INDUSTRIAL ENERGY EFFICIENCY IN ASIA: A BACKGROUND PAPER
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This paper outlines the landscape of current and future industrial energy demand in Asia, highlights existing efforts in Asia to increase industrial energy efficiency, and provides recommendations for developing Asian countries to implement industrial efficiency Nationally Appropriate Mitigation Actions (NAMAs). It seeks to enhance awareness and opportunities pertaining to industrial efficiency NAMAs.
I. BACKGROUND

**Regional industrial energy demand.** In 2008, the industry sector consumed a total of 191.3 quadrillion BTU, 38% of global energy consumption across all sectors of the economy. China accounted for nearly a quarter (24%) of this industrial energy demand. Other developing economies in Asia, including India, South Korea and non-OECD Asian countries, accounted for another 14 percent of energy use by the industrial sector.¹ *(See Figure 1, below)*

![Figure 1. Asian Industrial Energy Delivered in 2008 (as a share of global industrial energy delivered)](image)

Industrial energy use is expected to increase substantially in the coming decades, with the most rapid growth expected by non-OECD countries in Asia. Non-OECD Asian countries will lead industrial energy demand by an average of 2.3 to 2.6% per year, compared to projected annual growth in OECD countries of 0.5% per year. *(See Figure 2, below)* Over the next 20 years, a significant share of this growth is expected to occur in China (projected increase of 2.4% per year), India (projected increase of 2.6% per year), and other non-OECD Asia countries (projected increase of 2.3% per year).² *(See Figure 3, below for values in BTU)*

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Figure 2. Projected Average Annual Percent Industrial Energy Growth from 2008-2035

Figure 3. Projected Industrial Energy Demand from 2008-2035 in Quadrillion BTU
1 quadrillion BTU = 1.055 exajoules (EJ)
**Sector breakdown.** Global industrial energy consumption is driven by five main industries, which together account for over 60% of industrial energy demand, including chemicals (33%), iron and steel (14%), nonmetallic minerals, which includes cement, glass, brick, and ceramics (7%), pulp and paper (4%), and nonferrous metals (3%).

In Asia, China dominates the industrial energy landscape, with significant energy demand coming from the iron and steel, nonmetallic minerals, and chemical sectors. In contrast, energy demand in India comes from a combination of light manufacturing and services as well as heavier industries such as iron and steel production.

Outside of China and India, the chemical sector in Asia (mainly from Malaysia, Taiwan, Singapore and Indonesia) makes up 20% of the total energy demand. In South East Asia (especially Indonesia but also Thailand, Vietnam and Laos), a growing manufacturing sector is increasing demand for cement, steel, brick/ceramic, glass, pulp and paper, plastics, chemicals, food processing, and textiles. (See Appendix, below for Participant Country Industrial Growth Spotlight)

**Energy efficiency opportunity.** While knowing the projected growth and sectors are important in identifying opportunities for improvement, the design of specific policies should be based on a detailed understanding of the specific sector-based opportunities and barriers in each country. For example, an analysis by Lawrence Berkeley National Laboratory (LBNL) of China’s cement and steel industries found various cost-effective technologies and measures that have not yet been adopted.

Top options in China’s cement industry, based on the largest electricity savings potential (GWH) and reduction in CO2 emissions, are as follows:

1. Using a high pressure roller press as pre-grinding to a ball mill
2. Replacing a ball mill with vertical roller mill
3. Using adjustable speed drives

Other options resulting in large fuel savings and reduction in CO2 emissions include:
4. Production of blended cement
5. Energy management and process control systems in clinker making process

Similarly, top options in China’s iron and steel industry, based on the largest electricity savings potential (GWH) and reductions in CO2 emissions include:

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1. Increasing the penetration of top-pressure recovery turbines (TRT)
2. Increasing the penetration of coke dry quenching (CDQ) technologies
3. Continuing to replace (or upgrade) smaller, less-efficient facilities with larger international-class mills

Further, industry expert Dr. Hasanbeigi of LBNL commented on future policy options in the cement sector that can result in large energy savings and reductions in CO2 emissions.

