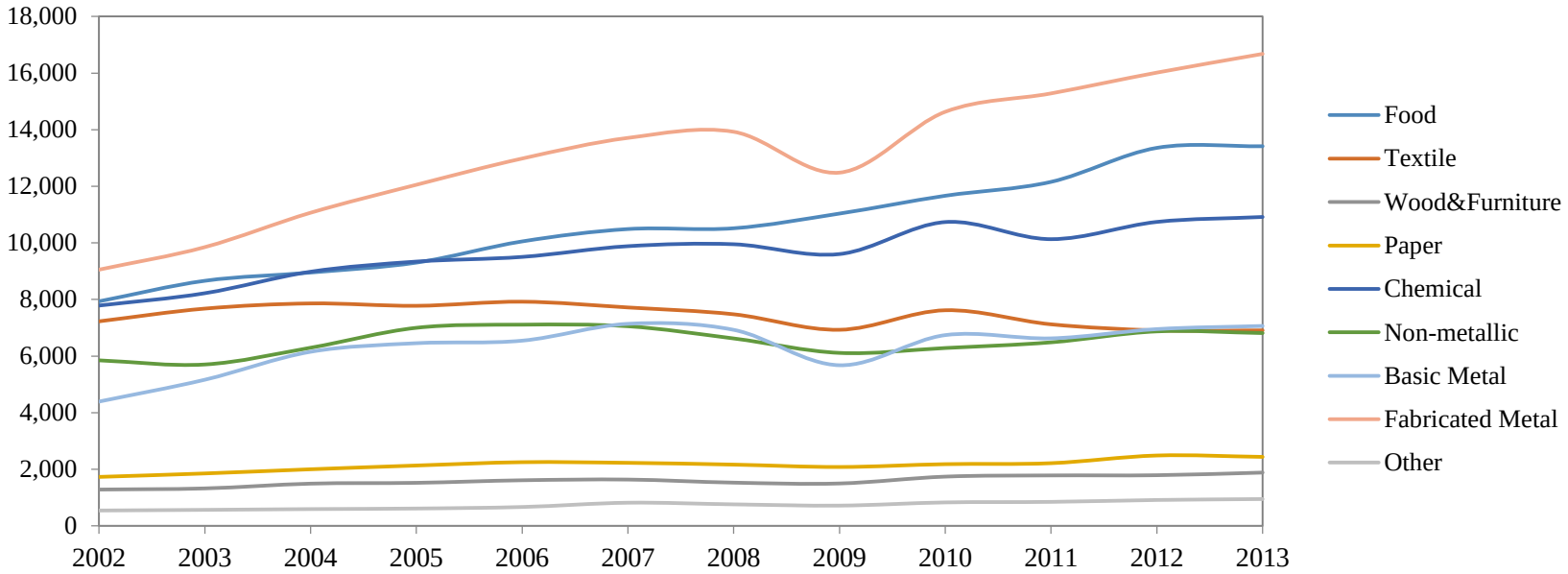

Figure A-1 Electricity Consumption for the Whole Country by Industrial Sector (2002-2013) [44]

Table A.2 Growth Rate of Electricity Consumption for the Whole Country by Industrial Sector (2002-2013)

Industrial Sector	%Growth Rate
Food	6.56
Textile	-0.87
Wood & Furniture	3.66
Paper	2.83
Chemical	3.17
Non-metal	0.88
Basic metal	3.10
Fabricated metal	6.98
Other	7.44

Appendix B: Electric Measure Inputs

Table B.1 Applicability Factor by Measures and Industry [42]

Applicability Factor (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Base Compressed Air	9.00	4.00	5.00	3.77	3.67	6.00	6.00	12.84	12.00
Compressed Air - O&M	9.00	4.00	5.00	3.77	3.67	6.00	6.00	12.84	12.00
Compressed Air - Controls	9.00	4.00	5.00	3.77	3.67	6.00	6.00	12.84	12.00
Compressed Air - System Optimization	9.00	4.00	5.00	3.77	3.67	6.00	6.00	12.84	12.00
Compressed Air- Sizing	9.00	4.00	5.00	3.77	3.67	6.00	6.00	12.84	12.00
Comp Air - Replace 1-5 HP motor	9.00	4.00	5.00	3.77	3.67	6.00	6.00	12.84	12.00
Comp Air - ASD (1-5 hp)	9.00	4.00	5.00	3.77	3.67	6.00	6.00	12.84	12.00
Comp Air - Motor practices-1 (1-5 HP)	9.00	4.00	5.00	3.77	3.67	6.00	6.00	12.84	12.00
Comp Air - Replace 6-100 HP motor	9.00	4.00	5.00	3.77	3.67	6.00	6.00	12.84	12.00
Comp Air - ASD (6-100 hp)	9.00	4.00	5.00	3.77	3.67	6.00	6.00	12.84	12.00
Comp Air - Motor practices-1 (6-100 HP)	9.00	4.00	5.00	3.77	3.67	6.00	6.00	12.84	12.00
Comp Air - Replace 100+ HP motor	9.00	4.00	5.00	3.77	3.67	6.00	6.00	12.84	12.00
Comp Air - ASD (100+ hp)	9.00	4.00	5.00	3.77	3.67	6.00	6.00	12.84	12.00
Comp Air - Motor practices-1 (100+ HP)	9.00	4.00	5.00	3.77	3.67	6.00	6.00	12.84	12.00
Power recovery	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.00
Refinery Controls	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.00
Energy Star Transformers	9.00	4.00	5.00	3.77	3.67	6.00	6.00	12.84	12.00
Base Fans	10.00	8.00	10.00	13.94	6.47	14.00	14.00	5.29	4.00
Fans - O&M	10.00	8.00	10.00	13.94	6.47	14.00	14.00	5.29	4.00
Fans - Controls	10.00	8.00	10.00	13.94	6.47	14.00	14.00	5.29	4.00
Fans - System Optimization	10.00	8.00	10.00	13.94	6.47	14.00	14.00	5.29	4.00
Fans- Improve components	10.00	8.00	10.00	13.94	6.47	14.00	14.00	5.29	4.00
Fans - Replace 1-5 HP motor	10.00	8.00	10.00	13.94	6.47	14.00	14.00	5.29	4.00
Fans - ASD (1-5 hp)	10.00	8.00	10.00	13.94	6.47	14.00	14.00	5.29	4.00

Table B.1 Applicability Factor by Measures and Industry (cont') [42]

Applicability Factor (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Fans - Motor practices-1 (1-5 HP)	10.00	8.00	10.00	13.94	6.47	14.00	14.00	5.29	4.00
Fans - Replace 6-100 HP motor	10.00	8.00	10.00	13.94	6.47	14.00	14.00	5.29	4.00
Fans - ASD (6-100 hp)	10.00	8.00	10.00	13.94	6.47	14.00	14.00	5.29	4.00
Fans - Motor practices-1 (6-100 HP)	10.00	8.00	10.00	13.94	6.47	14.00	14.00	5.29	4.00
Fans - Replace 100+ HP motor	10.00	8.00	10.00	13.94	6.47	14.00	14.00	5.29	4.00
Fans - ASD (100+ hp)	10.00	8.00	10.00	13.94	6.47	14.00	14.00	5.29	4.00
Fans - Motor practices-1 (100+ HP)	10.00	8.00	10.00	13.94	6.47	14.00	14.00	5.29	4.00
Optimize drying process	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Power recovery	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00
Refinery Controls	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00
Energy Star Transformers	10.00	8.00	10.00	13.94	6.47	14.00	14.00	5.29	4.00
Base Pumps	17.00	10.00	13.00	22.88	13.12	18.00	18.00	6.85	5.00
Pumps - O&M	17.00	10.00	13.00	22.88	13.12	18.00	18.00	6.85	5.00
Pumps - Controls	17.00	10.00	13.00	22.88	13.12	18.00	18.00	6.85	5.00
Pumps - System Optimization	17.00	10.00	13.00	22.88	13.12	18.00	18.00	6.85	5.00
Pumps - Sizing	17.00	10.00	13.00	22.88	13.12	18.00	18.00	6.85	5.00
Pumps - Replace 1-5 HP motor	17.00	10.00	13.00	22.88	13.12	18.00	18.00	6.85	5.00
Pumps - ASD (1-5 hp)	17.00	10.00	13.00	22.88	13.12	18.00	18.00	6.85	5.00
Pumps - Motor practices-1 (1-5 HP)	17.00	10.00	13.00	22.88	13.12	18.00	18.00	6.85	5.00
Pumps - Replace 6-100 HP motor	17.00	10.00	13.00	22.88	13.12	18.00	18.00	6.85	5.00
Pumps - ASD (6-100 hp)	17.00	10.00	13.00	22.88	13.12	18.00	18.00	6.85	5.00
Pumps - Motor practices-1 (6-100 HP)	17.00	10.00	13.00	22.88	13.12	18.00	18.00	6.85	5.00
Pumps - Replace 100+ HP motor	17.00	10.00	13.00	22.88	13.12	18.00	18.00	6.85	5.00
Pumps - ASD (100+ hp)	17.00	10.00	13.00	22.88	13.12	18.00	18.00	6.85	5.00
Pumps - Motor practices-1 (100+ HP)	17.00	10.00	13.00	22.88	13.12	18.00	18.00	6.85	5.00
Power recovery	0.00	0.00	0.00	0.00	1.30	0.00	0.00	0.00	0.00

Table B.1 Applicability Factor by Measures and Industry (cont') [42]

Applicability Factor (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Refinery Controls	0.00	0.00	0.00	0.00	1.30	0.00	0.00	0.00	0.00
Energy Star Transformers	17.00	10.00	13.00	22.88	13.12	18.00	18.00	6.85	5.00
Base Drives	3.0	36.0	47.0	34.1	27.5	20.0	21.0	14.3	20.0
Bakery - Process (Mixing) - O&M	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
O&M/drives spinning machines	0.0	36.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Air conveying systems	0.0	0.0	47.0	0.0	0.0	0.0	0.0	0.0	0.0
Replace V-Belts	0.0	0.0	47.0	0.0	0.0	0.0	0.0	0.0	0.0
Drives - EE motor	0.0	0.0	47.0	27.0	0.0	20.0	0.0	0.0	0.0
Gap Forming papermachine	0.0	0.0	0.0	27.0	0.0	0.0	0.0	0.0	0.0
High Consistency forming	0.0	0.0	0.0	27.0	0.0	0.0	0.0	0.0	0.0
Optimization control PM	0.0	0.0	0.0	27.0	0.0	0.0	0.0	0.0	0.0
Efficient practices printing press	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0
Efficient Printing press (fewer cylinders)	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0
Light cylinders	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0
Efficient drives	0.0	0.0	0.0	7.1	4.4	0.0	0.0	0.0	0.0
Clean Room - Controls	0.0	0.0	0.0	0.0	4.4	0.0	0.0	3.9	0.0
Clean Room - New Designs	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0
Drives - Process Controls (batch + site)	0.0	0.0	0.0	0.0	4.4	20.0	21.0	0.0	0.0
Process Drives - ASD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0
O&M - Extruders/Injection Moulding	0.0	0.0	0.0	0.0	23.0	0.0	0.0	0.0	0.0
Extruders/injection Moulding-multipump	0.0	0.0	0.0	0.0	23.0	0.0	0.0	0.0	0.0
Direct drive Extruders	0.0	0.0	0.0	0.0	23.0	0.0	0.0	0.0	0.0
Injection Moulding - Impulse Cooling	0.0	0.0	0.0	0.0	23.0	0.0	0.0	0.0	0.0
Injection Moulding - Direct drive	0.0	0.0	0.0	0.0	23.0	0.0	0.0	0.0	0.0
Efficient grinding	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0
Process control	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0

Table B.1 Applicability Factor by Measures and Industry (cont') [42]

Applicability Factor (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Process optimization	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0
Drives - Process Control	0.0	0.0	0.0	0.0	0.0	0.0	21.0	0.0	0.0
Efficient drives - rolling	0.0	0.0	0.0	0.0	0.0	0.0	21.0	0.0	0.0
Drives - Optimization process (M&T)	0.0	0.0	0.0	4.8	0.0	0.0	0.0	10.4	0.0
Drives - Scheduling	0.0	0.0	0.0	4.8	0.0	0.0	0.0	14.3	20.0
Machinery	0.0	0.0	0.0	4.8	0.0	0.0	0.0	14.3	0.0
Efficient Machinery	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Energy Star Transformers	3.0	36.0	47.0	34.1	27.5	20.0	21.0	14.3	20.0
Base Heating	8.0	5.0	6.0	2.3	0.0	23.0	20.0	12.8	11.0
Bakery - Process	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Drying (UV/IR)	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Heat Pumps - Drying	0.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0
Top-heating (glass)	0.0	0.0	0.0	0.0	0.0	23.0	0.0	0.0	0.0
Efficient electric melting	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0
Intelligent extruder (DOE)	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0
Near Net Shape Casting	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0
Heating - Process Control	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0
Efficient Curing ovens	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.8	11.0
Heating - Optimization process (M&T)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	0.0
Heating - Scheduling	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0
Energy Star Transformers	8.0	5.0	6.0	0.0	0.0	23.0	20.0	12.8	11.0
Base Refrigeration	26.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Efficient Refrigeration - Operations	26.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Optimization Refrigeration	26.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Energy Star Transformers	26.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Base Other Process	0.0	0.0	0.0	0.0	2.2	0.0	0.0	4.2	1.0

Table B.1 Applicability Factor by Measures and Industry (cont') [42]

Applicability Factor (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Other Process Controls (batch + site)	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0
Efficient desalter	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
New transformers welding	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0
Efficient processes (welding, etc.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0
Process control	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Power recovery	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Refinery Controls	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Energy Star Transformers	0.0	0.0	0.0	0.0	2.2	0.0	0.0	4.2	1.0
Base Centrifugal Chiller, 0.58 kW/ton, 500 tons	2.0	6.0	2.0	2.6	0.7	1.0	1.0	4.2	5.0
Centrifugal Chiller, 0.51 kW/ton, 500 tons	2.0	6.0	2.0	2.6	0.7	1.0	1.0	4.2	5.0
Window Film - Chiller	2.0	6.0	2.0	2.6	0.7	1.0	1.0	4.2	5.0
EMS - Chiller	2.0	6.0	2.0	2.6	0.7	1.0	1.0	4.2	5.0
Cool Roof - Chiller	2.0	6.0	2.0	2.6	0.7	1.0	1.0	4.2	5.0
Chiller Tune Up/Diagnostics	2.0	6.0	2.0	2.6	0.7	1.0	1.0	4.2	5.0
Cooling Circ. Pumps - VSD	2.0	6.0	2.0	2.6	0.7	1.0	1.0	4.2	5.0
Energy Star Transformers	2.0	6.0	2.0	2.6	0.7	1.0	1.0	4.2	5.0
Base DX Packaged System, EER=10.3, 10 tons	2.0	4.0	3.0	3.8	1.7	3.0	2.0	8.2	12.0
DX Tune Up/ Advanced Diagnostics	2.0	4.0	3.0	3.8	1.7	3.0	2.0	8.2	12.0
DX Packaged System, EER=10.9, 10 tons	2.0	4.0	3.0	3.8	1.7	3.0	2.0	8.2	12.0
Window Film - DX	2.0	4.0	3.0	3.8	1.7	3.0	2.0	8.2	12.0
Evaporative Pre-Cooler	2.0	4.0	3.0	3.8	1.7	3.0	2.0	8.2	12.0
Prog. Thermostat - DX	2.0	4.0	3.0	3.8	1.7	3.0	2.0	8.2	12.0
Cool Roof - DX	2.0	4.0	3.0	3.8	1.7	3.0	2.0	8.2	12.0
Energy Star Transformers	2.0	4.0	3.0	3.8	1.7	3.0	2.0	8.2	12.0
Base Lighting	7.0	10.0	6.0	7.6	8.2	5.0	4.0	14.5	16.0
RET 2L4' Premium T8, 1EB	7.0	10.0	6.0	7.6	8.2	5.0	4.0	14.5	16.0

Table B.1 Applicability Factor by Measures and Industry (cont') [42]

Applicability Factor (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
CFL Hardwired, Modular 36W	7.0	10.0	6.0	7.6	8.2	5.0	4.0	14.5	16.0
Metal Halide, 50W	7.0	10.0	6.0	7.6	8.2	5.0	4.0	14.5	16.0
Occupancy Sensor, 4L4' Fluorescent Fixtures	7.0	10.0	6.0	7.6	8.2	5.0	4.0	14.5	16.0
Energy Star Transformers	7.0	10.0	6.0	7.6	8.2	5.0	4.0	14.5	16.0
Base Other	7.0	7.0	6.0	4.2	3.1	4.0	1.0	6.5	8.0
Replace V-belts	7.0	7.0	6.0	4.2	3.1	4.0	1.0	6.5	8.0
Membranes for wastewater	0.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Energy Star Transformers	7.0	7.0	6.0	4.2	3.1	4.0	1.0	6.5	8.0

Table B.2 Incomplete Factor by Measures and Industry [42]

Incomplete Factor (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Base Compressed Air	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Compressed Air - O&M	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
Compressed Air - Controls	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Compressed Air - System Optimization	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Compressed Air- Sizing	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
Comp Air - Replace 1-5 HP motor	87.00	87.00	87.00	87.00	87.00	87.00	87.00	87.00	87.00
Comp Air - ASD (1-5 hp)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Comp Air - Motor practices-1 (1-5 HP)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Comp Air - Replace 6-100 HP motor	62.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00
Comp Air - ASD (6-100 hp)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Comp Air - Motor practices-1 (6-100 HP)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Comp Air - Replace 100+ HP motor	38.00	38.00	38.00	38.00	38.00	38.00	38.00	38.00	38.00
Comp Air - ASD (100+ hp)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Comp Air - Motor practices-1 (100+ HP)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Power recovery	100.00	100.00	100.00	100.00	98.13	100.00	100.00	100.00	100.00
Refinery Controls	100.00	100.00	100.00	100.00	98.75	100.00	100.00	100.00	100.00
Energy Star Transformers	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
Base Fans	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Fans - O&M	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Fans - Controls	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Fans - System Optimization	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Fans- Improve components	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Fans - Replace 1-5 HP motor	87.00	87.00	87.00	87.00	87.00	87.00	87.00	87.00	87.00
Fans - ASD (1-5 hp)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Fans - Motor practices-1 (1-5 HP)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table B.2 Incomplete Factor by Measures and Industry (cont') [42]

Incomplete Factor (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Fans - Replace 6-100 HP motor	62.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00
Fans - ASD (6-100 hp)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Fans - Motor practices-1 (6-100 HP)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Fans - Replace 100+ HP motor	38.00	38.00	38.00	38.00	38.00	38.00	38.00	38.00	38.00
Fans - ASD (100+ hp)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Fans - Motor practices-1 (100+ HP)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Optimize drying process	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Power recovery	100.00	100.00	100.00	100.00	98.13	100.00	100.00	100.00	100.00
Refinery Controls	100.00	100.00	100.00	100.00	98.75	100.00	100.00	100.00	100.00
Energy Star Transformers	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
Base Pumps	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Pumps - O&M	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
Pumps - Controls	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00
Pumps - System Optimization	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
Pumps - Sizing	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Pumps - Replace 1-5 HP motor	87.00	87.00	87.00	87.00	87.00	87.00	87.00	87.00	87.00
Pumps - ASD (1-5 hp)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Pumps - Motor practices-1 (1-5 HP)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Pumps - Replace 6-100 HP motor	62.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00
Pumps - ASD (6-100 hp)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Pumps - Motor practices-1 (6-100 HP)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Pumps - Replace 100+ HP motor	38.00	38.00	38.00	38.00	38.00	38.00	38.00	38.00	38.00
Pumps - ASD (100+ hp)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Pumps - Motor practices-1 (100+ HP)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Power recovery	100.00	100.00	100.00	100.00	98.13	100.00	100.00	100.00	100.00
Refinery Controls	100.00	100.00	100.00	100.00	98.75	100.00	100.00	100.00	100.00

Table B.2 Incomplete Factor by Measures and Industry (cont') [42]

Incomplete Factor (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Energy Star Transformers	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
Base Drives	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Bakery - Process (Mixing) - O&M	70.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
O&M/drives spinning machines	100.00	40.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Air conveying systems	100.00	100.00	25.00	100.00	100.00	100.00	100.00	100.00	100.00
Replace V-Belts	100.00	100.00	50.00	100.00	100.00	100.00	100.00	100.00	100.00
Drives - EE motor	100.00	100.00	40.00	65.29	100.00	30.00	100.00	100.00	100.00
Gap Forming papermachine	100.00	100.00	100.00	30.59	100.00	100.00	100.00	100.00	100.00
High Consistency forming	100.00	100.00	100.00	30.59	100.00	100.00	100.00	100.00	100.00
Optimization control PM	100.00	100.00	100.00	61.44	100.00	100.00	100.00	100.00	100.00
Efficient practices printing press	100.00	100.00	100.00	88.56	100.00	100.00	100.00	100.00	100.00
Efficient Printing press (fewer cylinders)	100.00	100.00	100.00	81.70	100.00	100.00	100.00	100.00	100.00
Light cylinders	100.00	100.00	100.00	81.70	100.00	100.00	100.00	100.00	100.00
Efficient drives	100.00	100.00	100.00	83.99	86.13	100.00	100.00	100.00	100.00
Clean Room - Controls	100.00	100.00	100.00	100.00	77.82	100.00	100.00	62.50	100.00
Clean Room - New Designs	100.00	100.00	100.00	100.00	86.13	100.00	100.00	100.00	100.00
Drives - Process Controls (batch + site)	100.00	100.00	100.00	100.00	100.00	50.00	50.00	100.00	100.00
Process Drives - ASD	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	50.00
O&M - Extruders/Injection Moulding	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Extruders/injection Moulding-multipump	100.00	100.00	100.00	100.00	65.11	100.00	100.00	100.00	100.00
Direct drive Extruders	100.00	100.00	100.00	100.00	44.18	100.00	100.00	100.00	100.00
Injection Moulding - Impulse Cooling	100.00	100.00	100.00	100.00	37.20	100.00	100.00	100.00	100.00
Injection Moulding - Direct drive	100.00	100.00	100.00	100.00	47.67	100.00	100.00	100.00	100.00
Efficient grinding	100.00	100.00	100.00	100.00	47.67	20.00	100.00	100.00	100.00
Process control	100.00	100.00	100.00	100.00	100.00	50.00	100.00	100.00	100.00
Process optimization	100.00	100.00	100.00	100.00	100.00	25.00	100.00	100.00	100.00

Table B.2 Incomplete Factor by Measures and Industry (cont') [42]

Incomplete Factor (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Drives - Process Control	100.00	100.00	100.00	100.00	100.00	100.00	50.00	100.00	100.00
Efficient drives - rolling	100.00	100.00	100.00	100.00	100.00	100.00	50.00	100.00	100.00
Drives - Optimization process (M&T)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	66.50	100.00
Drives - Scheduling	100.00	100.00	100.00	100.00	100.00	100.00	100.00	30.00	30.00
Machinery	100.00	100.00	100.00	100.00	100.00	100.00	100.00	23.44	100.00
Efficient Machinery	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	25.00
Energy Star Transformers	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
Base Heating	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Bakery - Process	30.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Drying (UV/IR)	100.00	20.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Heat Pumps - Drying	100.00	100.00	20.00	100.00	100.00	100.00	100.00	100.00	100.00
Top-heating (glass)	100.00	100.00	100.00	100.00	100.00	50.00	100.00	100.00	100.00
Efficient electric melting	100.00	100.00	100.00	100.00	100.00	100.00	25.00	100.00	100.00
Intelligent extruder (DOE)	100.00	100.00	100.00	100.00	100.00	100.00	25.00	100.00	100.00
Near Net Shape Casting	100.00	100.00	100.00	100.00	100.00	100.00	25.00	100.00	100.00
Heating - Process Control	100.00	100.00	100.00	100.00	100.00	100.00	50.00	100.00	100.00
Efficient Curing ovens	100.00	100.00	100.00	100.00	100.00	100.00	100.00	25.00	25.00
Heating - Optimization process (M&T)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	68.72	100.00
Heating - Scheduling	100.00	100.00	100.00	100.00	100.00	100.00	100.00	82.50	100.00
Energy Star Transformers	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
Base Refrigeration	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Efficient Refrigeration - Operations	22.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Optimization Refrigeration	15.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Energy Star Transformers	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
Base Other Process	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Other Process Controls (batch + site)	100.00	100.00	100.00	100.00	86.13	100.00	100.00	100.00	100.00

Table B.2 Incomplete Factor by Measures and Industry (cont') [42]

Incomplete Factor (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Efficient desalter	100.00	100.00	100.00	100.00	98.75	100.00	100.00	100.00	100.00
New transformers welding	100.00	100.00	100.00	100.00	100.00	100.00	100.00	69.63	100.00
Efficient processes (welding, etc.)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	80.37	100.00
Process control	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	25.00
Power recovery	100.00	100.00	100.00	100.00	98.13	100.00	100.00	100.00	100.00
Refinery Controls	100.00	100.00	100.00	100.00	98.75	100.00	100.00	100.00	100.00
Energy Star Transformers	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
Base Centrifugal Chiller, 0.58 kW/ton, 500 tons	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Centrifugal Chiller, 0.51 kW/ton, 500 tons	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Window Film - Chiller	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
EMS - Chiller	63.00	63.00	63.00	63.00	63.00	63.00	63.00	63.00	63.00
Cool Roof - Chiller	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00
Chiller Tune Up/Diagnostics	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Cooling Circ. Pumps - VSD	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
Energy Star Transformers	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
Base DX Packaged System, EER=10.3, 10 tons	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
DX Tune Up/ Advanced Diagnostics	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
DX Packaged System, EER=10.9, 10 tons	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Window Film - DX	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00
Evaporative Pre-Cooler	95.00	95.00	95.00	95.00	95.00	95.00	95.00	95.00	95.00
Prog. Thermostat - DX	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00
Cool Roof - DX	61.00	61.00	61.00	61.00	61.00	61.00	61.00	61.00	61.00
Energy Star Transformers	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
Base Lighting	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
RET 2L4' Premium T8, 1EB	89.00	74.00	85.00	79.69	87.19	89.00	87.00	83.39	84.00
CFL Hardwired, Modular 36W	58.00	58.00	58.00	58.00	58.00	58.00	58.00	58.00	58.00

Table B.2 Incomplete Factor by Measures and Industry (cont') [42]

Incomplete Factor (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Metal Halide, 50W	7.00	16.00	12.00	4.54	46.72	57.00	25.00	12.96	2.00
Occupancy Sensor, 4L4' Fluorescent Fixtures	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00
Energy Star Transformers	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
Base Other	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Replace V-belts	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Membranes for wastewater	100.00	15.00	15.00	100.00	100.00	100.00	100.00	100.00	100.00
Energy Star Transformers	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00

Table B.3 Feasibility Factor by Measures and Industry [42]

Feasibility Factor (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Base Compressed Air	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Compressed Air - O&M	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Compressed Air - Controls	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Compressed Air - System Optimization	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Compressed Air- Sizing	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Comp Air - Replace 1-5 HP motor	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Comp Air - ASD (1-5 hp)	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Comp Air - Motor practices-1 (1-5 HP)	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Comp Air - Replace 6-100 HP motor	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00
Comp Air - ASD (6-100 hp)	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00
Comp Air - Motor practices-1 (6-100 HP)	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00
Comp Air - Replace 100+ HP motor	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00
Comp Air - ASD (100+ hp)	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00
Comp Air - Motor practices-1 (100+ HP)	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00
Power recovery	0.00	0.00	0.00	0.00	69.77	0.00	0.00	0.00	0.00
Refinery Controls	0.00	0.00	0.00	0.00	69.77	0.00	0.00	0.00	0.00
Energy Star Transformers	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Base Fans	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Fans - O&M	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Fans - Controls	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Fans - System Optimization	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Fans- Improve components	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Fans - Replace 1-5 HP motor	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Fans - ASD (1-5 hp)	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Fans - Motor practices-1 (1-5 HP)	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00

Table B.3 Feasibility Factor by Measures and Industry (cont') [42]

Feasibility Factor (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Fans - Replace 6-100 HP motor	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00
Fans - ASD (6-100 hp)	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00
Fans - Motor practices-1 (6-100 HP)	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00
Fans - Replace 100+ HP motor	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00
Fans - ASD (100+ hp)	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00
Fans - Motor practices-1 (100+ HP)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Optimize drying process	0.00	0.00	0.00	0.00	69.77	0.00	0.00	0.00	0.00
Power recovery	0.00	0.00	0.00	0.00	69.77	0.00	0.00	0.00	0.00
Refinery Controls	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Energy Star Transformers	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Base Pumps	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Pumps - O&M	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Pumps - Controls	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Pumps - System Optimization	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Pumps - Sizing	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Pumps - Replace 1-5 HP motor	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Pumps - ASD (1-5 hp)	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Pumps - Motor practices-1 (1-5 HP)	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00
Pumps - Replace 6-100 HP motor	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00
Pumps - ASD (6-100 hp)	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00
Pumps - Motor practices-1 (6-100 HP)	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00
Pumps - Replace 100+ HP motor	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00
Pumps - ASD (100+ hp)	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00
Pumps - Motor practices-1 (100+ HP)	0.00	0.00	0.00	0.00	69.77	0.00	0.00	0.00	0.00
Power recovery	0.00	0.00	0.00	0.00	69.77	0.00	0.00	0.00	0.00
Refinery Controls	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00

