Low Carbon Development Options
for Indonesia

Emissions Reduction Opportunities and Policies

Manufacturing Sector

Technical Report

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f o r I n d o n e s i a

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May 2009

Foreword

In December 2007, Indonesia hosted the 13th session of Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in Bali, and with it a High Level Event on Climate Change for Ministers of Finance. During these events, the President of Indonesia launched the National Action Plan for Climate Change. Ministers of Finance also agreed that it is in the global interest to improve international financing mechanisms and develop innovative approaches for climate financing. As a result, it is now widely understood that climate change is a development issue.

In 2008, Indonesia published its blueprint for integrating climate change mitigation and adaptation into the national planning and budgeting process. The President also formed the National Council on Climate Change as the focal point on climate change and a focus for intra-governmental coordination, and other areas of technical assistance, outreach and capacity building. The National Council has engaged with external partners and key stakeholders, including the Ministry of Finance, on climate change adaptation and mitigation issues, including low carbon development.

Mitigating and adapting to climate change requires macro-economic management, fiscal policy plans, revenue raising alternatives, insurance markets, and long-term investment options. The Ministry of Finance recognizes the need to manage these challenges by adopting budget priorities, pricing policies, and financial market rules. To do this, the Fiscal Policy Office appointed a working group to study and map out fiscal issues for climate change.

The Government of Indonesia is collaborating with the World Bank and other donors to conduct the technical studies needed to inform the low carbon development strategy. The Governments of Netherlands and Australia have also contributed resources and expertise to this effort. The low carbon work begins with the premise that sound environmental management, reduction of emissions, economic efficiency and growth are compatible goals, important to the sustainability of Indonesia's development path.

These results can serve as an input to the Government's discussions of appropriate fiscal policy instruments to promote low carbon development, carbon markets, and climate finance opportunities.

Head of Fiscal Policy Office
Ministry of Finance
Jakarta, May 2009

Abbreviations and Acronyms

AIRD	Agency for Industrial Research and Development, Ministry of Industry Republic of Indonesia
BPPT	*Badan Pengkajian dan Penerapan Teknologi*, Agency for the Assessment and Application of Technology
BPS	*Badan Pusat Statistik*, Indonesia Statistics
CDM	Clean Development Mechanism
CER	Certified Emission Reductions
CF	Carbon Finance
CH_4	Methane
CIF	Climate Investment Funds
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
COP	Conference of the Parties
DNA	Designated National Authority for CDM
EE	Energy Efficiency
ESCO	Energy Services Company
FLI	Forward Linkage Index
GOI	Government of Indonesia
GDP	Gross Domestic Product
GHG	Greenhouse gas
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
ISIC	International Standard Industrial Classifications
KLH	*Kementerian Lingkungan Hidup*, Ministry of Environment Republic of Indonesia
$ktCO_2e$	Thousand Tons of Carbon Dioxide equivalent
MDB	Multilateral Development Bank
MITI	Ministry of International Trade and Industry, Japan
MOF	Ministry of Finance
$mtCO_2e$	Million Tons of Carbon Dioxide equivalent
NGO	Non-governmental Organizations
RE	Renewable Energy
tCO_2e	Tons of Carbon Dioxide equivalent
TNA	Technology Needs Assessment
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Manufacturing Development Organization
USDOE	United States Department of Energy

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Executive Summary

The Indonesian manufacturing sector is one of the nation's largest sources of fossil-fuel derived greenhouse gas (GHG) emissions, and continues to grow. Overall, manufacturing was responsible for over 40 percent of Indonesia's 2005 fossil-fuel emissions (including electricity use within manufacturing). Future emissions will be even larger because emissions from fossil-fuel use (non-forestry emissions) are growing at about 6 percent per year. With the growing focus on climate change issues and the potential for carbon market finance and other forms of assistance, there is now a good opportunity to address manufacturing sector emissions in a comprehensive manner.

The Government of Indonesia (GOI), in particular the Ministry of Finance and National Council on Climate Change, has commissioned a Low Carbon Development Options study to evaluate and develop strategic options to reduce emissions intensity without compromising development objectives. The Ministries of Industry and Environment have already identified important sectoral opportunities and the Agency for the Assessment and Application of Technology (BPPT) has prepared a technology needs assessment for climate change mitigation. This paper provides additional support and analysis toward development of a practical and coordinated approach to managing manufacturing sector emissions. The paper focuses on a few key sub-sectors that possess the combination of large reduction potential, strategic benefits for future economic development, and cost-effective opportunities. This paper adds an economic and policy dimension that may usefully complement prior work and engage the Ministry of Finance more actively in the quest for cost-effective emissions reductions.

This paper focuses first on the largest emitting industries within the manufacturing sector as the starting point for a multi-tiered screening approach. The three-tiered screening process further targets industry sub-sectors that are central to Indonesia's economic development process in a carbon-constrained world, as well as key industries where cost-effective energy and emissions reduction opportunities exist.

This review of greenhouse gas emissions from the manufacturing sector found that the largest emitters are concentrated within just four main economic sectors: non-metallic minerals, textiles, basic metals, and food and beverage. Looking in more detail at the industry or sub-sector level, there are several other significant emitters that might also be considered targets for emissions reduction efforts including garments, pulp, porcelain, auto parts, fertilizer, and crumb rubber.

Most of these sub-sectors are key to the current or future Indonesian economy as measured by a variety of statistics including their value added (textile, garments, transportation equipment, food and beverage), annual growth rate (auto parts, non-metallic minerals), or economic multipliers (food and beverage, textiles). If the GOI is seeking targets for emissions reductions, or potential carbon market opportunities, it makes sense to start with these sub-sectors that represent the combination of the most potential reductions and the most important economic targets. Public policy makers should be interested in making these sub-sectors more modern, efficient, and clean as a contribution to Indonesia's development and competitiveness, as well as to its environment. In fact, the Ministry of Industry has already identified several of these basic manufacturing sectors for further study and action.

Finally, the analysis shows that there is significant potential for cost-effective energy efficiency improvements among the same general set of sectors (i.e., cement, metals, textiles, garments, food and beverage). This indicates that much can be done to reduce the carbon intensity of the manufacturing sector with overall cost savings. Analysis shows that many of these sub-sectors also have an economic motive and incentive to reduce energy use, together with the emissions that come in parallel.

This paper developed a three-tiered screening process to identify industry sub-sectors with high emissions reduction potential, socioeconomic development interests, and economic incentive for improvement. The results of the screening process to identify targets for energy savings and emissions reductions are summarized briefly in the table below (Table ES-1).

Table ES-1. Manufacturing sub sectors resulting from screening process (Based on emissions, economic contribution, and energy efficiency)

Manufacturing Sector Organization	High Priority	Medium Priority
Few Targets: Concentrated, large firms	▪ Cement ▪ Structural materials of porcelain (ceramic tiles) ▪ Straight fertilizer	▪ Steel rolling ▪ Iron & steel basic industry ▪ Pulp
Many Targets: Decentralized, smaller firms	▪ Weaving mills ▪ Textile fiber ▪ Finished textiles ▪ Crumb rubber	▪ Spinning mills ▪ Motor vehicle components, apparatus ▪ Cultural papers ▪ Tires and inner tubes ▪ Crude vegetable and palm oil ▪ Basic chemicals

More detailed results for each of the metrics used to assess the screening characteristics are summarized in Table ES-3 below (and further described in Section 2.6 of this report). The top 20 GHG emitting industries are listed, along with an indication of their prominence among multiple indices used in the screening process. Eight industry groups are considered to be significant with respect to seven or more of the metrics considered and these are considered "high priority" sectors. Nine more are significant with respect to 4, 5, or 6 metrics and are considered "medium priority."

Having identified these low-carbon opportunities, the next step is to consider how to approach these opportunities. This paper reviewed global best practices and focused on approaches that are both cost effective and desirable for economic development, while also contributing to climate change mitigation. Based on this review, most of the actions appropriate in the manufacturing sector fall into three main categories (1) energy management and efficiency deployment, (2) specific technology investments, and (3) efficiency standards. Note that the sub-sectors identified for further action include both large capital-intensive industries with relatively few plants (e.g., steel) and diverse industry groups consisting of many smaller and medium-sized enterprises (e.g., textiles or automobile parts manufacturing). Different interventions may be appropriate for the two types of industries. More specific and tailored interventions, such as energy audits, might be cost effective for a few large plants. Alternatively, efficiency standards might be appropriate (and easier to apply) across an industry consisting of thousands of small and medium sized firms (e.g., food and beverage manufacturing).

To complement the technical and regulatory options, this analysis also emphasized fiscal policy options that could enhance and support the investment and energy management options. This fiscal angle may appeal to the Ministry of Finance and serve as an entry point for integrated and coordinated actions across ministries. Fiscal policy options would likely best be used to augment or provide an additional incentive to adopt a more technical standard or practice. For example, depreciation rules can provide an incentive for installation of newer, energy efficient technologies.

The possible policies and interventions to save energy and reduce emissions are briefly summarized in the table ES-2 below.

Table ES-2. Policy options and technologies to reduce emissions

Manufacturing Sector Organization	Capital Stock / Investment Options	Regulatory Options / Efficiency Standards	Fiscal Policies: Incentives & Enhancements	Energy Management & Efficiency
Few Targets: Concentrated, large firms	▪ Co-firing /co-generation ▪ Alternative fuels ▪ Heat recovery ▪ Process optimization & control	▪ Grinding equipment ▪ Motors ▪ Kilns ▪ Spray dryers	▪ Incentives for sectoral CDM / carbon mkts ▪ Faster depreciation ▪ Access to cheaper capital ▪ Targeted tax policies	▪ In-house energy audits ▪ Energy Service Companies
Many Targets: Dispersed, smaller firms	▪ Co-firing /co-generation ▪ Alternative fuels ▪ Heat recovery	▪ Arc furnaces & drive efficiency ▪ Compact Fluorescent Lighting ▪ Loom & Mill Efficiency	▪ Fiscal incentives for investment ▪ Faster depreciation for new equipment ▪ Financing or incentives for Energy Service Companies ▪ Targeted donor or grant assistance	▪ Energy mgmt ▪ Energy Service Companies ▪ Target donor assistance

These policy options and investment opportunities are summarized in greater detail in Table ES-4 on the following pages.

Table ES-3. Summary of screening indicators used to assess: (1) Emissions reduction potential, (2) Socioeconomic development importance, and (3) Financial incentive and opportunity to improve energy efficiency.

Emissions Rank	Sector	Overall Emission	Economic Development Importance			Energy Efficiency: Opportunity, Capacity, & Incentive to Improve			Overall (Number of Indicators "Positive")
		GHG Emitter (* & Natural Gas User)	Top GDP Contributor	High GDP Growth (2000 - 2005)	High Backward or Forward Linkage	Energy Inefficiency ("Opportunity" to Improve)	Range of Inefficiency within Sector ("Capacity" to Emulate Better Performers)	Energy Share of Total Input Value ("Incentive" to Reduce Energy Spending)	
1	Cement	X*	X	X		XX		XX	HI
2	Steel rolling industry	X			F	XX	XX		MED
3	Iron and steel basic industries	X*				XX		X	MED
4	Weaving mills except gunny and other sacks	X	XX		F*		XX	X	HI
5	Wearing apparel made of textile (garments)	X	XX						LO
6	Pulp	X*			BF*	X			MED
7	Preparation of textile fiber	X*	X		F	XX	X	X	HI
8	Structural materials made of porcelain	X*				XX	XX	XX	HI
9	Motor vehicle component and apparatus	X	XX	X					MED
10	Straight fertilizers	X*		XX	F*		XX	X	HI
11	Crumb rubber	X	X	XX	BF	X			HI
12	Toys	X							LO
13	Finished textiles	X	XX		F*	XX	X	X	HI
14	Spinning mills	X	X		F	XX		X	MED
15	Cultural papers	X	XX		F*				MED
16	Tire and inner tubes	X		X					MED
17	Crude vegetable and animal cooking oil	X	XX		BF*				MED
18	Products of plastics for technical/ industrial purposes	X	X		F				LO
19	Basic chemicals n.e.c	X	X		F	X	XX		MED
20	Cooking oil made of palm oil	X	XX		BF*	XX			HI

Table ES-4. Summary of policy options to promote investments and technologies that reduce energy use and GHG emissions for priority manufacturing sectors.

Emissions rank	Industry Sectors	No. of firms/ plants	Ministry of Industry Priority	Capital Stock/ Investment Options: (potentially eligible for carbon finance)	Regulatory Options: Energy/ Equipment Efficiency Standards	Fiscal Policy Enhancements: Incentives & Financial Assistance	Energy Management & Energy Efficiency Options
Large, Concentrated Industries (50 firms or less)							
1*	Cement	18	High	Co-firing with biomass; blended cement; MOI plan implementation	Grinding equipment; motors	Encourage sectoral CDM; Faster depreciation or tax breaks for energy efficiency/emissions reduction investments	All sectors with few, large firms can benefit from energy management practices and audits using in-house resources or through Energy Services Companies (ESCOs)
2	Steel rolling	51	Medium	MOI plan implementation; Ecotec options in rolling industry	Arc furnaces; voluntary agreement	Tax breaks, soft financing for capital stock improvements	
3*	Iron and steel basic industry	16	Medium	Alternative fuels; heat recovery; MOI plan implementation	Furnace and drive efficiency	Access to international climate finance to lower cost of capital	
6*	Pulp	9	Medium	Co-firing with biomass; heat recovery; cogeneration		Direct grant program or targeted tax policy for 9 pulp mills	
8*	Structural materials made of porcelain (ceramic tile)	30	High	Process optimization; thermal efficiency	Kilns; spray dryers	Govt finance of ESCOs; incentives (or penalties) for underperforming firms; (e.g. low interest loans, change depreciation schedule)	
10*	Straight fertilizer	15	High	Optimize process controls; heat recovery	High efficiency process equipment	Direct grant program or targeted tax policy for 15 fertilizer/urea plants; Govt finance of ESCOs; low interest loans for investment	
Textiles, many firms, less concentrated target							
4	Weaving mills	495	High	Modernize equipment throughout industry (2700 machines at a cost of US$1.7 billion); co-gen & heating system reconstruction	CFLs; loom & mill efficiency	Tax policy to encourage foreign investment; low interest loans for efficiency investment; accelerated depreciation schedule	Consider a donor assistance project to provide ESCO-like advice for the textile industry
7*	Textile fiber	78	High		CFLs; loom & mill efficiency		
13	Finished textiles	167	High		CFLs; loom & mill efficiency		
14	Spinning mills	68	Medium		CFLs; loom & mill efficiency		
Other industries: Distributed, smaller firms, less concentrated target							
9	Motor vehicle component and apparatus	168	Medium	Sector-specific analysis for electric equipment and process efficiency	Motor; Chain drive		Energy management & energy efficiency options
11	Crumb rubber	146	High			Government finance of ESCOs	Govt assisted ESCO services
15	Cultural papers	43	Medium		CFL		ESCO
16	Tire and inner tubes	33	Medium		CFL		ESCO
17 (&20)	Crude vegetable oil (& palm) and animal cooking oil	295	Medium			Government finance of ESCOs	Govt assisted ESCO services
19	Basic chemicals not elsewhere classified	37	Medium				Energy management & energy efficiency options

Section 1
Introduction

Climate change is a strategic and development challenge facing Indonesia. The Government of Indonesia (GOI) recognizes climate change as a key economic development and planning issue. The GOI also acknowledges that early action to address mitigation and adaptation concerns will be strategically and economically beneficial for Indonesia. As one important step on mitigation, the GOI has embarked on a Low Carbon Development Options Study as an opportunity to evaluate and develop strategic options to reduce emissions intensity without compromising development objectives.