1. Closing down vertical shaft kiln (VSK) cement plants and building only new suspension preheater rotary kilns*
2. Increasing the use of alternative fuels and raw materials
3. Increasing the use of municipal solid waste and sewage sludge as alternative fuels

*Note this first option is only applicable to China since other countries do not use VSK; options 2 and 3 are applicable to other countries.

By identifying the largest opportunities for mitigation actions and understanding the barriers to implement effective programs to promote the implementation of energy efficiency, China can begin to develop effective policies and procedures that address these issues.

II. POLICIES AND MEASURES

The projected growth in energy demand for industrial production comes at a steep environmental cost. Efficiency improvements can help reduce the projected increase in industrial energy demand while continuing to support the levels of industrial growth required to meet development goals. A variety of tools are available to encourage energy efficiency and more sustainable development, including: 1. Political mandates, 2. Technological change, 3. Financial support, 4. Rationalizing energy prices, 5. Benchmarking and auditing and 6. Information and awareness. In most cases, a combination of these policies will be most effective in yielding improvements.

1. Political Mandates

National or sub-national energy efficiency or energy intensity targets can signal the importance of efficiency improvements and provide an organizing framework for other more specific policies and measures. China and India have established high-level political mandates, as follows:

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7 John Newman, Energy and Environment Consultant
• In China’s 12th Five-Year Plan, the national government instituted a goal of reducing energy intensity by 16% and carbon emissions per unit of GDP by 17% between 2011 and 2015.
• India’s government established a goal of reducing GHG intensity per unit of GDP by 20%-25% below 2005 levels by 2020.

2. Technological Change

A variety of technological improvements can reduce energy use and improve emissions intensity in industrial facilities, including technologies that improve the efficiency of energy production and those that improve the efficiency of energy use. This includes improvements in production processes and facility integration, materials, equipment, management techniques and fuels. Some examples include replacing boilers and meeting electric demand by using combined heat and power systems and using waste heat and steam generated from industrial processes. Technological improvements can be required or encouraged using financial or other incentives.

• The South Korean government provides subsidies for energy efficient electric motors, and imposes mandatory standards for electric motors.
• China’s Iron and Steel Industrial Development Policy specified various technological improvements, including a minimum utilization area for a sintering machine, the minimum height of the carbonization chamber in a coke oven, the minimum effective volume of a blast furnace, as well as the minimum capacity of BOF and EAF units. China also required all new blast furnaces to adopt Top Gas Pressure Recovery Turbine (TRT) and Pulverized Coal Injection equipment; all coke ovens to have Coke Dry Quenching (CDQ) equipment; and all coke ovens, blast furnaces and BOFs to have gas recovery equipment. In addition, China encouraged use of combined cycle power plants in the iron and steel sector.

3. Financial Support

Governments can also provide financial support for industrial efficiency projects, either directly, or indirectly through measures that encourage investments by private sector financial institutions. Common methods for financing technological advancements include: loans, loan guarantees, energy efficiency and demand management funds, and third party financing.

• In 2010, China’s State Council endorsed a key policy document instructing localities and ministries to support the development of a full-fledged ESCO industry by 2015. To help achieve this goal the government established financial award incentives for the completion of qualified projects which achieved at least 500 tce in energy savings in capacity generated per year.9

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4. Rationalizing Energy Prices

Government can influence industrial energy consumption patterns by changing the price of electricity or other energy sources to more closely reflect the real costs of energy use. For example, for electricity prices, this could mean removing subsidies given to industrial consumers or charging customers based on real-time prices. This could also mean increasing energy prices to reflect the health and environmental impacts associated with energy production and use.

