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Title

INDUSTRIAL ENERGY: WHAT ROLE FOR POLICIES?

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ABSTRACT:

Industry in the largest energy used sector in the world today. A wide variety of energy efficiency of policies, programmes, products, services and delivery mechanisms have been implemented by countries in efforts to improve energy efficiency in industry. Energy efficiency efforts have been shown to be more likely to succeed if a supportive framework of policies and regulatory environment exists.

During the past decade, liberalization of energy markets, as a process, was initiated in the Australia, Canada, U.K., and U.S., while there is broad experience and history of innovation in industrial energy efficiency policies in developed countries, there remains much potential for further improvement. Moreover, while some developing countries have shown notable improvements in energy efficiency, there is an urgent need for widen diffusion of industrial energy efficiency policies and application of technologies in developing countries.

According to the World Energy Council, energy efficiency has a broader meaning than mere technological efficiency of equipment; it encompasses all changes that result in decreasing the amount of energy used to produce one unit of economic output (e.g. the energy used per unit of GDP) or to achieve a given level of comfort. Energy efficiency is associated with economic efficiency and includes technological, organizational and behavioural changes[1]. The importance of energy intensity of national economies as an indicator of sustainable development was agreed in Agenda 21, which states that "reducing the amount of energy and materials used per unit in the production of goods and services can contribute both to the alleviation of environmental stress and to greater economic and industrial productivity and competitiveness."

ENERGY EFFICIENCY IN INDUSTRY:

Energy efficiency is rising toward the top of many national agendas for a number of compelling reasons that are economic, environmental and intergovernmental in nature. As many industries are energy-intensive, this is resulting in new impetus to industrial energy efficiency policies. The economic reasons are quite clear. Most important has been the rise in energy prices from 2005-2006 and their likely continuation at a high level. Increasing concerns over energy security (reliability of supply) are a second factor. Energy supply in many countries increasingly depends on imported oil and gas, and supply is being constrained by geopolitical events while global economic growth is resulting in greater energy demand. Additionally, in many developing countries energy efficiency is also a way to alleviate the investment costs for expanding energy supply infrastructure in the face of tight fiscal constraints.

Environmental pressures are also exerting influence. There is now the need to reduce greenhouse gas emissions to meet commitments under global environment agreements, particularly for Annex 1 signatories to the Kyoto Protocol. In the European Union and in other countries, cap and trade carbon dioxide (CO_2) emission trading schemes are now in place, compelling them to reduce greenhouse gas (GHG) emissions, and the focus is often on energy-intensive industries. Moreover, environmental directives in major markets are influencing global industrial supply chains. For example, the European Union's Directive for Energy-using Products (EuP) encompasses the entire life cycle of a product: design, manufacturing, use and disposal, and sets legal requirements for energy use of manufactured products.

Finally, energy efficiency has recently been high on the intergovernmental agenda, where it was a main topic of discussion in the G8 meetings at both Gleneagles and St. Petersburg. Energy efficiency and industrial development are also currently on the agenda of the 14th and 15th sessions of the United Nations Commission on Sustainable Development, which will result in recommendations for international action. Industrial energy efficiency also figures prominently in the "Marrakech Process" on sustainable consumption and production.

Industry is the largest energy end-use sector in the world today and consumed 30 per cent of delivered energy in OECD countries in 2003 [2]. Moreover, energy use in the industrial sector is forecast to grow an average of 2.4 per cent per year through 2030 – 3.2 per cent in developing countries and 1.2 per cent in developed countries[3].

A wide variety of energy efficiency policies, programmes, products, services and delivery mechanisms have been implemented by countries in efforts to improve energy efficiency in industry. Results in developed countries due to such efforts have been significant. For example, while the manufacturing output of the OECD countries has doubled since the 1970s, the amount of energy used in manufacturing has not changed (World Energy Council, 2004). While it is true that most of those gains were achieved between 1973 and 1986 as a response to high oil prices, many opportunities for significant energy savings continue to exist.

Energy efficiency efforts have been shown to be more likely to succeed if a supportive framework of policies and regulatory environment exists. This framework may include: overall energy policy; power sector reform; energy efficiency policies, laws and targets; the establishment of energy efficiency agencies within governments; utility demand-side management programs; negotiated agreements with industry; support and promotion of energy audits; and energy efficiency standards, codes, testing, certification and labelling.