Table B.3 Feasibility Factor by Measures and Industry (cont') [42]

Feasibility Factor (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Energy Star Transformers	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Base Drives	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Bakery - Process (Mixing) - O&M	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O&M/drives spinning machines	0.00	60.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Air conveying systems	0.00	0.00	30.00	0.00	0.00	0.00	0.00	0.00	0.00
Replace V-Belts	0.00	0.00	70.00	0.00	0.00	0.00	0.00	0.00	0.00
Drives - EE motor	0.00	0.00	100.00	77.12	0.00	100.00	0.00	0.00	0.00
Gap Forming papermachine	0.00	0.00	0.00	77.12	0.00	0.00	0.00	0.00	0.00
High Consistency forming	0.00	0.00	0.00	77.12	0.00	0.00	0.00	0.00	0.00
Optimization control PM	0.00	0.00	0.00	77.12	0.00	0.00	0.00	0.00	0.00
Efficient practices printing press	0.00	0.00	0.00	22.88	0.00	0.00	0.00	0.00	0.00
Efficient Printing press (fewer cylinders)	0.00	0.00	0.00	22.88	0.00	0.00	0.00	0.00	0.00
Light cylinders	0.00	0.00	0.00	22.88	0.00	0.00	0.00	0.00	0.00
Efficient drives	0.00	0.00	0.00	22.88	8.32	0.00	0.00	0.00	0.00
Clean Room - Controls	0.00	0.00	0.00	0.00	8.32	0.00	0.00	23.55	0.00
Clean Room - New Designs	0.00	0.00	0.00	0.00	23.85	0.00	0.00	0.00	0.00
Drives - Process Controls (batch + site)	0.00	0.00	0.00	0.00	19.41	100.00	100.00	0.00	0.00
Process Drives - ASD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.00
O&M - Extruders/Injection Moulding	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Extruders/injection Moulding-multipump	0.00	0.00	0.00	0.00	69.77	0.00	0.00	0.00	0.00
Direct drive Extruders	0.00	0.00	0.00	0.00	69.77	0.00	0.00	0.00	0.00
Injection Moulding - Impulse Cooling	0.00	0.00	0.00	0.00	34.89	0.00	0.00	0.00	0.00
Injection Moulding - Direct drive	0.00	0.00	0.00	0.00	34.89	0.00	0.00	0.00	0.00
Efficient grinding	0.00	0.00	0.00	0.00	34.89	100.00	0.00	0.00	0.00
Process control	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
Process optimization	0.00	0.00	0.00	0.00	0.00	25.00	0.00	0.00	0.00

Table B.3 Feasibility Factor by Measures and Industry (cont') [42]

Feasibility Factor (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Drives - Process Control	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00
Efficient drives - rolling	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00
Drives - Optimization process (M&T)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.30	0.00
Drives - Scheduling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.00	40.00
Machinery	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	0.00
Efficient Machinery	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00
Energy Star Transformers	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Base Heating	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Bakery - Process	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Drying (UV/IR)	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heat Pumps - Drying	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Top-heating (glass)	0.00	0.00	0.00	0.00	0.00	25.00	0.00	0.00	0.00
Efficient electric melting	0.00	0.00	0.00	0.00	0.00	0.00	90.00	0.00	0.00
Intelligent extruder (DOE)	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00
Near Net Shape Casting	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0.00	0.00
Heating - Process Control	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00
Efficient Curing ovens	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.26	50.00
Heating - Optimization process (M&T)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.52	0.00
Heating - Scheduling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00
Energy Star Transformers	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Base Refrigeration	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Efficient Refrigeration - Operations	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Optimization Refrigeration	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Energy Star Transformers	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Base Other Process	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Other Process Controls (batch + site)	0.00	0.00	0.00	0.00	23.85	0.00	0.00	0.00	0.00

Table B.3 Feasibility Factor by Measures and Industry (cont') [42]

Feasibility Factor (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Efficient desalter	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New transformers welding	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54.17	0.00
Efficient processes (welding, etc.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39.25	0.00
Process control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Power recovery	0.00	0.00	0.00	0.00	2.50	0.00	0.00	0.00	0.00
Refinery Controls	0.00	0.00	0.00	0.00	2.50	0.00	0.00	0.00	0.00
Energy Star Transformers	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Base Centrifugal Chiller, 0.58 kW/ton, 500 tons	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Centrifugal Chiller, 0.51 kW/ton, 500 tons	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Window Film - Chiller	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
EMS - Chiller	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Cool Roof - Chiller	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Chiller Tune Up/Diagnostics	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Cooling Circ. Pumps - VSD	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
Energy Star Transformers	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Base DX Packaged System, EER=10.3, 10 tons	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
DX Tune Up/ Advanced Diagnostics	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
DX Packaged System, EER=10.9, 10 tons	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Window Film - DX	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
Evaporative Pre-Cooler	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Prog. Thermostat - DX	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
Cool Roof - DX	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Energy Star Transformers	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Base Lighting	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
RET 2L4' Premium T8, 1EB	76.00	86.00	87.00	83.66	79.09	62.00	66.00	88.66	93.00
CFL Hardwired, Modular 36W	17.00	8.00	8.00	13.03	15.58	20.00	27.00	8.53	6.00

Table B.3 Feasibility Factor by Measures and Industry (cont') [42]

Feasibility Factor (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Metal Halide, 50W	6.00	6.00	5.00	3.54	5.02	18.00	7.00	2.86	0.00
Occupancy Sensor, 4L4' Fluorescent Fixtures	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Energy Star Transformers	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Base Other	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Replace V-belts	73.00	71.00	80.00	69.85	37.15	70.00	20.00	42.08	55.00
Membranes for wastewater	0.00	29.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Energy Star Transformers	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00

Table B.4 Energy Saving by Measures and Industry [42]

Energy Saving (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Base Compressed Air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Compressed Air - O&M	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00
Compressed Air - Controls	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
Compressed Air - System Optimization	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Compressed Air- Sizing	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
Comp Air - Replace 1-5 HP motor	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Comp Air - ASD (1-5 hp)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Comp Air - Motor practices-1 (1-5 HP)	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Comp Air - Replace 6-100 HP motor	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Comp Air - ASD (6-100 hp)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Comp Air - Motor practices-1 (6-100 HP)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Comp Air - Replace 100+ HP motor	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Comp Air - ASD (100+ hp)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Comp Air - Motor practices-1 (100+ HP)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Power recovery	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
Refinery Controls	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00
Energy Star Transformers	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Base Fans	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fans - O&M	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Fans - Controls	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
Fans - System Optimization	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00
Fans- Improve components	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Fans - Replace 1-5 HP motor	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Fans - ASD (1-5 hp)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Fans - Motor practices-1 (1-5 HP)	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00

Table B.4 Energy Saving by Measures and Industry (cont') [42]

Energy Saving (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Fans - Replace 6-100 HP motor	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Fans - ASD (6-100 hp)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Fans - Motor practices-1 (6-100 HP)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Fans - Replace 100+ HP motor	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Fans - ASD (100+ hp)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Fans - Motor practices-1 (100+ HP)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Optimize drying process	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Power recovery	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
Refinery Controls	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00
Energy Star Transformers	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Base Pumps	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pumps - O&M	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Pumps - Controls	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
Pumps - System Optimization	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00
Pumps - Sizing	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Pumps - Replace 1-5 HP motor	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Pumps - ASD (1-5 hp)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Pumps - Motor practices-1 (1-5 HP)	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Pumps - Replace 6-100 HP motor	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Pumps - ASD (6-100 hp)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Pumps - Motor practices-1 (6-100 HP)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Pumps - Replace 100+ HP motor	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Pumps - ASD (100+ hp)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Pumps - Motor practices-1 (100+ HP)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Power recovery	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
Refinery Controls	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00

Table B.4 Energy Saving by Measures and Industry (cont') [42]

Energy Saving (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Energy Star Transformers	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Base Drives	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bakery - Process (Mixing) - O&M	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O&M/drives spinning machines	0.00	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Air conveying systems	0.00	0.00	41.00	0.00	0.00	0.00	0.00	0.00	0.00
Replace V-Belts	0.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00
Drives - EE motor	0.00	0.00	4.00	2.31	0.00	4.00	0.00	0.00	0.00
Gap Forming papermachine	0.00	0.00	0.00	6.17	0.00	0.00	0.00	0.00	0.00
High Consistency forming	0.00	0.00	0.00	6.17	0.00	0.00	0.00	0.00	0.00
Optimization control PM	0.00	0.00	0.00	3.86	0.00	0.00	0.00	0.00	0.00
Efficient practices printing press	0.00	0.00	0.00	2.29	0.00	0.00	0.00	0.00	0.00
Efficient Printing press (fewer cylinders)	0.00	0.00	0.00	4.58	0.00	0.00	0.00	0.00	0.00
Light cylinders	0.00	0.00	0.00	2.29	0.00	0.00	0.00	0.00	0.00
Efficient drives	0.00	0.00	0.00	0.92	2.77	0.00	0.00	0.00	0.00
Clean Room - Controls	0.00	0.00	0.00	0.00	8.32	0.00	0.00	3.93	0.00
Clean Room - New Designs	0.00	0.00	0.00	0.00	2.22	0.00	0.00	0.00	0.00
Drives - Process Controls (batch + site)	0.00	0.00	0.00	0.00	1.67	2.00	5.00	0.00	0.00
Process Drives - ASD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
O&M - Extruders/Injection Moulding	0.00	0.00	0.00	0.00	6.98	0.00	0.00	0.00	0.00
Extruders/injection Moulding-multipump	0.00	0.00	0.00	0.00	20.93	0.00	0.00	0.00	0.00
Direct drive Extruders	0.00	0.00	0.00	0.00	34.89	0.00	0.00	0.00	0.00
Injection Moulding - Impulse Cooling	0.00	0.00	0.00	0.00	14.65	0.00	0.00	0.00	0.00
Injection Moulding - Direct drive	0.00	0.00	0.00	0.00	13.95	0.00	0.00	0.00	0.00
Efficient grinding	0.00	0.00	0.00	0.00	0.00	21.00	0.00	0.00	0.00
Process control	0.00	0.00	0.00	0.00	0.00	2.00	5.00	0.00	0.00
Process optimization	0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00

Table B.4 Energy Saving by Measures and Industry (cont') [42]

Energy Saving (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Drives - Process Control	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00
Efficient drives - rolling	0.00	0.00	0.00	0.00	0.00	0.00	6.00	0.00	0.00
Drives - Optimization process (M&T)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.07	0.00
Drives - Scheduling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	5.00
Machinery	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.07	0.00
Efficient Machinery	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00
Energy Star Transformers	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Base Heating	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bakery - Process	37.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Drying (UV/IR)	0.00	26.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heat Pumps - Drying	0.00	0.00	22.00	0.00	0.00	0.00	0.00	0.00	0.00
Top-heating (glass)	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00
Efficient electric melting	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00
Intelligent extruder (DOE)	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00
Near Net Shape Casting	0.00	0.00	0.00	0.00	0.00	0.00	12.00	0.00	0.00
Heating - Process Control	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00
Efficient Curing ovens	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.00	20.00
Heating - Optimization process (M&T)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.63	0.00
Heating - Scheduling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.25	0.00
Energy Star Transformers	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Base Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Efficient Refrigeration - Operations	12.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Optimization Refrigeration	26.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Energy Star Transformers	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Base Other Process	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Process Controls (batch + site)	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00

Table B.4 Energy Saving by Measures and Industry (cont') [42]

Energy Saving (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Efficient desalter	0.00	0.00	0.00	0.00	13.95	0.00	0.00	0.00	0.00
New transformers welding	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.19	0.00
Efficient processes (welding, etc.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.81	0.00
Process control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00
Power recovery	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
Refinery Controls	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00
Energy Star Transformers	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Base Centrifugal Chiller, 0.58 kW/ton, 500 tons	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Centrifugal Chiller, 0.51 kW/ton, 500 tons	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
Window Film - Chiller	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
EMS - Chiller	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Cool Roof - Chiller	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Chiller Tune Up/Diagnostics	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Cooling Circ. Pumps - VSD	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Energy Star Transformers	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Base DX Packaged System, EER=10.3, 10 tons	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DX Tune Up/ Advanced Diagnostics	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
DX Packaged System, EER=10.9, 10 tons	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Window Film - DX	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Evaporative Pre-Cooler	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Prog. Thermostat - DX	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Cool Roof - DX	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Energy Star Transformers	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Base Lighting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RET 2L4' Premium T8, 1EB	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00
CFL Hardwired, Modular 36W	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00

Table B.4 Energy Saving by Measures and Industry (cont') [42]

Energy Saving (%) Measure	**Food & Beverages**	**Textiles**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic Metals**	**Fabricated Metals**	**Other**
Metal Halide, 50W	58.00	58.00	58.00	58.00	58.00	58.00	58.00	58.00	58.00
Occupancy Sensor, 4L4' Fluorescent Fixtures	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Energy Star Transformers	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Base Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Replace V-belts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Membranes for wastewater	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Energy Star Transformers	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00

Table B.5 Measure Cost by Measures and Industry [42]

Measure Costs Measure	**Unit Equip. Cost (Baht/kWh)**	**Unit Labor Cost (Baht/kWh)**	**NPV of Lifetime O&M Cost (Baht/kWh)**	**Implementation Cost (Baht/kWh)**
Base Compressed Air	0.000	0.000	0.000	0.000
Compressed Air - O&M	0.288	0.029	0.000	0.317
Compressed Air - Controls	0.512	0.051	0.000	0.563
Compressed Air - System Optimization	0.480	0.048	0.000	0.528
Compressed Air- Sizing	0.128	0.013	0.000	0.141
Comp Air - Replace 1-5 HP motor	1.536	0.154	0.000	1.690
Comp Air - ASD (1-5 hp)	2.240	0.224	0.000	2.464
Comp Air - Motor practices-1 (1-5 HP)	0.608	0.061	0.000	0.669
Comp Air - Replace 6-100 HP motor	0.864	0.086	0.000	0.950
Comp Air - ASD (6-100 hp)	0.064	0.006	0.000	0.070
Comp Air - Motor practices-1 (6-100 HP)	0.160	0.016	0.000	0.176
Comp Air - Replace 100+ HP motor	0.256	0.026	0.000	0.282
Comp Air - ASD (100+ hp)	0.160	0.016	0.000	0.176
Comp Air - Motor practices-1 (100+ HP)	0.064	0.006	0.000	0.070
Power recovery	0.096	0.010	0.000	0.106
Refinery Controls	0.096	0.010	0.000	0.106
Energy Star Transformers	2.048	0.205	0.000	2.253
Base Fans	0.000	0.000	0.000	0.000
Fans - O&M	0.032	0.003	0.000	0.035
Fans - Controls	2.688	0.269	0.000	2.957
Fans - System Optimization	1.760	0.176	0.000	1.936
Fans- Improve components	0.160	0.016	0.000	0.176
Fans - Replace 1-5 HP motor	1.536	0.154	0.000	1.690
Fans - ASD (1-5 hp)	2.240	0.224	0.000	2.464
Fans - Motor practices-1 (1-5 HP)	0.608	0.061	0.000	0.669

Table B.5 Measure Cost by Measures and Industry (cont') [42]

Measure Costs Measure	**Unit Equip. Cost (Baht/kWh)**	**Unit Labor Cost (Baht/kWh)**	**NPV of Lifetime O&M Cost (Baht/kWh)**	**Implementation Cost (Baht/kWh)**
Fans - Replace 6-100 HP motor	0.864	0.086	0.000	0.950
Fans - ASD (6-100 hp)	0.064	0.006	0.000	0.070
Fans - Motor practices-1 (6-100 HP)	0.160	0.016	0.000	0.176
Fans - Replace 100+ HP motor	0.256	0.026	0.000	0.282
Fans - ASD (100+ hp)	0.160	0.016	0.000	0.176
Fans - Motor practices-1 (100+ HP)	0.064	0.006	0.000	0.070
Optimize drying process	1.472	0.147	0.000	1.619
Power recovery	0.096	0.010	0.000	0.106
Refinery Controls	0.096	0.010	0.000	0.106
Energy Star Transformers	2.048	0.205	0.000	2.253
Base Pumps	0.000	0.000	0.000	0.000
Pumps - O&M	0.160	0.016	0.000	0.176
Pumps - Controls	0.800	0.080	0.000	0.880
Pumps - System Optimization	1.920	0.192	0.000	2.112
Pumps - Sizing	0.576	0.058	0.000	0.634
Pumps - Replace 1-5 HP motor	1.536	0.154	0.000	1.690
Pumps - ASD (1-5 hp)	2.240	0.224	0.000	2.464
Pumps - Motor practices-1 (1-5 HP)	0.608	0.061	0.000	0.669
Pumps - Replace 6-100 HP motor	0.864	0.086	0.000	0.950
Pumps - ASD (6-100 hp)	0.064	0.006	0.000	0.070
Pumps - Motor practices-1 (6-100 HP)	0.160	0.016	0.000	0.176
Pumps - Replace 100+ HP motor	0.256	0.026	0.000	0.282
Pumps - ASD (100+ hp)	0.160	0.016	0.000	0.176
Pumps - Motor practices-1 (100+ HP)	0.064	0.006	0.000	0.070
Power recovery	0.096	0.010	0.000	0.106

Table B.5 Measure Cost by Measures and Industry (cont') [42]

Measure Costs Measure	**Unit Equip. Cost (Baht/kWh)**	**Unit Labor Cost (Baht/kWh)**	**NPV of Lifetime O&M Cost (Baht/kWh)**	**Implementation Cost (Baht/kWh)**
Refinery Controls	0.096	0.010	0.000	0.106
Energy Star Transformers	2.048	0.205	0.000	2.253
Base Drives	0.000	0.000	0.000	0.000
Bakery - Process (Mixing) - O&M	0.160	0.016	0.000	0.176
O&M/drives spinning machines	0.928	0.093	0.000	1.021
Air conveying systems	1.120	0.112	0.000	1.232
Replace V-Belts	0.160	0.016	0.000	0.176
Drives - EE motor	0.192	0.019	0.000	0.211
Gap Forming papermachine	0.224	0.022	0.000	0.246
High Consistency forming	0.224	0.022	0.000	0.246
Optimization control PM	0.352	0.035	0.000	0.387
Efficient practices printing press	0.288	0.029	0.000	0.317
Efficient Printing press (fewer cylinders)	1.760	0.176	0.000	1.936
Light cylinders	2.048	0.205	0.000	2.253
Efficient drives	0.160	0.016	0.000	0.176
Clean Room - Controls	0.640	0.064	0.000	0.704
Clean Room - New Designs	3.840	0.384	0.000	4.224
Drives - Process Controls (batch + site)	0.704	0.070	0.000	0.774
Process Drives - ASD	0.064	0.006	0.000	0.070
O&M - Extruders/Injection Moulding	0.160	0.016	0.000	0.176
Extruders/injection Moulding-multipump	2.880	0.288	0.000	3.168
Direct drive Extruders	8.960	0.896	0.000	9.856
Injection Moulding - Impulse Cooling	2.016	0.202	0.000	2.218
Injection Moulding - Direct drive	2.816	0.282	0.000	3.098
Efficient grinding	6.720	0.672	0.000	7.392

Table B.5 Measure Cost by Measures and Industry (cont') [42]

Measure Costs Measure	**Unit Equip. Cost (Baht/kWh)**	**Unit Labor Cost (Baht/kWh)**	**NPV of Lifetime O&M Cost (Baht/kWh)**	**Implementation Cost (Baht/kWh)**
Process control	0.064	0.006	0.000	0.070
Process optimization	0.864	0.086	0.000	0.950
Drives - Process Control	0.448	0.045	0.000	0.493
Efficient drives - rolling	0.256	0.026	0.000	0.282
Drives - Optimization process (M&T)	0.224	0.022	0.000	0.246
Drives - Scheduling	0.288	0.029	0.000	0.317
Machinery	0.352	0.035	0.000	0.387
Efficient Machinery	0.192	0.019	0.000	0.211
Energy Star Transformers	2.048	0.205	0.000	2.253
Base Heating	0.000	0.000	0.000	0.000
Bakery - Process	1.472	0.147	0.000	1.619
Drying (UV/IR)	2.176	0.218	0.000	2.394
Heat Pumps - Drying	5.120	0.512	0.000	5.632
Top-heating (glass)	0.128	0.013	0.000	0.141
Efficient electric melting	0.960	0.096	0.000	1.056
Intelligent extruder (DOE)	0.480	0.048	0.000	0.528
Near Net Shape Casting	0.352	0.035	0.000	0.387
Heating - Process Control	0.448	0.045	0.000	0.493
Efficient Curing ovens	2.336	0.234	0.000	2.570
Heating - Optimization process (M&T)	0.224	0.022	0.000	0.246
Heating - Scheduling	0.288	0.029	0.000	0.317
Energy Star Transformers	2.048	0.205	0.000	2.253
Base Refrigeration	0.000	0.000	0.000	0.000
Efficient Refrigeration - Operations	0.224	0.022	0.000	0.246
Optimization Refrigeration	3.168	0.317	0.000	3.485

Table B.5 Measure Cost by Measures and Industry (cont') [42]

Measure Costs Measure	**Unit Equip. Cost (Baht/kWh)**	**Unit Labor Cost (Baht/kWh)**	**NPV of Lifetime O&M Cost (Baht/kWh)**	**Implementation Cost (Baht/kWh)**
Energy Star Transformers	2.048	0.205	0.000	2.253
Base Other Process	0.000	0.000	0.000	0.000
Other Process Controls (batch + site)	0.704	0.070	0.000	0.774
Efficient desalter	1.152	0.115	0.000	1.267
New transformers welding	1.472	0.147	0.000	1.619
Efficient processes (welding, etc.)	1.472	0.147	0.000	1.619
Process control	0.480	0.048	0.000	0.528
Power recovery	0.096	0.010	0.000	0.106
Refinery Controls	0.096	0.010	0.000	0.106
Energy Star Transformers	2.048	0.205	0.000	2.253
Base Centrifugal Chiller, 0.58 kW/ton, 500 tons	-	-	-	0.000
Centrifugal Chiller, 0.51 kW/ton, 500 tons	-	-	-	0.960
Window Film - Chiller	-	-	-	1.600
EMS - Chiller	-	-	-	2.560
Cool Roof - Chiller	-	-	-	4.480
Chiller Tune Up/Diagnostics	-	-	-	1.600
Cooling Circ. Pumps - VSD	-	-	-	2.880
Energy Star Transformers	-	-	-	1.920
Base DX Packaged System, EER=10.3, 10 tons	-	-	-	0.000
DX Tune Up/ Advanced Diagnostics	-	-	-	1.920
DX Packaged System, EER=10.9, 10 tons	-	-	-	1.280
Window Film - DX	-	-	-	0.960
Evaporative Pre-Cooler	-	-	-	7.360
Prog. Thermostat - DX	-	-	-	0.640
Cool Roof - DX	-	-	-	2.560

Table B.5 Measure Cost by Measures and Industry (cont') [42]

Measure Costs Measure	**Unit Equip. Cost (Baht/kWh)**	**Unit Labor Cost (Baht/kWh)**	**NPV of Lifetime O&M Cost (Baht/kWh)**	**Implementation Cost (Baht/kWh)**
Energy Star Transformers				1.920
Base Lighting	-	-	-	0.000
RET 2L4' Premium T8, 1EB	-	-	-	4.160
CFL Hardwired, Modular 36W	-	-	-	4.160
Metal Halide, 50W	-	-	-	23.680
Occupancy Sensor, 4L4' Fluorescent Fixtures	-	-	-	1.600
Energy Star Transformers	-	-	-	1.920
Base Other	0.000	0.000	0.000	0.000
Replace V-belts	0.000	0.000	0.000	0.000
Membranes for wastewater	1.024	0.102	0.000	1.126
Energy Star Transformers	2.048	0.205	0.000	2.253

Appendix C: Measure Electric Results by Industry

Table C.1 Measure Electric Results of Food & Beverage Industry

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Base Compressed Air	0.00	14.5	0	N/A	0.000000	0	0	0.00
Compressed Air - O&M	0.32	10.0	153948600	0.150039	0.047532	184926551	13923119	13.28
Compressed Air - Controls	0.56	10.0	36223200	0.150039	0.084502	43512130	5824050	7.47
Compressed Air - System Optimization	0.53	10.0	120744000	0.150039	0.079221	145040432	18200156	7.97
Compressed Air- Sizing	0.14	10.0	43467840	0.150039	0.021126	52214556	1747215	29.88
Comp Air - Replace 1-5 HP motor	1.69	14.5	3151418	0.120044	0.202826	3785555	1520077	2.49
Comp Air - ASD (1-5 hp)	2.46	14.5	3622320	0.120044	0.295788	4351213	2548022	1.71
Comp Air - Motor practices-1 (1-5 HP)	0.67	14.5	3018600	0.120044	0.080285	3626011	576338	6.29
Comp Air - Replace 6-100 HP motor	0.95	10.0	10780024	0.150039	0.142597	12949210	2924838	4.43
Comp Air - ASD (6-100 hp)	0.07	10.0	26080704	0.150039	0.010563	31328733	524164	59.77
Comp Air - Motor practices-1 (6-100 HP)	0.18	10.0	8693568	0.150039	0.026407	10442911	436804	23.91
Comp Air - Replace 100+ HP motor	0.28	6.0	8121241	0.217301	0.061192	9755419	652876	14.94
Comp Air - ASD (100+ hp)	0.18	6.0	42743376	0.217301	0.038245	51344313	2147618	23.91
Comp Air - Motor practices-1 (100+ HP)	0.07	6.0	14247792	0.217301	0.015298	17114771	286349	59.77
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Energy Star Transformers	2.25	25.0	1931904	0.094882	0.213750	2320647	1242464	1.87
Base Fans	0.00	14.5	0	N/A	0.000000	0	0	0.00
Fans - O&M	0.04	10.0	13416000	0.150039	0.005281	16115604	134816	119.54
Fans - Controls	2.96	10.0	100620000	0.150039	0.443636	120867027	84934060	1.42
Fans - System Optimization	1.94	10.0	42260400	0.150039	0.290476	50764151	23356866	2.17
Fans- Improve components	0.18	10.0	13416000	0.150039	0.026407	16115604	674080	23.91
Fans - Replace 1-5 HP motor	1.69	14.5	3501576	0.120044	0.202826	4206173	1688974	2.49
Fans - ASD (1-5 hp)	2.46	14.5	4024800	0.120044	0.295788	4834681	2831135	1.71
Fans - Motor practices-1 (1-5 HP)	0.67	14.5	3354000	0.120044	0.080285	4028901	640376	6.29

Table C.1 Measure Electric Results of Food & Beverage Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Fans - Replace 6-100 HP motor	0.95	10.0	11977805	0.150039	0.142597	14388011	3249820	4.43
Fans - ASD (6-100 hp)	0.07	10.0	28978560	0.150039	0.010563	34809704	582405	59.77
Fans - Motor practices-1 (6-100 HP)	0.18	10.0	9659520	0.150039	0.026407	11603235	485337	23.91
Fans - Replace 100+ HP motor	0.28	6.0	9023602	0.217301	0.061192	10839355	725418	14.94
Fans - ASD (100+ hp)	0.18	6.0	47492640	0.217301	0.038245	57049237	2386243	23.91
Fans - Motor practices-1 (100+ HP)	0.07	6.0	15830880	0.217301	0.015298	19016412	318166	59.77
Optimize drying process	1.62	10.0	0	0.150039	0.242944	0	0	0.00
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Energy Star Transformers	2.25	25.0	2146560	0.094882	0.213750	2578497	1380516	1.87
Base Pumps	0.00	14.5	0	N/A	0.000000	0	0	0.00
Pumps - O&M	0.18	10.0	91228800	0.150039	0.026407	109586105	4583743	23.91
Pumps - Controls	0.88	10.0	239475600	0.150039	0.132035	287663524	60161625	4.78
Pumps - System Optimization	2.11	10.0	225791280	0.150039	0.316883	271225609	136137164	1.99
Pumps - Sizing	0.63	10.0	91228800	0.150039	0.095065	109586105	16501474	6.64
Pumps - Replace 1-5 HP motor	1.69	14.5	5952679	0.120044	0.202826	7150493	2871257	2.49
Pumps - ASD (1-5 hp)	2.46	14.5	6842160	0.120044	0.295788	8218958	4812930	1.71
Pumps - Motor practices-1 (1-5 HP)	0.67	14.5	5701800	0.120044	0.080285	6849132	1088639	6.29
Pumps - Replace 6-100 HP motor	0.95	10.0	20362268	0.150039	0.142597	24459619	5524694	4.43
Pumps - ASD (6-100 hp)	0.07	10.0	49263552	0.150039	0.010563	59176496	990088	59.77
Pumps - Motor practices-1 (6-100 HP)	0.18	10.0	16421184	0.150039	0.026407	19725499	825074	23.91
Pumps - Replace 100+ HP motor	0.28	6.0	15340123	0.217301	0.061192	18426903	1233210	14.94
Pumps - ASD (100+ hp)	0.18	6.0	80737488	0.217301	0.038245	96983703	4056612	23.91
Pumps - Motor practices-1 (100+ HP)	0.07	6.0	26912496	0.217301	0.015298	32327901	540882	59.77
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00