The first phase of low carbon work showed that Indonesia is a relatively large greenhouse gas (GHG) emitter, especially from forests and land use, but also from fast growing fossil fuel use. Among fossil fuels, oil is currently the main contributor of emissions. However, emissions from use of coal have been the fastest growing for the last decade, attributed to its increasing use in electric power generation. Among economic sectors, industry is the largest source of emissions, mainly from oil and coal. Electric power generation is the fastest increasing source of emissions, which also has implications for manufacturing which relies on power for many processes. Emissions from the transportation sector grew steadily but less so than the industrial sector. Residential sector emissions are relatively smaller and not growing rapidly, mainly from kerosene use in cooking.

The second phase of the study (ongoing) will help to inform the GOI about the main emissions reduction potentials by source and category of use, to estimate the potential costs and benefits associated with movements toward alternative development paths, and to build consensus toward appropriate approaches for lowering emissions. Ongoing analyses include a macro policy options element and four sector analyses covering forestry and land use, power generation, and transport.

This study about energy efficiency and emissions reductions opportunities in the manufacturing sector is an important component of the Low Carbon Development Options Study. The manufacturing sector is one of the main sources of fossil-fuel GHG emissions, and continues to grow. Overall, manufacturing was responsible for over 40 percent of Indonesia's 2005 fossil-fuel emissions (including electricity use within manufacturing). Future emissions will be even larger because emissions from fossil-fuel use (non-forestry emissions) are growing at about 6 percent per year. With the growing focus on climate change issues and the potential for carbon market finance and other forms of assistance, there is now a good opportunity to address manufacturing sector emissions in a comprehensive manner.

The Government of Indonesia, in particular the Ministries of Industry and Environment and the Agency for the Assessment and Application of Technology (BPPT), has already prepared a technology needs assessment for climate change mitigation and identified important sectoral opportunities (BPPT and KLH, 2009). This paper provides additional support and analysis toward development of a practical and coordinated approach to managing manufacturing sector emissions, focused on a few key sub-sectors that possess the combination of large reduction potential, strategic benefits for future economic development, and cost-effective opportunities. This paper adds an economic and policy dimension that may usefully complement prior work and engage the Ministry of Finance more actively in the quest for cost effective emissions reductions.

This paper focuses first on the largest emitting industries within the manufacturing sector[1] as the starting point for a multi-tiered screening approach. The three-tiered screening process further targets industry sub-sectors that are central to Indonesia's economic development process in a carbon-constrained world, as well as key industries where cost-effective energy and emissions reduction opportunities exist.

In this review of low carbon options for the Indonesian economy, the aim is to identify options that address current and future GHG emissions and that will complement future economic and social development. Special focus is placed on policies that assist the MOF to create an appropriate fiscal environment that enables and encourages GHG reduction programs throughout the GOI and private sector. To achieve this aim, this study focuses on three main questions: (1) What are the priority sub-sectors in the Indonesian economy and why? (2) What general mechanisms and approaches are appropriate for reducing GHG emissions from manufacturing industries? (3) What specific options and measures should be considered for the priority sub-sectors identified through this screening analysis? An overview of the fiscal policies that can be used to enhance and support an effort to improve energy efficiency and reduce emissions is also included. At a later stage, it may also be useful to consider which stakeholder groups and partners can be engaged in further developing and implementing these concepts in practical programs. This process of engagement will be initiated through workshops and dissemination activities.

The structure of this paper is as follows. Section 2 develops a screening process to identify priority sectors and lay out a rationale for the trio of criteria used to screen industries (i.e. GHG emissions, strategic importance to economy, and cost-effective opportunity). Section 3 provides an overview of policy approaches and characteristics that align with needs of specific manufacturing sub-sectors, laying the groundwork for identifying approaches well suited to each. Finally, Section 4 reviews best practices for several of the priority sectors and identifies target policy approaches for consideration by the GOI.

1 The study is based on several different data sources that have different levels of aggregation and detail. Generally, the term "sector" is used to mean the largest aggregations, while "industries" or "sub-sectors" refer to a lower level of aggregation of firms engaged in the same line of business. See section 2.2 for information on methods and data.

Section 2

Identifying Priority Sectors

This section is based on the idea that the Government of Indonesia (GOI) wants to improve energy efficiency and reduce emissions intensity in the manufacturing sector while continuing to develop in a sustainable manner. This implies that the approach should have well-defined priorities and should consider economic issues, not just environmental ones (emissions). To improve efficiency and emissions at the same time, it makes sense to start where emissions are highest, but also where industries have an incentive to make improvements. Energy efficiency improvements mean more production or value per unit of energy consumed.

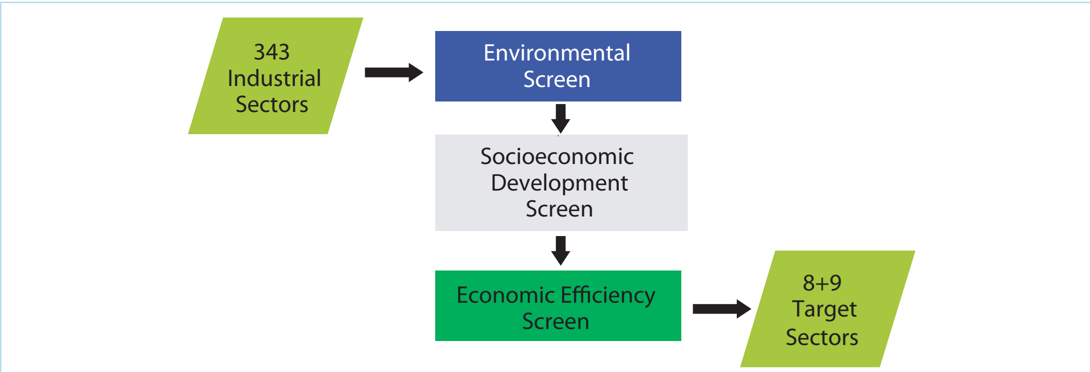
A development focus also implies consideration of the role and position of the target sectors in the wider economy. By definition, efficiency improvements are good for Indonesia's development, allowing more growth and development using less energy resources. In this way, development and efficiency provide the primary rationale for policy and investment interventions. Greenhouse gas (GHG) emissions reductions that come along with energy efficiency are an important additional rationale for action, especially when considering future scenarios with greater attention to and constraints on emissions. There are also important co-benefits of reducing energy use and intensity, less air pollution and other toxic combustion products. These are not the focus of this paper, however.

Of course, the Government's own strategic priorities should be an important factor in targeting policies or interventions. In its analysis of carbon mitigation options for the manufacturing sector (AIRD, 2009; BPPT and KLH, 2009), the Ministry of Industry has identified mitigation priorities for seven key manufacturing sectors including: cement, steel, glass and ceramic, paper and pulp, petrochemical, textile and food and beverage. There is great similarity with the sub-sectoral targets identified in this paper, as will be seen through the following sections. This paper provides some additional insights based on economic and energy efficiency metrics, as well as a summary of policy and regulatory tools that could become part of an integrated, inter-ministerial approach to encourage emissions reductions.

2.1. Three Tier Screening Approach

Consideration of the simultaneous importance of emissions, economic development and energy efficiency led to the development of a multi-tiered screening approach focused on the manufacturing sector. This approach aims to identify the high emitting industrial sub-sectors that are central to the Indonesian economy and strategic for future growth in a carbon-constrained world. The approach also aims to identify the key industries where cost-effective opportunities exist – industries that have an economic incentive to improve energy efficiency and reduce emissions. Globally, research has consistently shown that energy efficiency and energy productivity often provide the lowest hanging fruit, in terms of GHG reduction potential for a given investment (Bernstein, 2007, Price et al., 2005, Farrell et al., 2008).

Figure 2.1. Three-tiered screening



The first screening tier looks at emissions reductions potential: which are the highest emitting sectors? The second screening tier looks at strategic importance to socioeconomic development: which sectors contribute the most to economic growth and economic inter-linkages? The third screening tier looks at energy efficiency: which firms have the greatest opportunity, capacity, and incentive to improve energy use. The following sections explain the screening process and results in greater detail.

2.2. Methods and Data

This section introduces several key data sources that were available for this analysis and how they were used to support the development of the screening approach. This analysis of the Indonesian manufacturing sector relied on two primary datasets. The Indonesian Central Statistics Bureau (Badan Pusat Statistik or BPS) annually develops the Manufacturing Statistics Indonesia (ISI) database from a survey of medium and large firms (BPS, 2005a). The firm-level information collected includes number of establishments, capital status, value and volume of production, labor, electricity and other energy inputs. (Duarte et al., 2008). The dataset allows analysis of information at firm, "sector" and "industry" level[2] for about 20,000 firms. Through statistical analyses and comparison, a representative picture of energy use and GHG emissions for each sector and industry has been developed from the distribution of responses. These are more fully described in Section 2.3 (Screen 1) below. Several specific metrics have been developed for describing firms' and industries' energy efficiency status and opportunities for improvement. These are described more fully in Section 2.5 (Screen 3) below. This analysis relies only on the 2005 data only – although data exist for several years and the approach could be applied to more years, or to recent

2 On terminology, generally "sector" is used to mean the largest aggregations, based on the International Standard Industrial Classification code. "Industries" are a lower level of aggregation. For example, the cement industry is part of the non-metallic minerals sector. "Sub-sector" is a rough synonym for "industry." The dataset and this analysis relies on the International Standard Industrial Classifications (ISIC) system, which uses a 2 digit code to define the sector level and a 5 digit code to define the industry level.

average performance. One important limitation of these data is that natural gas use was lumped in with "other fuels" so it is not possible to identify the amount of natural gas, biomass, or other fuel types that were used by each industry from this source alone.

The second important source of data for this analysis is the national macroeconomic statistics from BPS. Every five years, BPS develops and refines an economy-wide 175-sector input-output table (BPS, 2005b). These national economic statistics are generally reported at the 2- or 3- digit ISIC level, while the Survey of Manufactures provides a finer level of aggregation and detail. Analysis at each level has advantages and disadvantages. A higher level of aggregation allows comparability with other national level economic data published by BPS, such as the IO table, and international sources, such as International Energy Agency (IEA). The survey data allow finer targeting, even geographic targeting, but less comparability at the macro level. BPS statistics for 2000 and 2005 have been used to identify those sectors with large contributions to current GDP, those showing the largest growth, and those with high rank of several other economic metrics. These are described more fully in Section 2.4 (Screen 2) below.

A recent study on mitigation approaches for industry from the Agency for Manufacturing Research and Development, within the Ministry Industry, provided timely and useful information to support this analysis, including – in particular – industry level data on natural gas use (AIRD, 2009). The Agency for the Assessment and Application of Technology (BPPT) together with the Ministry of Environment (KLH) also recently produced a Technology Needs Assessment for Indonesia (BPPT and KLH, 2009), which includes the detailed industry data and cost curves that provided insights to support the discussion in Section 4.

Other important data sources and literature are cited in the usual manner. The U.S. Energy Information Administration (2008) provided important sources of conversion factors and the International Energy Agency (2008) provided emissions estimates for the Indonesian energy and manufacturing sectors.

2.3. Screen 1: Carbon Reduction Potential

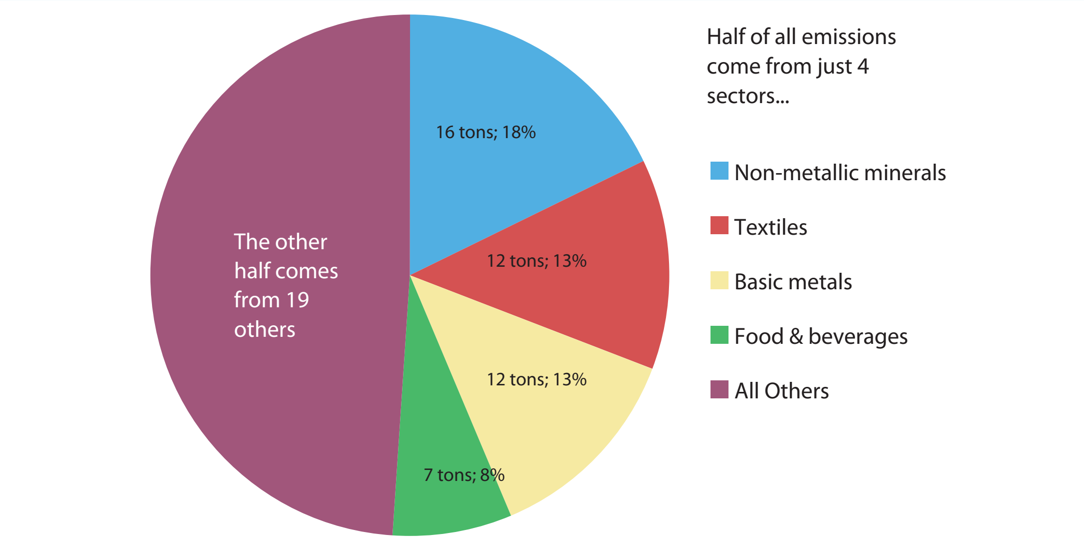
The initial screen for manufacturing sectors was designed to identify those sectors with the largest GHG emissions and thus the greatest reduction potential. BPS data on energy use by fuel type and electricity purchases were used at the 5 digit ISIC level to calculate total industry level GHG emissions. Raw quantities of purchased electricity and fuel were converted to metric tons of carbon dioxide equivalent (CO_2e) based on carbon content of the various fuel types (EIA, 2008).[3] The result of these calculations is a ranked list of industries by GHG emission level that was then further aggregated to the 2 digit ISIC sector level.

An important caveat to this ranked list is that natural gas use is not included in the BPS data because of the limitations of the survey data. While the majority of the 29 percent of Indonesia's energy mix that comes from natural gas is mostly used for fertilizer production, power generation and export (IEA, 2008) substantial amounts are still used in the largest manufacturing sectors that are the focus here. The Agency for Manufacturing Research and Development within the Indonesian Ministry of Industry has made estimates of natural gas use in several key sectors (including fertilizer, cement, steel, ceramics, paper and pulp) (AIRD, 2009). This information has been used to address the natural gas data gap in

3 Carbon intensity of the electric sector was calculated based on the breakdown provided in the IEA *Indonesia Energy Policy Analysis Review* (2008): 3equivalent to 40% coal, 32% oil, 13% natural gas, and 14% renewables (mostly hydro and geothermal). Power generation efficiency of 32% and transmission and distribution losses of 12% were used, also drawing on IEA 2008. Also note that natural gas use was not included in this calculation of industry GHG emissions for all industry groups – only very large users.

the BPS survey information. However, inclusion of the natural gas data does not change the relative ranking of the four primary greenhouse-gas emitting industries. Figure 1 demonstrates that just 4 of the 23 manufacturing sectors included in the BPS survey, contributed over half of the estimated 91 Million tons of CO_2e emissions in 2005.[4]

Figure 2.2. Contribution to 2005 surveyed Indonesian manufacturing GHG emissions (total represents 91 million metric tons CO_2e)



These results point to the relative importance of minerals, textiles, metals, and food and beverage manufacture over other sectors in terms of emissions. To provide a more targeted look at the sub-sectoral opportunities, we take advantage of the detailed firm-level database and repeat the analysis at the 5 digit ISIC level to determine the specific industries/sub-sectors that contribute the greatest share of emissions. Appendix A shows this analysis at the 5 digit ISIC level for comparison to the 2 digit results shown here.