- In Jiangsu province, China, interruptible tariffs have been imposed mainly on steel corporations. Customers are compensated about 1 RMB per kWh for interruptions. In 2002, five steel corporations took part in the interruptible tariff program, where facilities are paid to reduce below a level indicated by a power corporation. Consumers were interrupted 15 times in ten days for a total of 28 hours. The power corporation paid them 7.6 million RMB (USD 1.2 million) for these interruptions, and peak load was reduced by about 400 MW.  

5. Benchmarking and Auditing

Governments can also encourage efficiency improvements through the use of mandatory energy audits and benchmarking programs. Benchmarking can be useful in designing policy to improve energy efficiency, evaluate performance, and understand energy consumption patterns.  

- Indonesia’s Ministry of Industries introduced energy conservation plans and audits in all major industries, including the tune-up of furnaces and boilers.

6. Information and Awareness

Government, utilities and third parties can guide the activities of industrial energy users through effective awareness and education campaigns. For instance, some programs can include the publicity and dissemination of energy efficiency information, energy efficiency consultancy services, seminars on energy efficiency, exhibitions of energy efficiency products, and publicity of energy efficiency policies.

- Shanghai hosted its ‘Energy Conservation Week’ to promote energy conservation.

- The Philippine’s government launched The Industrial Energy Efficiency Project which seeks to improve industrial energy efficiency through the provision of tools and capacity building for industrial energy system optimization.

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III. NAMA OPPORTUNITIES

NAMAS are voluntary actions perceived as appropriate in the national context by a developing country government that leads to a reduction of greenhouse gas emissions and contributes to sustainable development in that country. These actions could be expressed as a specific technological outcome or as one or more policies and measures expected to reduce greenhouse gas emissions within one or more sectors of the economy. The large and growing industrial and manufacturing sector in Asian developing countries presents an important opportunity for developing countries to receive international support to reduce emissions in the context of sustainable development. Supported NAMAs that are likely to work best will permit continued industrial growth and competitiveness while also achieving significant reductions off of business-as-usual emissions trajectories. Moreover, effective NAMAs will include measures targeted to the specific barriers and risks that currently prevent the action from taking place.

As described below, a number of Asian countries (China, India, Japan, South Korea, and Thailand) are already taking important actions to reduce greenhouse gas emissions from industry. These examples could be adapted and replicated in other Asian countries, and could fit well within the supported NAMA framework.

China

In China’s 11th Five-Year Plan the Central Government set a target of reducing energy intensity by 20% from 2005 levels by 2010. To achieve this target, the government sought to accelerate industrial development while also eliminating outdated production capacity through a variety of government policies, actions, and regulations.

One of the programs used to improve the efficiency of the industrial sector and help meet the national energy intensity target is China’s Top 1000 Enterprise Program. This program affects large state-owned enterprises consuming 1/3 of the nation’s energy. A variety of policies and measures were used in tandem:

- **Political Mandates:** In addition to the national energy intensity target noted above, the government established a separate goal for the Top 1000 Enterprise Program of reducing 100 MTCE/year by 2010.13
- **Benchmarking and Auditing:** All participating enterprises were asked to formulate and implement energy conservation plans with clear targets for energy conservation premised on domestic or international efficiency benchmarks. Achievement of the energy-saving targets is part of the provincial government evaluation system in which

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the responsible government officials are evaluated annually on whether or not the targets under their jurisdiction have been achieved.

- **Financial Support:** In 2007, for example, the Chinese government offered financial incentives to encourage energy savings that roughly came to $12-15/t CO2. “The rewards and rebates (were) paid to enterprises that have energy metering and measuring systems that can document proven energy savings of at least 10,000 tce (0.29 PJ) from “energy saving technical transformation” projects.” The government also reduced or eliminated export tax rebates for energy-intensive and highly polluting products.\(^{14}\)

- **Rationalizing Energy Prices:** While not a part of the Top 1000 Enterprise Program, differentiated electric power tariffs helped to encourage efficiency improvements (or closure) of the least efficient facilities.