Table C.1 Measure Electric Results of Food & Beverage Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Energy Star Transformers	2.25	25.0	3649152	0.094882	0.213750	4383444	2346876	1.87
Base Drives	0.00	20.0	0	N/A	0.000000	0	0	0.00
Bakery - Process (Mixing) - O&M	0.18	10.0	28173600	0.150039	0.026407	33842768	1415568	23.91
O&M/drives spinning machines	1.02	10.0	0	0.150039	0.153160	0	0	0.00
Air conveying systems	1.23	14.0	0	0.122356	0.150742	0	0	0.00
Replace V-Belts	0.18	10.0	0	0.150039	0.026407	0	0	0.00
Drives - EE motor	0.21	10.0	0	0.150039	0.031688	0	0	0.00
Gap Forming papermachine	0.25	20.0	0	0.102992	0.025377	0	0	0.00
High Consistency forming	0.25	20.0	0	0.102992	0.025377	0	0	0.00
Optimization control PM	0.39	10.0	0	0.150039	0.058095	0	0	0.00
Efficient practices printing press	0.32	20.0	0	0.102992	0.032628	0	0	0.00
Efficient Printing press (fewer cylinders)	1.94	10.0	0	0.150039	0.290476	0	0	0.00
Light cylinders	2.25	10.0	0	0.150039	0.338009	0	0	0.00
Efficient drives	0.18	10.0	0	0.150039	0.026407	0	0	0.00
Clean Room - Controls	0.70	10.0	0	0.150039	0.105628	0	0	0.00
Clean Room - New Designs	4.22	10.0	0	0.150039	0.633766	0	0	0.00
Drives - Process Controls (batch + site)	0.77	10.0	0	0.150039	0.116190	0	0	0.00
Process Drives - ASD	0.07	10.0	0	0.150039	0.010563	0	0	0.00
O&M - Extruders/Injection Moulding	0.18	12.0	0	0.133728	0.023536	0	0	0.00
Extruders/injection Moulding-multipump	3.17	12.0	0	0.133728	0.423651	0	0	0.00
Direct drive Extruders	9.86	12.0	0	0.133728	1.318024	0	0	0.00
Injection Moulding - Impulse Cooling	2.22	12.0	0	0.133728	0.296556	0	0	0.00
Injection Moulding - Direct drive	3.10	12.0	0	0.133728	0.414236	0	0	0.00
Efficient grinding	7.39	15.0	0	0.117902	0.871530	0	0	0.00
Process control	0.07	10.0	0	0.150039	0.010563	0	0	0.00
Process optimization	0.95	10.0	0	0.150039	0.142597	0	0	0.00

Table C.1 Measure Electric Results of Food & Beverage Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Drives - Process Control	0.49	15.0	0	0.117902	0.058102	0	0	0.00
Efficient drives - rolling	0.28	10.0	0	0.150039	0.042251	0	0	0.00
Drives - Optimization process (M&T)	0.25	10.0	0	0.150039	0.036970	0	0	0.00
Drives - Scheduling	0.32	10.0	0	0.150039	0.047532	0	0	0.00
Machinery	0.39	10.0	0	0.150039	0.058095	0	0	0.00
Efficient Machinery	0.21	10.0	0	0.150039	0.031688	0	0	0.00
Energy Star Transformers	2.25	25.0	643968	0.094882	0.213750	773549	414155	1.87
Base Heating	0.00	20.0	0	N/A	0.000000	0	0	0.00
Bakery - Process	1.62	15.0	119134080	0.117902	0.190907	143106560	55069626	2.60
Drying (UV/IR)	2.39	8.0	0	0.175007	0.418896	0	0	0.00
Heat Pumps - Drying	5.63	15.0	0	0.117902	0.664023	0	0	0.00
Top-heating (glass)	0.14	8.0	0	0.175007	0.024641	0	0	0.00
Efficient electric melting	1.06	20.0	0	0.102992	0.108759	0	0	0.00
Intelligent extruder (DOE)	0.53	10.0	0	0.150039	0.079221	0	0	0.00
Near Net Shape Casting	0.39	15.0	0	0.117902	0.045652	0	0	0.00
Heating - Process Control	0.49	15.0	0	0.117902	0.058102	0	0	0.00
Efficient Curing ovens	2.57	15.0	0	0.117902	0.302960	0	0	0.00
Heating - Optimization process (M&T)	0.25	10.0	0	0.150039	0.036970	0	0	0.00
Heating - Scheduling	0.32	10.0	0	0.150039	0.047532	0	0	0.00
Energy Star Transformers	2.25	25.0	1717248	0.094882	0.213750	2062797	1104412	1.87
Base Refrigeration	0.00	20.0	0	N/A	0.000000	0	0	0.00
Efficient Refrigeration - Operations	0.25	10.0	92087424	0.150039	0.036970	110617503	6477638	17.08
Optimization Refrigeration	3.48	15.0	136038240	0.117902	0.410864	163412221	135336357	1.21
Energy Star Transformers	2.25	25.0	5581056	0.094882	0.213750	6704091	3589340	1.87
Base Other Process	0.00	15.0	0	N/A	0.000000	0	0	0.00
Other Process Controls (batch + site)	0.77	10.0	0	0.150039	0.116190	0	0	0.00

Table C.1 Measure Electric Results of Food & Beverage Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Efficient desalter	1.27	10.0	0	0.150039	0.190130	0	0	0.00
New transformers welding	1.62	15.0	0	0.117902	0.190907	0	0	0.00
Efficient processes (welding, etc.)	1.62	15.0	0	0.117902	0.190907	0	0	0.00
Process control	0.53	15.0	0	0.117902	0.062252	0	0	0.00
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Energy Star Transformers	2.25	25.0	0	0.094882	0.213750	0	0	0.00
Base Centrifugal Chiller, 0.58 kW/ton, 500 tons	0.00	20.0	0	N/A	0.000000	0	0	0.00
Centrifugal Chiller, 0.51 kW/ton, 500 tons	0.96	20.0	32198400	0.102992	0.098872	38677449	8824318	4.38
Window Film - Chiller	1.60	10.0	10062000	0.150039	0.240063	12086703	4595999	2.63
EMS - Chiller	2.56	10.0	16904160	0.150039	0.384101	20305661	12354045	1.64
Cool Roof - Chiller	4.48	10.0	7915440	0.150039	0.672176	9508206	10123454	0.94
Chiller Tune Up/Diagnostics	1.60	10.0	2683200	0.150039	0.240063	3223121	1225600	2.63
Cooling Circ. Pumps - VSD	2.88	15.0	9055800	0.117902	0.339557	10878032	7445518	1.46
Energy Star Transformers	1.92	25.0	429312	0.094882	0.182173	515699	235315	2.19
Base DX Packaged System, EER=10.3, 10 tons	0.00	15.0	0	N/A	0.000000	0	0	0.00
DX Tune Up/ Advanced Diagnostics	1.92	3.0	10062000	0.389084	0.747042	12086703	5515199	2.19
DX Packaged System, EER=10.9, 10 tons	1.28	15.0	16099200	0.117902	0.150914	19338724	5882879	3.29
Window Film - DX	0.96	10.0	6238440	0.150039	0.144038	7493756	1709712	4.38
Evaporative Pre-Cooler	7.36	10.0	6372600	0.150039	1.104290	7654912	13389677	0.57
Prog. Thermostat - DX	0.64	10.0	9055800	0.150039	0.096025	10878032	1654560	6.57
Cool Roof - DX	2.56	10.0	8183760	0.150039	0.384101	9830518	5980927	1.64
Energy Star Transformers	1.92	25.0	429312	0.094882	0.182173	515699	235315	2.19
Base Lighting	0.00	10.0	0	N/A	0.000000	0	0	0.00
RET 2L4' Premium T8, 1EB	4.16	15.0	196918438	0.117902	0.490471	236542896	233859670	1.01
CFL Hardwired, Modular 36W	4.16	4.0	66670007	0.302929	1.260187	80085525	79177075	1.01

Table C.1 Measure Electric Results of Food & Beverage Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Metal Halide, 50W	23.68	5.0	2287696	0.251447	5.954275	2748033	15465205	0.18
Occupancy Sensor, 4L4' Fluorescent Fixtures	1.60	9.0	30051840	0.161080	0.257727	36098952	13726717	2.63
Energy Star Transformers	1.92	25.0	1502592	0.094882	0.182173	1804948	823603	2.19
Base Other	0.00	15.0	0	N/A	0.000000	0	0	0
Replace V-belts	0.00	5.0	0	0.251447	0.000000	0	0	0.00
Membranes for wastewater	1.13	15.0	0	0.117902	0.132805	0	0	0.00
Energy Star Transformers	2.25	25.0	1502592	0.094882	0.213750	1804948	966361	1.87

Table C.2 Measure Electric Results of Textiles Industry

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Base Compressed Air	0.00	14.5	0	N/A	0.000000	0	0	0.00
Compressed Air - O&M	0.32	10.0	35235900	0.149029	0.047213	34354365	2586540	13.28
Compressed Air - Controls	0.56	10.0	8290800	0.149029	0.083933	8083380	1081951	7.47
Compressed Air - System Optimization	0.53	10.0	27636000	0.149029	0.078688	26944600	3381098	7.97
Compressed Air- Sizing	0.14	10.0	9948960	0.149029	0.020983	9700056	324585	29.88
Comp Air - Replace 1-5 HP motor	1.69	14.5	721300	0.118978	0.201026	703254	282389	2.49
Comp Air - ASD (1-5 hp)	2.46	14.5	829080	0.118978	0.293163	808338	473354	1.71
Comp Air - Motor practices-1 (1-5 HP)	0.67	14.5	690900	0.118978	0.079573	673615	107068	6.29
Comp Air - Replace 6-100 HP motor	0.95	10.0	2467342	0.149029	0.141638	2405614	543356	4.43
Comp Air - ASD (6-100 hp)	0.07	10.0	5969376	0.149029	0.010492	5820034	97376	59.77
Comp Air - Motor practices-1 (6-100 HP)	0.18	10.0	1989792	0.149029	0.026229	1940011	81146	23.91
Comp Air - Replace 100+ HP motor	0.28	6.0	1858797	0.216315	0.060914	1812294	121287	14.94
Comp Air - ASD (100+ hp)	0.18	6.0	9783144	0.216315	0.038072	9538388	398970	23.91
Comp Air - Motor practices-1 (100+ HP)	0.07	6.0	3261048	0.216315	0.015229	3179463	53196	59.77
Power recovery	0.11	10.0	0	0.149029	0.015738	0	0	0.00
Refinery Controls	0.11	10.0	0	0.149029	0.015738	0	0	0.00
Energy Star Transformers	2.25	25.0	442176	0.093679	0.211040	431114	230816	1.87
Base Fans	0.00	14.5	0	N/A	0.000000	0	0	0.00
Fans - O&M	0.04	10.0	5527200	0.149029	0.005246	5388920	45081	119.54
Fans - Controls	2.96	10.0	41454000	0.149029	0.440650	40416900	28401223	1.42
Fans - System Optimization	1.94	10.0	17410680	0.149029	0.288521	16975098	7810336	2.17
Fans- Improve components	0.18	10.0	5527200	0.149029	0.026229	5388920	225407	23.91
Fans - Replace 1-5 HP motor	1.69	14.5	1442599	0.118978	0.201026	1406508	564779	2.49
Fans - ASD (1-5 hp)	2.46	14.5	1658160	0.118978	0.293163	1616676	946707	1.71
Fans - Motor practices-1 (1-5 HP)	0.67	14.5	1381800	0.118978	0.079573	1347230	214136	6.29

Table C.2 Measure Electric Results of Textiles Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Fans - Replace 6-100 HP motor	0.95	10.0	4934684	0.149029	0.141638	4811228	1086712	4.43
Fans - ASD (6-100 hp)	0.07	10.0	11938752	0.149029	0.010492	11640067	194751	59.77
Fans - Motor practices-1 (6-100 HP)	0.18	10.0	3979584	0.149029	0.026229	3880022	162293	23.91
Fans - Replace 100+ HP motor	0.28	6.0	3717595	0.216315	0.060914	3624588	242573	14.94
Fans - ASD (100+ hp)	0.18	6.0	19566288	0.216315	0.038072	19076777	797939	23.91
Fans - Motor practices-1 (100+ HP)	0.07	6.0	6522096	0.216315	0.015229	6358926	106392	59.77
Optimize drying process	1.62	10.0	0	0.149029	0.241309	0	0	0.00
Power recovery	0.11	10.0	0	0.149029	0.015738	0	0	0.00
Refinery Controls	0.11	10.0	0	0.149029	0.015738	0	0	0.00
Energy Star Transformers	2.25	25.0	884352	0.093679	0.211040	862227	461633	1.87
Base Pumps	0.00	14.5	0	N/A	0.000000	0	0	0.00
Pumps - O&M	0.18	10.0	27636000	0.149029	0.026229	26944600	1127033	23.91
Pumps - Controls	0.88	10.0	72544500	0.149029	0.131146	70729574	14792304	4.78
Pumps - System Optimization	2.11	10.0	68399100	0.149029	0.314750	66687884	33472870	1.99
Pumps - Sizing	0.63	10.0	27636000	0.149029	0.094425	26944600	4057318	6.64
Pumps - Replace 1-5 HP motor	1.69	14.5	1803249	0.118978	0.201026	1758135	705973	2.49
Pumps - ASD (1-5 hp)	2.46	14.5	2072700	0.118978	0.293163	2020845	1183384	1.71
Pumps - Motor practices-1 (1-5 HP)	0.67	14.5	1727250	0.118978	0.079573	1684037	267670	6.29
Pumps - Replace 6-100 HP motor	0.95	10.0	6168355	0.149029	0.141638	6014035	1358390	4.43
Pumps - ASD (6-100 hp)	0.07	10.0	14923440	0.149029	0.010492	14550084	243439	59.77
Pumps - Motor practices-1 (6-100 HP)	0.18	10.0	4974480	0.149029	0.026229	4850028	202866	23.91
Pumps - Replace 100+ HP motor	0.28	6.0	4646993	0.216315	0.060914	4530734	303217	14.94
Pumps - ASD (100+ hp)	0.18	6.0	24457860	0.216315	0.038072	23845971	997424	23.91
Pumps - Motor practices-1 (100+ HP)	0.07	6.0	8152620	0.216315	0.015229	7948657	132990	59.77
Power recovery	0.11	10.0	0	0.149029	0.015738	0	0	0.00
Refinery Controls	0.11	10.0	0	0.149029	0.015738	0	0	0.00

Table C.2 Measure Electric Results of Textiles Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Energy Star Transformers	2.25	25.0	1105440	0.093679	0.211040	1077784	577041	1.87
Base Drives	0.00	20.0	0	N/A	0.000000	0	0	0.00
Bakery - Process (Mixing) - O&M	0.18	10.0	0	0.149029	0.026229	0	0	0.00
O&M/drives spinning machines	1.02	10.0	95510016	0.149029	0.152129	93120537	22591144	4.12
Air conveying systems	1.23	14.0	0	0.121297	0.149438	0	0	0.00
Replace V-Belts	0.18	10.0	0	0.149029	0.026229	0	0	0.00
Drives - EE motor	0.21	10.0	0	0.149029	0.031475	0	0	0.00
Gap Forming papermachine	0.25	20.0	0	0.101852	0.025096	0	0	0.00
High Consistency forming	0.25	20.0	0	0.101852	0.025096	0	0	0.00
Optimization control PM	0.39	10.0	0	0.149029	0.057704	0	0	0.00
Efficient practices printing press	0.32	20.0	0	0.101852	0.032267	0	0	0.00
Efficient Printing press (fewer cylinders)	1.94	10.0	0	0.149029	0.288521	0	0	0.00
Light cylinders	2.25	10.0	0	0.149029	0.335734	0	0	0.00
Efficient drives	0.18	10.0	0	0.149029	0.026229	0	0	0.00
Clean Room - Controls	0.70	10.0	0	0.149029	0.104917	0	0	0.00
Clean Room - New Designs	4.22	10.0	0	0.149029	0.629501	0	0	0.00
Drives - Process Controls (batch + site)	0.77	10.0	0	0.149029	0.115408	0	0	0.00
Process Drives - ASD	0.07	10.0	0	0.149029	0.010492	0	0	0.00
O&M - Extruders/Injection Moulding	0.18	12.0	0	0.132695	0.023354	0	0	0.00
Extruders/injection Moulding-multipump	3.17	12.0	0	0.132695	0.420378	0	0	0.00
Direct drive Extruders	9.86	12.0	0	0.132695	1.307842	0	0	0.00
Injection Moulding - Impulse Cooling	2.22	12.0	0	0.132695	0.294264	0	0	0.00
Injection Moulding - Direct drive	3.10	12.0	0	0.132695	0.411036	0	0	0.00
Efficient grinding	7.39	15.0	0	0.116830	0.863604	0	0	0.00
Process control	0.07	10.0	0	0.149029	0.010492	0	0	0.00
Process optimization	0.95	10.0	0	0.149029	0.141638	0	0	0.00

Table C.2 Measure Electric Results of Textiles Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Drives - Process Control	0.49	15.0	0	0.116830	0.057574	0	0	0.00
Efficient drives - rolling	0.28	10.0	0	0.149029	0.041967	0	0	0.00
Drives - Optimization process (M&T)	0.25	10.0	0	0.149029	0.036721	0	0	0.00
Drives - Scheduling	0.32	10.0	0	0.149029	0.047213	0	0	0.00
Machinery	0.39	10.0	0	0.149029	0.057704	0	0	0.00
Efficient Machinery	0.21	10.0	0	0.149029	0.031475	0	0	0.00
Energy Star Transformers	2.25	25.0	3979584	0.093679	0.211040	3880022	2077347	1.87
Base Heating	0.00	20.0	0	N/A	0.000000	0	0	0.00
Bakery - Process	1.62	15.0	0	0.116830	0.189170	0	0	0.00
Drying (UV/IR)	2.39	8.0	17963400	0.174015	0.416522	17513990	9962969	1.76
Heat Pumps - Drying	5.63	15.0	0	0.116830	0.657984	0	0	0.00
Top-heating (glass)	0.14	8.0	0	0.174015	0.024501	0	0	0.00
Efficient electric melting	1.06	20.0	0	0.101852	0.107556	0	0	0.00
Intelligent extruder (DOE)	0.53	10.0	0	0.149029	0.078688	0	0	0.00
Near Net Shape Casting	0.39	15.0	0	0.116830	0.045236	0	0	0.00
Heating - Process Control	0.49	15.0	0	0.116830	0.057574	0	0	0.00
Efficient Curing ovens	2.57	15.0	0	0.116830	0.300205	0	0	0.00
Heating - Optimization process (M&T)	0.25	10.0	0	0.149029	0.036721	0	0	0.00
Heating - Scheduling	0.32	10.0	0	0.149029	0.047213	0	0	0.00
Energy Star Transformers	2.25	25.0	552720	0.093679	0.211040	538892	288520	1.87
Base Refrigeration	0.00	20.0	0	N/A	0.000000	0	0	0.00
Efficient Refrigeration - Operations	0.25	10.0	0	0.149029	0.036721	0	0	0.00
Optimization Refrigeration	3.48	15.0	0	0.116830	0.407128	0	0	0.00
Energy Star Transformers	2.25	25.0	0	0.093679	0.211040	0	0	0.00
Base Other Process	0.00	15.0	0	N/A	0.000000	0	0	0.00
Other Process Controls (batch + site)	0.77	10.0	0	0.149029	0.115408	0	0	0.00

Table C.2 Measure Electric Results of Textiles Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Efficient desalter	1.27	10.0	0	0.149029	0.188850	0	0	0.00
New transformers welding	1.62	15.0	0	0.116830	0.189170	0	0	0.00
Efficient processes (welding, etc.)	1.62	15.0	0	0.116830	0.189170	0	0	0.00
Process control	0.53	15.0	0	0.116830	0.061686	0	0	0.00
Power recovery	0.11	10.0	0	0.149029	0.015738	0	0	0.00
Refinery Controls	0.11	10.0	0	0.149029	0.015738	0	0	0.00
Energy Star Transformers	2.25	25.0	0	0.093679	0.211040	0	0	0.00
Base Centrifugal Chiller, 0.58 kW/ton, 500 tons	0.00	20.0	0	N/A	0.000000	0	0	0.00
Centrifugal Chiller, 0.51 kW/ton, 500 tons	0.96	20.0	49744800	0.101852	0.097778	48500280	11065411	4.38
Window Film - Chiller	1.60	10.0	15545250	0.149029	0.238447	15156337	5763235	2.63
EMS - Chiller	2.56	10.0	26116020	0.149029	0.381515	25462647	15491576	1.64
Cool Roof - Chiller	4.48	10.0	12228930	0.149029	0.667652	11922985	12694486	0.94
Chiller Tune Up/Diagnostics	1.60	10.0	4145400	0.149029	0.238447	4041690	1536863	2.63
Cooling Circ. Pumps - VSD	2.88	15.0	13990725	0.116830	0.336469	13640704	9336441	1.46
Energy Star Transformers	1.92	25.0	663264	0.093679	0.179863	646670	295078	2.19
Base DX Packaged System, EER=10.3, 10 tons	0.00	15.0	0	N/A	0.000000	0	0	0.00
DX Tune Up/ Advanced Diagnostics	1.92	3.0	10363500	0.388034	0.745024	10104225	4610588	2.19
DX Packaged System, EER=10.9, 10 tons	1.28	15.0	16581600	0.116830	0.149542	16166760	4917961	3.29
Window Film - DX	0.96	10.0	6425370	0.149029	0.143068	6264619	1429282	4.38
Evaporative Pre-Cooler	7.36	10.0	6563550	0.149029	1.096857	6399342	11193483	0.57
Prog. Thermostat - DX	0.64	10.0	9327150	0.149029	0.095379	9093802	1383176	6.57
Cool Roof - DX	2.56	10.0	8428980	0.149029	0.381515	8218103	4999927	1.64
Energy Star Transformers	1.92	25.0	442176	0.093679	0.179863	431114	196718	2.19
Base Lighting	0.00	10.0	0	N/A	0.000000	0	0	0.00
RET 2L4' Premium T8, 1EB	4.16	15.0	136303515.6	0.116830	0.486011	132893461	131385983	1.01
CFL Hardwired, Modular 36W	4.16	4.0	23081587.2	0.301921	1.255991	22504130	22248854	1.01

Table C.2 Measure Electric Results of Textiles Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Metal Halide, 50W	23.68	5.0	3846931.2	0.250456	5.930809	3750688	21107887	0.18
Occupancy Sensor, 4L4' Fluorescent Fixtures	1.60	9.0	22108800	0.160080	0.256128	21555680	8196601	2.63
Energy Star Transformers	1.92	25.0	1105440	0.093679	0.179863	1077784	491796	2.19
Base Other	0.00	15.0	0	N/A	0.000000	0	0	0
Replace V-belts	0.00	5.0	0	0.250456	0.000000	0	0	0.00
Membranes for wastewater	1.13	15.0	2103791	0.116830	0.131597	2051158	549090	3.74
Energy Star Transformers	2.25	25.0	773808	0.093679	0.211040	754449	403929	1.87

Table C.3 Measure Electric Results of Wood & Furniture Industry

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Base Compressed Air	0.00	14.5	0	N/A	0.000000	0	0	0.00
Compressed Air - O&M	0.32	10.0	12010500	0.150039	0.047532	14427285	1086230	13.28
Compressed Air - Controls	0.56	10.0	2826000	0.150039	0.084502	3394655	454371	7.47
Compressed Air - System Optimization	0.53	10.0	9420000	0.150039	0.079221	11315518	1419909	7.97
Compressed Air- Sizing	0.14	10.0	3391200	0.150039	0.021126	4073586	136311	29.88
Comp Air - Replace 1-5 HP motor	1.69	14.5	245862	0.120044	0.202826	295335	118591	2.49
Comp Air - ASD (1-5 hp)	2.46	14.5	282600	0.120044	0.295788	339466	198787	1.71
Comp Air - Motor practices-1 (1-5 HP)	0.67	14.5	235500	0.120044	0.080285	282888	44964	6.29
Comp Air - Replace 6-100 HP motor	0.95	10.0	841018	0.150039	0.142597	1010249	228185	4.43
Comp Air - ASD (6-100 hp)	0.07	10.0	2034720	0.150039	0.010563	2444152	40893	59.77
Comp Air - Motor practices-1 (6-100 HP)	0.18	10.0	678240	0.150039	0.026407	814717	34078	23.91
Comp Air - Replace 100+ HP motor	0.28	6.0	633589	0.217301	0.061192	761082	50935	14.94
Comp Air - ASD (100+ hp)	0.18	6.0	3334680	0.217301	0.038245	4005693	167549	23.91
Comp Air - Motor practices-1 (100+ HP)	0.07	6.0	1111560	0.217301	0.015298	1335231	22340	59.77
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Energy Star Transformers	2.25	25.0	150720	0.094882	0.213750	181048	96932	1.87
Base Fans	0.00	14.5	0	N/A	0.000000	0	0	0.00
Fans - O&M	0.04	10.0	1884000	0.150039	0.005281	2263104	18932	119.54
Fans - Controls	2.96	10.0	14130000	0.150039	0.443636	16973277	11927234	1.42
Fans - System Optimization	1.94	10.0	5934600	0.150039	0.290476	7128776	3279989	2.17
Fans- Improve components	0.18	10.0	1884000	0.150039	0.026407	2263104	94661	23.91
Fans - Replace 1-5 HP motor	1.69	14.5	491724	0.120044	0.202826	590670	237182	2.49
Fans - ASD (1-5 hp)	2.46	14.5	565200	0.120044	0.295788	678931	397574	1.71
Fans - Motor practices-1 (1-5 HP)	0.67	14.5	471000	0.120044	0.080285	565776	89928	6.29

Table C.3 Measure Electric Results of Wood & Furniture Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Fans - Replace 6-100 HP motor	0.95	10.0	1682035	0.150039	0.142597	2020499	456370	4.43
Fans - ASD (6-100 hp)	0.07	10.0	4069440	0.150039	0.010563	4888304	81787	59.77
Fans - Motor practices-1 (6-100 HP)	0.18	10.0	1356480	0.150039	0.026407	1629435	68156	23.91
Fans - Replace 100+ HP motor	0.28	6.0	1267178	0.217301	0.061192	1522163	101870	14.94
Fans - ASD (100+ hp)	0.18	6.0	6669360	0.217301	0.038245	8011387	335098	23.91
Fans - Motor practices-1 (100+ HP)	0.07	6.0	2223120	0.217301	0.015298	2670462	44680	59.77
Optimize drying process	1.62	10.0	0	0.150039	0.242944	0	0	0.00
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Energy Star Transformers	2.25	25.0	301440	0.094882	0.213750	362097	193865	1.87
Base Pumps	0.00	14.5	0	N/A	0.000000	0	0	0.00
Pumps - O&M	0.18	10.0	9796800	0.150039	0.026407	11768138	492235	23.91
Pumps - Controls	0.88	10.0	25716600	0.150039	0.132035	30891363	6460585	4.78
Pumps - System Optimization	2.11	10.0	24247080	0.150039	0.316883	29126143	14619381	1.99
Pumps - Sizing	0.63	10.0	9796800	0.150039	0.095065	11768138	1772046	6.64
Pumps - Replace 1-5 HP motor	1.69	14.5	639241	0.120044	0.202826	767871	308336	2.49
Pumps - ASD (1-5 hp)	2.46	14.5	734760	0.120044	0.295788	882610	516847	1.71
Pumps - Motor practices-1 (1-5 HP)	0.67	14.5	612300	0.120044	0.080285	735509	116906	6.29
Pumps - Replace 6-100 HP motor	0.95	10.0	2186646	0.150039	0.142597	2626649	593281	4.43
Pumps - ASD (6-100 hp)	0.07	10.0	5290272	0.150039	0.010563	6354795	106323	59.77
Pumps - Motor practices-1 (6-100 HP)	0.18	10.0	1763424	0.150039	0.026407	2118265	88602	23.91
Pumps - Replace 100+ HP motor	0.28	6.0	1647332	0.217301	0.061192	1978812	132431	14.94
Pumps - ASD (100+ hp)	0.18	6.0	8670168	0.217301	0.038245	10414803	435628	23.91
Pumps - Motor practices-1 (100+ HP)	0.07	6.0	2890056	0.217301	0.015298	3471601	58084	59.77
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00