This closer look provides a deeper understanding of the sources of emissions, and later, a finer level targeting of low-cost emissions reductions options. For example, emissions from the non-metal mineral sector (over 1500 firms) are dominated by the cement industry/sub-sector (only 18 firms) with over 71 percent of sector emissions. Similarly, 61 percent of emissions from the pulp and paper sector (with over 400 firms) come from the pulp industry (with only 9 plants). Just two industries – iron and steel manufacture and steel rolling – make up 88 percent of emissions from the basic metals sector. The combined emissions of weaving mills, and fiber production contribute 64 percent of the textile sector emissions.

4 Note that overall estimates of emissions using BPS survey of large and medium firms will not match IEA estimates of total emissions from the sector, which take into account estimates for smaller firms, as well as (possibly) a broader selection of sectors (e.g., refining or petroleum transport) and smaller natural gas users.

Table 2.1. Twenty highest GHG emitting Indonesian manufacturing industry groups (at 5 digit ISIC level) in 2005*

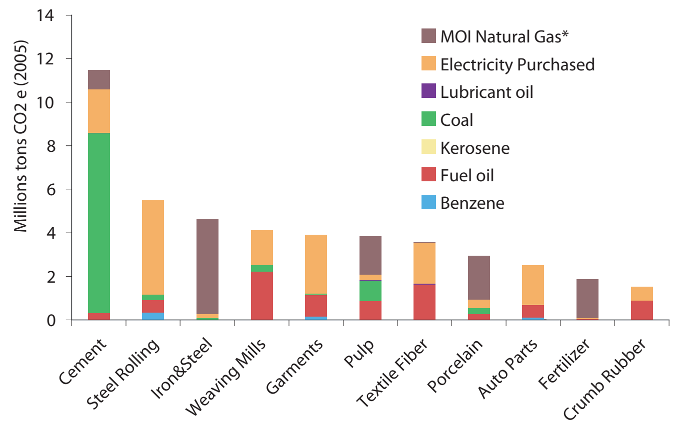
Rank	Manufacturing Sectors	5 digit ISIC Code	Estimated 2005 GHG emissions [Million Metric Tons CO_2e]
1	Cement	26411	11.5
2	Steel rolling industry	27102	5.5
3	Iron and steel basic industries	27101	4.6
4	Weaving mills except gunny and other sacks	17114	4.1
5	Wearing apparel made of textile (garments)	18101	3.9
6	Pulp	21011	3.8
7	Preparation of textile fiber	17111	3.6
8	Structural materials made of porcelain	26202	2.9
9	Motor vehicle component and apparatus	34300	2.5
10	Straight fertilizers	24122	1.9
11	Crumb rubber	25123	1.5
12	Toys	36941	1.4
13	Finished textiles	17122	1.2
14	Spinning mills	17112	1.1
15	Cultural papers	21012	1.1
16	Tire and inner tubes	25111	1.1
17	Crude vegetable and animal cooking oil	15141	1.0
18	Products of plastics for technical/industrial purposes	25206	1.0
19	Basic chemicals, not elsewhere classified	24119	1.0
20	Cooking oil made of palm oil	15144	0.9

*Note: Estimates are based on BPS (2005a) surveyed energy use among medium and large firms and Ministry of Industry (AIRD, 2009) natural gas estimates for major users.

In contrast, the food and beverage sector as a whole is an important source of emissions, but no one sub-sector is responsible for a large share. Thus if one were to look only at the finer level of analysis, at sub-sectors individually, food and beverage manufacturing would not appear to be an important source of emissions. However, there may be specific technologies (e.g., refrigeration or grinders) that are commonly used across this sector and could be a useful point of focus for efforts to reduce emissions cost effectively in a large and widely distributed industrial sector. This is discussed later in this section. Table 2.1. (above) provides a list of the 20 highest emitting 5 digit ISIC manufacturing sector industries, with total estimated emissions included within the BPS survey data and AIRD natural gas data.

A second useful result of the 5 digit ISIC analysis is that we find several other industry groups that may be worth considering as important GHG emitters. This more detailed look identified 11 industries (out of 343 total) that contributed over half of the surveyed GHG emissions (See Appendix A). While these 11 industries were mostly in the four sectors shown in Figure 1, several additional sub-sectors emerge as potentially important, including manufacture of garments, pulp, porcelain, autoparts, fertilizer, and crumb rubber. These large GHG emitting industries are not identified using the sector level (2 digit ISIC), but may well be worth considering for further analysis and potential intervention. However, as pointed out earlier, the reverse is also true: analysis only at the industry level (5 digit ISIC) does not reveal that the food and beverage industry is a large emitter, because no single industry sub-sector appears among the top emitters (the largest food and beverage industry group is ranked only #17 in Table 2.1). Rather it is only the combined contributions of the many diverse food and beverage industry sub-sectors that place it among the top half of emitters. Here, the industry sub-sectors for cooking oil (rank #17 and #20) are treated as representatives of the entire 2 digit food and beverage sector in the analysis of options for these industry groups in Section 4.

Figure 2.3. Sectoral breakdown of surveyed GHG emissions by fuel-type for 2005



Another interesting use of these data is to look at which fuel type is contributing most to GHG emissions within each sector. Figure 2.3. demonstrates that most of the large industry groups show a fairly even split among emissions from fuel-oil use and electricity purchases.[5] There are three important exceptions: cement (which has very high coal use), the large natural gas users (iron & steel, pulp, porcelain, and fertilizer), and steel rolling which uses a very high proportion of electricity. It is also useful to note that smaller manufacturing sectors seem to use a greater proportion of electricity relative to the largest sectors.

Figure 2.3. shows a dramatic change in the relative importance of specific sub-sectors with the inclusion of the AIRD gas data. The iron and steel, porcelain, and fertilizer industries would not rank in the top half of emitters were it not for their estimated natural gas use. Natural gas use within the pulp industry brings its total emissions even with garments and textile fiber industries. It is for this reason that the AIRD gas data is kept in the analysis despite the fact that we do not have a consistent dataset for all 343 5 digit ISIC sectors. To leave out these data would miss an important part of this picture.

This analysis highlights the clear opportunities for fuel shifting in the cement industry, natural gas efficiency in the porcelain and fertilizer industries, and reducing the emissions intensity of the power generation sector. The Ministry of Energy and Mineral Resources, working with IEA, has identified significant potential for development of geothermal, hydroelectric and micro-hydro power generation (IEA, 2008). Incentives to encourage deployment of these technologies will help reduce the fossil-intensity of many smaller industries that rely on electric power. However, the power sector is the focus of a parallel low carbon study and these issues will not be taken up in this paper.

This paper will focus on the important role of energy efficiency within the demand sectors and the opportunities to encourage improvements through policies and regulatory approaches. The aim of this work is to lay out a broader economic rationale for selecting targets for action and to provide some tools and policies that may be useful in encouraging low carbon options. The aim is not to provide a specific and final ranking of manufacturing sector emitters.

5 Footnote 3 explains the assumptions used in calculating emissions from electricity purchases.

2.4. Screen 2: Strategic Interest and Importance to Socioeconomic Development

In keeping with the development needs of Indonesia and following the specific guidance of the Ministry of Finance, emissions should not be the only consideration in where to target industry sub-sectors for policy or technical interventions toward efficiency and mitigation. In selecting industries for government programs or regulation that may reduce energy consumption (and therefore industry energy costs), it makes sense to consider those economic sectors that will also boost social and economic development.

BPS data and other macroeconomic data (Indonesian I-O Table statistics) provide a means to consider each sector's contribution to growth, economic activity and value added (GDP), as measures of socioeconomic development importance.

Table 2.2. Value added by top emitting manufacturing sectors to Indonesian economy in 2005

Emissions Rank	Manufacturing Industry Sub-sectors (ISIC)	I-O Parent Sector Mapping (2005 175-Sector I-O Table)	I-O Table Value Added (95 manufacturing sector contribution to Indonesian economy)
			Units: trillion 2005 Rupiah
Top 20 GHG Emitting Subsectors (5 Digit ISIC)		I-O Subsectors (175 sector I-O)	Top 10% highlighted in gold; Top quarter highlighted in yellow)
1	Cement (26411)	Cement (113)	8,60
2	Steel rolling industry (27102)	Basic iron and steel products (116)	4,93
3	Iron and steel basic industries (27101)	Basic iron and steel (115)	3,23
4	Weaving mills except gunny and other sacks (17114)	Textile (076)	16,60
5	Wearing apparel made of textile (garments) (18101)	Wearing apparel (079)	22,90
6	Pulp (21011)	Pulp (090)	4,95
7	Preparation of textile fiber (17111)	Yarn (075)	13,80
8	Structural materials made of porcelain (26202)	Other non ferrous products (114)	7,45
9	Motor vehicle component and apparatus (34300)	Motor vehicle except motorcycle (133)	25,90
10	Straight fertilizer (24122)	Fertilizer (095)	5,58
11	Crumb rubber (25123)	Smoked and crumb rubber (106)	8,69
12	Toys (36941)	Other manufacturing (141)	2,24
13	Finished textile (17122)	Textile (076)	16,60
14	Spinning mills (17112)	Yarn (075)	13,80
15	Cultural papers (21012)	Paper and cardboard (091)	16,70
16	Tire and inner tubes (25111)	Tire (107)	6,64
17	Crude vegetable and animal cooking oil (15141)	Animal and vegetable oil (056)	31,40
18	Products of plastics for technical/industrial processes (25206)	Plastic products (109)	15,10
19	Basic chemicals n.e.c (24119)	Basic chemicals (094)	11,70
20	Cooking oil made of palm oil (15144)	Animal and vegetable oil (056)	31,40

Sources: BPS 2005 I-O table

Value added. Indonesia's manufacturing sector contributed about one quarter of the 2005 Indonesian GDP of Rp2,800 trillion (or about US$287 billion). The top emitting sub-sectors identified in Table 2.1. are responsible for about one third of the manufacturing sector total (or about 8 percent of the national value added). Table 2.2. shows a closer look at the top 20 GHG emitting sub-sectors. Table 2 lists value added for the top 20 GHG sectors (5 digit ISIC level), based on the corresponding sector from the Indonesia Input-Output Table (based on 175-sectors, of which 91 are in manufacturing). The table also indicates which are in the top 25 percent of value added contributors (in yellow) and in the top 10 percent (in gold) (all based on 91 non-energy manufacturing sub-sectors within the I-O table). This mapping economic indicators based on the I-O sectors to the targeted 5 digit ISIC codes is not precise in several cases, so value added contributions may not be coming exclusively from the 20 high emissions subsectors targeted here.[6] The imprecise mapping is also true for growth and economic linkages, covered in the next two sections. However, it is possible to say with confidence when the 20 targeted high emissions subsectors are *within* sub-sectors of economic significance from the point of view of value added, growth, or economic linkages. This is sufficient for the purpose of screening at this level, as we are only seeking priority targets based on a range of indicators.

Over half of the large emitting sub-sectors are among the largest direct contributors to the economy, suggesting that there is a strong correspondence between energy consumption and economic activity. This is expected given the trend of *increasing* energy intensity for the Indonesian economy. The development goal, however, is to see this relationship decoupled and eventually to reduce to correspondence between energy use and profitability. It is also worth noting that subsectors with high value added (textiles, cooking oil) may be in a better position to finance energy efficiency projects relative to other sub-sectors.

Growth. Economic growth is another important consideration in socio-economic development. Using constant Rupiah values from the 2000 and 2005 I-O table data, sectoral growth has been calculated for the same mapping of our target sub-sectors. Table 3 shows 5-year average growth rates for value added among the I-O sectors that contain our 20 high GHG emitting manufacturing sub-sectors. Again, we use yellow to indicate sub-sectors in the top quarter of all non-fuel manufacturing sub-sectors and gold to indicate those in the top 10 percent. It shows that fertilizer and crumb rubber grew at over 3 times the manufacturing sector average of 45 percent. In addition, cement, autoparts, and tire manufacture grew at almost twice the sector average. Garments, ceramic tile, and cultural paper sub-sectors grew at just about the average for the manufacturing sector on the whole, but this still constitutes robust growth. Sub-sectors with high growth should be considered by the Ministry of Finance in terms of their contribution to the future Indonesian economy. Addressing the fast growing sub-sectors with high emissions now, will have added benefit toward reducing the carbon intensity of the Indonesian economy in the future.

6 Weaving mills and finished textiles map to the same I-O sector "textile" which also includes other 5 digit ISIC sectors; similarly spinning mills and textile fiber preparation both map to the I-O sector "yarn"; cooking oil from animal and vegetable fats as well as cooking oil from palm oil both map to the I-O sector "animal and vegetable oil."

Table 2.3. Annual average growth rate of Indonesian manufacturing sectors between 2000 and 2005 (in percent change of constant Rp)

Emissions Rank	Manufacturing Industry Sub-Sector (ISIC)	I-O Parent Sector Mapping (2005 175 Sector I-O Table)	I-O Table 5-year Growth (91 Manufacturing sectors)
			Units: constant rupiah percent growth
Top 20 GHG Emitting Subsectors (5 digit ISIC)		I-O Subsectors I-O (175 sector I-O)	Top 10% highlighted in gold; Top quarter highlighted in yellow)
1	Cement (26411)	Cement (113)	88,90
2	Steel rolling industry (27102)	Basic iron and steel products (116)	-37,80
3	Iron and basic steel industries (27101)	Basic iron and steel (115)	-34,70
4	Weaving mills except gunny and other sacks (17114)	Textile (076)	20,40
5	Wearing apparel made of textile (garment) (18101)	Wearing apparel (079)	45,50
6	Pulp (21011)	Pulp (090)	39,30
7	Preparation of textile fiber (17111)	Yarn (075)	-8,30
8	Structural materials made of porcelain (26202)	Other non-ferrous products (114)	47,10
9	Motor vehicle component and apparatus (34300)	Motor vehicle (133)	78,90
10	Straight fertilizer (24122)	Fertilizer (095)	157,00
11	Crumb rubber (25123)	Smoked and crum rubber (106)	138,00
12	Toys (36941)	Other manufacturing (141)	-6,10
13	Finished textile (17122)	Textile (076)	20,40
14	Spinning mills (17112)	Yarn (075)	-8,30
15	Cultural papers (21012)	Paper and cardboard (091)	49,80
16	Tire and inner tubes (25111)	Tire (107)	83,70
17	Crude vegetable and animal cooking oil (15141)	Animal and vegetable oil (056)	11,70
18	Products of plastics for technical/ industrial purposes (25206)	Plastic products (109)	22,40
19	Basic chemicals (24119)	Basic chemicals (094)	10,80
20	Cooking oil made of palm oil (15144)	Animal and vegetable oil (056)	11,70

Source: BPS 2005 I-O table

Economic linkages. The Input Output Table can also provide measures of the importance of a sector in terms of its linkages within the economy. Backward linkage measures the impact of a given sector in terms of demanding upstream inputs from upstream sectors. Forward linkage measures the impact of a given sector in contributing to output in downstream sectors. A Backward Linkage Index (BLI) of 2 means that a 1 unit (value) increase in demand for the sector's products will lead to an increase of 2 units (value) of production from other sectors. Similarly, a Forward Linkage Index (FLI) of 2 means that an 1 unit (value) increase in demand for the sector's products will result in an increase of 2 units (value) of final demand for all sectors that rely on the first sector for inputs. BLI or FLI values greater than 1 have greater proportional economic impact. Values less than 1 mean that the sector does not contribute in an important manner to the economic activity in other sectors. Sectors with strong forward linkages would tend to be key primary inputs essential for a range of downstream products (e.g., fertilizer or paper). Sectors with strong backward linkages would tend to be economically important and comprised of many inputs from economically important sectors (e.g., processed leather goods rely on agriculture and chemicals sectors). "Key" sectors are those defined as having both a backward and a forward linkage index greater than 1 since they have positive linkage throughout the economy.