TRENDS IN INDUSTRIAL ENERGY INTENSITY:

Energy efficiency is a main determining factor of industrial energy intensity, but another important factor is structural change in the economy (such as growth of the service sector). At the world level, there has been a continuous decline in primary energy intensity. Global energy intensity is expected to decline at a rate of between 1.5 - 1.9 per cent per annum between 2003 and 2030, depending on economic growth [4]. As shown in Figure 1, there is considerable regional variation in industrial energy intensity. The clear trend has been a continuous decline in industrial energy intensity with significant strides made in China and North America. The exceptions are the Middle East and Africa where energy intensities are still climbing.

Figure 2 highlights energy use and trends in energy-intensive industries in the EU-15. Primary metals, non-metallic minerals and chemicals, as the largest energy-consuming sectors, have over the past decade been the focus of negotiated agreements to achieve energy efficiency and, as a result, significant progress has been made in reducing their energy intensities. Other sectors such as paper, food and textiles show minor increases in the amount of energy required for a unit of output.

MARKET-BASED MEASURES FOR ENERGY EFFICIENCY:

During the past decade, liberalization of energy markets, as a process, was initiated in the Australia, Canada, United Kingdom and United States. The EU established rules to liberalize its electricity market, which became operational in 1999, and liberalization of the natural gas market is now being phased-in over time. Liberalization of the energy markets in developing countries and economies in transition has taken place in a number of countries under World Bank structural adjustment programmes, one of the main objectives being to attract private capital to expand and improve the sector[5].

The change from vertically integrated, monopolistic sectors to competitive markets has also changed the way governments intervene in the energy sector. Instead of regulating monopolies, governments are now in the process of introducing a range of market-based measures. A number of these measures promote energy efficiency either directly or indirectly (for example through reduction of greenhouse gases).

Tax and fiscal policies encourage investment in energy efficient equipment by increasing the cost of energy or reducing the cost of investments. Main targets for these policies are energy-intensive industries, energy service companies and equipment vendors. Such incentive programmes typically have short-term objectives of increasing energy efficiency by 10 per cent and long-term objectives as high as 25 per cent as compared to a baseline year. For example, fiscal incentives in Japan encourage the acquisition of energy efficient equipment. The Energy Conservation Law enacted in 1993 introduced several special tax measures related to energy efficient equipment. These included: a corporate tax rebate equivalent to 7 per cent of the purchase price; and accelerated tax depreciation for new equipment yielding at least a 5 per cent energy savings. As a result of the incentives, investment in energy efficient products increased by US$4 billion per year for several years during the 1990s (Price et al., 2005).

Taxes and charges:

Energy or energy-related CO_2 taxes have the advantages that they reduce demand for the taxed product, they increase public revenues and they reduce pollution and its related impacts. These taxes have the disadvantage that they may negatively affect the competitiveness of an industry. Such taxes were first introduced in the 1990s in Europe and are now in practice throughout the EU.

Pollution levies are imposed by a wide number of countries for violations of pollution emission standards that are often associated with energy use. Such levies are usually imposed on energy-intensive industries and levels of penalties for offences have been rising over time. Efforts are often made to balance the social and economic benefits of the services violators produce with the environmental harm. Countries have developed systems with both civil and criminal penalties. Civil penalties have the advantage that it is only necessary to show that a violation of regulations has occurred, and no lengthy judicial hearings are required; consequently, the majority of penalties imposed come as a result of civil actions. Penalties for pollution levies can range from warning notices or small fines issued in field actions, to substantial administrative penalties, to legal settlements requiring payments of large sums and requirements to install pollution mitigation equipment (see table 1). For example, several manufacturers of diesel engines were jointly penalized over US$1 billion for installing special computer chips that allowed their engines to pass laboratory inspections when in conditions of actual operation they exceeded the emissions standards[6].

Restructuring of public electric utilities in the 1990s introduced competition but also reduced incentives for demand-side management programmes. To regain the benefits of DSM programmes, *public benefits charges* were introduced whereby a fee is imposed on electricity distributed to all users. Most experience has been in the United States where 25 states currently have energy efficiency programmes funded by public benefits charges. But other countries, such as the UK, Australia, Norway, and Sweden, found the same under investment in energy efficiency after deregulation and developed similar programs funded through general revenues or through charges on energy consumption. In the US, as of 2005 these funds have financed over US$900 million of spending on energy efficiency programmes leading to average annual reductions in power demand of 0.4 per cent and a total reduction in demand of over 1,000 Mega Watts (MW) (Price et al., 2005).