Table C.3 Measure Electric Results of Wood & Furniture Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Energy Star Transformers	2.25	25.0	391872	0.094882	0.213750	470726	252024	1.87
Base Drives	0.00	20.0	0	N/A	0.000000	0	0	0.00
Bakery - Process (Mixing) - O&M	0.18	10.0	0	0.150039	0.026407	0	0	0.00
O&M/drives spinning machines	1.02	10.0	0	0.150039	0.153160	0	0	0.00
Air conveying systems	1.23	14.0	27228510	0.122356	0.150742	32707504	9576575	3.42
Replace V-Belts	0.18	10.0	18595080	0.150039	0.026407	22336832	934300	23.91
Drives - EE motor	0.21	10.0	14167680	0.150039	0.031688	17018539	854217	19.92
Gap Forming papermachine	0.25	20.0	0	0.102992	0.025377	0	0	0.00
High Consistency forming	0.25	20.0	0	0.102992	0.025377	0	0	0.00
Optimization control PM	0.39	10.0	0	0.150039	0.058095	0	0	0.00
Efficient practices printing press	0.32	20.0	0	0.102992	0.032628	0	0	0.00
Efficient Printing press (fewer cylinders)	1.94	10.0	0	0.150039	0.290476	0	0	0.00
Light cylinders	2.25	10.0	0	0.150039	0.338009	0	0	0.00
Efficient drives	0.18	10.0	0	0.150039	0.026407	0	0	0.00
Clean Room - Controls	0.70	10.0	0	0.150039	0.105628	0	0	0.00
Clean Room - New Designs	4.22	10.0	0	0.150039	0.633766	0	0	0.00
Drives - Process Controls (batch + site)	0.77	10.0	0	0.150039	0.116190	0	0	0.00
Process Drives - ASD	0.07	10.0	0	0.150039	0.010563	0	0	0.00
O&M - Extruders/Injection Moulding	0.18	12.0	0	0.133728	0.023536	0	0	0.00
Extruders/injection Moulding-multipump	3.17	12.0	0	0.133728	0.423651	0	0	0.00
Direct drive Extruders	9.86	12.0	0	0.133728	1.318024	0	0	0.00
Injection Moulding - Impulse Cooling	2.22	12.0	0	0.133728	0.296556	0	0	0.00
Injection Moulding - Direct drive	3.10	12.0	0	0.133728	0.414236	0	0	0.00
Efficient grinding	7.39	15.0	0	0.117902	0.871530	0	0	0.00
Process control	0.07	10.0	0	0.150039	0.010563	0	0	0.00
Process optimization	0.95	10.0	0	0.150039	0.142597	0	0	0.00

Table C.3 Measure Electric Results of Wood & Furniture Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Drives - Process Control	0.49	15.0	0	0.117902	0.058102	0	0	0.00
Efficient drives - rolling	0.28	10.0	0	0.150039	0.042251	0	0	0.00
Drives - Optimization process (M&T)	0.25	10.0	0	0.150039	0.036970	0	0	0.00
Drives - Scheduling	0.32	10.0	0	0.150039	0.047532	0	0	0.00
Machinery	0.39	10.0	0	0.150039	0.058095	0	0	0.00
Efficient Machinery	0.21	10.0	0	0.150039	0.031688	0	0	0.00
Energy Star Transformers	2.25	25.0	1416768	0.094882	0.213750	1701854	911165	1.87
Base Heating	0.00	20.0	0	N/A	0.000000	0	0	0.00
Bakery - Process	1.62	15.0	0	0.117902	0.190907	0	0	0.00
Drying (UV/IR)	2.39	8.0	0	0.175007	0.418896	0	0	0.00
Heat Pumps - Drying	5.63	15.0	4973760	0.117902	0.664023	5974593	7996926	0.75
Top-heating (glass)	0.14	8.0	0	0.175007	0.024641	0	0	0.00
Efficient electric melting	1.06	20.0	0	0.102992	0.108759	0	0	0.00
Intelligent extruder (DOE)	0.53	10.0	0	0.150039	0.079221	0	0	0.00
Near Net Shape Casting	0.39	15.0	0	0.117902	0.045652	0	0	0.00
Heating - Process Control	0.49	15.0	0	0.117902	0.058102	0	0	0.00
Efficient Curing ovens	2.57	15.0	0	0.117902	0.302960	0	0	0.00
Heating - Optimization process (M&T)	0.25	10.0	0	0.150039	0.036970	0	0	0.00
Heating - Scheduling	0.32	10.0	0	0.150039	0.047532	0	0	0.00
Energy Star Transformers	2.25	25.0	180864	0.094882	0.213750	217258	116319	1.87
Base Refrigeration	0.00	20.0	0	N/A	0.000000	0	0	0.00
Efficient Refrigeration - Operations	0.25	10.0	0	0.150039	0.036970	0	0	0.00
Optimization Refrigeration	3.48	15.0	0	0.117902	0.410864	0	0	0.00
Energy Star Transformers	2.25	25.0	0	0.094882	0.213750	0	0	0.00
Base Other Process	0.00	15.0	0	N/A	0.000000	0	0	0.00
Other Process Controls (batch + site)	0.77	10.0	0	0.150039	0.116190	0	0	0.00

Table C.3 Measure Electric Results of Wood & Furniture Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Efficient desalter	1.27	10.0	0	0.150039	0.190130	0	0	0.00
New transformers welding	1.62	15.0	0	0.117902	0.190907	0	0	0.00
Efficient processes (welding, etc.)	1.62	15.0	0	0.117902	0.190907	0	0	0.00
Process control	0.53	15.0	0	0.117902	0.062252	0	0	0.00
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Energy Star Transformers	2.25	25.0	0	0.094882	0.213750	0	0	0.00
Base Centrifugal Chiller, 0.58 kW/ton, 500 tons	0.00	20.0	0	N/A	0.000000	0	0	0.00
Centrifugal Chiller, 0.51 kW/ton, 500 tons	0.96	20.0	4521600	0.102992	0.098872	5431449	1239193	4.38
Window Film - Chiller	1.60	10.0	1413000	0.150039	0.240063	1697328	645413	2.63
EMS - Chiller	2.56	10.0	2373840	0.150039	0.384101	2851510	1734870	1.64
Cool Roof - Chiller	4.48	10.0	1111560	0.150039	0.672176	1335231	1421630	0.94
Chiller Tune Up/Diagnostics	1.60	10.0	376800	0.150039	0.240063	452621	172110	2.63
Cooling Circ. Pumps - VSD	2.88	15.0	1271700	0.117902	0.339557	1527595	1045569	1.46
Energy Star Transformers	1.92	25.0	60288	0.094882	0.182173	72419	33045	2.19
Base DX Packaged System, EER=10.3, 10 tons	0.00	15.0	0	N/A	0.000000	0	0	0.00
DX Tune Up/ Advanced Diagnostics	1.92	3.0	2119500	0.389084	0.747042	2545991	1161744	2.19
DX Packaged System, EER=10.9, 10 tons	1.28	15.0	3391200	0.117902	0.150914	4073586	1239193	3.29
Window Film - DX	0.96	10.0	1314090	0.150039	0.144038	1578515	360140	4.38
Evaporative Pre-Cooler	7.36	10.0	1342350	0.150039	1.104290	1612461	2820455	0.57
Prog. Thermostat - DX	0.64	10.0	1907550	0.150039	0.096025	2291392	348523	6.57
Cool Roof - DX	2.56	10.0	1723860	0.150039	0.384101	2070740	1259846	1.64
Energy Star Transformers	1.92	25.0	90432	0.094882	0.182173	108629	49568	2.19
Base Lighting	0.00	10.0	0	N/A	0.000000	0	0	0.00
RET 2L4' Premium T8, 1EB	4.16	15.0	25913854.8	0.117902	0.490471	31128310	30775206	1.01
CFL Hardwired, Modular 36W	4.16	4.0	3776440.32	0.302929	1.260187	4536346	4484888	1.01

Table C.3 Measure Electric Results of Wood & Furniture Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Metal Halide, 50W	23.68	5.0	393379.2	0.251447	5.954275	472536	2659308	0.18
Occupancy Sensor, 4L4' Fluorescent Fixtures	1.60	9.0	3617280	0.161080	0.257727	4345159	1652257	2.63
Energy Star Transformers	1.92	25.0	180864	0.094882	0.182173	217258	99135	2.19
Base Other	0.00	15.0	0	N/A	0.000000	0	0	0
Replace V-belts	0.00	5.0	0	0.251447	0.000000	0	0	0.00
Membranes for wastewater	1.13	15.0	0	0.117902	0.132805	0	0	0.00
Energy Star Transformers	2.25	25.0	180864	0.094882	0.213750	217258	116319	1.87

Table C.4 Measure Electric Results of Paper Industry

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Base Compressed Air	0.00	14.5	0	N/A	0.000000	0	0	0.00
Compressed Air - O&M	0.32	10.0	11722684	0.150039	0.047532	14081554	1060200	13.28
Compressed Air - Controls	0.56	10.0	2758279	0.150039	0.084502	3313307	443482	7.47
Compressed Air - System Optimization	0.53	10.0	9194262	0.150039	0.079221	11044356	1385883	7.97
Compressed Air- Sizing	0.14	10.0	3309934	0.150039	0.021126	3975968	133045	29.88
Comp Air - Replace 1-5 HP motor	1.69	14.5	239970	0.120044	0.202826	288258	115749	2.49
Comp Air - ASD (1-5 hp)	2.46	14.5	275828	0.120044	0.295788	331331	194024	1.71
Comp Air - Motor practices-1 (1-5 HP)	0.67	14.5	229857	0.120044	0.080285	276109	43886	6.29
Comp Air - Replace 6-100 HP motor	0.95	10.0	820864	0.150039	0.142597	986040	222717	4.43
Comp Air - ASD (6-100 hp)	0.07	10.0	1985961	0.150039	0.010563	2385581	39913	59.77
Comp Air - Motor practices-1 (6-100 HP)	0.18	10.0	661987	0.150039	0.026407	795194	33261	23.91
Comp Air - Replace 100+ HP motor	0.28	6.0	618406	0.217301	0.061192	742843	49714	14.94
Comp Air - ASD (100+ hp)	0.18	6.0	3254769	0.217301	0.038245	3909702	163534	23.91
Comp Air - Motor practices-1 (100+ HP)	0.07	6.0	1084923	0.217301	0.015298	1303234	21805	59.77
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Energy Star Transformers	2.25	25.0	147108	0.094882	0.213750	176710	94610	1.87
Base Fans	0.00	14.5	0	N/A	0.000000	0	0	0.00
Fans - O&M	0.04	10.0	3398836	0.150039	0.005281	4082759	34155	119.54
Fans - Controls	2.96	10.0	25491268	0.150039	0.443636	30620690	21517361	1.42
Fans - System Optimization	1.94	10.0	10706333	0.150039	0.290476	12860690	5917274	2.17
Fans- Improve components	0.18	10.0	3398836	0.150039	0.026407	4082759	170773	23.91
Fans - Replace 1-5 HP motor	1.69	14.5	887096	0.120044	0.202826	1065600	427888	2.49
Fans - ASD (1-5 hp)	2.46	14.5	1019651	0.120044	0.295788	1224828	717245	1.71
Fans - Motor practices-1 (1-5 HP)	0.67	14.5	849709	0.120044	0.080285	1020690	162234	6.29

Table C.4 Measure Electric Results of Paper Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Fans - Replace 6-100 HP motor	0.95	10.0	3034481	0.150039	0.142597	3645087	823316	4.43
Fans - ASD (6-100 hp)	0.07	10.0	7341485	0.150039	0.010563	8818759	147548	59.77
Fans - Motor practices-1 (6-100 HP)	0.18	10.0	2447162	0.150039	0.026407	2939586	122956	23.91
Fans - Replace 100+ HP motor	0.28	6.0	2286057	0.217301	0.061192	2746063	183779	14.94
Fans - ASD (100+ hp)	0.18	6.0	12031879	0.217301	0.038245	14452966	604535	23.91
Fans - Motor practices-1 (100+ HP)	0.07	6.0	4010626	0.217301	0.015298	4817655	80605	59.77
Optimize drying process	1.62	10.0	0	0.150039	0.242944	0	0	0.00
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Energy Star Transformers	2.25	25.0	543814	0.094882	0.213750	653241	349743	1.87
Base Pumps	0.00	14.5	0	N/A	0.000000	0	0	0.00
Pumps - O&M	0.18	10.0	22314686	0.150039	0.026407	26804907	1121190	23.91
Pumps - Controls	0.88	10.0	58576051	0.150039	0.132035	70362882	14715614	4.78
Pumps - System Optimization	2.11	10.0	55228848	0.150039	0.316883	66342146	33299332	1.99
Pumps - Sizing	0.63	10.0	22314686	0.150039	0.095065	26804907	4036283	6.64
Pumps - Replace 1-5 HP motor	1.69	14.5	1456033	0.120044	0.202826	1749020	702313	2.49
Pumps - ASD (1-5 hp)	2.46	14.5	1673601	0.120044	0.295788	2010368	1177249	1.71
Pumps - Motor practices-1 (1-5 HP)	0.67	14.5	1394668	0.120044	0.080285	1675307	266283	6.29
Pumps - Replace 6-100 HP motor	0.95	10.0	4980638	0.150039	0.142597	5982855	1351347	4.43
Pumps - ASD (6-100 hp)	0.07	10.0	12049931	0.150039	0.010563	14474650	242177	59.77
Pumps - Motor practices-1 (6-100 HP)	0.18	10.0	4016644	0.150039	0.026407	4824883	201814	23.91
Pumps - Replace 100+ HP motor	0.28	6.0	3752214	0.217301	0.061192	4507245	301645	14.94
Pumps - ASD (100+ hp)	0.18	6.0	19748497	0.217301	0.038245	23722343	992253	23.91
Pumps - Motor practices-1 (100+ HP)	0.07	6.0	6582832	0.217301	0.015298	7907448	132300	59.77
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00

Table C.4 Measure Electric Results of Paper Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Energy Star Transformers	2.25	25.0	892587	0.094882	0.213750	1072196	574049	1.87
Base Drives	0.00	20.0	0	N/A	0.000000	0	0	0.00
Bakery - Process (Mixing) - O&M	0.18	10.0	0	0.150039	0.026407	0	0	0.00
O&M/drives spinning machines	1.02	10.0	0	0.150039	0.153160	0	0	0.00
Air conveying systems	1.23	14.0	0	0.122356	0.150742	0	0	0.00
Replace V-Belts	0.18	10.0	0	0.150039	0.026407	0	0	0.00
Drives - EE motor	0.21	10.0	7667507	0.150039	0.031688	9210383	462300	19.92
Gap Forming papermachine	0.25	20.0	9578854	0.102992	0.025377	11506337	673798	17.08
High Consistency forming	0.25	20.0	9578854	0.102992	0.025377	11506337	673798	17.08
Optimization control PM	0.39	10.0	12024468	0.150039	0.058095	14444064	1329159	10.87
Efficient practices printing press	0.32	20.0	801365	0.102992	0.032628	962618	72475	13.28
Efficient Printing press (fewer cylinders)	1.94	10.0	1478527	0.150039	0.290476	1776040	817166	2.17
Light cylinders	2.25	10.0	739263	0.150039	0.338009	888020	475442	1.87
Efficient drives	0.18	10.0	303986	0.150039	0.026407	365154	15274	23.91
Clean Room - Controls	0.70	10.0	0	0.150039	0.105628	0	0	0.00
Clean Room - New Designs	4.22	10.0	0	0.150039	0.633766	0	0	0.00
Drives - Process Controls (batch + site)	0.77	10.0	0	0.150039	0.116190	0	0	0.00
Process Drives - ASD	0.07	10.0	0	0.150039	0.010563	0	0	0.00
O&M - Extruders/Injection Moulding	0.18	12.0	0	0.133728	0.023536	0	0	0.00
Extruders/injection Moulding-multipump	3.17	12.0	0	0.133728	0.423651	0	0	0.00
Direct drive Extruders	9.86	12.0	0	0.133728	1.318024	0	0	0.00
Injection Moulding - Impulse Cooling	2.22	12.0	0	0.133728	0.296556	0	0	0.00
Injection Moulding - Direct drive	3.10	12.0	0	0.133728	0.414236	0	0	0.00
Efficient grinding	7.39	15.0	0	0.117902	0.871530	0	0	0.00
Process control	0.07	10.0	0	0.150039	0.010563	0	0	0.00
Process optimization	0.95	10.0	0	0.150039	0.142597	0	0	0.00

Table C.4 Measure Electric Results of Paper Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Drives - Process Control	0.49	15.0	0	0.117902	0.058102	0	0	0.00
Efficient drives - rolling	0.28	10.0	0	0.150039	0.042251	0	0	0.00
Drives - Optimization process (M&T)	0.25	10.0	0	0.150039	0.036970	0	0	0.00
Drives - Scheduling	0.32	10.0	0	0.150039	0.047532	0	0	0.00
Machinery	0.39	10.0	0	0.150039	0.058095	0	0	0.00
Efficient Machinery	0.21	10.0	0	0.150039	0.031688	0	0	0.00
Energy Star Transformers	2.25	25.0	1329585	0.094882	0.213750	1597127	855095	1.87
Base Heating	0.00	20.0	0	N/A	0.000000	0	0	0.00
Bakery - Process	1.62	15.0	0	0.117902	0.190907	0	0	0.00
Drying (UV/IR)	2.39	8.0	0	0.175007	0.418896	0	0	0.00
Heat Pumps - Drying	5.63	15.0	0	0.117902	0.664023	0	0	0.00
Top-heating (glass)	0.14	8.0	0	0.175007	0.024641	0	0	0.00
Efficient electric melting	1.06	20.0	0	0.102992	0.108759	0	0	0.00
Intelligent extruder (DOE)	0.53	10.0	0	0.150039	0.079221	0	0	0.00
Near Net Shape Casting	0.39	15.0	0	0.117902	0.045652	0	0	0.00
Heating - Process Control	0.49	15.0	0	0.117902	0.058102	0	0	0.00
Efficient Curing ovens	2.57	15.0	0	0.117902	0.302960	0	0	0.00
Heating - Optimization process (M&T)	0.25	10.0	0	0.150039	0.036970	0	0	0.00
Heating - Scheduling	0.32	10.0	0	0.150039	0.047532	0	0	0.00
Energy Star Transformers	2.25	25.0	0	0.094882	0.213750	0	0	0.00
Base Refrigeration	0.00	20.0	0	N/A	0.000000	0	0	0.00
Efficient Refrigeration - Operations	0.25	10.0	0	0.150039	0.036970	0	0	0.00
Optimization Refrigeration	3.48	15.0	0	0.117902	0.410864	0	0	0.00
Energy Star Transformers	2.25	25.0	0	0.094882	0.213750	0	0	0.00
Base Other Process	0.00	15.0	0	N/A	0.000000	0	0	0.00
Other Process Controls (batch + site)	0.77	10.0	0	0.150039	0.116190	0	0	0.00

Table C.4 Measure Electric Results of Paper Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Efficient desalter	1.27	10.0	0	0.150039	0.190130	0	0	0.00
New transformers welding	1.62	15.0	0	0.117902	0.190907	0	0	0.00
Efficient processes (welding, etc.)	1.62	15.0	0	0.117902	0.190907	0	0	0.00
Process control	0.53	15.0	0	0.117902	0.062252	0	0	0.00
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Energy Star Transformers	2.25	25.0	0	0.094882	0.213750	0	0	0.00
Base Centrifugal Chiller, 0.58 kW/ton, 500 tons	0.00	20.0	0	N/A	0.000000	0	0	0.00
Centrifugal Chiller, 0.51 kW/ton, 500 tons	0.96	20.0	7610599.428	0.102992	0.098872	9142025	2085767	4.38
Window Film - Chiller	1.60	10.0	2378312.321	0.150039	0.240063	2856883	1086337	2.63
EMS - Chiller	2.56	10.0	3995564.7	0.150039	0.384101	4799563	2920073	1.64
Cool Roof - Chiller	4.48	10.0	1870939.026	0.150039	0.672176	2247414	2392838	0.94
Chiller Tune Up/Diagnostics	1.60	10.0	634216.619	0.150039	0.240063	761835	289690	2.63
Cooling Circ. Pumps - VSD	2.88	15.0	2140481.089	0.117902	0.339557	2571194	1759866	1.46
Energy Star Transformers	1.92	25.0	101474.659	0.094882	0.182173	121894	55620	2.19
Base DX Packaged System, EER=10.3, 10 tons	0.00	15.0	0	N/A	0.000000	0	0	0.00
DX Tune Up/ Advanced Diagnostics	1.92	3.0	3501714.081	0.389084	0.747042	4206338	1919365	2.19
DX Packaged System, EER=10.9, 10 tons	1.28	15.0	5602742.53	0.117902	0.150914	6730141	2047322	3.29
Window Film - DX	0.96	10.0	2171062.73	0.150039	0.144038	2607930	595003	4.38
Evaporative Pre-Cooler	7.36	10.0	2217752.252	0.150039	1.104290	2664014	4659791	0.57
Prog. Thermostat - DX	0.64	10.0	3151542.673	0.150039	0.096025	3785705	575809	6.57
Cool Roof - DX	2.56	10.0	2848060.786	0.150039	0.384101	3421155	2081445	1.64
Energy Star Transformers	1.92	25.0	149406.4675	0.094882	0.182173	179470	81893	2.19
Base Lighting	0.00	10.0	0	N/A	0.000000	0	0	0.00
RET 2L4' Premium T8, 1EB	4.16	15.0	38168276.57	0.117902	0.490471	45848600	45328516	1.01
CFL Hardwired, Modular 36W	4.16	4.0	10046378.95	0.302929	1.260187	12067938	11931046	1.01

Table C.4 Measure Electric Results of Paper Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Metal Halide, 50W	23.68	5.0	172370.2809	0.251447	5.954275	207055	1165252	0.18
Occupancy Sensor, 4L4' Fluorescent Fixtures	1.60	9.0	5910003.374	0.161080	0.257727	7099230	2699500	2.63
Energy Star Transformers	1.92	25.0	295500.1687	0.094882	0.182173	354962	161970	2.19
Base Other	0.00	15.0	0	N/A	0.000000	0	0	0.00
Replace V-belts	0.00	5.0	0	0.251447	0.000000	0	0	0.00
Membranes for wastewater	1.13	15.0	0	0.117902	0.132805	0	0	0.00
Energy Star Transformers	2.25	25.0	164956	0.094882	0.213750	198149	106088	1.87

Table C.5 Measure Electric Results of Chemical Industry

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Base Compressed Air	0.00	14.5	0	N/A	0.000000	0	0	0.00
Compressed Air - O&M	0.32	10.0	51078979	0.150039	0.047532	61357229	4619585	13.28
Compressed Air - Controls	0.56	10.0	12018583	0.150039	0.084502	14436995	1932376	7.47
Compressed Air - System Optimization	0.53	10.0	40061944	0.150039	0.079221	48123317	6038674	7.97
Compressed Air- Sizing	0.14	10.0	14422300	0.150039	0.021126	17324394	579713	29.88
Comp Air - Replace 1-5 HP motor	1.69	14.5	1045617	0.120044	0.202826	1256019	504350	2.49
Comp Air - ASD (1-5 hp)	2.46	14.5	1201858	0.120044	0.295788	1443699	845414	1.71
Comp Air - Motor practices-1 (1-5 HP)	0.67	14.5	1001549	0.120044	0.080285	1203083	191225	6.29
Comp Air - Replace 6-100 HP motor	0.95	10.0	3576730	0.150039	0.142597	4296450	970439	4.43
Comp Air - ASD (6-100 hp)	0.07	10.0	8653380	0.150039	0.010563	10394636	173914	59.77
Comp Air - Motor practices-1 (6-100 HP)	0.18	10.0	2884460	0.150039	0.026407	3464879	144928	23.91
Comp Air - Replace 100+ HP motor	0.28	6.0	2694566	0.217301	0.061192	3236774	216619	14.94
Comp Air - ASD (100+ hp)	0.18	6.0	14181928	0.217301	0.038245	17035654	712564	23.91
Comp Air - Motor practices-1 (100+ HP)	0.07	6.0	4727309	0.217301	0.015298	5678551	95008	59.77
Power recovery	0.11	10.0	6052	0.150039	0.015844	7270	182	39.85
Refinery Controls	0.11	10.0	18272	0.150039	0.015844	21949	551	39.85
Energy Star Transformers	2.25	25.0	640991	0.094882	0.213750	769973	412240	1.87
Base Fans	0.00	14.5	0	N/A	0.000000	0	0	0.00
Fans - O&M	0.04	10.0	7063040	0.150039	0.005281	8484284	70976	119.54
Fans - Controls	2.96	10.0	52972801	0.150039	0.443636	63632130	44714719	1.42
Fans - System Optimization	1.94	10.0	22248576	0.150039	0.290476	26725495	12296548	2.17
Fans- Improve components	0.18	10.0	7063040	0.150039	0.026407	8484284	354879	23.91
Fans - Replace 1-5 HP motor	1.69	14.5	1843453	0.120044	0.202826	2214398	889184	2.49
Fans - ASD (1-5 hp)	2.46	14.5	2118912	0.120044	0.295788	2545285	1490491	1.71
Fans - Motor practices-1 (1-5 HP)	0.67	14.5	1765760	0.120044	0.080285	2121071	337135	6.29

Table C.5 Measure Electric Results of Chemical Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Fans - Replace 6-100 HP motor	0.95	10.0	6305882	0.150039	0.142597	7574769	1710913	4.43
Fans - ASD (6-100 hp)	0.07	10.0	15256167	0.150039	0.010563	18326053	306615	59.77
Fans - Motor practices-1 (6-100 HP)	0.18	10.0	5085389	0.150039	0.026407	6108684	255513	23.91
Fans - Replace 100+ HP motor	0.28	6.0	4750601	0.217301	0.061192	5706529	381906	14.94
Fans - ASD (100+ hp)	0.18	6.0	25003162	0.217301	0.038245	30034365	1256271	23.91
Fans - Motor practices-1 (100+ HP)	0.07	6.0	8334387	0.217301	0.015298	10011455	167503	59.77
Optimize drying process	1.62	10.0	0	0.150039	0.242944	0	0	0.00
Power recovery	0.11	10.0	3724	0.150039	0.015844	4474	112	39.85
Refinery Controls	0.11	10.0	11244	0.150039	0.015844	13507	339	39.85
Energy Star Transformers	2.25	25.0	1130086	0.094882	0.213750	1357485	726792	1.87
Base Pumps	0.00	14.5	0	N/A	0.000000	0	0	0.00
Pumps - O&M	0.18	10.0	57302511	0.150039	0.026407	68833076	2879134	23.91
Pumps - Controls	0.88	10.0	150419091	0.150039	0.132035	180686825	37788639	4.78
Pumps - System Optimization	2.11	10.0	141823714	0.150039	0.316883	170361863	85510292	1.99
Pumps - Sizing	0.63	10.0	57302511	0.150039	0.095065	68833076	10364884	6.64
Pumps - Replace 1-5 HP motor	1.69	14.5	3738989	0.120044	0.202826	4491358	1803490	2.49
Pumps - ASD (1-5 hp)	2.46	14.5	4297688	0.120044	0.295788	5162481	3023091	1.71
Pumps - Motor practices-1 (1-5 HP)	0.67	14.5	3581407	0.120044	0.080285	4302067	683794	6.29
Pumps - Replace 6-100 HP motor	0.95	10.0	12789920	0.150039	0.142597	15363543	3470163	4.43
Pumps - ASD (6-100 hp)	0.07	10.0	30943356	0.150039	0.010563	37169861	621893	59.77
Pumps - Motor practices-1 (6-100 HP)	0.18	10.0	10314452	0.150039	0.026407	12389954	518244	23.91
Pumps - Replace 100+ HP motor	0.28	6.0	9635417	0.217301	0.061192	11574282	774602	14.94
Pumps - ASD (100+ hp)	0.18	6.0	50712722	0.217301	0.038245	60917272	2548034	23.91
Pumps - Motor practices-1 (100+ HP)	0.07	6.0	16904241	0.217301	0.015298	20305757	339738	59.77
Power recovery	0.11	10.0	24209	0.150039	0.015844	29081	730	39.85
Refinery Controls	0.11	10.0	73089	0.150039	0.015844	87796	2203	39.85

Table C.5 Measure Electric Results of Chemical Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Energy Star Transformers	2.25	25.0	2292100	0.094882	0.213750	2753323	1474117	1.87
Base Drives	0.00	20.0	0	N/A	0.000000	0	0	0.00
Bakery - Process (Mixing) - O&M	0.18	10.0	0	0.150039	0.026407	0	0	0.00
O&M/drives spinning machines	1.02	10.0	0	0.150039	0.153160	0	0	0.00
Air conveying systems	1.23	14.0	0	0.122356	0.150742	0	0	0.00
Replace V-Belts	0.18	10.0	0	0.150039	0.026407	0	0	0.00
Drives - EE motor	0.21	10.0	0	0.150039	0.031688	0	0	0.00
Gap Forming papermachine	0.25	20.0	0	0.102992	0.025377	0	0	0.00
High Consistency forming	0.25	20.0	0	0.102992	0.025377	0	0	0.00
Optimization control PM	0.39	10.0	0	0.150039	0.058095	0	0	0.00
Efficient practices printing press	0.32	20.0	0	0.102992	0.032628	0	0	0.00
Efficient Printing press (fewer cylinders)	1.94	10.0	0	0.150039	0.290476	0	0	0.00
Light cylinders	2.25	10.0	0	0.150039	0.338009	0	0	0.00
Efficient drives	0.18	10.0	962365	0.150039	0.026407	1156015	48354	23.91
Clean Room - Controls	0.70	10.0	2608255	0.150039	0.105628	3133095	524202	5.98
Clean Room - New Designs	4.22	10.0	2207024	0.150039	0.633766	2651127	2661378	1.00
Drives - Process Controls (batch + site)	0.77	10.0	1572624	0.150039	0.116190	1889071	347669	5.43
Process Drives - ASD	0.07	10.0	0	0.150039	0.010563	0	0	0.00
O&M - Extruders/Injection Moulding	0.18	12.0	0	0.133728	0.023536	0	0	0.00
Extruders/injection Moulding-multipump	3.17	12.0	239027664	0.133728	0.423651	287125454	216176739	1.33
Direct drive Extruders	9.86	12.0	270310259	0.133728	1.318024	324702816	760569390	0.43
Injection Moulding - Impulse Cooling	2.22	12.0	47800312	0.133728	0.296556	57418819	30261438	1.90
Injection Moulding - Direct drive	3.10	12.0	58331024	0.133728	0.414236	70068550	51582283	1.36
Efficient grinding	7.39	15.0	0	0.117902	0.871530	0	0	0.00
Process control	0.07	10.0	0	0.150039	0.010563	0	0	0.00
Process optimization	0.95	10.0	0	0.150039	0.142597	0	0	0.00