Table 4 presents the backward and forward linkage index for the same target sectors using 175-sector I-O Table data. In general, high GHG emitting target sub-sectors have much higher forward linkage than backward linkage. Pulp, cooking oil, and rubber are the sub-sectors with the greatest linkage throughout the economy.

Table 2.4. Backward and Forward Linkage Index for high GHG target sub-sectors

Emissions Rank	High GHG Target Sub-Sector	I-O Parent Sector Mapping	I-O Table Backward Linkage Index	I-O Table Forward Linkage Index	Key Sector
Top 20 GHG Emitting Subsectors (5 digit ISIC)		(2005 175-Sector I-O Table)	Top 10% highlighted in gold; Top quarter highlighted in yellow		(>1)
1	Cement (26411)	Cement (113)	1,0634	0,7980	
2	Steel rolling industry (27102)	Basic iron and steel products (116)	1,0110	0,9953	
3	Iron and basic steel industries (27101)	Basic iron and steel (115)	1,0530	0,8605	
4	Weaving mills except gunny and other sacks (17114)	Textile (076)	1,1331	1,1487	*
5	Wearing apparel made of textile (garment) (18101)	Wearing apparel (079)	1,1794	0,6666	
6	Pulp (21011)	Pulp (090)	1,3732	1,1962	*
7	Preparation of textile fiber (17111)	Yarn (075)	0,9934	1,4604	
8	Structural materials made of porcelain (26202)	Other non-ferrous products (114)	0,9850	0,7318	
9	Motor vehicle component and apparatus (34300)	Motor vehicle (133)	0,8715	0,8868	
10	Straight fertilizer (24122)	Fertilizer (095)	1,0260	1,7733	*
11	Crumb rubber (25123)	Smoked and crumb rubber (106)	1,2309	0,9911	
12	Toys (36941)	Other manufacturing (141)	1,1035	0,6886	
13	Finished textile (17122)	Textile (076)	1,1331	1,1487	*
14	Spinning mills (17112)	Yarn (075)	0,9934	1,4604	
15	Cultural papers (21012)	Paper and cardboard (091)	1,0195	1,4643	*
16	Tire and inner tubes (25111)	Tire (107)	1,0358	0,9163	
17	Crude vegetable and animal cooking oil (15141)	Animal and vegetable oil (056)	1,3136	1,2640	*
18	Products of plastics for technical/ industrial purposes (25206)	Plastic products (109)	0,9841	1,4058	
19	Basic chemicals (24119)	Basic chemicals (094)	0,9051	1,5652	
20	Cooking oil made of palm oil (15144)	Animal and vegetable oil (056)	1,3136	1,2640	*

Source: BPS 2005 I-O table

2.5. Screen 3: Energy Efficiency – Opportunity, Capacity, and Incentive to Improve

The third element of the screening approach tries to identify where environmental goals align with economic incentive. That is, where cost-effective mitigation opportunities exist.

The literature establishes in general terms that the greatest reduction potential within the manufacturing sector lies in the cement, steel, paper and pulp industries and that much of this mitigation potential can be achieved at less than $50 US per ton of CO_2 eq (Bernstein et al., 2007, p. 449). However, a closer look at the Indonesian manufacturing sector may yield other cost-effective potential and more specific information that helps the GOI with targeting approaches and the pros and cons of specific policies.

To identify cost-effective opportunities for energy efficiency improvements in the manufacturing sector, the BPS Survey of Manufacturing was used. Statistical analysis and specific metrics were developed to assess the relative *opportunity* for efficiency improvements of individual industries, the *capacity* for improvement within an industry, as well as economic *incentive* to invest in GHG mitigation options that would improve efficiency. The measures can be summarized as follows:[7]

- 'Opportunity' to improve is evaluated through a measure of energy 'inefficiency.' More inefficient sub-sectors have an opportunity to reduce their energy use (and GHG emissions) cost effectively.
- 'Capacity' (or 'means') to improve is evaluated through a measure of the range of inefficiency within a sector. A wider range means the industry group has the capacity improve. The better performers on energy efficiency can serve as a 'proof of concept' model for the weaker performers to emulate.[8]
- 'Incentive' (or 'motive') to reduce energy spending is evaluated through a measure of energy cost as a share of total spending on production inputs. Industries (or firms) with high energy cost shares (e.g., cement, textiles) face a greater economic incentive to reduce energy use (spending) than industries that spend relatively little on energy (e.g., chemicals, plastics).

'Opportunity.' More inefficient sub-sectors have an opportunity to reduce their energy use (and GHG emissions) cost effectively. Using the BPS survey of manufactures, an energy inefficiency index is calculated as 'Total Energy Cost as a share of Total Value Added.' The index is a fraction less than 1. A higher result means greater energy cost per unit of value added, hence 'inefficiency'. An econometric analysis of this 'inefficiency' metric has shown that more energy-efficient firms in Indonesia also tend to be more productive, face higher energy prices, and are often foreign-owned. Firms with their own on-site power generation tend to be less efficient (Duarte et al., 2008).

Using this index/metric, manufacturing sub-sectors were ranked by their firms' average energy inefficiency. Table 4 below demonstrates that several of the key GHG emitters are also among the "top 10 percent" manufacturing sub-sectors with respect to the inefficiency metric: they have a good opportunity to reduce energy use. This showed that that the cement, iron and steel, and tire and inner tube sub-sectors

7 This approach follows the results of Duarte, et al. (2008).

8 In contrast, a narrow range of inefficiency may mean all firms are using similar technologies and improvement may need to come from outside intervention, or major technology shifts.

are among the most inefficient of Indonesia's manufacturing industries. In contrast, the toy, cooking oil, and cultural papers sub-sectors are relatively efficient within the Indonesia context. The garment and textile industries, however, offer mixed results with respect to this metric. While garments and weaving mills are shown to be relatively efficient within the Indonesian context that is presented here, textile fiber, spinning mills, and finished textiles are extremely inefficient, consistent with conventional wisdom that Indonesia's textile industry suffers from obsolete, outdated, and inefficient machines, which puts these industries at a severe competitive disadvantage on the world market (BPPT and KLH, 2009; Hakim, 2009; Wu, 2007).

'Capacity' (or 'means') to improve on energy use is evaluated through a measure of the distributional range of inefficiency within an industry. This indicator compares the energy performance of a high performing firm (75th percentile of the distribution of energy efficiency) to a low performing one (25th percentile). This ratio shows that even within a subsector, lower performing firms may be several times more inefficient than better performing firms. This is an index that allows assessment of the range of performance on energy use within a sector. Using the BPS survey of manufactures (firm level data), the measure of capacity (range of energy inefficiency) is calculated within a sub-sector (or 5 digit ISIC) as the ratio of the Energy Efficiency Index of the firm at the 75th percentile (higher inefficiency) to that of the firm at the 25th percentile (lower inefficiency). A higher result (the index is much greater than 1) means a wider range of inefficiency within the sub-sector. A wide range indicates that some firms are much more efficient in their energy use, thus demonstrating economic feasibility. Less efficient firms could presumably be brought up to the higher standard through some means that are already deployed by the higher performing firms within the subsector.

Using this measure, the sub-sectors in the top 10 percent and top quartile with respect to range of inefficiency have been identified. Firms at the lower end of efficiency in these sub-sectors will have the greatest opportunity for improvement. The poorest performing firms in a given industry sub-sector could expect to achieve a higher level of efficiency, based on the (demonstrated economically viable) performance of their competitors in the same industry group. For example, the ceramic tile industry (top 10 percent) clearly has some firms with much higher efficiency than others, suggesting that at least half of these survey respondents (the lower half) can improve their performance to compete with those at the high end of this range. This variation is likely due to upgrades and modernization that have taken place at some of the 30 firms manufacturing tile, but not others. In contrast, the cement industry – which is ranked low with respect to this index – has recently converted all wet-clinker kilns to dry-clinker kilns and may be using similar technology across the 18 plants that make up this industry group. This does not mean that efficiency improvement is not available for the cement industry, but examples must come from outside the Indonesian BPS survey sample (e.g., global best practices).

Incentive. Financial incentive is also critical from the perspective of motivating inefficient firms to undertake capital investments or energy management programs. These can be potentially costly, or at least require investment of human resources. Using the BPS survey of manufactures, the measure of incentive is calculated as 'Total Energy Cost as a share of Total Input Costs.' The index is a fraction less than 1. A higher result means greater energy cost as a share of total inputs, hence greater 'incentive' to reduce these costs.

Table 2.5. Energy efficiency metrics: Opportunity, capacity and incentive to improve

Emissions Rank	Manufacturing Industry Sub-sector	Energy Efficiency ("Opportunity" to improve)	Range of Inefficiency within Sector ("Capacity" to emulate better performers)	Energy Share of Total Input Value ("Incentive" to reduce energy spending)
		Metric range: 0-9.1	Metric range: 1-285	Metric range: 0-1
Basic statistics for the metrics for 343 ISIC at 5-digit				
	Average result	0,32	7,4	0,15
	Maximum result	9,1	285	0,93
	(Example industry groups)	Components, parts, malt liquor, metal extrusion, ice	Shore construction equipment, chemicals from fossil fuels	Aircraft, ice, cement, shore construction equip., eyeglasses
	Minimum result	0	1	0
	(Example industry groups)	Wood working machines, copra, industrial leather	Aircraft, office equipment; glass, publishing, fur	Peeling/cleaning of nuts, capoc, processed fish
Top 20 GHG Emitting Subsectors (5 digit ISIC)		Top 10% highlighted in gold; Top quarter highlighted in yellow		
1	Cement	0,72	2,16	0,50
2	Steel rolling industry	0,80	15,90	0,09
3	Iron and steel basic industry	1,17	3,09	0,19
4	Weaving mills except gunny and other sacks	0,32	12,50	0,21
5	Wearing apparel made of textile (garment)	0,13	4,47	0,16
6	Pulp	0,36	6,32	0,17
7	Preparation of textile fiber	1,04	8,52	0,19
8	Structural materials made of porcelain	0,71	10,80	0,29
9	Motor vehicle component and apparatus	0,26	3,89	0,13
10	Straight fertilizer	0,27	12,50	0,23
11	Crumb rubber	0,46	5,68	0,08
12	Toys	0,22	4,92	0,17
13	Finished textiles	0,69	9,10	0,22
14	Spinning mills	0,67	4,84	0,23
15	Cultural papers	0,29	10,40	0,16
16	Tire and inner tubes	1,10	2,43	0,15
17	Crude vegetable and animal cooking oil	0,22	5,79	0,05
18	Products of plastics for technical/industrial purposes	0,31	4,18	0,18
19	Basic chemicals n.e.c	0,41	10,70	0,13
20	Cooking oil made of palm oil	0,80	4,13	0,06

Source: WB calculations, based on BPS Survey of Manufactures, 2005. Duarte, et al. (2008)

Comparing the metrics is also interesting and useful. Looking, once again, at our example of the cement and ceramic tile (porcelain) industries, we see that both industry groups spend a very high fraction of their total input costs on energy (between a third and half!). Thus while both industries should have high incentive to cut these costs, we must refer back to the other metrics to see if they have the opportunity (ability) and capacity (means) to do so.

The cement industry has above average inefficiency and a narrow range of performance, but has high incentive to cut energy costs. This suggests that all 18 firms are at relatively similar levels of efficiency. There may be standard industry equipment or practice that is beyond an individual firm's ability to improve upon. However, as we will see in Section 4, there are additional measures that can be taken to bring the industry up to world best practice level (Indeed, the Ministry of Industry has already laid out plans to undertake some of these measures). Despite the high motivation to cut costs, some of these steps may take additional fiscal incentives, such as carbon payments through the clean development mechanism (CDM) or special tax considerations. On the other hand, Table 2 shows that this industry has among the highest value added among manufacturing sectors, so might be able to shoulder some of the costs on its own, if provided with government assistance in terms of energy management and energy efficiency capacity building.

Metal manufacturing seems to face similar challenges to the cement industry, in that it appears to have opportunity to become more efficient relative to other manufacturing sectors based on its energy use per unit value added, however, the range within the iron and steel industry group suggests that there may not exist means for improvement in terms of more efficient industries to emulate within the survey base. The steel rolling industry, in contrast, does have a wide range of efficiencies. Again, world best practices have been examined and the Ministry of Industry has identified a course of efficiency improvement that would result in significant improvement, but this industry appears to have somewhat less incentive than the cement industry (though still a strong incentive) for reducing costs. Iron and steel appear to have significantly less value added relative to cement and thus fiscal policy is likely to be needed to encourage these investments.

The pulp industry and the ceramic tile (porcelain) industry represent clear differences from this model. Both have opportunity to become more efficient as measured by their energy per unit of value produced. However, the pulp industry has little apparent means to improve and not much incentive. In contrast, the ceramic tile industry has a wide range of firms with varied efficiency practices to emulate and strong incentive to do so. The required fiscal policy response is likely to be different in these instances with targeted specific government investment likely to be needed at the 9 pulp mills in the country and perhaps only government encouragement or threat of regulation. Or perhaps, free energy consulting services through government programs or trade associations to help the underperformers in the ceramic tile industry see what is in their own self-interest.

The textile industry shows mixed results across the 4 separate industries that are within this sector (5 if garments are included). Textile fiber, spinning mills, and finished textiles show a strong opportunity for efficiency improvement relative to their value added. It is interesting to note that this sub-sector has the highest value added among the large GHG emitters (suggesting great potential inefficiency). Weaving mills, on the other hand, do not exhibit unusual inefficiency, but have a wide range in efficiency performance among firms within the sector (perhaps suggesting that a few weaving mills have made the decision to invest in modern, more efficient equipment that clearly is lacking throughout the rest of the Indonesian textile sub-sectors. Finally all of the large GHG emitting sub-sectors within the Textile sector are within the top quarter of industry groups in terms of incentive. They pay between one-fifth and one-quarter of their input costs for energy. The development of approaches for encouraging investment in more efficient equipment requires additional context for this sector, which is provided in Section 4.

2.6. Summary Results of Screening Approach

The screening process outlined in this section aims to facilitate GOI efforts to pursue a lower carbon development path, while maintaining economic growth and improving competitiveness. The 3-tier screening approach provides an analytical, empirical basis for targeting actions and industrial sub-sectors for further action. The screening process helps to break down the problem of energy efficiency in the manufacturing sector into some manageable steps and targets that produce benefits in the short term.