Financial incentives:

A range of incentive measures may aim at reducing costs associated with increasing energy efficiency, including subsidies or grants for energy efficiency investments, tax relief for purchase of energy efficient equipment or for participation in negotiated agreements, subsidies for energy audits, and loans or guarantee funds for energy efficiency projects.

Subsidies or grants for the purchase of energy efficient equipment are the most widespread fiscal incentive in use today. Subsidies and grants are particularly useful to encourage energy efficiency investments in developing country environments where perceived risks may be higher and where competition with infrastructure projects may put energy efficiency projects at a disadvantage. They also effectively stimulate energy efficiency measures in countries where energy prices do not reflect the real costs of energy and are too low to allow financial benefits to accrue to energy projects through energy savings. To make a subsidy programme more effective, care should be given to avoid free riders (those companies that would have upgraded their equipment even without a subsidy) and to reduce transaction costs.

One market-based approach to energy efficiency is the development of an *energy service company* (ESCO) industry. An ESCO is a company that is engaged in developing, implementing and financing performance-based projects that seek to improve energy efficiency or reduce electricity loads of facilities owned or operated by customers. ESCOs are promoting energy efficiency around the world but particularly in countries experiencing increased competition and privatization in the electric utility business, as well as in other sectors undergoing liberalization, e.g., heat production in Central and Eastern Europe. Since ESCO remuneration is often tied to the level of energy savings, it makes good business sense for them to target energy intensive industries.

Energy audits of industrial enterprises are key to assessing the potential for energy savings and for identifying energy efficiency measures that could be employed. Energy audits of industrial enterprises are often subsidized or provided free of charge to encourage participation and to facilitate the adoption of modern energy efficient technologies. For example, in France ADEME provides a subsidy of 50 per cent for audits conducted on Industrial sites. About 75 per cent of the companies that received the subsidy stated that they made investments immediately after the audit. The subsidy programme cost the public about € 76 per toe saved and yielded investments with an average cost of € 570 per toe savings per annum, which yields a savings of approximately € 1500 for every toe saved at 2006 oil prices. In some countries, regular audits are mandatory for large energy consumers. In Portugal, Thailand and Tunisia, audits are mandatory for buildings and large factories using over 1000 toe per year. According to the World Energy Council, subsidies generally cover 40-100 per cent of the cost of an energy audit. The Korea Energy Management Corporation performs approximately 2000 energy audits every five years and roughly 80 per cent of the audits are performed for free. A sample of eight audits in the industrial sector required an investment of US$48.65 million and yielded energy savings of 198,604 toe annually. This amounted to annual cost savings of US$37.33 million with an average pay back period of 1.3 years (World Energy Council, 2004).

In many countries, financing of energy efficiency investments is made possible via a combination of soft *public loans and innovative private financing*, aimed at increasing the involvement of private capital. Such innovative financing instruments include ESCO funding, guarantee funds, revolving funds and venture capital. ESCOs sometimes use a shared savings approach in which the ESCO guarantees the energy savings of the project and secures the needed upfront financing. Guarantee funds provide a repayment guarantee to banks granting loans for energy efficiency projects and thus cover the associated credit risk. This is particularly useful in developing countries where financial institutions have little experience in making loans to often asset-free energy efficiency projects.

France, Hungary, Brazil and China have established *loan guarantee* funds for energy efficiency projects. The guarantee fund set up in France is directed to energy efficiency projects of small and medium-size companies (SMEs) which typically have trouble financing energy efficiency due to the small size of their projects. The national guarantee fund covers 40 per cent of the risk, the French Agency for Environment and Energy Management (ADEME) covers an additional 30 per cent of the risk, and a national bank supporting SME growth provides soft lending terms. This fund guarantees up to € 242 million for loans to the private sector. Its goal is to provide SMEs with the option to obtain loans for energy efficiency and renewable energy investments [7].

Taxes and fiscal incentives promoting industrial energy efficiency in selected countries are summarized in table 2.

One of the most significant co-benefits of energy efficiency is its contribution to GHG emission mitigation. *Carbon dioxide emission trading schemes* are now in place both within the EU and among signatories of the Kyoto Protocol. While designed with environmental goals, these market mechanisms also provide incentives for energy efficiency. The EU Emission Trading Scheme (EU ETS) will cover about one-half of the EU-25's total CO_2 emissions by 2010, including all the energy intensive industries. While significant energy efficiency gains are expected as a result of the EU ETS, greater gains could be realized if there was tighter and more consistent target setting. International commitment to post-2012 Kyoto targets is also needed. The Clean Development Mechanism within the Kyoto Protocol supports, among other things, energy efficiency projects that can certify emission reductions with an approved methodology. The first such projects are now being piloted.