Table C.5 Measure Electric Results of Chemical Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Drives - Process Control	0.49	15.0	0	0.117902	0.058102	0	0	0.00
Efficient drives - rolling	0.28	10.0	0	0.150039	0.042251	0	0	0.00
Drives - Optimization process (M&T)	0.25	10.0	0	0.150039	0.036970	0	0	0.00
Drives - Scheduling	0.32	10.0	0	0.150039	0.047532	0	0	0.00
Machinery	0.39	10.0	0	0.150039	0.058095	0	0	0.00
Efficient Machinery	0.21	10.0	0	0.150039	0.031688	0	0	0.00
Energy Star Transformers	2.25	25.0	4796448	0.094882	0.213750	5761603	3084736	1.87
Base Heating	0.00	20.0	0	N/A	0.000000	0	0	0.00
Bakery - Process	1.62	15.0	0	0.117902	0.190907	0	0	0.00
Drying (UV/IR)	2.39	8.0	0	0.175007	0.418896	0	0	0.00
Heat Pumps - Drying	5.63	15.0	0	0.117902	0.664023	0	0	0.00
Top-heating (glass)	0.14	8.0	0	0.175007	0.024641	0	0	0.00
Efficient electric melting	1.06	20.0	0	0.102992	0.108759	0	0	0.00
Intelligent extruder (DOE)	0.53	10.0	0	0.150039	0.079221	0	0	0.00
Near Net Shape Casting	0.39	15.0	0	0.117902	0.045652	0	0	0.00
Heating - Process Control	0.49	15.0	0	0.117902	0.058102	0	0	0.00
Efficient Curing ovens	2.57	15.0	0	0.117902	0.302960	0	0	0.00
Heating - Optimization process (M&T)	0.25	10.0	0	0.150039	0.036970	0	0	0.00
Heating - Scheduling	0.32	10.0	0	0.150039	0.047532	0	0	0.00
Energy Star Transformers	2.25	25.0	0	0.094882	0.213750	0	0	0.00
Base Refrigeration	0.00	20.0	0	N/A	0.000000	0	0	0.00
Efficient Refrigeration - Operations	0.25	10.0	0	0.150039	0.036970	0	0	0.00
Optimization Refrigeration	3.48	15.0	0	0.117902	0.410864	0	0	0.00
Energy Star Transformers	2.25	25.0	0	0.094882	0.213750	0	0	0.00
Base Other Process	0.00	15.0	0	N/A	0.000000	0	0	0.00
Other Process Controls (batch + site)	0.77	10.0	99320	0.150039	0.116190	119306	21957	5.43

Table C.5 Measure Electric Results of Chemical Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Efficient desalter	1.27	10.0	0	0.150039	0.190130	0	0	0.00
New transformers welding	1.62	15.0	0	0.117902	0.190907	0	0	0.00
Efficient processes (welding, etc.)	1.62	15.0	0	0.117902	0.190907	0	0	0.00
Process control	0.53	15.0	0	0.117902	0.062252	0	0	0.00
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Energy Star Transformers	2.25	25.0	387459	0.094882	0.213750	465424	249186	1.87
Base Centrifugal Chiller, 0.58 kW/ton, 500 tons	0.00	20.0	0	N/A	0.000000	0	0	0.00
Centrifugal Chiller, 0.51 kW/ton, 500 tons	0.96	20.0	9139843	0.102992	0.098872	10978987	2504872	4.38
Window Film - Chiller	1.60	10.0	2856201	0.150039	0.240063	3430933	1304621	2.63
EMS - Chiller	2.56	10.0	4798418	0.150039	0.384101	5763968	3506821	1.64
Cool Roof - Chiller	4.48	10.0	2246878	0.150039	0.672176	2699001	2873645	0.94
Chiller Tune Up/Diagnostics	1.60	10.0	761654	0.150039	0.240063	914916	347899	2.63
Cooling Circ. Pumps - VSD	2.88	15.0	2570581	0.117902	0.339557	3087840	2113486	1.46
Energy Star Transformers	1.92	25.0	121865	0.094882	0.182173	146386	66797	2.19
Base DX Packaged System, EER=10.3, 10 tons	0.00	15.0	0	N/A	0.000000	0	0	0.00
DX Tune Up/ Advanced Diagnostics	1.92	3.0	7051867	0.389084	0.747042	8470863	3865280	2.19
DX Packaged System, EER=10.9, 10 tons	1.28	15.0	11282987	0.117902	0.150914	13553380	4122965	3.29
Window Film - DX	0.96	10.0	4372158	0.150039	0.144038	5251935	1198237	4.38
Evaporative Pre-Cooler	7.36	10.0	4466183	0.150039	1.104290	5364880	9384041	0.57
Prog. Thermostat - DX	0.64	10.0	6346680	0.150039	0.096025	7623777	1159584	6.57
Cool Roof - DX	2.56	10.0	5735519	0.150039	0.384101	6889635	4191682	1.64
Energy Star Transformers	1.92	25.0	300880	0.094882	0.182173	361423	164919	2.19
Base Lighting	0.00	10.0	0	N/A	0.000000	0	0	0.00
RET 2L4' Premium T8, 1EB	4.16	15.0	190450735	0.117902	0.490471	228773744	226178647	1.01
CFL Hardwired, Modular 36W	4.16	4.0	57971471	0.302929	1.260187	69636646	68846722	1.01

Table C.5 Measure Electric Results of Chemical Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Metal Halide, 50W	23.68	5.0	12126102	0.251447	5.954275	14566149	81974453	0.18
Occupancy Sensor, 4L4' Fluorescent Fixtures	1.60	9.0	28509048	0.161080	0.257727	34245715	13022019	2.63
Energy Star Transformers	1.92	25.0	1425452	0.094882	0.182173	1712286	781321	2.19
Base Other	0.00	15.0	0	N/A	0.000000	0	0	0.00
Replace V-belts	0.00	5.0	0	0.251447	0.000000	0	0	0.00
Membranes for wastewater	1.13	15.0	0	0.117902	0.132805	0	0	0.00
Energy Star Transformers	2.25	25.0	540250	0.094882	0.213750	648960	347450	1.87

Table C.6 Measure Electric Results of Non-metallic Industry

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Base Compressed Air	0.00	14.5	0	N/A	0.000000	0	0	0.00
Compressed Air - O&M	0.32	10.0	52119450	0.150039	0.047532	62607066	4713686	13.28
Compressed Air - Controls	0.56	10.0	12263400	0.150039	0.084502	14731074	1971738	7.47
Compressed Air - System Optimization	0.53	10.0	40878000	0.150039	0.079221	49103581	6161681	7.97
Compressed Air- Sizing	0.14	10.0	14716080	0.150039	0.021126	17677289	591521	29.88
Comp Air - Replace 1-5 HP motor	1.69	14.5	1066916	0.120044	0.202826	1281603	514624	2.49
Comp Air - ASD (1-5 hp)	2.46	14.5	1226340	0.120044	0.295788	1473107	862635	1.71
Comp Air - Motor practices-1 (1-5 HP)	0.67	14.5	1021950	0.120044	0.080285	1227590	195120	6.29
Comp Air - Replace 6-100 HP motor	0.95	10.0	3649588	0.150039	0.142597	4383968	990207	4.43
Comp Air - ASD (6-100 hp)	0.07	10.0	8829648	0.150039	0.010563	10606374	177456	59.77
Comp Air - Motor practices-1 (6-100 HP)	0.18	10.0	2943216	0.150039	0.026407	3535458	147880	23.91
Comp Air - Replace 100+ HP motor	0.28	6.0	2749454	0.217301	0.061192	3302707	221032	14.94
Comp Air - ASD (100+ hp)	0.18	6.0	14470812	0.217301	0.038245	17382668	727078	23.91
Comp Air - Motor practices-1 (100+ HP)	0.07	6.0	4823604	0.217301	0.015298	5794223	96944	59.77
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Energy Star Transformers	2.25	25.0	654048	0.094882	0.213750	785657	420637	1.87
Base Fans	0.00	14.5	0	N/A	0.000000	0	0	0.00
Fans - O&M	0.04	10.0	9538200	0.150039	0.005281	11457502	95848	119.54
Fans - Controls	2.96	10.0	71536500	0.150039	0.443636	85931267	60384470	1.42
Fans - System Optimization	1.94	10.0	30045330	0.150039	0.290476	36091132	16605729	2.17
Fans- Improve components	0.18	10.0	9538200	0.150039	0.026407	11457502	479242	23.91
Fans - Replace 1-5 HP motor	1.69	14.5	2489470	0.120044	0.202826	2990408	1200788	2.49
Fans - ASD (1-5 hp)	2.46	14.5	2861460	0.120044	0.295788	3437251	2012816	1.71
Fans - Motor practices-1 (1-5 HP)	0.67	14.5	2384550	0.120044	0.080285	2864376	455280	6.29

Table C.6 Measure Electric Results of Non-metallic Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Fans - Replace 6-100 HP motor	0.95	10.0	8515705	0.150039	0.142597	10229258	2310482	4.43
Fans - ASD (6-100 hp)	0.07	10.0	20602512	0.150039	0.010563	24748205	414065	59.77
Fans - Motor practices-1 (6-100 HP)	0.18	10.0	6867504	0.150039	0.026407	8249402	345054	23.91
Fans - Replace 100+ HP motor	0.28	6.0	6415393	0.217301	0.061192	7706316	515741	14.94
Fans - ASD (100+ hp)	0.18	6.0	33765228	0.217301	0.038245	40559558	1696516	23.91
Fans - Motor practices-1 (100+ HP)	0.07	6.0	11255076	0.217301	0.015298	13519853	226202	59.77
Optimize drying process	1.62	10.0	0	0.150039	0.242944	0	0	0.00
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Energy Star Transformers	2.25	25.0	1526112	0.094882	0.213750	1833200	981487	1.87
Base Pumps	0.00	14.5	0	N/A	0.000000	0	0	0.00
Pumps - O&M	0.18	10.0	49053600	0.150039	0.026407	58924297	2464672	23.91
Pumps - Controls	0.88	10.0	128765700	0.150039	0.132035	154676281	32348823	4.78
Pumps - System Optimization	2.11	10.0	121407660	0.150039	0.316883	145837636	73200765	1.99
Pumps - Sizing	0.63	10.0	49053600	0.150039	0.095065	58924297	8872820	6.64
Pumps - Replace 1-5 HP motor	1.69	14.5	3200747	0.120044	0.202826	3844810	1543871	2.49
Pumps - ASD (1-5 hp)	2.46	14.5	3679020	0.120044	0.295788	4419322	2587906	1.71
Pumps - Motor practices-1 (1-5 HP)	0.67	14.5	3065850	0.120044	0.080285	3682769	585360	6.29
Pumps - Replace 6-100 HP motor	0.95	10.0	10948764	0.150039	0.142597	13151903	2970620	4.43
Pumps - ASD (6-100 hp)	0.07	10.0	26488944	0.150039	0.010563	31819121	532369	59.77
Pumps - Motor practices-1 (6-100 HP)	0.18	10.0	8829648	0.150039	0.026407	10606374	443641	23.91
Pumps - Replace 100+ HP motor	0.28	6.0	8248363	0.217301	0.061192	9908121	663095	14.94
Pumps - ASD (100+ hp)	0.18	6.0	43412436	0.217301	0.038245	52148003	2181235	23.91
Pumps - Motor practices-1 (100+ HP)	0.07	6.0	14470812	0.217301	0.015298	17382668	290831	59.77
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00

Table C.6 Measure Electric Results of Non-metallic Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Energy Star Transformers	2.25	25.0	2292100	0.094882	0.213750	2753323	1474117	1.87
Base Drives	0.00	20.0	0	N/A	0.000000	0	0	0.00
Bakery - Process (Mixing) - O&M	0.18	10.0	0	0.150039	0.026407	0	0	0.00
O&M/drives spinning machines	1.02	10.0	0	0.150039	0.153160	0	0	0.00
Air conveying systems	1.23	14.0	0	0.122356	0.150742	0	0	0.00
Replace V-Belts	0.18	10.0	0	0.150039	0.026407	0	0	0.00
Drives - EE motor	0.21	10.0	0	0.150039	0.031688	0	0	0.00
Gap Forming papermachine	0.25	20.0	0	0.102992	0.025377	0	0	0.00
High Consistency forming	0.25	20.0	0	0.102992	0.025377	0	0	0.00
Optimization control PM	0.39	10.0	0	0.150039	0.058095	0	0	0.00
Efficient practices printing press	0.32	20.0	0	0.102992	0.032628	0	0	0.00
Efficient Printing press (fewer cylinders)	1.94	10.0	0	0.150039	0.290476	0	0	0.00
Light cylinders	2.25	10.0	0	0.150039	0.338009	0	0	0.00
Efficient drives	0.18	10.0	962365	0.150039	0.026407	1156015	48354	23.91
Clean Room - Controls	0.70	10.0	2608255	0.150039	0.105628	3133095	524202	5.98
Clean Room - New Designs	4.22	10.0	2207024	0.150039	0.633766	2651127	2661378	1.00
Drives - Process Controls (batch + site)	0.77	10.0	1572624	0.150039	0.116190	1889071	347669	5.43
Process Drives - ASD	0.07	10.0	0	0.150039	0.010563	0	0	0.00
O&M - Extruders/Injection Moulding	0.18	12.0	0	0.133728	0.023536	0	0	0.00
Extruders/injection Moulding-multipump	3.17	12.0	239027664	0.133728	0.423651	287125454	216176739	1.33
Direct drive Extruders	9.86	12.0	270310259	0.133728	1.318024	324702816	760569390	0.43
Injection Moulding - Impulse Cooling	2.22	12.0	47800312	0.133728	0.296556	57418819	30261438	1.90
Injection Moulding - Direct drive	3.10	12.0	58331024	0.133728	0.414236	70068550	51582283	1.36
Efficient grinding	7.39	15.0	0	0.117902	0.871530	0	0	0.00
Process control	0.07	10.0	0	0.150039	0.010563	0	0	0.00
Process optimization	0.95	10.0	0	0.150039	0.142597	0	0	0.00

Table C.6 Measure Electric Results of Non-metallic Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Drives - Process Control	0.49	15.0	0	0.117902	0.058102	0	0	0.00
Efficient drives - rolling	0.28	10.0	0	0.150039	0.042251	0	0	0.00
Drives - Optimization process (M&T)	0.25	10.0	0	0.150039	0.036970	0	0	0.00
Drives - Scheduling	0.32	10.0	0	0.150039	0.047532	0	0	0.00
Machinery	0.39	10.0	0	0.150039	0.058095	0	0	0.00
Efficient Machinery	0.21	10.0	0	0.150039	0.031688	0	0	0.00
Energy Star Transformers	2.25	25.0	2180160	0.094882	0.213750	2618858	1402125	1.87
Base Heating	0.00	20.0	0	N/A	0.000000	0	0	0.00
Bakery - Process	1.62	15.0	0	0.117902	0.190907	0	0	0.00
Drying (UV/IR)	2.39	8.0	0	0.175007	0.418896	0	0	0.00
Heat Pumps - Drying	5.63	15.0	0	0.117902	0.664023	0	0	0.00
Top-heating (glass)	0.14	8.0	7834950	0.175007	0.024641	9411520	314930	29.88
Efficient electric melting	1.06	20.0	0	0.102992	0.108759	0	0	0.00
Intelligent extruder (DOE)	0.53	10.0	0	0.150039	0.079221	0	0	0.00
Near Net Shape Casting	0.39	15.0	0	0.117902	0.045652	0	0	0.00
Heating - Process Control	0.49	15.0	0	0.117902	0.058102	0	0	0.00
Efficient Curing ovens	2.57	15.0	0	0.117902	0.302960	0	0	0.00
Heating - Optimization process (M&T)	0.25	10.0	0	0.150039	0.036970	0	0	0.00
Heating - Scheduling	0.32	10.0	0	0.150039	0.047532	0	0	0.00
Energy Star Transformers	2.25	25.0	2507184	0.094882	0.213750	3011686	1612443	1.87
Base Refrigeration	0.00	20.0	0	N/A	0.000000	0	0	0.00
Efficient Refrigeration - Operations	0.25	10.0	0	0.150039	0.036970	0	0	0.00
Optimization Refrigeration	3.48	15.0	0	0.117902	0.410864	0	0	0.00
Energy Star Transformers	2.25	25.0	0	0.094882	0.213750	0	0	0.00
Base Other Process	0.00	15.0	0	N/A	0.000000	0	0	0.00
Other Process Controls (batch + site)	0.77	10.0	0	0.150039	0.116190	0	0	0.00

Table C.6 Measure Electric Results of Non-metallic Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Efficient desalter	1.27	10.0	0	0.150039	0.190130	0	0	0.00
New transformers welding	1.62	15.0	0	0.117902	0.190907	0	0	0.00
Efficient processes (welding, etc.)	1.62	15.0	0	0.117902	0.190907	0	0	0.00
Process control	0.53	15.0	0	0.117902	0.062252	0	0	0.00
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Energy Star Transformers	2.25	25.0	0	0.094882	0.213750	0	0	0.00
Base Centrifugal Chiller, 0.58 kW/ton, 500 tons	0.00	20.0	0	N/A	0.000000	0	0	0.00
Centrifugal Chiller, 0.51 kW/ton, 500 tons	0.96	20.0	8175600	0.102992	0.098872	9820716	2240611	4.38
Window Film - Chiller	1.60	10.0	2554875	0.150039	0.240063	3068974	1166985	2.63
EMS - Chiller	2.56	10.0	4292190	0.150039	0.384101	5155876	3136856	1.64
Cool Roof - Chiller	4.48	10.0	2009835	0.150039	0.672176	2414259	2570479	0.94
Chiller Tune Up/Diagnostics	1.60	10.0	681300	0.150039	0.240063	818393	311196	2.63
Cooling Circ. Pumps - VSD	2.88	15.0	2299387.5	0.117902	0.339557	2762076	1890516	1.46
Energy Star Transformers	1.92	25.0	109008	0.094882	0.182173	130943	59750	2.19
Base DX Packaged System, EER=10.3, 10 tons	0.00	15.0	0	N/A	0.000000	0	0	0.00
DX Tune Up/ Advanced Diagnostics	1.92	3.0	7664625	0.389084	0.747042	9206921	4201146	2.19
DX Packaged System, EER=10.9, 10 tons	1.28	15.0	12263400	0.117902	0.150914	14731074	4481222	3.29
Window Film - DX	0.96	10.0	4752067.5	0.150039	0.144038	5708291	1302355	4.38
Evaporative Pre-Cooler	7.36	10.0	4854262.5	0.150039	1.104290	5831050	10199449	0.57
Prog. Thermostat - DX	0.64	10.0	6898162.5	0.150039	0.096025	8286229	1260344	6.57
Cool Roof - DX	2.56	10.0	6233895	0.150039	0.384101	7488296	4555909	1.64
Energy Star Transformers	1.92	25.0	327024	0.094882	0.182173	392829	179249	2.19
Base Lighting	0.00	10.0	0	N/A	0.000000	0	0	0.00
RET 2L4' Premium T8, 1EB	4.16	15.0	58270907.7	0.117902	0.490471	69996336	69202333	1.01
CFL Hardwired, Modular 36W	4.16	4.0	28451088	0.302929	1.260187	34176092	33788416	1.01

Table C.6 Measure Electric Results of Non-metallic Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Metal Halide, 50W	23.68	5.0	20271400.2	0.251447	5.954275	24350466	137038017	0.18
Occupancy Sensor, 4L4' Fluorescent Fixtures	1.60	9.0	10900800	0.161080	0.257727	13094288	4979136	2.63
Energy Star Transformers	1.92	25.0	545040	0.094882	0.182173	654714	298748	2.19
Base Other	0.00	15.0	0	N/A	0.000000	0	0	0
Replace V-belts	0.00	5.0	0	0.251447	0.000000	0	0	0.00
Membranes for wastewater	1.13	15.0	0	0.117902	0.132805	0	0	0.00
Energy Star Transformers	2.25	25.0	436032	0.094882	0.213750	523772	280425	1.87

Table C.7 Measure Electric Results of Basic Metals Industry

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Base Compressed Air	0.00	14.5	0	N/A	0.000000	0	0	0.00
Compressed Air - O&M	0.32	10.0	54047250	0.150039	0.047532	64922783	4888036	13.28
Compressed Air - Controls	0.56	10.0	12717000	0.150039	0.084502	15275949	2044669	7.47
Compressed Air - System Optimization	0.53	10.0	42390000	0.150039	0.079221	50919830	6389590	7.97
Compressed Air- Sizing	0.14	10.0	15260400	0.150039	0.021126	18331139	613401	29.88
Comp Air - Replace 1-5 HP motor	1.69	14.5	1106379	0.120044	0.202826	1329008	533659	2.49
Comp Air - ASD (1-5 hp)	2.46	14.5	1271700	0.120044	0.295788	1527595	894543	1.71
Comp Air - Motor practices-1 (1-5 HP)	0.67	14.5	1059750	0.120044	0.080285	1272996	202337	6.29
Comp Air - Replace 6-100 HP motor	0.95	10.0	3784579	0.150039	0.142597	4546122	1026833	4.43
Comp Air - ASD (6-100 hp)	0.07	10.0	9156240	0.150039	0.010563	10998683	184020	59.77
Comp Air - Motor practices-1 (6-100 HP)	0.18	10.0	3052080	0.150039	0.026407	3666228	153350	23.91
Comp Air - Replace 100+ HP motor	0.28	6.0	2851151	0.217301	0.061192	3424868	229207	14.94
Comp Air - ASD (100+ hp)	0.18	6.0	15006060	0.217301	0.038245	18025620	753972	23.91
Comp Air - Motor practices-1 (100+ HP)	0.07	6.0	5002020	0.217301	0.015298	6008540	100530	59.77
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Energy Star Transformers	2.25	25.0	678240	0.094882	0.213750	814717	436196	1.87
Base Fans	0.00	14.5	0	N/A	0.000000	0	0	0.00
Fans - O&M	0.04	10.0	9891000	0.150039	0.005281	11881294	99394	119.54
Fans - Controls	2.96	10.0	74182500	0.150039	0.443636	89109702	62617977	1.42
Fans - System Optimization	1.94	10.0	31156650	0.150039	0.290476	37426075	17219944	2.17
Fans- Improve components	0.18	10.0	9891000	0.150039	0.026407	11881294	496968	23.91
Fans - Replace 1-5 HP motor	1.69	14.5	2581551	0.120044	0.202826	3101018	1245203	2.49
Fans - ASD (1-5 hp)	2.46	14.5	2967300	0.120044	0.295788	3564388	2087266	1.71
Fans - Motor practices-1 (1-5 HP)	0.67	14.5	2472750	0.120044	0.080285	2970323	472120	6.29

Table C.7 Measure Electric Results of Basic Metals Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Fans - Replace 6-100 HP motor	0.95	10.0	8830685	0.150039	0.142597	10607619	2395943	4.43
Fans - ASD (6-100 hp)	0.07	10.0	21364560	0.150039	0.010563	25663594	429380	59.77
Fans - Motor practices-1 (6-100 HP)	0.18	10.0	7121520	0.150039	0.026407	8554531	357817	23.91
Fans - Replace 100+ HP motor	0.28	6.0	6652687	0.217301	0.061192	7991358	534817	14.94
Fans - ASD (100+ hp)	0.18	6.0	35014140	0.217301	0.038245	42059779	1759267	23.91
Fans - Motor practices-1 (100+ HP)	0.07	6.0	11671380	0.217301	0.015298	14019926	234569	59.77
Optimize drying process	1.62	10.0	0	0.150039	0.242944	0	0	0.00
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Energy Star Transformers	2.25	25.0	1582560	0.094882	0.213750	1901007	1017791	1.87
Base Pumps	0.00	14.5	0	N/A	0.000000	0	0	0.00
Pumps - O&M	0.18	10.0	50868000	0.150039	0.026407	61103796	2555836	23.91
Pumps - Controls	0.88	10.0	133528500	0.150039	0.132035	160397464	33545345	4.78
Pumps - System Optimization	2.11	10.0	125898300	0.150039	0.316883	151231895	75908323	1.99
Pumps - Sizing	0.63	10.0	50868000	0.150039	0.095065	61103796	9201009	6.64
Pumps - Replace 1-5 HP motor	1.69	14.5	3319137	0.120044	0.202826	3987023	1600976	2.49
Pumps - ASD (1-5 hp)	2.46	14.5	3815100	0.120044	0.295788	4582785	2683628	1.71
Pumps - Motor practices-1 (1-5 HP)	0.67	14.5	3179250	0.120044	0.080285	3818987	607011	6.29
Pumps - Replace 6-100 HP motor	0.95	10.0	11353738	0.150039	0.142597	13638367	3080498	4.43
Pumps - ASD (6-100 hp)	0.07	10.0	27468720	0.150039	0.010563	32996050	552061	59.77
Pumps - Motor practices-1 (6-100 HP)	0.18	10.0	9156240	0.150039	0.026407	10998683	460050	23.91
Pumps - Replace 100+ HP motor	0.28	6.0	8553454	0.217301	0.061192	10274603	687622	14.94
Pumps - ASD (100+ hp)	0.18	6.0	45018180	0.217301	0.038245	54076859	2261915	23.91
Pumps - Motor practices-1 (100+ HP)	0.07	6.0	15006060	0.217301	0.015298	18025620	301589	59.77
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00

Table C.7 Measure Electric Results of Basic Metals Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Energy Star Transformers	2.25	25.0	2034720	0.094882	0.213750	2444152	1308588	1.87
Base Drives	0.00	20.0	0	N/A	0.000000	0	0	0.00
Bakery - Process (Mixing) - O&M	0.18	10.0	0	0.150039	0.026407	0	0	0.00
O&M/drives spinning machines	1.02	10.0	0	0.150039	0.153160	0	0	0.00
Air conveying systems	1.23	14.0	0	0.122356	0.150742	0	0	0.00
Replace V-Belts	0.18	10.0	0	0.150039	0.026407	0	0	0.00
Drives - EE motor	0.21	10.0	0	0.150039	0.031688	0	0	0.00
Gap Forming papermachine	0.25	20.0	0	0.102992	0.025377	0	0	0.00
High Consistency forming	0.25	20.0	0	0.102992	0.025377	0	0	0.00
Optimization control PM	0.39	10.0	0	0.150039	0.058095	0	0	0.00
Efficient practices printing press	0.32	20.0	0	0.102992	0.032628	0	0	0.00
Efficient Printing press (fewer cylinders)	1.94	10.0	0	0.150039	0.290476	0	0	0.00
Light cylinders	2.25	10.0	0	0.150039	0.338009	0	0	0.00
Efficient drives	0.18	10.0	0	0.150039	0.026407	0	0	0.00
Clean Room - Controls	0.70	10.0	0	0.150039	0.105628	0	0	0.00
Clean Room - New Designs	4.22	10.0	0	0.150039	0.633766	0	0	0.00
Drives - Process Controls (batch + site)	0.77	10.0	37091250	0.150039	0.116190	44554851	8199973	5.43
Process Drives - ASD	0.07	10.0	0	0.150039	0.010563	0	0	0.00
O&M - Extruders/Injection Moulding	0.18	12.0	0	0.133728	0.023536	0	0	0.00
Extruders/injection Moulding-multipump	3.17	12.0	0	0.133728	0.423651	0	0	0.00
Direct drive Extruders	9.86	12.0	0	0.133728	1.318024	0	0	0.00
Injection Moulding - Impulse Cooling	2.22	12.0	0	0.133728	0.296556	0	0	0.00
Injection Moulding - Direct drive	3.10	12.0	0	0.133728	0.414236	0	0	0.00
Efficient grinding	7.39	15.0	0	0.117902	0.871530	0	0	0.00
Process control	0.07	10.0	0	0.150039	0.010563	0	0	0.00
Process optimization	0.95	10.0	0	0.150039	0.142597	0	0	0.00