A review of the greenhouse gas emissions from the manufacturing sector shows that the largest emitters are concentrated within just four sectors: non-metallic minerals, textiles, basic metals, and food and beverage. This confirms similar findings from GOI studies (BPPT and KLH, 2009) and literature from other countries (Bernstein et al., 2007). Looking in more detail – at the industry level – several additional significant emitters can be identified for further analysis or action, including garments, pulp, porcelain, auto parts, fertilizer, and crumb rubber.

In addition to being large emitters, most of these sub-sectors are key to the current or future Indonesian economy as measured by several economic metrics including their value added (textile, garments, auto parts, cooking oil, cultural papers), growth rate (fertilizer, rubber), or economic multipliers (pulp, crumb rubber, and cooking oil).

Further, analysis of the potential for cost-effective energy savings shows good potential among most of these same sectors (i.e. cement, metals, textiles, ceramic tiles, fertilizer, etc.). This reinforces findings in the international literature (Bernstein et al., 2007, Price et al., 2005) and within Indonesia (AIRD, 2009, BPPT, 2002) that much can be done to reduce energy use and greenhouse gas emissions from the manufacturing sector through cost effective interventions that result in overall cost savings to the firms, with benefits to the entire economy.

The following table (Table 2.6.) provides a qualitative summary of all the metrics from the three-tiered screening process. The screening process aimed to identify industry groups with GHG emissions reduction potential, that benefit Indonesia's economic development interests, and that have a strong economic incentive to improve. If Indonesia wishes to pursue low carbon alternatives in the manufacturing sector – and to deploy policies, standards, incentives, and assistance toward that end – these would be the likely priority sectors that should be targeted for action.

Table 5 lists the top 20 GHG emitting industries according to BPS survey data for 2005, along with an indication of their prominence among the multiple indices/metrics used in the screening process. Based on significance across several of the screens[9], 17 industry groups (from the 20) are considered to offer significant potential and benefit from efforts to improve energy efficiency and reduce emissions cost effectively. Eight are considered high priority and nine more are medium priority. This is not to say that these 17 sub-sectors should be the GOI's only priority. Rather, this says that focusing on these 17 provides a logical, prioritized starting point for policy and regulatory actions. Such policy and regulatory actions (e.g., efficiency standards for industrial or commercial equipment, accelerated depreciation for energy efficiency investments) could also have wider benefits across other industrial sub-sectors.

9 This is a qualitative assessment, indicating that these industry groups were significant across four or more of the metrics used in this analysis.

Table 2.6. Summary of screening indicators used to assess: (1) Emissions reduction potential, (2) Socioeconomic development importance, and (3) Financial incentive and opportunity to improve energy efficiency

Emissions Rank	Sector	Overall Emission	Economic Development Importance			Energy Efficiency: Opportunity, Capacity, & Incentive to Improve			Overall (Number of Indicators "Positive")
		GHG Emitter (* & Natural Gas User)	Top GDP Contributor	High GDP Growth (2000 - 2005)	High Backward or Forward Linkage	Energy Inefficiency ("Opportunity" to Improve)	Range of Inefficiency within Sector ("Capacity" to Emulate Better Performers)	Energy Share of Total Input Value ("Incentive" to Reduce Energy Spending)	
1	Cement	X*	X	X		XX		XX	HI
2	Steel rolling industry	X			F	XX	XX		MED
3	Iron and steel basic industries	X*				XX		X	MED
4	Weaving mills except gunny and other sacks	X	XX		F*		XX	X	HI
5	Wearing apparel made of textile (garments)	X	XX						LO
6	Pulp	X*			BF*	X			MED
7	Preparation of textile fiber	X*	X		F	XX	X	X	HI
8	Structural materials made of porcelain	X*				XX	XX	XX	HI
9	Motor vehicle component and apparatus	X	XX	X					MED
10	Straight fertilizers	X*		XX	F*		XX	X	HI
11	Crumb rubber	X	X	XX	BF	X			HI
12	Toys	X							LO
13	Finished textiles	X	XX		F*	XX	X	X	HI
14	Spinning mills	X	X		F	XX		X	MED
15	Cultural papers	X	XX		F*				MED
16	Tire and inner tubes	X		X					MED
17	Crude vegetable and animal cooking oil	X	XX		BF*				MED
18	Products of plastics for technical/ industrial purposes	X	X		F				LO
19	Basic chemicals n.e.c	X	X		F	X	XX		MED
20	Cooking oil made of palm oil	X	XX		BF*	XX			HI

Section 3
General Approaches to GHG reductions in the Manufacturing Sector

The prior section identified manufacturing industry sub-sectors where economical and beneficial low-carbon opportunities exist. This section begins exploring how the government can approach these opportunities. A variety of approaches exist based on international best practices – ranging from regulations and government programs, to fiscal or tax policy, to direct assistance, to outreach and education. This section introduces general approaches to consider and points to industry-specific characteristics that might show one approach to be preferable over another.

3.1. General Regulatory and Incentive Approaches

The Government as a whole has a range of tools at its disposal: laws, regulations, fiscal policies, technical assistance, voluntary or educational approaches. Of course, different ministries would have the authority and responsibility for different instruments. The Ministry of Finance is most interested in fiscal policies, but these could also be used in concert with regulations from another appropriate regulatory authority.

Laws. Laws are the most basic policy option, but also one of the most challenging – and beyond the reach of the executive branch. Legislation could require reductions of carbon intensity or other provisions that have the effect of encouraging carbon reductions. Examples include 'cap and trade' permit systems or automobile fuel-efficiency standards. However, legislative approaches are not a typical route used for the highly heterogenous manufacturing sector. Legislation is more appropriately used for economy-wide programs where a 'one-size-fits-all' approach can be applied. Given the political capital and the enormous effort required to build a constituency for new laws, other alternatives may be more effective for an approach targeted at the manufacturing sector alone. Legislation does offer the greatest Government control over outcomes and regulatory certainty for the business community. In any case, new laws would typically be accompanied by more detailed regulations produced by the sectoral ministries.

Regulations. Regulations are much more common in the manufacturing sector, often a highly regulated sector anyway. Regulatory approaches could include energy efficiency standards (applied to various types of equipment or industrial processes), measurement and reporting standards, or requirements to undergo energy audits. Efficiency standards are an increasingly common regulatory approach (as in India, for example). Indonesia regulates fuel efficiency for automobiles and motorcycles (this topic is taken up in a Low Carbon Options report on the transport sector, in draft). Efficiency standards could cut across many sectors (for example, refrigeration) or be limited to just a single sector (for example, steel or cement processes). Regulatory approaches could also be used to establish energy management frameworks and reporting systems that may not require energy or carbon reductions directly, but would enable the tracking and verification of subsequent actions.

Regarding advantages and disadvantages, regulation is generally resisted by industry and does require the Government to enforce the rules to ensure compliance. However, on the positive side, regulation can be tailored specifically to individual industries. For example, one regulation could require a particular energy use requirement (e.g., share of biomass as an energy feedstock for steel and cement, say), while a different regulation could require participation in regular energy audits and tracking of energy usage in textile or food and beverage industries. The regulating ministry would control the regulatory approach.

Fiscal policies. Fiscal policy, tax policy, subsidies and incentives can be offered to encourage or discourage certain activities. Fiscal approaches are most directly within the mandate of the Ministry of Finance and may be the best point of entry for this specific ministry into climate policy. A range of fiscal policies can be used to address emissions and energy use in the manufacturing sector. Some potentially useful examples are summarized in the following Text Box.

Examples of potentially useful fiscal policies

- *Tax differentiation/Tax holidays* can be used to encourage or accelerate investments toward national priority areas. Tax holidays are often used to promote economic development through foreign direct investment.
- *Depreciation* (part of tax policy). Accelerated depreciation for certain kinds of investments provides relief through the tax code affecting firms' cash flow and return on investment.
- *Import tax breaks* (or differential taxation) can be used to stimulate investment in clean technologies (already in limited use in Indonesia)
- *Subsidies (or tax breaks)* for technology adoption can promote specific types of products or technology investments, such as insulation or refrigeration upgrades.
- *Tax treatment of carbon market revenue* can help or hinder investments that seek to obtain Carbon Emission Reduction credits. Some uncertainty over carbon revenue taxation policy has been raised as an issue in the Ministry of Finance Focus Group Discussion Process (see FGD Report, March 2009).
- *Emissions fees or user charges* can be used to reduce emissions or change the mix of inputs used in production processes toward cleaner alternatives
- *Risk guarantees* can be used to lower the cost of capital (and provide an incentive for private banks to lend toward national priority areas). These could be targeted toward specific industries or technologies through special investment funds or lending windows.

The following types of fiscal policies might be useful and effective, but would not be tightly targeted toward addressing energy efficiency issues in the manufacturing sector:

- *Transportation sector charges* (fuel taxes per liter, road tolls, airline traffic taxes) would raise revenue and encourage greater efficiency in fuel use. Economic effect is similar to reducing fuel subsidies.
- *Royalties/rent capture* systems push the incentives upstream to the production of energy resources from the extraction industries.

Source: Min. Finance (2007). Policy Instruments for Influencing Climate Change Mitigation And Adaptation. Background Paper to Accompany Remarks at HLECC for Finance Ministers. Bali. 2007

A more comprehensive fiscal approach involves putting a price on carbon-intensive activities. This approach is emerging in some developed countries, notably Europe and Australia.[10] Pricing carbon relies on market forces to achieve emissions reductions through investments by firms to reduce the cost of carbon as an input or output. Market-based approaches are generally thought to be more flexible and cost-effective than top-down regulatory approaches. However, market approaches may not achieve the expected result (in terms of emission reduction goals, or energy efficiency improvements), if the assessed fee or tax (or the quota level in a capping system) is not set appropriately.

Of course, the Government can also provide direct financial assistance to firms or sectors striving to make energy efficiency improvements and emissions reductions. This could be in the form of soft loans, or budget assistance to State-Owned Enterprises. While Indonesia's fiscal situation is improving, it is unlikely that a developing country focused on growth and poverty alleviation would have the extra resources needed for such direct financial assistance on a large scale. However, some forms of soft financing or loan guarantees could be considered, facilitated by new forms of international climate finance that are now emerging.[11]

Technical assistance. Technical assistance approaches refer to the provision of information and engineering assistance directly to industrial enterprises. This can be done by regulating ministries or through trade associations, assuming they have the technical expertise and resources to offer this kind of help to industries. More often, this kind of service relies on a private sector approach where consulting firms, or newer Energy Service Companies (ESCOs), provide energy audits and advice about cost saving improvements. Energy Service Companies typically identify and assist in the implementation of cost saving approaches and technologies, in exchange for a share of the savings. While these are mainly private sector approaches, Government does have a role, however, in providing an enabling environment for the emergence and development of Energy Service Companies, or other consulting/advisory approaches. The potential of ESCOs is discussed at greater length in the following sections.

Voluntary or educational approaches. Voluntary agreements have been used successfully in some countries (including China and Switzerland) to reduce energy consumption and GHG emissions. In other cases, voluntary approaches have not achieved expected progress (e.g., auto efficiency standards in the EU). Voluntary approaches may work with trade associations or leading firms to identify appropriate and cost-effective interventions. The more effective programs, however, have typically relied on the legitimate threat of regulation if voluntary benchmarks are not met (Price et al., 2006). If the right conditions for success are in place, voluntary approaches can be an ideal way to avoid regulation, but achieve desired results. Voluntary approaches can typically offer industry maximum flexibility in how they achieve goals. Price et al. (2006) use the steel industry in China as an example and this might be a good approach for the Indonesian Steel, Cement or Pulp industry as well. In the EU auto efficiency standard example, the governments were ready to backstop the voluntary agreement with strict regulations that now will be phased in to replace the non-binding targets that were missed.

10 Australia's 'Cap and Trade' approach does not directly set a price for carbon, but rather sets quotas ('caps') on allowable carbon emissions, through permits distributed or auctioned to emitting industries. The price emerges from trading and sales of carbon emissions allowances or permits.

11 Already, Indonesia has technical assistance in energy efficiency from several donor Governments (Denmark, Netherlands). The Climate Investment Funds (a multi donor climate financing instrument managed by the World Bank) also offers the potential for strategic and targeted investments in low carbon technologies, as well as innovative financial approaches, such as loan guarantees that lower the cost of capital and encourage the participation of private sector banks.

If clear energy management practices (enabling clear monitoring and verification of progress) are put in place, then industries can be offered fiscal incentives to achieve targets without the need for regulation. This approach offers the affected industries maximum control, but leaves them with the responsibility of achieving targets to avoid subsequent regulation.

This provides an overview of the various approaches that Indonesia could consider in designing an integrated approach to lowering emissions and improving energy efficiency in the manufacturing sector. After appropriate consideration and inter-ministerial consultation, Indonesia's approach might include a mix of these policy approaches targeted at one or more sectors and accompanied by fiscal incentives. The next section looks at specific mitigation opportunities for the target sectors identified in Section 2.

3.2. General Low Carbon Technology Options for Manufacturing Sector

The Inter-governmental Panel on Climate Change has evaluated and recommended several sector-wide options for GHG emission reductions from the manufacturing sector (Bernstein et al., 2007: p. 456). This provides a sound technical base for further consideration by the GOI. To the extent that industry-wide efforts on energy efficiency and alternative fuel use span multiple sub-sectors, additional benefits can be accrued by being more inclusive. The IPCC sector-wide recommendations for manufacturing are:

- **Management practices and benchmarking.** The development of GHG inventories and carbon intensity benchmarks with monitoring of trends is beneficial for emissions mitigation efforts. These practices have been shown to provide a foundation and guidance for GHG management systems and benchmarking programs.
- **Energy efficiency.** In manufacturing processes, steam and air leaks, poor insulation, and air leaks into boilers and furnaces can contribute to excess energy use. Improperly sized or inefficient manufacturing equipment can lead to low capacity utilization and efficiency. Process level optimization programs and equipment sizing efforts can significantly cut energy use. It has been estimated that 65% of manufacturing electricity use in the EU and US are for motors and motor driven systems. This indicates that efficiency standards on specific equipment can lead to potential savings (Bernstein et al., 2007: p. 473).
- **Fuel switching.** Switching from more to less carbon intensive fossil-fuels (e.g. coal to natural gas) can reduce overall emissions. Similarly, switching to alternative or waste fuels such as biomass, food, or plastic and tire waste can significantly reduce GHG emissions associated with process steam or process heat used in manufacturing processes. It is important to note that some fuel switches could reduce GHG emissions, but increase emissions of toxic substance and local air pollutants (e.g., burning tires for heat). Care should be taken to avoid these kinds of results.
- **Heat and power recovery.** Heat generated for process use at specific temperatures and pressures is often discarded or wasted. After process use, remaining heat (at lower temperatures and pressures) can be recycled to pre-heat incoming air or water streams or for other manufacturing processes. Application is process specific, but would be more relevant in larger firms where capture of waste heat may be more cost effective.
- **Material efficiency and recycling.** End-use programs to identify less energy-intensive substitutes for clinker, steel or other manufactured items can reduce demand for these products. Recycling within plants is also a possibility.

- **Renewable energy.** Use of renewable energy sources for power generation in place of more carbon intensive power generation methods offers mitigation potential and should be considered to the extent that it is economic. This may have specific applications in Indonesia in terms of biomass waste to energy in the paper and pulp sector or solar energy for food drying and dehydrating.
- **Carbon capture and storage.** At the global level IPCC recommends this technology be pursued. However, this is not seen as a viable mitigation option for Indonesia's manufacturing sector at this time. Still, it may be prudent to consider and plan for wider deployment of this technology in the longer term, after 2030.