**India**

In 2008, the Indian government established a National Action Plan on Climate Change. A key component of this plan, the National Mission on Enhanced Energy Efficiency (NMEEE) seeks to reduce energy consumption in eight industrial sectors (thermal power plants, fertilizer, cement, pulp and paper, textiles, chlor-alkali, iron and steel and aluminum).

As part of the NMEEE, India is embarking on an ambitious market-based mechanism called the Perform Achieve and Trade (PAT) mechanism that is scheduled to commence in 2011, and continue through 2014.\(^{15}\)

The PAT program will be implemented in several phases, which align well with the various categories of policies and measures previously identified.

- **Political Mandates:** The Perform Achieve and Trade (PAT) scheme seeks to achieve energy savings of 19GW per year. Separate targets are established for each Designated Consumer (large industries and facilities) in a way that considers historical energy consumption within the sector and the mix of fuels used.

- **Benchmarks and auditing:** Baselines and sub-sector reduction targets are set based on three years of data from energy audits. The government establishes a benchmark curve, and sets differentiated targets based on the relative positioning of different facilities on the curve. (The most efficient facilities within a given industry sector are assigned a less stringent reduction target, while the least efficient facilities get a tougher reduction target.) Energy data are monitored and evaluated by accredited energy auditors.

- **Financial Support:** The government established an energy certificate trading system to encourage facilities with lower cost mitigation options to over-comply and sell excess certificates to those with higher cost mitigation options.


Other actions developed to achieve GHG reductions and increase industrial efficiency in support of the National Plan are listed below.

- **Information and Awareness:** The Ministry of Power instituted National Energy Conservation Awards, coordinated by the Bureau of Energy Efficiency, to recognize industrial units that have made special efforts to reduce energy consumption. Collectively this resulted in 2397 million units of saved electrical energy; 9067 kilo liter of furnace oil; 2.76 Mt of coal and 11,585 million cubic meter of gas per year.

- **Financial support:** The government developed an energy efficiency financing platform, a mechanism to finance demand-side management programs in all sectors by capturing future energy savings. The government also developed fiscal instruments to promote energy efficiency.

**Japan**
The Japanese government developed a National Energy Strategy in 2005 which outlines energy demand and supply prospects from 2010 to 2030. Within this framework, the government established a political mandate to achieve energy reductions by approximately 2% by 2020, and 3% by 2030.

A variety of policies and measures are helping to achieve this goal.

- **Financial support:** Since 1987, the government has instituted low interest loans for the installation of cogeneration (CHP) systems. As of October 2011, this program is still in effect.

- **Benchmarking and auditing:** Starting in 2004 the Government of Japan has enforced Auditing, Benchmarking, and Advisory Projects for Factories.

- **Technological change:** The government’s Energy Conservation Law mandated the use of high-efficiency industrial furnaces, high-efficiency boilers, combined heat and power generation systems, and fuel cells.

- **Information and awareness:** To support energy management and compliance, the Ministry of Economy, Trade and Industry (METI) and the Agency for Natural Resources and Energy (ANRE) released 1) Guidelines for Energy Management in Industry, 2) a listing of regulatory standards, and 3) inspection guidelines for improving energy efficiency.

**South Korea**
In 2008 the Ministry of Knowledge Economy released a medium- to long-term National Energy Basic Plan for the period 2008-2030. The energy intensity target is 0.185 tons of oil equivalent (Toe)/USD 1000, and the target share for new and renewable energy of total energy consumption is 11% for the year 2030.

Other actions to achieve this goal include:
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• **Financial support:** To encourage industry to invest in energy efficiency, the government invested KRW 28 billion (USD 23 million) to develop energy efficiency technology and CO2 sequestration in the industry sector.

• **Benchmarking and auditing:** In 2007, the government imposed a mandatory energy audit program for energy-intensive companies consuming more than 2 kilo-tons of oil equivalent (ktoe) per year.