Table C.7 Measure Electric Results of Basic Metals Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Drives - Process Control	0.49	15.0	37091250	0.117902	0.058102	44554851	5218165	8.54
Efficient drives - rolling	0.28	10.0	44509500	0.150039	0.042251	53465821	3578170	14.94
Drives - Optimization process (M&T)	0.25	10.0	0	0.150039	0.036970	0	0	0.00
Drives - Scheduling	0.32	10.0	0	0.150039	0.047532	0	0	0.00
Machinery	0.39	10.0	0	0.150039	0.058095	0	0	0.00
Efficient Machinery	0.21	10.0	0	0.150039	0.031688	0	0	0.00
Energy Star Transformers	2.25	25.0	2373840	0.094882	0.213750	2851510	1526686	1.87
Base Heating	0.00	20.0	0	N/A	0.000000	0	0	0.00
Bakery - Process	1.62	15.0	0	0.117902	0.190907	0	0	0.00
Drying (UV/IR)	2.39	8.0	0	0.175007	0.418896	0	0	0.00
Heat Pumps - Drying	5.63	15.0	0	0.117902	0.664023	0	0	0.00
Top-heating (glass)	0.14	8.0	0	0.175007	0.024641	0	0	0.00
Efficient electric melting	1.06	20.0	31792500	0.102992	0.108759	38189872	9584384	3.98
Intelligent extruder (DOE)	0.53	10.0	706500	0.150039	0.079221	848664	106493	7.97
Near Net Shape Casting	0.39	15.0	8478000	0.117902	0.045652	10183966	937140	10.87
Heating - Process Control	0.49	15.0	35325000	0.117902	0.058102	42433192	4969681	8.54
Efficient Curing ovens	2.57	15.0	0	0.117902	0.302960	0	0	0.00
Heating - Optimization process (M&T)	0.25	10.0	0	0.150039	0.036970	0	0	0.00
Heating - Scheduling	0.32	10.0	0	0.150039	0.047532	0	0	0.00
Energy Star Transformers	2.25	25.0	2260800	0.094882	0.213750	2715724	1453987	1.87
Base Refrigeration	0.00	20.0	0	N/A	0.000000	0	0	0.00
Efficient Refrigeration - Operations	0.25	10.0	0	0.150039	0.036970	0	0	0.00
Optimization Refrigeration	3.48	15.0	0	0.117902	0.410864	0	0	0.00
Energy Star Transformers	2.25	25.0	0	0.094882	0.213750	0	0	0.00
Base Other Process	0.00	15.0	0	N/A	0.000000	0	0	0.00
Other Process Controls (batch + site)	0.77	10.0	0	0.150039	0.116190	0	0	0.00

Table C.7 Measure Electric Results of Basic Metals Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Efficient desalter	1.27	10.0	0	0.150039	0.190130	0	0	0.00
New transformers welding	1.62	15.0	0	0.117902	0.190907	0	0	0.00
Efficient processes (welding, etc.)	1.62	15.0	0	0.117902	0.190907	0	0	0.00
Process control	0.53	15.0	0	0.117902	0.062252	0	0	0.00
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Energy Star Transformers	2.25	25.0	0	0.094882	0.213750	0	0	0.00
Base Centrifugal Chiller, 0.58 kW/ton, 500 tons	0.00	20.0	0	N/A	0.000000	0	0	0.00
Centrifugal Chiller, 0.51 kW/ton, 500 tons	0.96	20.0	8478000	0.102992	0.098872	10183966	2323487	4.38
Window Film - Chiller	1.60	10.0	2649375	0.150039	0.240063	3182489	1210150	2.63
EMS - Chiller	2.56	10.0	4450950	0.150039	0.384101	5346582	3252882	1.64
Cool Roof - Chiller	4.48	10.0	2084175	0.150039	0.672176	2503558	2665556	0.94
Chiller Tune Up/Diagnostics	1.60	10.0	706500	0.150039	0.240063	848664	322707	2.63
Cooling Circ. Pumps - VSD	2.88	15.0	2384437.5	0.117902	0.339557	2864240	1960442	1.46
Energy Star Transformers	1.92	25.0	113040	0.094882	0.182173	135786	61960	2.19
Base DX Packaged System, EER=10.3, 10 tons	0.00	15.0	0	N/A	0.000000	0	0	0.00
DX Tune Up/ Advanced Diagnostics	1.92	3.0	5298750	0.389084	0.747042	6364979	2904359	2.19
DX Packaged System, EER=10.9, 10 tons	1.28	15.0	8478000	0.117902	0.150914	10183966	3097983	3.29
Window Film - DX	0.96	10.0	3285225	0.150039	0.144038	3946287	900351	4.38
Evaporative Pre-Cooler	7.36	10.0	3355875	0.150039	1.104290	4031153	7051138	0.57
Prog. Thermostat - DX	0.64	10.0	4768875	0.150039	0.096025	5728481	871308	6.57
Cool Roof - DX	2.56	10.0	4309650	0.150039	0.384101	5176849	3149616	1.64
Energy Star Transformers	1.92	25.0	226080	0.094882	0.182173	271572	123919	2.19
Base Lighting	0.00	10.0	0	N/A	0.000000	0	0	0.00
RET 2L4' Premium T8, 1EB	4.16	15.0	50303365.2	0.117902	0.490471	60425544	59740106	1.01
CFL Hardwired, Modular 36W	4.16	4.0	31863715.2	0.302929	1.260187	38275418	37841240	1.01

Table C.7 Measure Electric Results of Basic Metals Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Metal Halide, 50W	23.68	5.0	2868390	0.251447	5.954275	3445575	19390791	0.18
Occupancy Sensor, 4L4' Fluorescent Fixtures	1.60	9.0	9043200	0.161080	0.257727	10862897	4130644	2.63
Energy Star Transformers	1.92	25.0	452160	0.094882	0.182173	543145	247839	2.19
Base Other	0.00	15.0	0	N/A	0.000000	0	0	0.00
Replace V-belts	0.00	5.0	0	0.251447	0.000000	0	0	0.00
Membranes for wastewater	1.13	15.0	0	0.117902	0.132805	0	0	0.00
Energy Star Transformers	2.25	25.0	113040	0.094882	0.213750	135786	72699	1.87

Table C.8 Measure Electric Results of Basic Fabricated Metals Industry

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Base Compressed Air	0.00	14.5	0	N/A	0.000000	0	0	0.00
Compressed Air - O&M	0.32	10.0	273052859	0.150039	0.047532	327997290	24694914	13.28
Compressed Air - Controls	0.56	10.0	64247732	0.150039	0.084502	77175833	10329899	7.47
Compressed Air - System Optimization	0.53	10.0	214159105	0.150039	0.079221	257252777	32280934	7.97
Compressed Air- Sizing	0.14	10.0	77097278	0.150039	0.021126	92611000	3098970	29.88
Comp Air - Replace 1-5 HP motor	1.69	14.5	5589553	0.120044	0.202826	6714297	2696104	2.49
Comp Air - ASD (1-5 hp)	2.46	14.5	6424773	0.120044	0.295788	7717583	4519331	1.71
Comp Air - Motor practices-1 (1-5 HP)	0.67	14.5	5353978	0.120044	0.080285	6431319	1022230	6.29
Comp Air - Replace 6-100 HP motor	0.95	10.0	19120125	0.150039	0.142597	22967528	5187675	4.43
Comp Air - ASD (6-100 hp)	0.07	10.0	46258367	0.150039	0.010563	55566600	929691	59.77
Comp Air - Motor practices-1 (6-100 HP)	0.18	10.0	15419456	0.150039	0.026407	18522200	774742	23.91
Comp Air - Replace 100+ HP motor	0.28	6.0	14404341	0.217301	0.061192	17302822	1157982	14.94
Comp Air - ASD (100+ hp)	0.18	6.0	75812323	0.217301	0.038245	91067483	3809150	23.91
Comp Air - Motor practices-1 (100+ HP)	0.07	6.0	25270774	0.217301	0.015298	30355828	507887	59.77
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Energy Star Transformers	2.25	25.0	3426546	0.094882	0.213750	4116044	2203712	1.87
Base Fans	0.00	14.5	0	N/A	0.000000	0	0	0.00
Fans - O&M	0.04	10.0	8821368	0.150039	0.005281	10596427	88645	119.54
Fans - Controls	2.96	10.0	66160259	0.150039	0.443636	79473205	55846347	1.42
Fans - System Optimization	1.94	10.0	27787309	0.150039	0.290476	33378746	15357745	2.17
Fans- Improve components	0.18	10.0	8821368	0.150039	0.026407	10596427	443225	23.91
Fans - Replace 1-5 HP motor	1.69	14.5	2302377	0.120044	0.202826	2765668	1110544	2.49
Fans - ASD (1-5 hp)	2.46	14.5	2646410	0.120044	0.295788	3178928	1861545	1.71
Fans - Motor practices-1 (1-5 HP)	0.67	14.5	2205342	0.120044	0.080285	2649107	421064	6.29

Table C.8 Measure Electric Results of Basic Fabricated Metals Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Fans - Replace 6-100 HP motor	0.95	10.0	7875717	0.150039	0.142597	9460490	2136841	4.43
Fans - ASD (6-100 hp)	0.07	10.0	19054155	0.150039	0.010563	22888283	382946	59.77
Fans - Motor practices-1 (6-100 HP)	0.18	10.0	6351385	0.150039	0.026407	7629428	319122	23.91
Fans - Replace 100+ HP motor	0.28	6.0	5933252	0.217301	0.061192	7127157	476981	14.94
Fans - ASD (100+ hp)	0.18	6.0	31227642	0.217301	0.038245	37511353	1569016	23.91
Fans - Motor practices-1 (100+ HP)	0.07	6.0	10409214	0.217301	0.015298	12503784	209202	59.77
Optimize drying process	1.62	10.0	0	0.150039	0.242944	0	0	0.00
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Energy Star Transformers	2.25	25.0	1411419	0.094882	0.213750	1695428	907725	1.87
Base Pumps	0.00	14.5	0	N/A	0.000000	0	0	0.00
Pumps - O&M	0.18	10.0	45712754	0.150039	0.026407	54911198	2296813	23.91
Pumps - Controls	0.88	10.0	119995980	0.150039	0.132035	144141894	30145673	4.78
Pumps - System Optimization	2.11	10.0	113139067	0.150039	0.316883	135905215	68215352	1.99
Pumps - Sizing	0.63	10.0	45712754	0.150039	0.095065	54911198	8268528	6.64
Pumps - Replace 1-5 HP motor	1.69	14.5	2982757	0.120044	0.202826	3582956	1438724	2.49
Pumps - ASD (1-5 hp)	2.46	14.5	3428457	0.120044	0.295788	4118340	2411654	1.71
Pumps - Motor practices-1 (1-5 HP)	0.67	14.5	2857047	0.120044	0.080285	3431950	545493	6.29
Pumps - Replace 6-100 HP motor	0.95	10.0	10203087	0.150039	0.142597	12256179	2768303	4.43
Pumps - ASD (6-100 hp)	0.07	10.0	24684887	0.150039	0.010563	29652047	496112	59.77
Pumps - Motor practices-1 (6-100 HP)	0.18	10.0	8228296	0.150039	0.026407	9884016	413426	23.91
Pumps - Replace 100+ HP motor	0.28	6.0	7686600	0.217301	0.061192	9233318	617935	14.94
Pumps - ASD (100+ hp)	0.18	6.0	40455788	0.217301	0.038245	48596410	2032680	23.91
Pumps - Motor practices-1 (100+ HP)	0.07	6.0	13485263	0.217301	0.015298	16198803	271024	59.77
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00

Table C.8 Measure Electric Results of Basic Fabricated Metals Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Energy Star Transformers	2.25	25.0	1828510	0.094882	0.213750	2196448	1175968	1.87
Base Drives	0.00	20.0	0	N/A	0.000000	0	0	0.00
Bakery - Process (Mixing) - O&M	0.18	10.0	0	0.150039	0.026407	0	0	0.00
O&M/drives spinning machines	1.02	10.0	0	0.150039	0.153160	0	0	0.00
Air conveying systems	1.23	14.0	0	0.122356	0.150742	0	0	0.00
Replace V-Belts	0.18	10.0	0	0.150039	0.026407	0	0	0.00
Drives - EE motor	0.21	10.0	0	0.150039	0.031688	0	0	0.00
Gap Forming papermachine	0.25	20.0	0	0.102992	0.025377	0	0	0.00
High Consistency forming	0.25	20.0	0	0.102992	0.025377	0	0	0.00
Optimization control PM	0.39	10.0	0	0.150039	0.058095	0	0	0.00
Efficient practices printing press	0.32	20.0	0	0.102992	0.032628	0	0	0.00
Efficient Printing press (fewer cylinders)	1.94	10.0	0	0.150039	0.290476	0	0	0.00
Light cylinders	2.25	10.0	0	0.150039	0.338009	0	0	0.00
Efficient drives	0.18	10.0	0	0.150039	0.026407	0	0	0.00
Clean Room - Controls	0.70	10.0	3782521	0.150039	0.105628	4543650	760203	5.98
Clean Room - New Designs	4.22	10.0	0	0.150039	0.633766	0	0	0.00
Drives - Process Controls (batch + site)	0.77	10.0	0	0.150039	0.116190	0	0	0.00
Process Drives - ASD	0.07	10.0	0	0.150039	0.010563	0	0	0.00
O&M - Extruders/Injection Moulding	0.18	12.0	0	0.133728	0.023536	0	0	0.00
Extruders/injection Moulding-multipump	3.17	12.0	0	0.133728	0.423651	0	0	0.00
Direct drive Extruders	9.86	12.0	0	0.133728	1.318024	0	0	0.00
Injection Moulding - Impulse Cooling	2.22	12.0	0	0.133728	0.296556	0	0	0.00
Injection Moulding - Direct drive	3.10	12.0	0	0.133728	0.414236	0	0	0.00
Efficient grinding	7.39	15.0	0	0.117902	0.871530	0	0	0.00
Process control	0.07	10.0	0	0.150039	0.010563	0	0	0.00
Process optimization	0.95	10.0	0	0.150039	0.142597	0	0	0.00

Table C.8 Measure Electric Results of Basic Fabricated Metals Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Drives - Process Control	0.49	15.0	0	0.117902	0.058102	0	0	0.00
Efficient drives - rolling	0.28	10.0	0	0.150039	0.042251	0	0	0.00
Drives - Optimization process (M&T)	0.25	10.0	16982210	0.150039	0.036970	20399416	1194567	17.08
Drives - Scheduling	0.32	10.0	14308786	0.150039	0.047532	17188038	1294087	13.28
Machinery	0.39	10.0	19768463	0.150039	0.058095	23746326	2185163	10.87
Efficient Machinery	0.21	10.0	0	0.150039	0.031688	0	0	0.00
Energy Star Transformers	2.25	25.0	3815676	0.094882	0.213750	4583477	2453973	1.87
Base Heating	0.00	20.0	0	N/A	0.000000	0	0	0.00
Bakery - Process	1.62	15.0	0	0.117902	0.190907	0	0	0.00
Drying (UV/IR)	2.39	8.0	0	0.175007	0.418896	0	0	0.00
Heat Pumps - Drying	5.63	15.0	0	0.117902	0.664023	0	0	0.00
Top-heating (glass)	0.14	8.0	0	0.175007	0.024641	0	0	0.00
Efficient electric melting	1.06	20.0	0	0.102992	0.108759	0	0	0.00
Intelligent extruder (DOE)	0.53	10.0	0	0.150039	0.079221	0	0	0.00
Near Net Shape Casting	0.39	15.0	0	0.117902	0.045652	0	0	0.00
Heating - Process Control	0.49	15.0	0	0.117902	0.058102	0	0	0.00
Efficient Curing ovens	2.57	15.0	56952625	0.117902	0.302960	68412786	41778697	1.64
Heating - Optimization process (M&T)	0.25	10.0	9363647	0.150039	0.036970	11247825	658660	17.08
Heating - Scheduling	0.32	10.0	570050	0.150039	0.047532	684757	51555	13.28
Energy Star Transformers	2.25	25.0	3421817	0.094882	0.213750	4110365	2200671	1.87
Base Refrigeration	0.00	20.0	0	N/A	0.000000	0	0	0.00
Efficient Refrigeration - Operations	0.25	10.0	0	0.150039	0.036970	0	0	0.00
Optimization Refrigeration	3.48	15.0	0	0.117902	0.410864	0	0	0.00
Energy Star Transformers	2.25	25.0	0	0.094882	0.213750	0	0	0.00
Base Other Process	0.00	15.0	0	N/A	0.000000	0	0	0.00
Other Process Controls (batch + site)	0.77	10.0	0	0.150039	0.116190	0	0	0.00

Table C.8 Measure Electric Results of Basic Fabricated Metals Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Efficient desalter	1.27	10.0	0	0.150039	0.190130	0	0	0.00
New transformers welding	1.62	15.0	21431048	0.117902	0.190907	25743461	9906483	2.60
Efficient processes (welding, etc.)	1.62	15.0	10134103	0.117902	0.190907	12173315	4684480	2.60
Process control	0.53	15.0	0	0.117902	0.062252	0	0	0.00
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Energy Star Transformers	2.25	25.0	1122340	0.094882	0.213750	1348181	721810	1.87
Base Centrifugal Chiller, 0.58 kW/ton, 500 tons	0.00	20.0	0	N/A	0.000000	0	0	0.00
Centrifugal Chiller, 0.51 kW/ton, 500 tons	0.96	20.0	84060896.71	0.102992	0.098872	100975856	23037793	4.38
Window Film - Chiller	1.60	10.0	26269030.22	0.150039	0.240063	31554955	11998851	2.63
EMS - Chiller	2.56	10.0	44131970.77	0.150039	0.384101	53012325	32252910	1.64
Cool Roof - Chiller	4.48	10.0	20664970.44	0.150039	0.672176	24823231	26429468	0.94
Chiller Tune Up/Diagnostics	1.60	10.0	7005074.726	0.150039	0.240063	8414655	3199693	2.63
Cooling Circ. Pumps - VSD	2.88	15.0	23642127.2	0.117902	0.339557	28399460	19438138	1.46
Energy Star Transformers	1.92	25.0	1120811.956	0.094882	0.182173	1346345	614341	2.19
Base DX Packaged System, EER=10.3, 10 tons	0.00	15.0	0	N/A	0.000000	0	0	0.00
DX Tune Up/ Advanced Diagnostics	1.92	3.0	51102710.63	0.389084	0.747042	61385736	28010495	2.19
DX Packaged System, EER=10.9, 10 tons	1.28	15.0	81764337	0.117902	0.150914	98217177	29877861	3.29
Window Film - DX	0.96	10.0	31683680.59	0.150039	0.144038	38059156	8683253	4.38
Evaporative Pre-Cooler	7.36	10.0	32365050.06	0.150039	1.104290	38877632	68003258	0.57
Prog. Thermostat - DX	0.64	10.0	45992439.56	0.150039	0.096025	55247162	8403149	6.57
Cool Roof - DX	2.56	10.0	41563537.98	0.150039	0.384101	49927065	30375826	1.64
Energy Star Transformers	1.92	25.0	2180382.32	0.094882	0.182173	2619125	1195114	2.19
Base Lighting	0.00	10.0	0	N/A	0.000000	0	0	0.00
RET 2L4' Premium T8, 1EB	4.16	15.0	555398707.7	0.117902	0.490471	667157530	659589624	1.01
CFL Hardwired, Modular 36W	4.16	4.0	86342295.43	0.302929	1.260187	103716324	102539818	1.01

Table C.8 Measure Electric Results of Basic Fabricated Metals Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Metal Halide, 50W	23.68	5.0	5205687.916	0.251447	5.954275	6253190	35191311	0.18
Occupancy Sensor, 4L4' Fluorescent Fixtures	1.60	9.0	77551059.68	0.161080	0.257727	93156093	35422837	2.63
Energy Star Transformers	1.92	25.0	3877552.984	0.094882	0.182173	4657805	2125370	2.19
Base Other	0.00	15.0	0	N/A	0.000000	0	0	0.00
Replace V-belts	0.00	5.0	0	0.251447	0.000000	0	0	0.00
Membranes for wastewater	1.13	15.0	0	0.117902	0.132805	0	0	0.00
Energy Star Transformers	2.25	25.0	1736027	0.094882	0.213750	2085355	1116490	1.87

Table C.9 Measure Electric Results of Basic Other Industry

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Base Compressed Air	0.00	14.5	0	N/A	0.000000	0	0	0.00
Compressed Air - O&M	0.32	10.0	14519700	0.150039	0.047532	17441393	1313162	13.28
Compressed Air - Controls	0.56	10.0	3416400	0.150039	0.084502	4103857	549297	7.47
Compressed Air - System Optimization	0.53	10.0	11388000	0.150039	0.079221	13679524	1716552	7.97
Compressed Air- Sizing	0.14	10.0	4099680	0.150039	0.021126	4924629	164789	29.88
Comp Air - Replace 1-5 HP motor	1.69	14.5	297227	0.120044	0.202826	357036	143366	2.49
Comp Air - ASD (1-5 hp)	2.46	14.5	341640	0.120044	0.295788	410386	240317	1.71
Comp Air - Motor practices-1 (1-5 HP)	0.67	14.5	284700	0.120044	0.080285	341988	54357	6.29
Comp Air - Replace 6-100 HP motor	0.95	10.0	1016721	0.150039	0.142597	1221308	275857	4.43
Comp Air - ASD (6-100 hp)	0.07	10.0	2459808	0.150039	0.010563	2954777	49437	59.77
Comp Air - Motor practices-1 (6-100 HP)	0.18	10.0	819936	0.150039	0.026407	984926	41197	23.91
Comp Air - Replace 100+ HP motor	0.28	6.0	765957	0.217301	0.061192	920085	61576	14.94
Comp Air - ASD (100+ hp)	0.18	6.0	4031352	0.217301	0.038245	4842551	202553	23.91
Comp Air - Motor practices-1 (100+ HP)	0.07	6.0	1343784	0.217301	0.015298	1614184	27007	59.77
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Energy Star Transformers	2.25	25.0	182208	0.094882	0.213750	218872	117183	1.87
Base Fans	0.00	14.5	0	N/A	0.000000	0	0	0.00
Fans - O&M	0.04	10.0	379600	0.150039	0.005281	455984	3815	119.54
Fans - Controls	2.96	10.0	2847000	0.150039	0.443636	3419881	2403173	1.42
Fans - System Optimization	1.94	10.0	1195740	0.150039	0.290476	1436350	660873	2.17
Fans- Improve components	0.18	10.0	379600	0.150039	0.026407	455984	19073	23.91
Fans - Replace 1-5 HP motor	1.69	14.5	99076	0.120044	0.202826	119012	47789	2.49
Fans - ASD (1-5 hp)	2.46	14.5	113880	0.120044	0.295788	136795	80106	1.71
Fans - Motor practices-1 (1-5 HP)	0.67	14.5	94900	0.120044	0.080285	113996	18119	6.29

Table C.9 Measure Electric Results of Basic Other Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Fans - Replace 6-100 HP motor	0.95	10.0	338907	0.150039	0.142597	407103	91952	4.43
Fans - ASD (6-100 hp)	0.07	10.0	819936	0.150039	0.010563	984926	16479	59.77
Fans - Motor practices-1 (6-100 HP)	0.18	10.0	273312	0.150039	0.026407	328309	13732	23.91
Fans - Replace 100+ HP motor	0.28	6.0	255319	0.217301	0.061192	306695	20525	14.94
Fans - ASD (100+ hp)	0.18	6.0	1343784	0.217301	0.038245	1614184	67518	23.91
Fans - Motor practices-1 (100+ HP)	0.07	6.0	447928	0.217301	0.015298	538061	9002	59.77
Optimize drying process	1.62	10.0	0	0.150039	0.242944	0	0	0.00
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Energy Star Transformers	2.25	25.0	60736	0.094882	0.213750	72957	39061	1.87
Base Pumps	0.00	14.5	0	N/A	0.000000	0	0	0.00
Pumps - O&M	0.18	10.0	1898000	0.150039	0.026407	2279921	95364	23.91
Pumps - Controls	0.88	10.0	4982250	0.150039	0.132035	5984792	1251653	4.78
Pumps - System Optimization	2.11	10.0	4697550	0.150039	0.316883	5642804	2832311	1.99
Pumps - Sizing	0.63	10.0	1898000	0.150039	0.095065	2279921	343310	6.64
Pumps - Replace 1-5 HP motor	1.69	14.5	123845	0.120044	0.202826	148765	59736	2.49
Pumps - ASD (1-5 hp)	2.46	14.5	142350	0.120044	0.295788	170994	100132	1.71
Pumps - Motor practices-1 (1-5 HP)	0.67	14.5	118625	0.120044	0.080285	142495	22649	6.29
Pumps - Replace 6-100 HP motor	0.95	10.0	423634	0.150039	0.142597	508878	114940	4.43
Pumps - ASD (6-100 hp)	0.07	10.0	1024920	0.150039	0.010563	1231157	20599	59.77
Pumps - Motor practices-1 (6-100 HP)	0.18	10.0	341640	0.150039	0.026407	410386	17166	23.91
Pumps - Replace 100+ HP motor	0.28	6.0	319149	0.217301	0.061192	383369	25657	14.94
Pumps - ASD (100+ hp)	0.18	6.0	1679730	0.217301	0.038245	2017730	84397	23.91
Pumps - Motor practices-1 (100+ HP)	0.07	6.0	559910	0.217301	0.015298	672577	11253	59.77
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00

Table C.9 Measure Electric Results of Basic Other Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Energy Star Transformers	2.25	25.0	75920	0.094882	0.213750	91197	48826	1.87
Base Drives	0.00	20.0	0	N/A	0.000000	0	0	0.00
Bakery - Process (Mixing) - O&M	0.18	10.0	0	0.150039	0.026407	0	0	0.00
O&M/drives spinning machines	1.02	10.0	0	0.150039	0.153160	0	0	0.00
Air conveying systems	1.23	14.0	0	0.122356	0.150742	0	0	0.00
Replace V-Belts	0.18	10.0	0	0.150039	0.026407	0	0	0.00
Drives - EE motor	0.21	10.0	0	0.150039	0.031688	0	0	0.00
Gap Forming papermachine	0.25	20.0	0	0.102992	0.025377	0	0	0.00
High Consistency forming	0.25	20.0	0	0.102992	0.025377	0	0	0.00
Optimization control PM	0.39	10.0	0	0.150039	0.058095	0	0	0.00
Efficient practices printing press	0.32	20.0	0	0.102992	0.032628	0	0	0.00
Efficient Printing press (fewer cylinders)	1.94	10.0	0	0.150039	0.290476	0	0	0.00
Light cylinders	2.25	10.0	0	0.150039	0.338009	0	0	0.00
Efficient drives	0.18	10.0	0	0.150039	0.026407	0	0	0.00
Clean Room - Controls	0.70	10.0	0	0.150039	0.105628	0	0	0.00
Clean Room - New Designs	4.22	10.0	0	0.150039	0.633766	0	0	0.00
Drives - Process Controls (batch + site)	0.77	10.0	0	0.150039	0.116190	0	0	0.00
Process Drives - ASD	0.07	10.0	379600	0.150039	0.010563	455984	7629	59.77
O&M - Extruders/Injection Moulding	0.18	12.0	0	0.133728	0.023536	0	0	0.00
Extruders/injection Moulding-multipump	3.17	12.0	0	0.133728	0.423651	0	0	0.00
Direct drive Extruders	9.86	12.0	0	0.133728	1.318024	0	0	0.00
Injection Moulding - Impulse Cooling	2.22	12.0	0	0.133728	0.296556	0	0	0.00
Injection Moulding - Direct drive	3.10	12.0	0	0.133728	0.414236	0	0	0.00
Efficient grinding	7.39	15.0	0	0.117902	0.871530	0	0	0.00
Process control	0.07	10.0	0	0.150039	0.010563	0	0	0.00
Process optimization	0.95	10.0	0	0.150039	0.142597	0	0	0.00

Table C.9 Measure Electric Results of Basic Other Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Drives - Process Control	0.49	15.0	0	0.117902	0.058102	0	0	0.00
Efficient drives - rolling	0.28	10.0	0	0.150039	0.042251	0	0	0.00
Drives - Optimization process (M&T)	0.25	10.0	0	0.150039	0.036970	0	0	0.00
Drives - Scheduling	0.32	10.0	1138800	0.150039	0.047532	1367952	102993	13.28
Machinery	0.39	10.0	0	0.150039	0.058095	0	0	0.00
Efficient Machinery	0.21	10.0	0	0.150039	0.031688	0	0	0.00
Energy Star Transformers	2.25	25.0	303680	0.094882	0.213750	364787	195305	1.87
Base Heating	0.00	20.0	0	N/A	0.000000	0	0	0.00
Bakery - Process	1.62	15.0	0	0.117902	0.190907	0	0	0.00
Drying (UV/IR)	2.39	8.0	0	0.175007	0.418896	0	0	0.00
Heat Pumps - Drying	5.63	15.0	0	0.117902	0.664023	0	0	0.00
Top-heating (glass)	0.14	8.0	0	0.175007	0.024641	0	0	0.00
Efficient electric melting	1.06	20.0	0	0.102992	0.108759	0	0	0.00
Intelligent extruder (DOE)	0.53	10.0	0	0.150039	0.079221	0	0	0.00
Near Net Shape Casting	0.39	15.0	0	0.117902	0.045652	0	0	0.00
Heating - Process Control	0.49	15.0	0	0.117902	0.058102	0	0	0.00
Efficient Curing ovens	2.57	15.0	2609750	0.117902	0.302960	3134891	1914432	1.64
Heating - Optimization process (M&T)	0.25	10.0	0	0.150039	0.036970	0	0	0.00
Heating - Scheduling	0.32	10.0	0	0.150039	0.047532	0	0	0.00
Energy Star Transformers	2.25	25.0	167024	0.094882	0.213750	200633	107418	1.87
Base Refrigeration	0.00	20.0	0	N/A	0.000000	0	0	0.00
Efficient Refrigeration - Operations	0.25	10.0	0	0.150039	0.036970	0	0	0.00
Optimization Refrigeration	3.48	15.0	0	0.117902	0.410864	0	0	0.00
Energy Star Transformers	2.25	25.0	0	0.094882	0.213750	0	0	0.00
Base Other Process	0.00	15.0	0	N/A	0.000000	0	0	0.00
Other Process Controls (batch + site)	0.77	10.0	0	0.150039	0.116190	0	0	0.00