The first two recommendations bear special mention because energy management practices or energy audits followed by deployment of energy efficiency opportunities is so broadly appropriate that it serves as a key recommendation across all industry sectors and, generally, should be supported on principle. The major distinction between industry groups with respect to implementation of these options has more to do with the size of the facility, rather than the number of affected industries. It is unlikely that every small business or micro enterprise would have the capacity to undertake energy management practices and employ the services of ESCOs to identify and finance cost effective energy improvements. Approaches employing ESCOs certainly do have a proven record of success for in industries where the economy of scale justifies the effort. Lighting, heating, refrigeration, and motor efficiency have been demonstrated to pay for themselves when there are wasteful practices on a large enough scale. Thus some options, such as CFLs and the use of ESCOs, will appear frequently among industry-specific recommendations.

Following these general recommendations, Section 4 provides more specific suggestions tailored to the key manufacturing industry sub-sectors identified in Section 2.

Chapter 4

Low Carbon Options for Key Manufacturing Industries

For the key industry sectors identified previously, this section summarizes literature on technology, regulatory, policy and energy management options that are likely appropriate for stimulating movement toward lower carbon alternatives. This chapter is divided into three sections that address heavy industry, the textile industry, and other more diverse and decentralized industry groups.

4.1. Heavy Industry

Cement

GHG emissions from the cement industry stem from fossil-fuel combustion for power and process heat as well as from the chemical reactions that turn heated limestone into clinker ("calcination process"), the chief component of cement (Bernstein et al., 2007: p. 467). Options for this sector include those that address overall efficiency of the production process and those that reduce carbon emissions from the calcination process. The Ministry of Industry has already targeted this sector for interventions and projects a reduction in emissions of 17.4% relative to a "business as usual" scenario between 2006 and 2025 (BPPT and KLH, 2009). However, the Ministry also notes that these reductions will only be possible through investment and application of technology and believes that the industry needs fiscal or financial incentives to make these GHG reductions (public good) more affordable and cost effective (private good).

The clinker production process is the most energy-intensive stage in the cement making process, responsible for 90% of total energy use (Worrell and Galitsky, 2008). The most significant factor in determining the energy-intensity of an individual plant's clinker making process is whether it has a dry- or wet-process clinker kiln.[12] The cement industry in Indonesia has already cut its energy intensity in half

12 Wet-process kilns allow much higher moisture content of the ground raw material that is fed into the kiln, but require a drying stage to evaporate the water from the slurry.

between 1990 and 2000 primarily by modernizing from wet- to dry-kiln processes (AIRD, 2009). However, the industry remains a large emitter because, as shown in Section 2, coal is widely used to provide process heat for the calcination process (this is also the case globally).

Many additional options are available for bringing Indonesian industry closer to international "best practice" levels of carbon intensity and energy efficiency (Worrell, et al., 2008). Fuel switching to natural gas, waste materials (e.g., plastics or solid waste), or renewable power offers a clear way to reduce significantly the emissions per ton of cement produced (Bernstein et al., 2007: p. 467). One successful CDM project being carried out by IndoCement involves the co-firing of rice husk and other bio-energy sources to reduce coal use and GHG emissions. With appropriate inducements or policies, this might be replicated at all 18 cement plants in Indonesia.

Other process-specific efficiency measures can also enhance efficiency and reduce emissions. Over 30 process-specific measures are considered by efficiency experts at the Lawrence Berkeley Laboratory of the U.S. Department of Energy (Worrell and Galitsky, 2008). These would provide a starting point for industry partners to explore options that may be appropriate for Indonesian firms/plants. The cement making process also uses a lot of electricity for motors for grinding processes. For this reason, motor efficiency standards and other optimizations to the grinding process may offer substantial reduction potential (Worrell and Galitsky, 2008). Energy service companies can draw on international experience and engineering expertise to identify process specific efficiency and optimization potential, that can be quantified and prioritized in terms of total energy cost savings and pay back period for initial investment. Energy management programs and guidance from the Ministry of Industry may also be beneficial.

Studies have shown that the addition of fly ash, limestone, and other materials (blended cements) can lead to material efficiency, lessening demand for clinker per ton of cement. Some of these additives can reduce emissions from the calcination process as well (Josa et al., 2004). This is also a component of a second methodology in the IndoCement CDM project. A review of whether blended cement production makes sense for other Indonesian cement plants may also be useful and has been included in the review of this industry carried out for the Technology Needs Assessment (BPPT and KLH, 2009) which has developed a detailed plan with specific technologies and efficiency measures for this sector to be carried out between now and 2025.

Industry or technology focused interventions, such as the Ministry of Industry climate mitigation plan for 2025, will be more effective in a good investment climate with enabling fiscal policies. This may be an appropriate entry point for the Ministry of Finance. Positive incentives for energy efficiency and climate friendly investments may even encourage additional efficiency improvement by the cement industry, where energy represents half of total input costs. The carbon market-CDM route, though slow, has provided some financial benefits for IndoCement. New sectoral or programmatic CDM approaches may facilitate the expansion of these initiatives to other Indonesian cement plants by lowering transactions costs. Additional fiscal or tax incentives for investment in new technologies could also be beneficial in ensuring the full implementation of energy and emissions savings measures in this industry.

Summary Suggestions for Cement Industry:

- Technology options:
  - Fuel switching/Alternative Fuels – rice husk, other biomass or municipal solid waste, natural gas
  - Employ ESCOs to conduct audits or review Ministry of Industry plans for additional efficiency opportunities
  - Consider additional blended cement plants

- Fiscal policy interventions:
  - Support sectoral CDM programs and encourage/reward new applications
  - Tax incentives for new efficiency equipment investments

Iron & steel/steel rolling

Most reviews of energy efficiency and GHG emission reduction opportunities in the steel and iron manufacturing sector focus on the energy intensive primary metal manufacturing and smelting process. In Indonesia, this occurs mainly at the Krakatau Steel plant in Banten Province and a few other (~16) large production facilities in Indonesia which utilize large quantities of natural gas for iron making. The secondary metal processing and steel rolling industry, with around 51 firms, is less energy intensive, but uses greater quantities of electricity. The Ministry of Industry has already targeted this sector for interventions and estimates a 15.4% reduction relative to a "business as usual" scenario between 2006 and 2025 (BPPT and KLH, 2009). As with cement, however, these are likely to be capital intensive interventions that may require fiscal or financial incentives for the industry. The Ministry's review of steel industry mitigation options (AIRD, 2009) corresponded to measures identified in international reviews including those conducted by Lawrence Berkeley Labs (Worrell et al., 1999; see Tables below). Here we look at both integrated steelmaking (primary iron & steel manufacturing sub-sector) as well as secondary steel processing (steel rolling sub-sector).

Iron & steel. For the U.S. steelmaking industry, a review of options for energy savings and GHG reductions (Worrell et al., 1999) identified 19 separate measures for iron and steelmaking specifically (integrated steel plants that include hot rolling and cold rolling processes are discussed in the next section). The Worrell et al. report provides a detailed description of the estimated capital cost, energy savings, and GHG reduction potential for each measure, based on U.S. economic conditions. In addition to identifying potential measures, the report's economic and financial statistics may serve as a guide for the Indonesian industry. These 19 measures reviewed by (Worrell et al., 1999) appear in the table below.

Table 4.1. Measures for energy savings and GHG reductions for U.S. steelmaking industry

Iron Ore Preparation	Coke Making/Steel Making	Iron Making
▪ Sinter plant heat recovery ▪ Reduction of air leakage ▪ Increase bed depth ▪ Improve process control ▪ Use of waste fuels in sintering plant	*Coke* ▪ Coal moisture control ▪ Programmed heating ▪ Variable speed drive coke oven gas compressors ▪ Coke dry quenching *Steel* ▪ BOF gas + sensible heat recovery ▪ Variable speed drive on ventilation fans	▪ Pulverized coal injection to 130 kg/thrm ▪ Pulverized coal injection to 225 kg/thrm ▪ Injection of natural gas to 140kg/thrm ▪ Top pressure recovery turbines (wet type) ▪ Recovery of blast furnace gas ▪ Hot blast stove automation ▪ Recuperator hot blast stove ▪ Improved blast furnace control systems

Source: Worrell et al., 1999

Steel rolling. India has undertaken a pilot project to reduce GHG emissions from small to medium enterprise steel re-rolling plants through implementation of 32 "Ecotec" options for achieving better environmental performance. "Ecotec" refers to energy efficient technology options that are also economically viable under local conditions. Conditions in India may be a more appropriate comparison for Indonesia than measures identified in the U.S. (see below). Of the 32 options, 13 related to fuel combustion and 19 related to rolling mill and electric efficiency. A detailed review of this UNDP/GEF sponsored project – including the approach to the many institutional and programmatic barriers that were overcome – may be useful (UNDP, 2004).

The Lawrence Berkeley Laboratory study mentioned earlier (Worrell et al., 1999) also identified 13 separate measures for integrated casting, hot rolling, and cold rolling processes. Measures reviewed by (Worrell et al., 1999) that may be appropriate for the steel rolling industry (and integrated plants) appear in the table below.

Table 4.2. Measures for energy savings and GHG reductions for U.S. steelmaking industry

Integrated casting	Integrated Hot Rolling	Integrated Cold Rolling and Finishing
▪ Adopt continuous casting ▪ Efficient ladle preheating ▪ Thin slab casting	▪ Hot charging ▪ Recuperative burners in the reheating furnace ▪ Controlling oxygen levels and variable speed drives on combustion air fans ▪ Process control in the hot strip mill ▪ Insulation of furnaces ▪ Energy efficient drives in the hot rolling mill ▪ Waste heat recovery from cooling water	▪ Heat recovery on the annealing line (integrated only) ▪ Automated monitoring & targeting system ▪ Reduced steam use in the pickling line

Source: Worrell et al., 1999

In the Technology Needs Assessment (BPPT and KLH, 2009) the Ministry of Industry has developed a plan for integrated iron and steel plants as well as for the steel rolling industry. This plan includes both technology needs as well as efficiency measures, many of which are among the listed measures. This plan is based on the experience at Krakatau Steel which has already reduced carbon dioxide emissions by 115,000 tons per year and plans to achieve further reductions of up to an additional 400,000 tons per year.

While many potential iron and steel efficiency improvements have been identified already, additional best practices should be considered independently or with the assistance of qualified ESCOs. The means of financing modernization and equipment upgrades may require slightly different emphasis in the iron and steel sub-sector relative to the steel rolling industry given its somewhat higher incentive to cut costs combined with lower value added (ability to pay).

In terms of an approach for implementing policy in this sector, voluntary agreements have been used in China for the steel industry. Price et al. (2003) provide a detailed description of the process, implementation issues, and results of these initiatives. As described in Section 3, voluntary approaches have worked successfully where a legitimate threat of regulation exists, but also where incentives can encourage participation and make agreements seem more like a partnership. Fiscal policies promoted under a voluntary program could be developed with stakeholder input.

Summary Suggestions for Metals Industry:

- Technology options:
  - Fuel switching/Alternative Fuels – rice husk, other biomass or municipal solid waste, natural gas for iron and steel
  - Employ ESCOs to conduct audits or review Ministry of Industry plans for additional efficiency opportunities
  - Review "Ecotec" technologies employed by India for steel rolling
- Fiscal policy interventions:
  - Sectoral CDM program for Metals industry
  - Voluntary agreement to exchange fiscal incentives for new "efficiency" technology investment

Pulp

Pulp and Paper is one of Indonesia's strategic industries. Pulp production has grown rapidly over the last 8 years (>8% per year), due to positive Government inducements and financial incentives, and at the expense of large areas of natural forest (Barr, 2002; World Bank, 2006).[13] Pulp production is an important export industry, earning $3 billion in 2000. Paper production is less important for trade and export earnings, but is important for economic development and employs more people in more and smaller plants than the pulp sub-sector. There are about 9 large primary pulp mills in Indonesia and thousands of smaller paper mills, some of which also pulp recycled paper for part of their feedstock. The Ministry of Industry has included the pulp sub-sector as an important target for investments and interventions that will result in a 17.5% emission reduction relative to a "business as usual" scenario between 2006 and 2025 (BPPT and KLH, 2009). In contrast to textiles, the pulp industry is very profitable and competitive internationally and should not need fiscal or financial incentives to achieve emissions reduction targets.

The primary opportunities to save energy and reduce GHG emissions in the complex manufacturing processes of paper and pulp manufacture are (1) expanded use of biomass fuels to offset the need for fossil-fuels for process heat, (2) greater use of heat recovery and combined heat and power, and (3) implementation of sector-wide energy management and energy efficiency practices (Bernstein et al., 2007, pg. 470).

13 Forest sector emissions are not considered in this paper, but are quite high due to deforestation, forest fires, and peat land conversion. Timber plantations to provide feedstock to pulp mills are an important contributor to forest loss. This paper focuses only on carbon emissions from the pulp manufacturing process, not the timber production process. Forest sector emissions and possible policy interventions are taken up in a separate Low Carbon Options Study.

Mirroring the IndoCement CDM project, the pulp industry could expand use of biomass fuels. By substituting a fraction of fossil fuel with mill residues, waste timber, or high caloric rice-husk, pulp and paper mills can reduce the need for some fraction of primary fuels. Fuel switching opportunities should be carefully considered in the context of process heat needs. In the pulp sub-sector, it may make more sense to look for combined heat and power opportunities that would provide process heat and electric power simultaneously (cogeneration). The Technology Needs Assessment plan (BPPT and KLH, 2009) relies on the experience at PT Pindo Deli, a firm that has undertaken oil to gas fuel switching, cogeneration, and energy efficiency measures.

Martin et al. (2000) reviews 45 energy saving options applied in the US paper and pulp manufacturing industry, which have *economic* potential to reduce energy use by 14 percent. A review of these technologies and an investment program for appropriate technologies to Indonesian industry should be considered. In addition, a "handy guide" for energy efficiency opportunities has been developed to offer practical guidance for developing economies in Asia and may offer ideas more tailored to the Asian industry (UNIDO and MITI, 1993).

As discussed in Section 2, the pulp industry has less incentive to improve efficiency relative to other heavy industry, so government incentives may be needed to make improvements. Given the opportunity to use on-site mill residue or other waste products and cogeneration potential, it seems like a targeted pulp industry tax policy or even a direct grant program may be appropriate. With only 9 pulp mills in the country, the total cost to the government is limited and the benefits, potentially large.

Summary Suggestions for Pulp Industry:

- Technology options:
  - Fuel switching/Alternative Fuels – mill residues and wood waste, natural gas
  - Cogeneration and additional process efficiency
  - Review Ministry of Industry plans and international best practice for additional efficiency opportunities at 9 pulp mills, specifically.

- Fiscal policy interventions:
  - Tax incentive for co-generation and process efficiency investment
  - Government grant program

Porcelain/ceramics

The major energy-intensive process in the ceramic tile industry is the firing of ceramic tiles in a kiln or the firing of porcelain tiles in a furnace. Natural gas is the primary fuel source for the kilns and furnaces at the large industrial tile makers in Indonesia leading the large natural gas emissions from this industry. This is in stark contrast to the state of this industry only two decades ago when 96 percent of the tile product came from numerous, wood-fired artisan production units (World Bank, 1987). Apparently rapid industrialization of this process has greatly expanded output capacity and quality of the product and increased greenhouse gas emissions along with the switch away from biofuels to fossil fuels.