**Thailand**
Thailand established a portfolio of Energy Efficiency Improvement Programs to achieve energy savings across all sectors of the economy. To accelerate energy efficiency and energy reductions the government deployed various policies and actions which include:16

• **Political mandate:** The government established a target to achieve energy savings of 4.4% in the industrial sector by 2011, compared to 2008 levels.

• **Financial support:**
  - Revolving funds (or soft loans) in the form of zero-interest loans and a dedicated Energy Conservation Promotion Fund. At the same time, Thailand’s Department of Alternative Energy Development and Efficiency will monitor the performance of the banks (lending and repayment), will ensure targets are met, and energy savings are measured.
  - ESCO venture capital fund provides equity capital up to 50% of total equity.
  - Cost-based and performance-based tax incentives. For example returning 30% of saving value to the project owners through income tax reduction, but not exceeding THB 2 million (USD 64,641).
  - An investment promotion via the Board of Investment which waives income tax for 8 years and waives the import tax for ESCO or renewable energy projects.

IV. APPENDIX

**GROWTH IN INDUSTRIAL SECTOR (COUNTRY SPOTLIGHT)**
The following section provides a brief snapshot of industrial growth in the Asian countries participating in the Mitigation Action Implementation Network. While the relative energy intensity of the industrial mix varies, all countries are experiencing rapid growth in their industrial sectors.

**Vietnam**
Between 1999 and 2007, with annual growth rates of 2.5, 3.3 and 3 percent, respectively, the cement, paper and paper products, and steel industries led the growth in industrial energy use.17 In 2007 industrial energy demand accounted for nearly half (46%) of total energy demand in Vietnam.

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Thailand
Light industry expanded at an average annual rate of 3.4% from 1995 to 2005. In 2008, the industrial sector represented the largest energy consuming sector, using 37.4% of total final energy consumed in the economy. The most important subsector of industry is manufacturing, which accounted for 34.5% of GDP in 2004.\textsuperscript{18}

Philippines
Most of the industrial sector is based on processing and assembly operations in the manufacturing of textiles, paper and paper products, electronics and other high-tech components. Heavier industries are dominated by the production of cement, glass and glass products, industrial chemicals, fertilizers, iron and steel, fabricated metal products, mineral products, machinery and equipment, transport equipment, and refined petroleum products.\textsuperscript{19}

Pakistan
The manufacturing sector in Pakistan (mostly light industry) accounts for about 25% of GDP. Cotton textile production and apparel manufacturing are Pakistan's largest industries, accounting for about 51.4% of total exports. Other major industries include food processing, beverages, construction materials, clothing, and paper products. The targeted growth rate for 2011-12 has been set at 3.7% for manufacturing sector as a whole. In 2011-2012, the main growth industries are projected to be chemicals, automobile, pharmaceutical, electronics, leather products, paper and boards, and non-metallic minerals.\textsuperscript{20}

Indonesia
Sectors experiencing the largest growth from 2003 to 2006 include: transport equipment, machinery and apparatus (87%), fertilizers, chemicals and rubber products (68%), iron, steel, and other basic metals (52%), and cement and non-metallic quarry products (50%).\textsuperscript{21} In 2010, industry made up 47% of Indonesia's GDP.

Malaysia
In 2010, industry comprised 41.4% of Malaysia's GDP. As indicated by the government’s Third Industrial Plan from 2006 – 2020, the government will target 12 industries in the manufacturing sector for further development and promotion. They include six non-resource based industries: electrical and electronics, medical devices, textiles and apparel, machinery and equipment, metals, and transport equipment; the remainder include six resource based industries, petrochemicals, pharmaceuticals, wood-based, rubber-based, oil palm-based, and food processing.\textsuperscript{22}

\textsuperscript{19} CIA World Factbook, May 15, 2009.
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