Table C.9 Measure Electric Results of Basic Other Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Efficient desalter	1.27	10.0	0	0.150039	0.190130	0	0	0.00
New transformers welding	1.62	15.0	0	0.117902	0.190907	0	0	0.00
Efficient processes (welding, etc.)	1.62	15.0	0	0.117902	0.190907	0	0	0.00
Process control	0.53	15.0	94900	0.117902	0.062252	113996	14305	7.97
Power recovery	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Refinery Controls	0.11	10.0	0	0.150039	0.015844	0	0	0.00
Energy Star Transformers	2.25	25.0	15184	0.094882	0.213750	18239	9765	1.87
Base Centrifugal Chiller, 0.58 kW/ton, 500 tons	0.00	20.0	0	N/A	0.000000	0	0	0.00
Centrifugal Chiller, 0.51 kW/ton, 500 tons	0.96	20.0	5694000	0.102992	0.098872	6839762	1560502	4.38
Window Film - Chiller	1.60	10.0	1779375	0.150039	0.240063	2137426	812761	2.63
EMS - Chiller	2.56	10.0	2989350	0.150039	0.384101	3590875	2184703	1.64
Cool Roof - Chiller	4.48	10.0	1399775	0.150039	0.672176	1681441	1790243	0.94
Chiller Tune Up/Diagnostics	1.60	10.0	474500	0.150039	0.240063	569980	216736	2.63
Cooling Circ. Pumps - VSD	2.88	15.0	1601438	0.117902	0.339557	1923683	1316674	1.46
Energy Star Transformers	1.92	25.0	75920	0.094882	0.182173	91197	41613	2.19
Base DX Packaged System, EER=10.3, 10 tons	0.00	15.0	0	N/A	0.000000	0	0	0.00
DX Tune Up/ Advanced Diagnostics	1.92	3.0	4270500	0.389084	0.747042	5129821	2340753	2.19
DX Packaged System, EER=10.9, 10 tons	1.28	15.0	6832800	0.117902	0.150914	8207714	2496803	3.29
Window Film - DX	0.96	10.0	2647710	0.150039	0.144038	3180489	725633	4.38
Evaporative Pre-Cooler	7.36	10.0	2704650	0.150039	1.104290	3248887	5682828	0.57
Prog. Thermostat - DX	0.64	10.0	3843450	0.150039	0.096025	4616839	702226	6.57
Cool Roof - DX	2.56	10.0	3473340	0.150039	0.384101	4172255	2538417	1.64
Energy Star Transformers	1.92	25.0	182208	0.094882	0.182173	218872	99872	2.19
Base Lighting	0.00	10.0	0	N/A	0.000000	0	0	0.00
RET 2L4' Premium T8, 1EB	4.16	15.0	36771396	0.117902	0.490471	44170636	43669586	1.01
CFL Hardwired, Modular 36W	4.16	4.0	3804503	0.302929	1.260187	4570055	4518215	1.01

Table C.9 Measure Electric Results of Basic Other Industry (cont')

Measure	Full Unit Cost Baht/kWh	Saving Life (year)	Technical Potential kWh	Capital Recovery Rate	Levelized Cost Baht/kWh	Benefits Baht	Costs Baht	Benefit-to-Cost Ratio
Metal Halide, 50W	23.68	5.0	0	0.251447	5.954275	0	0	0.00
Occupancy Sensor, 4L4' Fluorescent Fixtures	1.60	9.0	4858880	0.161080	0.257727	5836597	2219381	2.63
Energy Star Transformers	1.92	25.0	242944	0.094882	0.182173	291830	133163	2.19
Base Other	0.00	15.0	0	N/A	0.000000	0	0	0.00
Replace V-belts	0.00	5.0	0	0.251447	0.000000	0	0	0.00
Membranes for wastewater	1.13	15.0	0	0.117902	0.132805	0	0	0.00
Energy Star Transformers	2.25	25.0	121472	0.094882	0.213750	145915	78122	1.87

Appendix D: Supply Curve Data

Table D.1 Aggregated Measure Values for Electric Energy-Efficiency Supply Curves in Food and Beverages Ranked by Their Levelized Cost, 2013

No.	Measure	Economic Potential GWh	Cumulative Electricity Saving GWh	Levelized Cost (Baht/kWh)
1	Fans - Operation & Maintenance	13.42	13	0.0053
2	Installing ASD for Comp. Air, Fans, and Pumps (6-100 hp)	104.32	118	0.0106
3	Motor practices for Comp. Air, Fans, and Pumps (100+ hp)	56.99	175	0.0153
4	Compressed Air- Sizing	43.47	218	0.0211
5	Motor practices for Comp. Air, Fans, and Pumps (6-100 hp)	34.77	253	0.0264
6	Bakery - Process (Mixing) - Operation & Maintenance	28.17	281	0.0264
7	Fans- Improve components	13.42	295	0.0264
8	Pumps - Operation & Maintenance	91.23	386	0.0264
9	Efficient Refrigeration - Operations	92.09	478	0.0370
10	Installing ASD for Comp. Air, Fans, and Pumps (100+ hp)	170.97	649	0.0382
11	Compressed Air - Operation & Maintenance	153.95	803	0.0475
12	Replace HP Mpotors for Comp. Air, Fans, and Pumps (100+ hp)	32.48	835	0.0612
13	Compressed Air - System Optimization	120.74	956	0.0792
14	Motor practices for Comp. Air, Fans, and Pumps (1-5 hp)	12.07	968	0.0803
15	Compressed Air - Controls	36.22	1004	0.0845
16	Pumps - Sizing	91.23	1096	0.0951
17	Centrifugal Chiller, 0.51 kW/ton, 500 tons	32.20	1128	0.0989
18	Pumps - Controls	239.48	1367	0.1320
19	Replace HP Mpotors for Comp. Air, Fans, and Pumps (6-100 hp)	43.12	1410	0.1426
20	Bakery - Process	119.13	1529	0.1909
21	Replace HP Mpotors for Comp. Air, Fans, and Pumps (1-5 hp)	12.61	1542	0.2028
22	Fans - System Optimization	42.26	1584	0.2905
23	Installing ASD for Comp. Air, Fans, and Pumps (1-5 hp)	14.49	1599	0.2958
24	Pumps - System Optimization	225.79	1825	0.3169
25	Optimization Refrigeration	136.04	1961	0.4109
26	Fans - Controls	100.62	2061	0.4436
27	RET 2L4' Premium T8, 1EB	196.92	2258	0.4905
28	CFL Hardwired, Modular 36W	66.67	2325	1.2602

Table D.2 Aggregated Measure Values for Electric Energy-Efficiency Supply Curves in Textiles Ranked by Their Levelized Cost, 2013

No.	Measure	Economic Potential GWh	Cumulative Electricity Saving GWh	Levelized Cost (Baht/kWh)
1	Fans - O&M	5.53	6	0.0052
2	Installing ASD for Comp. Air, Fans, and Pumps (6-100 hp)	32.83	38	0.0105
3	Motor practices for Comp. Air, Fans, and Pumps (100+ hp)	17.94	56	0.0152
4	Compressed Air- Sizing	9.95	66	0.0210
5	Motor practices for Comp. Air, Fans, and Pumps (6-100 hp)	10.94	77	0.0262
6	Fans- Improve components	5.53	83	0.0262
7	Pumps - O&M	27.64	110	0.0262
8	Installing ASD for Comp. Air, Fans, and Pumps (100+ hp)	53.81	164	0.0381
9	Compressed Air - O&M	35.24	199	0.0472
10	Replace HP Mpotors for Comp. Air, Fans, and Pumps (100+ hp)	10.22	210	0.0609
11	Compressed Air - System Optimization	27.64	237	0.0787
12	Motor practices for Comp. Air, Fans, and Pumps (1-5 hp)	3.80	241	0.0796
13	Compressed Air - Controls	8.29	249	0.0839
14	Pumps - Sizing	27.64	277	0.0944
15	Centrifugal Chiller, 0.51 kW/ton, 500 tons	49.74	327	0.0978
16	Pumps - Controls	72.54	399	0.1311
17	Membranes for wastewater	2.10	401	0.1316
18	Replace HP Mpotors for Comp. Air, Fans, and Pumps (6-100 hp)	13.57	415	0.1416
19	O&M/drives spinning machines	95.51	510	0.1521
20	Replace HP Mpotors for Comp. Air, Fans, and Pumps (1-5 hp)	3.97	514	0.2010
21	Fans - System Optimization	17.41	532	0.2885
22	Installing ASD for Comp. Air, Fans, and Pumps (1-5 hp)	4.56	536	0.2932
23	Pumps - System Optimization	68.40	605	0.3148
24	Drying (UV/IR)	17.96	623	0.4165
25	Fans - Controls	41.45	664	0.4407
26	RET 2L4' Premium T8, 1EB	136.30	801	0.4860
27	CFL Hardwired, Modular 36W	23.08	824	1.2560

Table D.3 Aggregated Measure Values for Electric Energy-Efficiency Supply Curves in Wood and Furniture Ranked by Their Levelized Cost, 2013

No.	Measure	Economic Potential GWh	Cumulative Electricity Saving GWh	Levelized Cost (Baht/kWh)
1	Fans - O&M	2	2	0.0053
2	Installing ASD for Comp. Air, Fans, and Pumps (6-100 hp)	11	13	0.0106
3	Motor practices for Comp. Air, Fans, and Pumps (100+ hp)	6	20	0.0153
4	Compressed Air- Sizing	3	23	0.0211
5	Motor practices for Comp. Air, Fans, and Pumps (6-100 hp)	4	27	0.0264
6	Pumps - O&M	10	36	0.0264
7	Fans- Improve components	2	38	0.0264
8	Replace V-Belts	19	57	0.0264
9	Drives - EE motor	14	71	0.0317
10	Installing ASD for Comp. Air, Fans, and Pumps (100+ hp)	19	90	0.0382
11	Compressed Air - O&M	12	102	0.0475
12	Replace HP Mpotors for Comp. Air, Fans, and Pumps (100+ hp)	4	105	0.0612
13	Compressed Air - System Optimization	9	115	0.0792
14	Motor practices for Comp. Air, Fans, and Pumps (1-5 hp)	1	116	0.0803
15	Compressed Air - Controls	3	119	0.0845
16	Pumps - Sizing	10	129	0.0951
17	Centrifugal Chiller, 0.51 kW/ton, 500 tons	5	133	0.0989
18	Pumps - Controls	26	159	0.1320
19	Replace HP Mpotors for Comp. Air, Fans, and Pumps (6-100 hp)	5	164	0.1426
20	Air conveying systems	27	191	0.1507
21	Replace HP Mpotors for Comp. Air, Fans, and Pumps (1-5 hp)	1	192	0.2028
22	Fans - System Optimization	6	198	0.2905
23	Installing ASD for Comp. Air, Fans, and Pumps (1-5 hp)	2	200	0.2958
24	Pumps - System Optimization	24	224	0.3169
25	Fans - Controls	14	238	0.4436
26	RET 2L4' Premium T8, 1EB	26	264	0.4905
27	CFL Hardwired, Modular 36W	4	268	1.2602

Table D.4 Aggregated Measure Values for Electric Energy-Efficiency Supply Curves in Paper Ranked by Their Levelized Cost, 2013

No.	Measure	Economic Potential GWh	Cumulative Electricity Saving GWh	Levelized Cost (Baht/kWh)
1	Fans - O&M	3	3	0.0053
2	Installing ASD for Comp. Air, Fans, and Pumps (6-100 hp)	21	25	0.0106
3	Motor practices for Comp. Air, Fans, and Pumps (100+ hp)	12	36	0.0153
4	Compressed Air- Sizing	3	40	0.0211
5	Gap Forming papermachine	10	49	0.0254
6	High Consistency forming	10	59	0.0254
7	Motor practices for Comp. Air, Fans, and Pumps (6-100 hp)	7	66	0.0264
8	Fans- Improve components	3	69	0.0264
9	Pumps - O&M	22	92	0.0264
10	Drives - EE motor	8	99	0.0317
11	Installing ASD for Comp. Air, Fans, and Pumps (100+ hp)	35	134	0.0382
12	Compressed Air - O&M	12	146	0.0475
13	Optimization control PM	12	158	0.0581
14	Replace HP Mpotors for Comp. Air, Fans, and Pumps (100+ hp)	7	165	0.0612
15	Compressed Air - System Optimization	9	174	0.0792
16	Motor practices for Comp. Air, Fans, and Pumps (1-5 hp)	2	177	0.0803
17	Compressed Air - Controls	3	179	0.0845
18	Pumps - Sizing	22	202	0.0951
19	Centrifugal Chiller, 0.51 kW/ton, 500 tons	8	209	0.0989
20	Pumps - Controls	59	268	0.1320
21	Replace HP Mpotors for Comp. Air, Fans, and Pumps (6-100 hp)	9	277	0.1426
22	Replace HP Mpotors for Comp. Air, Fans, and Pumps (1-5 hp)	3	279	0.2028
23	Fans - System Optimization	11	290	0.2905
24	Installing ASD for Comp. Air, Fans, and Pumps (1-5 hp)	3	293	0.2958
25	Pumps - System Optimization	55	348	0.3169
26	Fans - Controls	25	374	0.4436
27	RET 2L4' Premium T8, 1EB	38	412	0.4905
28	CFL Hardwired, Modular 36W	10	422	1.2602

Table D.5 Aggregated Measure Values for Electric Energy-Efficiency Supply Curves in Chemical Ranked by Their Levelized Cost, 2013

No.	Measure	Economic Potential GWh	Cumulative Electricity Saving GWh	Levelized Cost (Baht/kWh)
1	Fans - O&M	7	7	0.0053
2	Installing ASD for Comp. Air, Fans, and Pumps (6-100 hp)	55	62	0.0106
3	Motor practices for Comp. Air, Fans, and Pumps (100+ hp)	30	92	0.0153
4	Power Recovery and Refinery Control	0	92	0.0158
5	Compressed Air- Sizing	14	106	0.0211
6	Motor practices for Comp. Air, Fans, and Pumps (6-100 hp)	18	125	0.0264
7	Fans- Improve components	7	132	0.0264
8	Pumps - O&M	57	189	0.0264
9	Installing ASD for Comp. Air, Fans, and Pumps (100+ hp)	90	279	0.0382
10	Compressed Air - O&M	51	330	0.0475
11	Replace HP Mpotors for Comp. Air, Fans, and Pumps (100+ hp)	17	347	0.0612
12	Compressed Air - System Optimization	40	387	0.0792
13	Motor practices for Comp. Air, Fans, and Pumps (1-5 hp)	6	394	0.0803
14	Compressed Air - Controls	12	406	0.0845
15	Pumps - Sizing	57	463	0.0951
16	Centrifugal Chiller, 0.51 kW/ton, 500 tons	9	472	0.0989
17	Clean Room - Controls	3	475	0.1056
18	Process Controls (batch + site)	2	476	0.1162
19	Pumps - Controls	150	627	0.1320
20	Replace HP Mpotors for Comp. Air, Fans, and Pumps (6-100 hp)	23	649	0.1426
21	Replace HP Mpotors for Comp. Air, Fans, and Pumps (1-5 hp)	7	656	0.2028
22	Fans - System Optimization	22	678	0.2905
23	Installing ASD for Comp. Air, Fans, and Pumps (1-5 hp)	8	686	0.2958
24	Injection Moulding - Impulse Cooling	48	734	0.2966
25	Pumps - System Optimization	142	876	0.3169
26	Injection Moulding - Direct drive	58	934	0.4142
27	Extruders/injection Moulding-multipump	239	1173	0.4237
28	Fans - Controls	53	1226	0.4436
29	RET 2L4' Premium T8, 1EB	190	1416	0.4905
30	Clean Room - New Designs	2	1418	0.6338
31	CFL Hardwired, Modular 36W	58	1476	1.2602

Table D.6 Aggregated Measure Values for Electric Energy-Efficiency Supply Curves in Non-metallic Ranked by Their Levelized Cost, 2013

No.	Measure	Economic Potential GWh	Cumulative Electricity Saving GWh	Levelized Cost (Baht/kWh)
1	Fans - O&M	10	10	0.0053
2	Process control	9	18	0.0106
3	Installing ASD for Comp. Air, Fans, and Pumps (6-100 hp)	56	74	0.0106
4	Motor practices for Comp. Air, Fans, and Pumps (100+ hp)	31	105	0.0153
5	Compressed Air- Sizing	15	120	0.0211
6	Top-heating (glass)	8	127	0.0246
7	Motor practices for Comp. Air, Fans, and Pumps (6-100 hp)	19	146	0.0264
8	Fans- Improve components	10	142	0.0264
9	Pumps - O&M	49	191	0.0264
10	Drives - EE motor	16	207	0.0317
11	Installing ASD for Comp. Air, Fans, and Pumps (100+ hp)	92	299	0.0382
12	Compressed Air - O&M	52	370	0.0475
13	Replace HP Mpotors for Comp. Air, Fans, and Pumps (100+ hp)	17	387	0.0612
14	Compressed Air - System Optimization	41	428	0.0792
15	Motor practices for Comp. Air, Fans, and Pumps (1-5 hp)	6	434	0.0803
16	Compressed Air - Controls	12	447	0.0845
17	Pumps - Sizing	49	496	0.0951
18	Centrifugal Chiller, 0.51 kW/ton, 500 tons	8	504	0.0989
19	Drives - Process Controls (batch + site)	14	517	0.1162
20	Pumps - Controls	129	646	0.1320
21	Replace HP Mpotors for Comp. Air, Fans, and Pumps (6-100 hp)	23	669	0.1426
22	Process optimization	9	678	0.1426
23	Replace HP Mpotors for Comp. Air, Fans, and Pumps (1-5 hp)	7	685	0.2028
24	Fans - System Optimization	30	715	0.2905
25	Installing ASD for Comp. Air, Fans, and Pumps (1-5 hp)	8	722	0.2958
26	Pumps - System Optimization	121	844	0.3169
27	Fans - Controls	72	915	0.4436
28	RET 2L4' Premium T8, 1EB	58	974	0.4905
29	CFL Hardwired, Modular 36W	28	1002	1.2602

Table D.7 Aggregated Measure Values for Electric Energy-Efficiency Supply Curves in Basic Metal Ranked by Their Levelized Cost, 2013

No.	Measure	Economic Potential GWh	Cumulative Electricity Saving GWh	Levelized Cost (Baht/kWh)
1	Fans - O&M	10	10	0.0053
2	Installing ASD for Comp. Air, Fans, and Pumps (6-100 hp)	58	68	0.0106
3	Motor practices for Comp. Air, Fans, and Pumps (100+ hp)	32	100	0.0153
4	Compressed Air- Sizing	15	115	0.0211
5	Motor practices for Comp. Air, Fans, and Pumps (6-100 hp)	19	134	0.0264
6	Fans- Improve components	10	144	0.0264
7	Pumps - O&M	51	195	0.0264
8	Installing ASD for Comp. Air, Fans, and Pumps (100+ hp)	95	290	0.0382
9	Efficient drives - rolling	45	334	0.0423
10	Near Net Shape Casting	8	343	0.0457
11	Compressed Air - O&M	54	397	0.0475
12	Heating - Process Control	35	432	0.0581
13	Drives - Process Control	37	469	0.0581
14	Replace HP Mpotors for Comp. Air, Fans, and Pumps (100+ hp)	18	487	0.0612
15	Compressed Air - System Optimization	42	530	0.0792
16	Motor practices for Comp. Air, Fans, and Pumps (1-5 hp)	7	537	0.0803
17	Compressed Air - Controls	13	549	0.0845
18	Pumps - Sizing	51	600	0.0951
19	Centrifugal Chiller, 0.51 kW/ton, 500 tons	8	609	0.0989
20	Efficient electric melting	32	640	0.1088
21	Drives - Process Controls (batch + site)	37	678	0.1162
22	Pumps - Controls	134	811	0.1320
23	Replace HP Mpotors for Comp. Air, Fans, and Pumps (6-100 hp)	24	835	0.1426
24	Replace HP Mpotors for Comp. Air, Fans, and Pumps (1-5 hp)	7	842	0.2028
25	Fans - System Optimization	31	873	0.2905
26	Installing ASD for Comp. Air, Fans, and Pumps (1-5 hp)	8	881	0.2958
27	Pumps - System Optimization	126	1007	0.3169
28	Fans - Controls	74	1081	0.4436
29	RET 2L4' Premium T8, 1EB	50	1132	0.4905
30	CFL Hardwired, Modular 36W	32	1163	1.2602

Table D.8 Aggregated Measure Values for Electric Energy-Efficiency Supply Curves in Fabricated Metal Ranked by Their Levelized Cost, 2013

No.	Measure	Economic Potential GWh	Cumulative Electricity Saving GWh	Levelized Cost (Baht/kWh)
1	Installing ASD for Comp. Air, Fans, and Pumps (6-100 hp)	90	90	0.0106
2	Motor practices for Comp. Air, Fans, and Pumps (100+ hp)	49	139	0.0153
3	Compressed Air- Sizing	77	216	0.0211
4	Motor practices for Comp. Air, Fans, and Pumps (6-100 hp)	30	246	0.0264
5	Pumps - O&M	46	292	0.0264
6	Drives - Optimization process (M&T)	17	309	0.0370
7	Installing ASD for Comp. Air, Fans, and Pumps (100+ hp)	147	456	0.0382
8	Compressed Air - O&M	273	730	0.0475
9	Machinery	20	749	0.0581
10	Replace HP Mpotors for Comp. Air, Fans, and Pumps (100+ hp)	28	777	0.0612
11	Compressed Air - System Optimization	214	991	0.0792
12	Motor practices for Comp. Air, Fans, and Pumps (1-5 hp)	10	1002	0.0803
13	Compressed Air - Controls	64	1066	0.0845
14	Pumps - Sizing	46	1112	0.0951
15	Prog. Thermostat - DX	46	1158	0.0960
16	Centrifugal Chiller, 0.51 kW/ton, 500 tons	84	1242	0.0989
17	Pumps - Controls	120	1362	0.1320
18	Replace HP Mpotors for Comp. Air, Fans, and Pumps (6-100 hp)	37	1399	0.1426
19	Window Film - DX	32	1431	0.1440
20	DX Packaged System, EER=10.9, 10 tons	82	1513	0.1509
21	New transformers welding	21	1534	0.1909
22	Efficient processes (welding, etc.)	10	1544	0.1909
23	Replace HP Mpotors for Comp. Air, Fans, and Pumps (1-5 hp)	11	1555	0.2028
24	Occupancy Sensor, 4L4' Fluorescent Fixtures	78	1633	0.2577
25	Fans - System Optimization	28	1660	0.2905
26	Installing ASD for Comp. Air, Fans, and Pumps (1-5 hp)	12	1673	0.2958
27	Efficient Curing ovens	57	1730	0.3030
28	Pumps - System Optimization	113	1843	0.3169
29	Fans - Controls	66	1909	0.4436
30	DX Tune Up/ Advanced Diagnostics	51	1960	0.7470
31	CFL Hardwired, Modular 36W	86	2047	1.2602

Table D.9 Aggregated Measure Values for Electric Energy-Efficiency Supply Curves in Other Ranked by Their Levelized Cost, 2013

No.	Measure	Economic Potential GWh	Cumulative Electricity Saving GWh	Levelized Cost (Baht/kWh)
1	Installing ASD for Comp. Air, Fans, and Pumps (6-100 hp)	4	4	0.0106
2	Motor practices for Comp. Air, Fans, and Pumps (100+ hp)	2	7	0.0153
3	Compressed Air- Sizing	4	11	0.0211
4	Motor practices for Comp. Air, Fans, and Pumps (6-100 hp)	1	12	0.0264
5	Pumps - O&M	2	14	0.0264
6	Installing ASD for Comp. Air, Fans, and Pumps (100+ hp)	7	21	0.0382
7	Compressed Air - O&M	15	36	0.0475
8	Drives - Scheduling	1	37	0.0475
9	Replace HP Mpotors for Comp. Air, Fans, and Pumps (100+ hp)	1	38	0.0612
10	Compressed Air - System Optimization	11	50	0.0792
11	Motor practices for Comp. Air, Fans, and Pumps (1-5 hp)	0.5	50	0.0803
12	Compressed Air - Controls	3	53	0.0845
13	Pumps - Sizing	2	55	0.0951
14	Prog. Thermostat - DX	4	59	0.0960
15	Centrifugal Chiller, 0.51 kW/ton, 500 tons	6	65	0.0989
16	Pumps - Controls	5	70	0.1320
17	Replace HP Mpotors for Comp. Air, Fans, and Pumps (6-100 hp)	2	72	0.1426
18	DX Packaged System, EER=10.9, 10 tons	7	78	0.1509
19	Replace HP Mpotors for Comp. Air, Fans, and Pumps (1-5 hp)	1	79	0.2028
20	Occupancy Sensor, 4L4' Fluorescent Fixtures	5	84	0.2577
21	Fans - System Optimization	1	85	0.2905
22	Installing ASD for Comp. Air, Fans, and Pumps (1-5 hp)	1	86	0.2958
23	Efficient Curing ovens	3	88	0.3030
24	Pumps - System Optimization	5	93	0.3169
25	Fans - Controls	3	96	0.4436
26	DX Tune Up/ Advanced Diagnostics	4	100	0.7470
27	CFL Hardwired, Modular 36W	4	104	1.2602

Appendix E: Penetration Rate Curve Data

Table E.1 Penetration Rate curve Data for Adopted from the Study [42], [43]

KEMA		LBNL		Adopted for the Study	
Benefit-to-Cost Ratio	**Penetration Rate**	**Benefit-to-Cost Ratio**	**Penetration Rate**	**Benefit-to-Cost Ratio**	**Penetration Rate**
1	1.9	1	2.0	1	2.0
2	10.5	2	10.0	2	10.2
3	20.5	3	20.0	3	20.2
4	29.7	4	28.0	4	28.8
5	36.9	5	33.0	5	35.0
6	42.3	6	36.0	6	39.1
7	46.9	7	40.0	7	43.5
8	50.2	8	42.8	8	46.5
9	53.2	9	45.1	9	49.2
10	55.6	10	47.0	10	51.3
12.5	59.4	12.5	50.3	12.5	54.8
15	62.5	15	53.1	15	57.8
20	67.0	20	56.4	20	61.7
25	69.0	25	58.8	25	63.9
30	70.0	30	60.3	30	65.2
40	70.0	40	62.3	40	66.2
60	70.0	60	64.4	60	67.2
80	70.0	80	65.7	80	67.9
100	70.0	100	66.0	100	68.0

Table E.2 Benefit-to-Cost Ratio of Measures

Measure	Benefit-to-Cost Ratio	Penetration Rate
Fans - O&M	119.54	68
Fans - ASD (6-100 hp)	59.77	67
Pumps - ASD (6-100 hp)	59.77	67
Comp Air - ASD (6-100 hp)	59.77	67
Process Drives - ASD	59.77	67
Fans - Motor practices-1 (100+ HP)	59.77	67
Comp Air - Motor practices-1 (100+ HP)	59.77	67
Pumps - Motor practices-1 (100+ HP)	59.77	67
Power recovery - CA	39.85	66
Power recovery - Pumps	39.85	66
Power recovery Fans	39.85	66
Refinery Controls - CA	39.85	66
Refinery Controls - Fans	39.85	66
Refinery Controls - Pumps	38.95	66
Compressed Air- Sizing	29.88	65
Top-heating (glass)	29.88	65
Comp Air - Motor practices-1 (6-100 HP)	23.91	64
Pumps - O&M	23.91	64
Fans- Improve components	23.91	64
Fans - Motor practices-1 (6-100 HP)	23.91	64
Bakery - Process (Mixing) - O&M	23.91	64
Pumps - Motor practices-1 (6-100 HP)	23.91	64
Replace V-Belts	23.91	64
Comp Air - ASD (100+ hp)	23.91	64
Efficient drives	23.91	64
Fans - ASD (100+ hp)	23.91	64
Pumps - ASD (100+ hp)	23.91	64
Drives - EE motor	19.92	62
Gap Forming papermachine	17.08	60
High Consistency forming	17.08	60
Drives - Optimization process (M&T)	17.08	60
Efficient Refrigeration - Operations	17.08	60
Heating - Optimization process (M&T)	17.08	60
Efficient drives - rolling	14.94	58
Comp Air - Replace 100+ HP motor	14.94	58
Fans - Replace 100+ HP motor	14.94	58
Pumps - Replace 100+ HP motor	14.94	58
Compressed Air - O&M	13.28	55
Efficient practices printing press	13.28	55
Heating - Scheduling	13.28	55
Drives - Scheduling	13.28	55
Near Net Shape Casting	10.87	53
Machinery	10.87	53

Table E.2 Benefit-to-Cost Ratio of Measures (Cont')