The Ministry of Industry studies and the Technology Needs Assessment (BPPT and KLH, 2009) examine the ceramic and glass industry, but do not identify a specific goal for this industry group citing a lack of detailed data. The current review, however, suggests that the ceramic tile makers (as incorporated into the "structural materials made from porcelain" ISIC category) are a higher priority than the glass-manufacturing sector and thus we focus on efficiency measures appropriate to ceramic tile.

Ceramics manufacture is typically accomplished by two-stage process whereby formed objects are first dried to remove excess surface moisture and shrink the product so that molecules are closer together. This is followed by a higher-temperature firing process that combusts organic material that is still present in the clay and sinters a portion of the clay to strengthen the product. Often the drying stage is performed in a kiln directly above the firing kiln in order to take advantage of heat recovery opportunities.

Addressing air leaks and heat recovery options were among the principal recommendations identified in 1994 *Handy Manual* on energy conservation in the Asian ceramics industry (UNIDO and MITI, 1994). The recommendations specific to the drying process include combustion control (combustion temperature) measures and thermal insulation measures. The firing process has a number of potential measures that can be reviewed including the following measures for the firing process:

Table 4.3. Measures for energy conservation in the ceramic industry

Good Housekeeping	Equipment Improvements	Process Improvements
1) Exhaust gas temperature control 2) kiln seal 3) Cooling air 4) Air ratio 5) Firing management (heat curve, temperature distribution in the kiln, kiln pressure, atmosphere) 6) Loading pattern on the kiln car 7) Clearance between kiln wall and kiln car 8) Sand seal 9) Kiln car pushing speed	1) Refractories on the kiln car (to be light in weight) 2) Refractories in the periodic kiln (to be light in weight) 3) Form of the tunnel kiln 4) Recovery of exhaust gas 5) Kiln car pushing speed	1) Conversion from the tunnel kiln to the roller hearth kiln

Source: UNIDO and MITI, 1994

IFC has developed an Environmental Health and Safety note (IFC, 2007) for the ceramics industry with energy consumption benchmarks and a variety of energy saving measures for spray-dryers, kilns, and other measures that are listed below.

Table 4.4. Energy conservation measures for the ceramics industry

Kilns	Spray dryers / Other
• Replace inefficient kilns (e.g. down-draft kilns), and install new, adequately sized tunnel or shuttle kilns or fast-firing kilns (e.g. roller hearth kilns). In the sanitary ware industry, consider installing roller hearth kilns, especially if a reduced number of patterns is produced; • Substitute heavy fuel oil and solid fuels with clean fuels (e.g. natural gas or LPG); • Improve kiln sealing to reduce heat losses arising from excessive air flow (e.g. metal casing and sand or water seals in tunnel kilns and intermittent kilns); • Improve thermal insulation of kilns to reduce heat loss; • Use low thermal mass insulation in intermittently fired kilns; • Use low thermal mass liln cars to improve overall efficiency (e.g. using materials such as cordierite-mullite, sillimanite, and recrystalized silicon carbide), as well as minimize other parasitic loads; • Use high-velocity burners to obtain a higher combustion efficiency and heat transfer; • Optimize peak flame temperatures in the kiln, and install computerized control of kiln firing; • Optimize dried-material transfer between the dryer and kiln, and where possible, use the preheating zone of the kiln for completing the drying process (to avoid unnecessary cooling of the dried ware before the firing process); • Recover excess heat from the kiln, especially from the cooling zone, for heating dryers and pre-drying products; • Recover heat from kiln exhaust gas to preheat combustion air.	**Spray dryers** • Selection of spray dryer with an optimized nozzle; • Installation of insulation for the spray dryer; • Proper sizing of exhaust fans and installation of inverter-based variable-speed controls, rather than fixed-speed fans and dampers. **Other** • Use of high-pressure hydraulic presses in ceramic tiles; • Use of press casting in sanitary ware plants; • Optimization of grinding-cycle time in ball mills; • Optimization of the amount of water in the mill mix; • Limitation of electrical load in mills, through adoptions of dual-speed electrical motors or electric motors fitted with fluid couplings; • Use of moisture sensors for dryness and coating control in ceramic tile manufacture; • Use of cogeneration of heat and power to generate power with waste heat from gas turbine-based operation of the spray dryer.

Source: IFC, 2007

Finally, an emerging technology developed by the U.S. Department of Energy and Huan Labs has resulted in a low-cost, energy-efficient process to manufacture ceramic tile from large quantities of waste glass which significantly reduced the energy associated with the raw material acquisition and preparation as well as large efficiency in the production steps (USDOE, 2001). This new process has not been demonstrated as scale yet, but may be as option over the next several years.

As shown in the screening analysis, while this sector may contribute somewhat less to GDP relative to other large emitting sub-sectors, it has been growing. Furthermore, it has by far the highest ranking in terms of opportunity, capacity, and incentive to become more efficient. Among the 30 medium and large firms in this sector, several are significantly outperforming others in terms of energy efficiency. With a model for efficient tile manufacture and additional international best practice efficiency options, this sector is ideally suited for reduction in carbon intensity.

The Ministry of Finance may want to consider a government program to provide ESCO services free of charge to the underperforming firms with respect to energy efficiency and potentially low interest loans (or accelerated depreciation) to those firms that decide to make efficiency investments. Energy management programs might be included and the establishment of reporting requirements or benchmarking (publish a list of the relative efficiency performance of the firms in the sector) could provide additional incentive for the poor performers to improve.

Summary Suggestions for Porcelain/Ceramic Tile Industry:

- Technology options:
  - ESCO review of underperforming firms for process efficiency in the drying and firing processes
  - Energy management/benchmarking programs
- Fiscal policy interventions:
  - Government funded energy audits
  - Low interest loans for efficiency investments, or accelerated depreciation schedule for older equipment

Fertilizer manufacture

Straight nitrogenous fertilizers such as ammonium nitrate and urea are produced widely in Indonesia via steam reformation of natural gas (methane, or CH_4). The steam is passed through natural gas to form hydrogen, carbon monoxide, and carbon dioxide. The hydrogen is then used to produce ammonia (NH3), which can be reacted with nitric acid to produce ammonium nitrate, or with some of the carbon dioxide produced to form urea. This feedstock carbon, however, is ultimately returned to the atmosphere, after the nitrogen from the urea has been taken up by crops. The large amount of natural gas used by the 15 ammonia and urea facilities in Indonesia has been identified by the Ministry of Industry as a potential for efficiency and conservation measures in the Technology Needs Assessment (BPPT and KLH, 2009). Measures identified as already implemented in the TNA have reduced emissions by about 70,000 tons per year of CO_2 from this industry segment.

Over 80 percent of the energy use in the production of straight nitrogenous fertilizers (i.e., urea) is in the ammonia production stage and generally, newer plants that use natural gas as a feedstock are likely to already be close to world best practice levels of energy efficiency (Schumacher and Sathaye, 1999). However, for older plants or those that might not be meeting world best practice levels of energy intensity, general strategies to increase efficiency of the ammonia production process include (Gellings and Parmenter, 2004):

- Replace process equipment with high efficiency models
- Improve process controls to optimize chemical reactions
- Recover process heat
- Maximize recovery of waste materials.

The measures identified at Indonesia urea plants in the TNA are more specific, but likely to be plant-specific. An audit of energy efficiency options for each of the 15 plants should be conducted to determine the specific measures appropriate for each plant. The range of energy efficiency opportunities for this sector (Section 2) demonstrates that the firms in this sector vary widely with respect to their efficiency practices. Similar to the ceramic tile industry, it is likely that the older plants are underperforming some of the more modern facilities. As with the pulp industry, there are only a limited number of firms, so the potential cost of helping the underperformers is likely to be quite limited. Tax incentives or a grant program for this industry may be appropriate.

Summary Suggestions for Fertilizer Industry:

- Technology options:
  - ESCO review of underperforming firms for process efficiency and heat recovery in the ammonia production process
  - Energy management/benchmarking programs

- Fiscal policy interventions:
  - Government funded energy audits
  - Low interest loans for efficiency investments
  - Government grants for efficiency investments

4.2. Textile Industry

Indonesia is an important global source for textiles and clothing. In 2004, it ranked tenth in the world and first in ASEAN for exports of textiles and clothing. In the manufacturing sector, it is the largest employer (>1.2 million people at over 4,500 factories), the third largest GDP contributor, and a major source of export earnings. The Ministry of Industry has included textiles as an important target for investments and interventions to decrease emissions by 27.8% relative to a "business as usual" scenario between 2006 and 2025 (BPPT and KLH, 2009). As with cement and steel, the Ministry notes that the industry may require fiscal or financial incentives to achieve this goal. Potential GHG reduction opportunities are entwined with overall investment, trade and growth potential in the textile industry.

The textile sector's major energy use is in the form of electricity to run the looms and mills needed for textile manufacture. It is also recognized, however, that the textile manufacturing equipment is in major need of upgrades and efficiency improvement (the majority of machines are over 15 years old, and less than 10% would be considered new, Wu, 2007). The industry's international competitiveness has languished due to higher labor and capital costs, a large debt load, and lack of recent capital investment and infrastructure renewal. Lack of investment is partly due to uncertainty of the future textile industry[14] and this has a great influence on the kinds of investments that can be considered for emissions reductions. If the industry is not investing in competitiveness and export markets, it is unlikely to invest in energy savings from electricity use.

Major investments in new, efficient manufacturing equipment is needed to maintain this market and protect current export markets in the U.S., EU, and Canada. A Government sponsored investment program or policy intervention to assist this industry could be justified based on its economic importance (trade and jobs, but not growth). If so, modernization of equipment and energy saving measures for competitiveness would also produce substantial additional benefits in terms of GHG emission reductions.

14 WTO regulations that historically benefited the Indonesian textile industry in the US and EU are due to change, threatening perhaps a third of Indonesia's exports. At the same time, China's and India's more competitive textile industries have been expanding rapidly (Hakim, 2004; Wu, 2007).

Throughout this discussion, manufacture of textile fiber, spinning mills, weaving mills, and the manufacture of finished textiles are included as contributors to the overall emissions. Issues specific to any individual sub-sector are noted. The main source of emissions is from the electricity used to run looms and mills, so newer and more efficient equipment would contribute to GHG reductions. The roughly 27 percent GHG emission reduction anticipated through the Ministry of Industry plan for industry renewal involves the replacement of machines in over 2,700 textile factories nationwide – at a cost of over US$1.7 billion – with new, more energy efficient equipment (BPPT and KLH, 2009).

Compact fluorescent Lamps (CFLs) are generally considered a 'negative cost' investment; that is, they pay for themselves very quickly through savings in the energy bill. Textile factories are among the larger employing industries. Thus, if energy-efficient lighting has not been introduced in textile, spinning, and weaving mills, it represents an even larger potential energy savings in these industry sub-sectors relative to others.

Summary Suggestions for Textile Industry:

- Technology options:
  - Efficiency standards for looms/mills
  - Energy management/benchmarking programs
  - CFLs and Process heat/cogeneration

- Fiscal policy interventions:
  - Tax policy to encourage foreign investment
  - Low interest lows for efficiency investments, or accelerated depreciation schedule for older equipment
  - Incentives for Energy Performance Contracting (usually with ESCOs)

Another source of energy/emissions reductions was identified by BPPT (2002) in a review of CDM potential in Indonesia. This study found that 38 million tons of GHG emissions could be avoided at a relatively inexpensive cost of approximately $9 US per ton by reconstructing cogeneration and heating systems in the textile industry. This would provide heat and onsite process heat/steam while generating electricity from the waste heat created. This option could have potential in the context of an overall investment revitalization program. Without major new investments for productive capacity and efficiency, it is unlikely that many firms would undertake process heat investments.

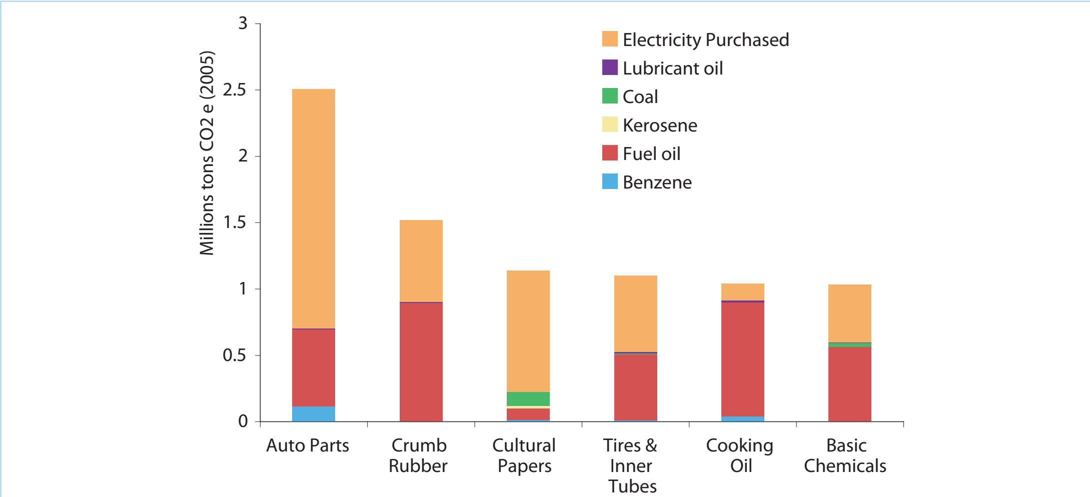
These recommendations depend on the GOI's policies and approaches to the overall strategic importance of the sector. If the competitiveness of the sector continues to decline, it will be difficult to encourage GHG emissions reductions on economic grounds.

4.3. Other Industries: Distributed, smaller firms, less concentrated target

Among the remaining high and medium priority sectors – including motor vehicle components and apparatus, crumb rubber, cultural papers, tires and inner tubes, cooking oil (from both vegetable oils and palm oil), plastics and basic chemicals – the approaches that might be considered are not necessarily industry specific.

These six categories tend to be more diverse in energy and technology use relative to the heavy industries discussed above. As Figure 4.1. demonstrates, all these industries are either large electricity users (auto parts and cultural papers), large oil users (crumb rubber and cooking oil), or large users of both (tires and inner tubes and basic chemicals). In fact, an analysis of the larger dataset shows the smaller industrial groups are even more likely to be dominated by electricity use alone.

Figure 4.1. Sub-sectoral breakdown of surveyed GHG emissions by fuel-type for 2005 for six priority industry groups



It should also be noted that further statistical analysis of the metrics presented in the third tier of our screening process (Duarte, et al., 2008) has shown that the variability of efficiency within sub-sectors is typically greater than the differences between sectors, suggesting that all sectors may have potential for efficiency improvements. Those identified through this screening process are likely to have some of the greatest inefficiencies, and thus may benefit the most from interventions. Improvement approaches may be more general and not specifically tailored to each specific industry sub-sectors.

Options to reduce the carbon intensity for these industries are also less varied than for industries with multiple unique fuel-types and processes. In general, electric energy efficiency identified through energy audits or ESCO service providers are going to provide the greatest opportunity to identify specific opportunities for each plant. What will matter more is the capacity of smaller firms and plants to undertake energy efficiency programs and implement meaningful reforms. Fiscal policy options that support this practice will benefit these industries and a range of smaller industry sectors.