Measure	Benefit-to-Cost Ratio	Penetration Rate
Optimization control PM	10.87	53
Heating - Process Control	8.54	47.5
Drives - Process Control	8.54	47.5
Process control - Drives	59.77	67.2
Process control - Other Process	7.97	46
Compressed Air - System Optimization	7.97	46
Intelligent extruder (DOE)	7.97	46
Compressed Air - Controls	7.47	45
Pumps - Sizing	6.64	41
Prog. Thermostat - DX	6.57	41
Pumps - Motor practices-1 (1-5 HP)	6.29	41
Comp Air - Motor practices-1 (1-5 HP)	6.29	41
Fans - Motor practices-1 (1-5 HP)	6.29	41
Clean Room - Controls	5.98	39
Drives - Process Controls (batch + site)	5.43	37
Other Process Controls (batch + site)	5.43	37
Pumps - Controls	4.78	33
Pumps - Replace 6-100 HP motor	4.43	32
Fans - Replace 6-100 HP motor	4.43	32
Comp Air - Replace 6-100 HP motor	4.43	32
Process optimization	4.43	32
Centrifugal Chiller, 0.51 kW/ton, 500 tons	4.38	32
Window Film - DX	4.38	32
O&M/drives spinning machines	4.12	30
Efficient electric melting	3.98	29
Membranes for wastewater	3.74	26
Air conveying systems	3.42	24
DX Packaged System, EER=10.9, 10 tons	3.29	23
Window Film - Chiller	2.63	16
Chiller Tune Up/Diagnostics	2.63	16
Occupancy Sensor, 4L4' Fluorescent Fixtures	2.63	16
Bakery - Process	2.6	16
New transformers welding	2.6	16
Efficient processes (welding, etc.)	2.6	16
Comp Air - Replace 1-5 HP motor	2.49	15
Fans - Replace 1-5 HP motor	2.49	15
Pumps - Replace 1-5 HP motor	2.49	15
Energy Star Transformers - Chiller	2.19	12
Energy Star Transformers - DX	2.19	12
Energy Star Transformers - Lighting	2.19	12
DX Tune Up/ Advanced Diagnostics	2.19	12
Fans - System Optimization	2.17	12
Efficient Printing press (fewer cylinders)	2.17	12

Table E.2 Benefit-to-Cost Ratio of Measures (Cont')

Measure	Benefit-to-Cost Ratio	Penetration Rate
Pumps - System Optimization	1.99	10
Injection Moulding - Impulse Cooling	1.9	9
Energy Star Transformers - Drives	1.87	9
Energy Star Transformers - CA	1.87	9
Energy Star Transformers - Fans	1.87	9
Energy Star Transformers - Refriguration	1.87	9
Energy Star Transformers - Pumps	1.87	9
Energy Star Transformers - Other	1.87	9
Energy Star Transformers - Heating	1.87	9
Energy Star Transformers - Other Process	1.87	9
Light cylinders	1.87	9
Drying (UV/IR)	1.76	8.5
Comp Air - ASD (1-5 hp)	1.71	8
Pumps - ASD (1-5 hp)	1.71	8
Fans - ASD (1-5 hp)	1.71	8
Cool Roof - DX	1.64	8
EMS - Chiller	1.64	8
Efficient Curing ovens	1.64	8
Cooling Circ. Pumps - VSD	1.46	5
Fans - Controls	1.42	5
Injection Moulding - Direct drive	1.36	4.5
Extruders/injection Moulding-multipump	1.33	4.5
Optimization Refrigeration	1.21	4
RET 2L4' Premium T8, 1EB	1.01	2
CFL Hardwired, Modular 36W	1.01	2
Clean Room - New Designs	1	1.968

Appendix F: Achievable Potential

Table F.1 Total Electricity Consumption in 2013 of Measures by Industry

Electricity Consumption (kWh) Measure	Food & Beverage	Textile	Wood & Furniture	Paper	Chemical	Non-metallic	Basic -metal	Fabricated metal	Other	Total of each measure
Fans - O&M	72594307	38603809	11904845	17806051	41619429	56253112	56919746	51223291	2246175	349170764
Fans - ASD (6-100 hp)	156803703	83384228	25714464	38461069	89897967	121506721	122946651	110642309	4851738	754208851
Pumps - ASD (6-100 hp)	266566296	104230285	33428804	63127991	182335762	156222928	158074265	143338447	6064672	1113389450
Comp Air - ASD (6-100 hp)	141123333	41692114	12857232	10404185	50990612	52074309	52691422	268609792	14555213	644998211
Fans - Motor practices-1 (100+ HP)	85661282	45552495	14047717	21011140	49110926	66378672	67165300	60443484	2650486	412021502
Comp Air - Motor practices-1 (100+ HP)	77095154	22776248	7023858	5683768	27855982	28448002	28785129	146740534	7951459	352360134
Pumps - Motor practices-1 (100+ HP)	145624180	56940619	18262032	34486588	99609352	85344007	86355386	78305263	3313108	608240533
Power recovery - CA	-	-	-	-	35663	-	-	-	-	35663
Power recovery - Pumps	-	-	-	-	142654	-	-	-	-	142654
Power recovery Fans	-	-	-	-	21947	-	-	-	-	21947
Refinery Controls - CA	-	-	-	-	107671	-	-	-	-	107671
Refinery Controls - Fans	-	-	-	-	66259	-	-	-	-	66259
Refinery Controls - Pumps	-	-	-	-	430682	-	-	-	-	430682
Compressed Air- Sizing	235205555	69486857	21428720	17340308	84984353	86790515	87819036	447682986	24258688	1074997019
Top-heating (glass)	-	-	-	-	-	46207913	-	-	-	46207913
Comp Air - Motor practices-1 (6-100 HP)	47041111	13897371	5314323	3468062	16996871	17358103	17563807	89536597	4851738	216027982
Pumps - O&M	493641288	193019047	61905192	116903687	337658819	289301718	292730121	265441569	11230874	2061832315
Fans- Improve components	72594307	38603809	11904845	17806051	41619429	56253112	56919746	51223291	2246175	349170764
Fans - Motor practices-1 (6-100 HP)	52267901	27794743	8571488	12820356	29965989	40502240	40982217	36880770	1617246	251402950
Bakery - Process (Mixing) - O&M	152448045	-	-	-	-	-	-	-	-	152448045
Pumps - Motor practices-1 (6-100 HP)	88855432	34743428	11142935	21042664	60778587	52074309	52691422	47779482	2021557	371129817
Replace V-Belts	-	-	117500817	-	-	-	-	-	-	117500817
Comp Air - ASD (100+ hp)	231285463	68328743	21071575	17051303	83567947	85344007	-	440221603	23854377	970725016
Fans - ASD (100+ hp)	256983847	136657485	42143150	63033419	147332779	199136016	201495900	181330451	7951459	1236064506
Pumps - ASD (100+ hp)	436872540	170821856	54786095	103459763	298828055	256032020	259066157	234915788	9939324	1824721598

Table F.1 Total Electricity Consumption in 2013 of Measures by Industry (cont')

Electricity Consumption (kWh) Measure	Food & Beverage	Textile	Wood & Furniture	Paper	Chemical	Non-metallic	Basic -metal	Fabricated metal	Other	Total of each measure
Drives - EE motor	-	-	89524432	40169055	-	96433906	-	-	-	226127392
Gap Forming papermachine	-	-	-	50182349	-	-	-	-	-	50182349
High Consistency forming	-	-	-	50182349	-	-	-	-	-	50182349
Drives - Optimization process (M&T)	-	-	-	-	-	-	-	98611090	-	98611090
Efficient Refrigeration - Operations	498287324	-	-	-	-	-	-	-	-	498287324
Efficient drives - rolling	-	-	-	-	-	-	256138856	-	-	256138856
Comp Air - Replace 100+ HP motor	43944238	12982461	4003599	3239747	15877910	16215361	16407523	83642105	4532332	200845276
Fans - Replace 100+ HP motor	48826931	25964922	8007199	11976350	27993228	37835843	38284221	34452786	1510777	234852256
Pumps - Replace 100+ HP motor	83005783	32456153	10409358	19657355	56777330	48646084	49222570	44634000	1888472	346697104
Compressed Air - O&M	833019674	246099285	75893385	61413590	300986249	307383075	311025754	1585543909	85916188	3807281108
Drives - Scheduling	-	-	-	-	-	-	-	83087238	6738525	89825762
Near Net Shape Casting	-	-	-	-	-	-	48788353	-	-	48788353
Machinery	-	-	-	-	-	-	-	114790101	-	114790101
Optimization control PM	-	-	-	62994596	-	-	-	-	-	62994596
Heating - Process Control	-	-	-	-	-	-	203284806	-	-	203284806
Drives - Process Control	-	-	-	-	-		213449047	-	-	213449047
Process control - Drives	-	-	-	-	-	80361588	-	-	-	80361588
Process control - Other Process	-	-	-	-	-	-	-	-	561544	561544
Compressed Air - System Optimization	653348764	193019047	59524223	48167521	236067646	241084765	243941767	1243563850	67385245	2986102830
Fans - ASD (100+ hp)	256983847	136657485	42143150	63033419	147332779	199136016	201495900	181330451	7951459	1236064506
Pumps - ASD (100+ hp)	436872540	170821856	54786095	103459763	298828055	256032020	259066157	234915788	9939324	1824721598
Compressed Air - Controls	196004629	57905714	17857267	14450256	70820294	72325429	73182530	373069155	20215574	895830849
Pumps - Sizing	493641288	193019047	61905192	116903687	337658819	289301718	292730121	265441569	11230874	2061832315
Prog. Thermostat - DX	49001157	65143928	12053655	16510515	37398232	40683054	27443449	267065625	22742520	538042136
Pumps - Motor practices-1 (1-5 HP)	30852581	12063690	3869075	7306480	21103676	18081357	18295633	16590098	701930	128864520
Comp Air - Motor practices-1 (1-5 HP)	16333719	4825476	1488106	1204188	5901691	6027119	6098544	31089096	1684631	74652571

Table F.1 Total Electricity Consumption in 2013 of Measures by Industry (cont')

Electricity Consumption (kWh) Measure	Food & Beverage	Textile	Wood & Furniture	Paper	Chemical	Non-metallic	Basic -metal	Fabricated metal	Other	Total of each measure
Fans - Motor practices-1 (1-5 HP)	18148577	9650952	2976211	4451513	10404857	14063278	14229936	12805823	561544	87292691
Clean Room - Controls	-	-	-	-	15369315	-	-	21964074	-	37333388
Drives - Process Controls (batch + site)	-	-	-	-	9266789	80361588	213449047	-	-	303077424
Other Process Controls (batch + site)	-	-	-	-	585250	-	-	-	-	585250
Pumps - Controls	1295808382	506674998	162501130	306872178	886354400	759417009	768416568	696784118	29481045	5412309826
Pumps - Replace 6-100 HP motor	110180736	43081851	13817239	26092903	75365448	64572143	65337363	59246558	2506731	460200973
Fans - Replace 6-100 HP motor	64812197	34465481	10628645	15897242	37157826	50222778	50817949	45732154	2005385	311739659
Comp Air - Replace 6-100 HP motor	58330978	17232740	5314323	4300396	21076119	6292312	21779121	111025381	4851738	250203108
Process optimization	-					50225993	-	-	-	50225993
Centrifugal Chiller, 0.51 kW/ton, 500 tons	174226337	347434284	28571627	39870923	53857129	48216953	48788353	488118832	33692623	1262777061
Window Film - DX	33756353	44876928	8303629	11373910	25763227	28026104	18905487	183978541	15667070	370651249
O&M/drives spinning machines	-	667073825	-	-	-	-	-	-	-	667073825
Efficient electric melting	-		-	-	-	-	182956326	-	-	182956326
Membranes for wastewater	-	14693575	-	-	-	-	-	-	-	14693575
Air conveying systems	-		172054767	-	-	-	-	-	-	172054767
DX Packaged System, EER=10.9, 10 tons	87113169	115811428	21428720	29352026	66485747	72325429	48788353	474783333	40431147	956519353
Occupancy Sensor, 4L4' Fluorescent Fixtures	162611248	154415237	22857302	30961725	167991441	64289271	52040910	450317974	28751038	1134236146
Bakery - Process	644637447	-	-	-	-	-	-	-	-	644637447
New transformers welding	-	-	-	-	-	-	-	124444281	-	124444281
Efficient processes (welding, etc.)	-	-	-	-	-	-	-	58845988	-	58845988
Comp Air - Replace 1-5 HP motor	17052403	5037797	1553582	1257172	6161366	6292312	6366880	32457016	1758755	77937284
Fans - Replace 1-5 HP motor	18947114	10075594	3107164	4647379	10862671	14682062	14856054	13369279	586252	91133570
Pumps - Replace 1-5 HP motor	32210094	12594493	4039314	7627966	22032238	18876937	19100640	17320062	732815	134534559
DX Tune Up/ Advanced Diagnostics	54445730	72382143	13392950	18345016	41553592	45203393	30492721	296739583	25269467	597824595
Fans - System Optimization	228672067	121601999	37500261	56089060	131101201	177197302	179297199	161353368	7075451	1099887908
Efficient Printing press (fewer cylinders)	-	-	-	7745806	-	-	-	-	-	7745806

Table F.1 Total Electricity Consumption in 2013 of Measures by Industry (cont')

Electricity Consumption (kWh) Measure	Food & Beverage	Textile	Wood & Furniture	Paper	Chemical	Non-metallic	Basic -metal	Fabricated metal	Other	Total of each measure
Pumps - System Optimization	1221762189	477722141	153215351	289336625	835705577	716021751	724507049	656967882	27796414	5103034979
Injection Moulding - Impulse Cooling	-	-	-	-	281666485	-	-	-	-	281666485
Drying (UV/IR)	-	125462380	-	-	-	-	-	-	-	125462380
Comp Air - ASD (1-5 hp)	19600463	5790571	1785727	1445026	7082029	7232543	7318253	37306916	2021557	89583085
Pumps - ASD (1-5 hp)	37023097	14476429	4642889	8767777	25324411	21697629	21954759	19908118	842316	154637424
Fans - ASD (1-5 hp)	21778292	11581143	3571453	5341815	12485829	16875934	17075924	15366987	673852	104751229
Efficient Curing ovens	-	-	-	-	-	-	-	330708452	15442452	346150904
Fans - Controls	544457303	289528570	89286335	133545380	312145718	421898338	426898093	384174685	16846311	2618780734
Injection Moulding - Direct drive	-	-	-	-	343719404	-	-	-	-	343719404
Extruders/injection Moulding-multipump	-	-	-	-	1408486257	-	-	-	-	1408486257
Optimization Refrigeration	736106274	-	-	-	-	-	-	-	-	736106274
RET 2L4' Premium T8, 1EB	1065530529	951989240	163747567	199958548	1122243499	343662314	289480817	3225049686	217584262	7579246461
CFL Hardwired, Modular 36W	360753054	161209508	23863023	52631649	341600710	167794996	183366148	501366296	22512063	1815097446
Clean Room - New Designs	-	-	-	-	13005032	-	-	-	-	13005032

Table F.2 Electric Achievable Savings Potential by Measures and Industrial Sector – cumulative 2014-2030

Electricity Consumption (kWh) **Measure**	**Food & Beverage**	**Textile**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic -metal**	**Fabricated metal**	**Other**	**Cumulative Achievable Potential**
Fans - O&M	417455373	55631541	38381770	60557785	133148507	126467579	211203124	0	0	1042845679
Fans - ASD (6-100 hp)	891095329	118750434	81929274	129265935	284217237	269956206	450831704	627129899	28922953	2882098971
Pumps - ASD (6-100 hp)	1514862059	148438042	106508056	212170355	576464279	347086551	579640763	812454354	36153691	4333778149
Comp Air - ASD (6-100 hp)	801985796	59375217	40964637	34967999	161209550	115695517	193213588	1522502854	86768859	3016684016
Fans - Motor practices-1 (100+ HP)	486802078	64872922	44757659	70617501	155266824	147476076	246287690	342598741	15800502	1574479993
Comp Air - Motor practices-1 (100+ HP)	438121870	32436461	22378829	19102888	88068180	63204032	105551867	831737670	47401506	1648003305
Pumps - Motor practices-1 (100+ HP)	827563532	81091153	58184956	115907879	314920301	189612097	316655602	443840805	19750628	2367526952
Power recovery - CA	-	-	-	-	110990	-	-	-	-	110990
Power recovery - Pumps	-	-	-	-	443960	-	-	-	-	443960
Power recovery Fans	-	-	-	-	68302	-	-	-	-	68302
Refinery Controls - CA	-	-	-	-	335087	-	-	-	-	335087
Refinery Controls - Fans	-	-	-	-	206208	-	-	-	-	206208
Refinery Controls - Pumps	-	-	-	-	1337310	-	-	-	-	1337310
Compressed Air- Sizing	1295867425	95939866	66191619	56502112	260486165	186943525	312199039	2460095758	140203154	4874428663
Top-heating (glass)	-	-	-	-	-	99530117	-	-	-	99530117
Comp Air - Motor practices-1 (6-100 HP)	252609613	18702015	13014020	11014226	50777810	36441792	60858446	479558191	27330469	950306583
Pumps - O&M	2650841620	259750211	186377358	371274733	1008748946	607363204	1014307442	1421705563	63264974	7583634052
Fans- Improve components	389829650	51950042	35841800	56550284	124337209	118098401	197226447	-	-	973833833
Fans - Motor practices-1 (6-100 HP)	280677348	37404030	25806096	40716205	89522790	85030849	142003042	197533475	9110156	907803991
Bakery - Process (Mixing) - O&M	818642265	-	-	-	-	-	-	-	-	818642265
Pumps - Motor practices-1 (6-100 HP)	477151492	46755038	33547924	66829452	181574810	109325377	182575339	255907001	11387695	1365054129
Replace V-Belts	-	-	353758561	-	-	-	-	-	-	353758561
Comp Air - ASD (100+ hp)	1241997265	91951575	63439985	54153278	249657564	179172145	299220695	2357827771	134374806	4671795084
Fans - ASD (100+ hp)	1379996961	183903150	126879970	200188006	440153720	418068339	698181622	971206253	44791602	4463369624
Pumps - ASD (100+ hp)	2345994834	229878937	164943961	328578139	892742817	537516436	897662086	1258209424	55989502	6711516136
Drives - EE motor	-	-	263163474	124559473	-	197672014	-	-	-	585394961

Table F.2 Electric Achievable Savings Potential by Measures and Industrial Sector – cumulative 2014-2030 (cont')

Electricity Consumption (kWh) **Measure**	**Food & Beverage**	**Textile**	**Wood & Furniture**	**Paper**	**Chemical**	**Non-metallic**	**Basic -metal**	**Fabricated metal**	**Other**	**Cumulative Achievable Potential**
Gap Forming papermachine	-	-	-	150589849	-	-	-	-	-	150589849
High Consistency forming	-	-	-	150589849	-	-	-	-	-	150589849
Drives - Optimization process (M&T)	-	-	-	-	-	-	-	499049943	-	499049943
Efficient Refrigeration - Operations	2528306190	-	-	-	-	-	-	-	-	2528306190
Efficient drives - rolling	-	-	-	-	-	-	810647286	-	-	810647286
Comp Air - Replace 100+ HP motor	215540313	15957580	11009585	9397939	43326399	31094127	51927749	409185229	23319848	810758769
Fans - Replace 100+ HP motor	239489236	31915161	22019170	34741289	76385732	72552962	121164748	168546345	7773283	774587925
Pumps - Replace 100+ HP motor	407131702	39893951	28624921	57022537	154929541	93282380	155783247	218353824	9716603	1164738706
Compressed Air - O&M	3888596802	287893227	198625658	169549699	781658408	560974046	936836716	7382175298	420717062	14627026915
Drives - Scheduling	-	-	-	-	-	-	-	-	32997417	32997417
Near Net Shape Casting	-	-	-	-	-	-	141097886	-	-	141097886
Machinery	-	-	-	-	-	-	-	513153518	-	513153518
Optimization control PM	-	-	-	166983141	-	-	-	-	-	166983141
Heating - Process Control	-	-	-	-	-	-	526898551	-	-	526898551
Drives - Process Control	-	-	-	-	-	-	553243478	-	-	553243478
Process control - Drives	-	-	-	-	-	178542464	-	-	-	178542464
Process control - Other Process	-	-	-	-	-	-	-	-	2315398	2315398
Compressed Air - System Optimization	2568087232	190128974	131175342	111973146	516218852	370475613	618700917	4875298492	277847812	9659906380
Compressed Air - Controls	745894527	55222486	38099551	32522321	149934477	107603717	179700137	1416018280	80700204	2805695700
Pumps - Sizing	1711567031	167712735	120338136	239720694	651318217	392155770	654907167	917951624	40848251	4896519624
Prog. Thermostat - DX	-	-	-	-	-	-	-	923567944	82717709	1006285652
Pumps - Motor practices-1 (1-5 HP)	106190211	10405348	7466101	14872915	40409530	24330396	40632198	56952182	2534335	303793215
Comp Air - Motor practices-1 (1-5 HP)	56218347	4162139	2871577	2451219	11300617	8110132	13544066	106725822	6082404	211466324
Fans - Motor practices-1 (1-5 HP)	62464830	8324278	5743154	9061404	19923324	18923641	31602820	43961135	2027468	202032056
Clean Room - Controls	-	-	-	-	28294083	-	-	-	-	28294083

Table F.2 Electric Achievable Savings Potential by Measures and Industrial Sector – cumulative 2014-2030 (cont')

Electricity Consumption (kWh) Measure	Food & Beverage	Textile	Wood & Furniture	Paper	Chemical	Non-metallic	Basic -metal	Fabricated metal	Other	Cumulative Achievable Potential
Drives - Process Controls (batch + site)	-	-	-	-	16131036	98304631	430947551	-	-	545383218
Other Process Controls (batch + site)	-	-	-	-	1018766	-	-	-	-	1018766
Pumps - Controls	3561416153	348975432	250398714	498809066	1355258180	815994856	1362726041	1910067022	84996742	10188642206
Pumps - Replace 6-100 HP motor	298163326	29216377	20963490	41760514	113462811	68315448	114088023	159911651	7115965	852997604
Fans - Replace 6-100 HP motor	175390192	23373101	16125762	25442819	55941170	53134237	88735129	123435091	5692772	567270274
Comp Air - Replace 6-100 HP motor	157851172	11686551	8062881	6882590	31730134	22132974	38029341	299667228	16708912	592751784
Process optimization	-	-	-	-	-	53137638	-	-	-	53137638
Centrifugal Chiller, 0.51 kW/ton, 500 tons	471479010	235615940	43348822	63811614	81081999	51012133	85191176	1317475489	95644686	2444660868
Window Film - DX	-	-	12598251	-	-	-	-	496574201	-	509172452
O&M/drives spinning machines	-	424108692	-	-	-	-	-	-	-	424108692
Efficient electric melting	-	-	-	-	-	-	287919553	-	-	287919553
Membranes for wastewater	-	8096230	-	-	-	-	-	-	-	8096230
Air conveying systems	-	-	195780891	-	-	-	-	-	-	195780891
DX Packaged System, EER=10.9, 10 tons	-	-	-	-	-	-	-	921065050	82493542	1003558591
Occupancy Sensor, 4L4' Fluorescent Fixtures	-	-	-	-	-	-	-	607723831	40808399	648532230
Bakery - Process	855881740	-	-	-	-	-	-	-	-	855881740
New transformers welding	-	-	-	-	-	-	-	164794077	-	164794077
Efficient processes (welding, etc.)	-	-	-	-	-	-	-	77926203	-	77926203
Comp Air - Replace 1-5 HP motor	21630941	1601452	1104887	943147	4348100	3120508	5211304	41064530	2340306	81365175
Fans - Replace 1-5 HP motor	24034379	3202904	2209774	3486525	7665829	7281185	12159709	16914776	780102	77735184
Pumps - Replace 1-5 HP motor	40858445	4003630	2872706	5722601	15548237	9361523	15633912	21913296	975127	116889478
DX Tune Up/ Advanced Diagnostics	-	-	-	-	-	-	-	300347299	26900068	327247367
Fans - System Optimization	232056075	30924592	21335748	33663004	74014905	70301095	117404090	163315078	7532019	750546607
Pumps - System Optimization	1057998898	103671014	74386579	148182470	402609973	242409654	404828469	567428438	25250197	3026765692
Injection Moulding - Impulse Cooling	-	-	-	-	119263886	-	-	-	-	119263886

Table F.2 Electric Achievable Savings Potential by Measures and Industrial Sector – cumulative 2014-2030 (cont')

Electricity Consumption (kWh) Measure	Food & Beverage	Textile	Wood & Furniture	Paper	Chemical	Non-metallic	Basic -metal	Fabricated metal	Other	Cumulative Achievable Potential
Drying (UV/IR)	-	22600314	-	-	-	-	-	-	-	22600314
Comp Air - ASD (1-5 hp)	13260347	981733	677325	578175	2665502	1912955	3194669	25173658	1434670	49879035
Pumps - ASD (1-5 hp)	25047322	2454333	1761046	3508108	9531486	5738865	9584007	13433438	597779	71656385
Fans - ASD (1-5 hp)	14733719	1963466	1354651	2137334	4699359	4463562	7454228	10369211	478223	47653753
Efficient Curing ovens	-	-	-	-	-	-	-	209205723	10274331	219480054
Fans - Controls	230214360	30679159	21166417	33395837	73427486	69743150	116472311	162018927	7472241	744589888
Injection Moulding - Direct drive	-	-	-	-	72769239	-	-	-	-	72769239
Extruders/injection Moulding-multipump	-	-	-	-	298192282	-	-	-	-	298192282
Optimization Refrigeration	248999852	-	-	-	-	-	-	-	-	248999852
RET 2L4' Premium T8, 1EB	177513220	39744797	15294435	19701517	104012275	22383185	31118202	-	-	409767630
CFL Hardwired, Modular 36W	60100048	6730369	2228866	5185691	31660390	10928712	19711236	83308318	3934210	223787841
Clean Room - New Designs	-	-	-	-	1204114.541	-	-	-	-	1204115

Appendix G: Summary of Potential

Table G.1 Summary of Electricity Consumption by End Use and Industry – Base Year 2013

Industry	Electricity Consumption (GWh)	End Use										
		Compressed Air	Fans	Pumps	Drives	Heating	Refrigeration	Other Process	Chiller	DX-Packed	Lighting	Other
Food & Beverage	13,416	2580	1654	4756	156	654	1265	0	429	305	1609	8
Textiles	6,909	762	880	1860	695	129	0	0	855	406	1302	20
Wood & Furniture	1,884	235	271	596	388	33	0	0	70	75	214	1
Paper	2,438	190	406	1126	228	0	0	0	98	103	286	1
Chemical	10,916	932	948	3254	3698	0	0	3	133	233	1712	3
Non-metallic	6,813	952	1282	2787	658	61	0	0	119	254	699	3
Basic Metal	7,065	963	1297	2820	697	452	0	0	120	171	544	1
Fabricated Metal	16,679	4910	1167	2557	341	408	0	190	1201	1665	4229	10
Other (Unclassified)	949	266	51	108	11	16	0	1	83	142	270	1
	Total	11,791	7,956	19,864	6,871	1,754	1,265	193	3,108	3,353	10,866	47

Table G.2 Summary of Technical Electric Savings Potential by End Use and Industry – Base Year 2013

End Use	Electricity Consumption (GWh)	Technical Electric Savings Potential by Industrial Sector									Overall Technical Savings Potential
		Food & Beverages	Textiles	Wood & Furniture	Paper	Chemical	Non-metallic	Basic Metal	Fabricated Metal	Other (Unclassified)	
Compressed Air	11,791	477	109	37	36	158	161	167	846	45	2037
Fans	7,956	306	126	43	77	161	217	225	201	9	1366
Pumps	19,864	879	266	94	215	552	473	490	440	18	3427
Drives	6,871	29	99	61	44	628	112	121	59	2	1153
Heating	1,754	121	19	5	0	0	10	79	70	3	307
Refrigeration	1,265	234	0	0	0	0	0	0	0	0	234
Space Cooling	6,461	136	181	23	38	62	63	51	494	38	1086
Lighting	10,866	297	186	34	55	290	118	95	728	46	1849
Other	241	2	3	0.2	0	1	0	0	34	0	42
Total	67,069	2481	989	297	465	1853	1155	1228	2872	160	

Table G.3 Summary of Economic Electric Savings Potential by End Use and Industry – Base Year 2013

End Use	Electricity Consumption (GWh)	Economic Electric Savings Potential by Industrial Sector									Overall Economic Savings Potential
		Food & Beverages	Textiles	Wood & Furniture	Paper	Chemical	Non-metallic	Basic Metal	Fabricated Metal	Other (Unclassified)	
Compressed Air	5174	475	109	37	36	158	161	167	842	45	2029
Fans	5936	304	125	43	77	160	216	224	182	8	1337
Pumps	8898	875	265	94	214	550	471	488	439	18	3414
Drives	15787	28	96	60	39	352	52	119	37	1	783
Heating	6751	119	18	0	0	0	8	76	57	3	280
Refrigeration	3488	228	0	0	0	0	0	0	0	0	228
Space Cooling	4418	32	50	8	8	9	8	8	295	21	438
Lighting	5975	264	159	30	48	248	87	82	164	9	1091
Other	4774	0	2	0	0	0	0	0	32	0	35
Total	61201	2325	824	271	422	1476	1002	1164	2047	104	