Section 5
Putting it Together

Based on literature on best practices and international recommendations, this review has identified several important types of programs and interventions that may help in achieving lower carbon goals in the manufacturing sector. The literature mainly focuses on three main areas: Capital Stock/Investment Options, Regulatory Options: Energy/Equipment Efficiency Standards, and Energy Management and Energy Efficiency Options. Following the interest of the Ministry of Finance and based on prior work in the Low Carbon Options Study, this review has also identified, where possible, fiscal policies and incentives that can enhance the effectiveness or uptake of the other interventions. It has been noted where some industries may expect or require financial assistance to undertake these investments. Carbon markets and international climate finance instruments can provide some assistance in identifying and accessing softer forms of investment capital or donor grant funds that can help Indonesia achieve its carbon reduction goals in the manufacturing sector.

This review also highlights that the carbon emitting target sectors comprise two very different forms of industrial organization. Some manufacturing sectors (cement, steel, and pulp) consist mainly of large capital-intensive industries with relatively few plants. Others (food and beverage, textiles) consist mainly of many (thousands) smaller and medium-sized enterprises. Different approaches to energy and greenhouse gases (GHG) emissions improvements will be needed in the two types of sectors. Where there are a few, large firms, tailored solutions and detailed technical assistance can be offered cost effectively (whether by the Government, through donor projects, or the private sector). Where there are thousands of small firms, sector wide approaches, technology standards and general tax incentives may be more effective.

This section provides a brief summary of the main findings regarding technical interventions. These are also summarized in the Table 5.1.

Capital stock/investment options. There are *specific technology investments* that make sense for large, capital-intensive industry groups like cement, steel, or pulp. The specific technology and financing requirements will differ from industry to industry. In the larger sectors (cement, steel, pulp), some carbon reduction opportunities will involve capital intensive projects. Fiscal incentives or soft financing, or loan guarantees may be needed for firms or sub-sectors that have little incentive to carry out the energy efficiency measures.

The Ministry of Finance has a useful point of entry into the process through the use of fiscal incentives and management of the investment climate. The Ministry of Finance may also play an important role in identifying and accessing international funding from climate finance sources or donors. The Ministry of Finance also plays a role in enhancing firms' ability and incentive to produce and sell Carbon Emissions Reductions through the Clean Development Mechanism (by clarifying tax policy for Certified Emission Reductions (CERs) and by clarifying the status of CERs as collateral in the banking sector). Greater regulatory certainty can help to catalyze both foreign and domestic direct investment in climate friendly technologies.

Regulatory options: Equipment efficiency standards. *Efficiency standards* should be considered for industry sectors with thousands of small and medium enterprises, like the food and beverage industry or even the textile industry. Efficiency standards will help move firms toward more efficient equipment as capital stock is turned over. Efficiency standards could be targeted at the most energy inefficient equipment that is most widespread in the sector. For example, in the food and beverage industry, refrigeration and grinding equipment are common, so standards aimed at these devices could have important benefits, both in terms of energy efficiency and in terms of GHG emissions reductions.

Again, this is mainly a technical area, but the Ministry of Finance has an important entry point. Fiscal incentives can be provided to speed up the transition to new equipment (e.g., tax rebates or changes to the depreciation schedule of purchased equipment). Further, development assistance (low cost or grant financing) could be directed at the underlying industries that produce basic equipment, such as refrigerators. In the Ozone Depleting Substances program, an international program and grant assistance targeted technology changes in the manufacture of chillers used in the production of air conditioners. This has been an effective program internationally (UNEP, 1987), and could be replicated for lighting, refrigerators, and possibly some kinds of food processing equipment or the motors that power them.

Energy management and energy efficiency options. *General energy management practice* and *intensive energy efficiency deployment* will benefit all industry groups. These approaches have been shown to be effective and efficient ways to reduce energy use, energy costs, and greenhouse gas emissions. The GOI could support the development of energy management practices through an energy audit program or other forms of assistance. The GOI could also enable future energy savings by establishing monitoring and verification protocols that allow for crediting of energy and carbon reductions through a variety of efficiency deployment models. One of the most successful models of efficiency deployment has been the combination of voluntary or regulatory efficiency targets backed up by Energy Service Company (ESCO) supported implementation. Efforts to expand this service sector in Indonesia through tax incentives or other means would pay long-term dividends in terms of efficiency gains.

One entry point for the Ministry of Finance would be helping to pay for audits and other services through prioritized budget allocations or through directing of donor assistance. A second entry point would be through facilitating the regulatory environment to allow the emergence and profitable activities of ESCOs.

Table 5.1. on the following page summarizes these findings in somewhat greater detail, focusing on the "8 + 8" industry sectors identified as key targets in Section 2. The industries are listed in rows, while the intervention areas are listed in columns. This table may provide a basis for further discussion of appropriate roles and responsibilities among the Finance Ministry and other sectoral ministries toward designing an integrated low carbon approach to the manufacturing sector.

Table 5.1. Summary of policy options to promote investments and technologies that reduce energy use and GHG emissions for priority manufacturing sectors

Emissions rank	Industry Sectors	No. of firms/ plants	Ministry of Industry Priority	Capital Stock/ Investment Options: (potentially eligible for carbon finance)	Regulatory Options: Energy/ Equipment Efficiency Standards	Fiscal Policy Enhancements: Incentives & Financial Assistance	Energy Management & Energy Efficiency Options
Large, Concentrated Industries (50 firms or less)							
1*	Cement	18	High	Co-firing with biomass; blended cement; MOI plan implementation	Grinding equipment; motors	Encourage sectoral CDM; Faster depreciation or tax breaks for energy efficiency/emissions reduction investments	All sectors with few, large firms can benefit from energy management practices and audits using in-house resources or through Energy Services Companies (ESCOs)
2	Steel rolling	51	Medium	MOI plan implementation; Ecotec options in rolling industry	Arc furnaces; voluntary agreement	Tax breaks, soft financing for capital stock improvements	
3*	Iron and steel basic industry	16	Medium	Alternative fuels; heat recovery; MOI plan implementation	Furnace and drive efficiency	Access to international climate finance to lower cost of capital	
6*	Pulp	9	Medium	Co-firing with biomass; heat recovery; cogeneration		Direct grant program or targeted tax policy for 9 pulp mills	
8*	Structural materials made of porcelain (ceramic tile)	30	High	Process optimization; thermal efficiency	Kilns; spray dryers	Govt finance of ESCOs; incentives (or penalties) for underperforming firms; (e.g. low interest loans, change depreciation schedule)	
10*	Straight fertilizer	15	High	Optimize process controls; heat recovery	High efficiency process equipment	Direct grant program or targeted tax policy for 15 fertilizer/urea plants; Govt finance of ESCOs; low interest loans for investment	
Textiles, many firms, less concentrated target							
4	Weaving mills	495	High	Modernize equipment throughout industry (2700 machines at a cost of US$1.7 billion); co-gen & heating system reconstruction	CFLs; loom & mill efficiency	Tax policy to encourage foreign investment; low interest loans for efficiency investment; accelerated depreciation schedule	Consider a donor assistance project to provide ESCO-like advice for the textile industry
7*	Textile fiber	78	High		CFLs; loom & mill efficiency		
13	Finished textiles	167	High		CFLs; loom & mill efficiency		
14	Spinning mills	68	Medium		CFLs; loom & mill efficiency		
Other industries: Distributed, smaller firms, less concentrated target							
9	Motor vehicle component and apparatus	168	Medium	Sector-specific analysis for electric equipment and process efficiency	Motor; Chain drive		Energy management & energy efficiency options
11	Crumb rubber	146	High			Government finance of ESCOs	Govt assisted ESCO services
15	Cultural papers	43	Medium		CFL		ESCO
16	Tire and inner tubes	33	Medium		CFL		ESCO
17 (&20)	Crude vegetable oil (& palm) and animal cooking oil	295	Medium			Government finance of ESCOs	Govt assisted ESCO services
19	Basic chemicals not elsewhere classified	37	Medium				Energy management & energy efficiency options

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Appendix A

Alternative Representations of Carbon Rank Data for Screen 1

As described in the main text, several ways to look at the ranked carbon data were explored both with and without the estimated natural gas use by specific manufacturing sectors provided by the Ministry of Industry, AIRD (2009). The following figures demonstrate several alternative ways to display the carbon emissions calculated from the BPS Large and Medium industry survey data for 2005.

Figure A-1: 2 digit ISIC carbon ranking for medium and large businesses surveyed by BPS (with supplemental estimates of natural gas use from AIRD for select industries; Same as Figure 1).

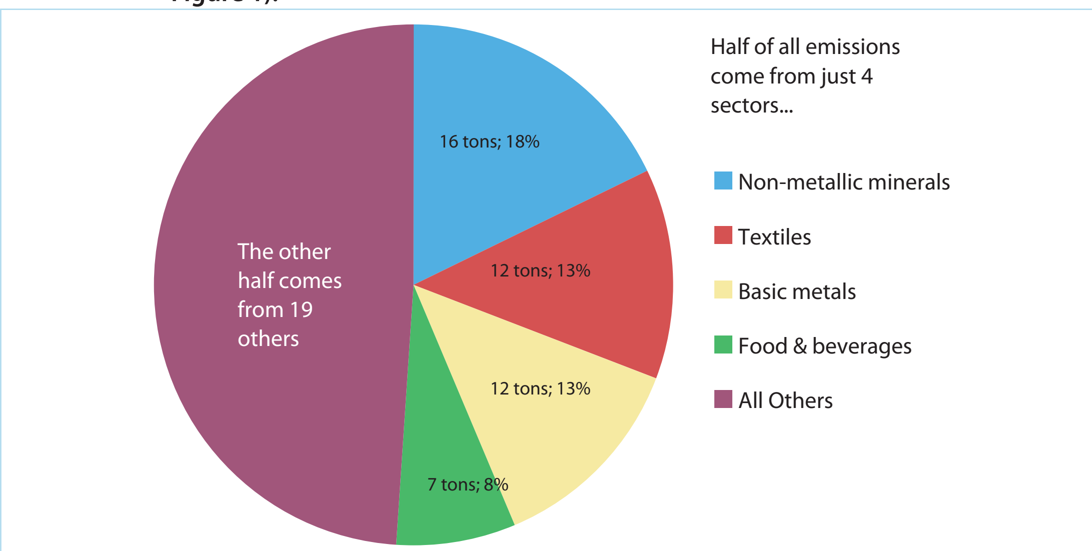


Figure A-2: 5 digit ISIC carbon ranking for medium and large businesses surveyed by BPS (with supplemental estimates of natural gas use from AIRD for select industries).

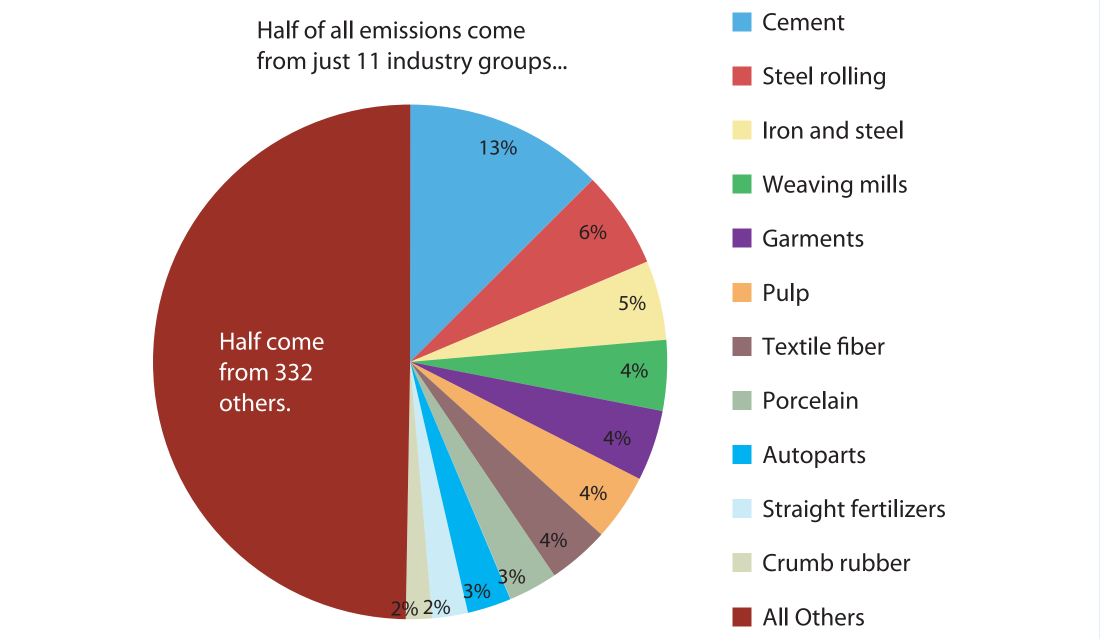
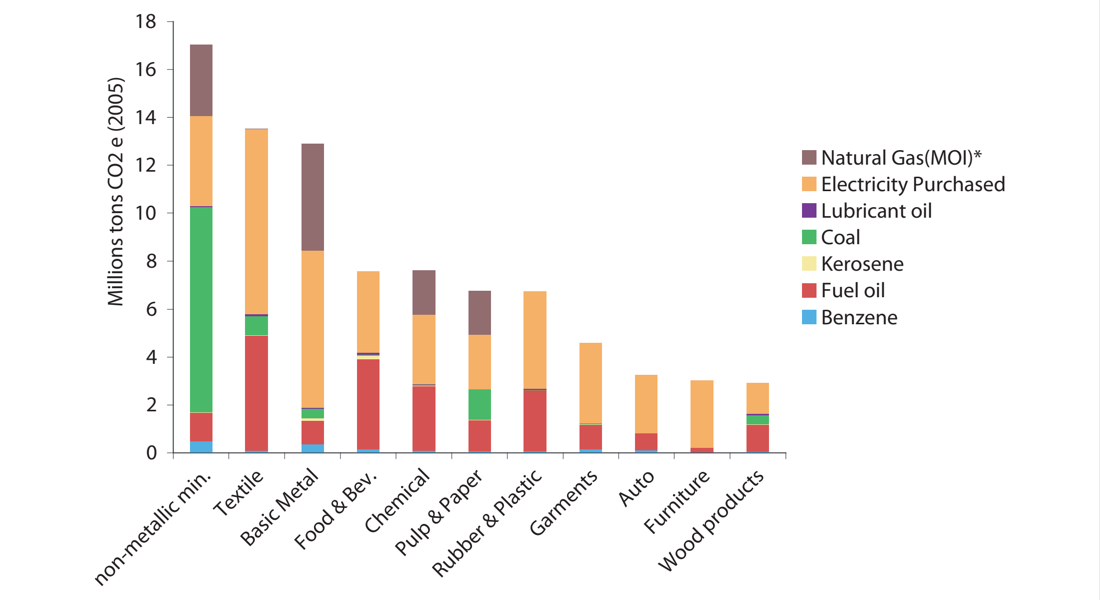


Figure A-3: 2 digit ISIC carbon ranking with fuel breakout for medium and large businesses surveyed by BPS (with supplemental estimates of natural gas use from AIRD for select industries; to be compared to Figure 2).



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