White certificate programmes for energy efficiency are being implemented in Italy, the UK, France, Belgium and New South Wales, Australia. In these programmes electricity and gas utilities are required to promote energy efficiency among end-users and to show that they have saved an amount of energy that is a percentage of the energy they distribute. That amount of energy saved is certified through “white certificates”. These certificates can then be traded, with those parties that do not meet their energy saving targets having to purchase certificates in the market (Farinelli et al., 2005). The white certificate program in Italy was launched in January 2005. Figure 3 shows the energy savings targets and projected evolution of energy savings over the first 5-year compliance period in Italy with respect to the electricity sector due to white certificates. During this phase of the programme, 3 million tons of oil equivalent (Mtoe) of cumulative primary energy savings are projected to be realised, of which 1.6 Mtoe by electricity distributors and 1.3 Mtoe by natural gas distributors (Bertoldi and Rezessy, 2006).

POLICIES FOR INDUSTRIAL ENERGY EFFICIENCY:

Figure 4 depicts the various energy efficiency policies employed by over sixty countries[8] and identifies the percentage of countries that use a particular policy. The survey was conducted in 2004 by the World Energy Council and the French Agency for Environment and Energy Management. The chart does not indicate the effectiveness of those policies, their impact, or whether the targets or stipulations of those policies were ambitious or lax.

Negotiated agreements between government and industry to improve energy efficiency are playing a significant role in both developed and developing countries (see table3). While most programmes are voluntary, they generally provide either incentives and/or penalties to encourage participation by companies. Typically, companies or industry associations set targets for reducing energy use or greenhouse gas emissions in exchange for government support, such as financial incentives, publicity, or relief from other environmental or tax obligations.

Negotiated agreements may be categorized in three ways: 1) those that are entirely voluntary; 2) those that have implied threats of regulation or taxation; and 3) those with a mix of incentives and penalties for non-compliance. As voluntary programmes have few incentives and lack penalties, they tend to have less participation by industry and results are usually small improvements on business-as-usual. Programmes with implied future threats of regulation or taxation promise easy environmental

permitting, relief from regulations, and avoidance of energy or GHG emissions taxes in return for participation. As a result these negotiated agreements have been more successful; for example, the Netherlands achieved an industrial energy efficiency improvement of 22.3 per cent between 1989 and 2000. Programmes with a mix of incentives along with penalties for noncompliance achieved both wide participation and strong results. Participation by industrial enterprises in these agreements is generally high, representing about 90 per cent of industrial GHG emissions in Canada, Denmark, New Zealand, Switzerland and UK [9].

Higher levels of end-use energy efficiency can allow deferral of a part of the investment needed to meet growing energy demand. While electric utilities in developed countries have been implementing *demand-side management (DSM) programmes* aggressively during the past 25 years, the electricity sectors in developing countries have had little exposure to the DSM process. Until the early 1990s, subsidized energy prices, non-competitive end-use markets, lack of sufficient DSM knowledge and expertise, and the absence of adequate regulatory and institutional support were the primary factors limiting DSM activities in developing countries. However, as increasing numbers of these countries adopt pricing schemes that reflect actual costs in their electricity sectors, the incentives are likely to increase for realizing energy and capacity savings through DSM.

Energy performance standards and labels: Electricity consumption is rising worldwide every year as people gain access to electricity and become increasingly dependent on electrical equipment. In industry, electricity motors power pumps, compressors, fans and a wide variety of machinery. One of the most cost-effective and proven methods for increasing energy efficiency at industrial enterprises is to establish energy efficiency standards for industrial motors. Currently, minimum energy performance standards for motors have been adopted in 30 countries. According to a study by the European Copper Institute, European industry could save over 200 billion kilowatt hours (kWh) of electricity per year by using more energy-efficient electrical motor systems. Research by the EU's motor challenge programme found that industry across the EU-25 could save € 10 billion per year on its electricity bills plus a similar amount from reduced maintenance. Carbon dioxide emissions would be reduced by 100 million tonnes per year, equivalent to one quarter of the EU-15's Kyoto commitment [10]. Labelling of efficient motors has been shown to boost their sales. At present 26 countries use a labelling scheme to help industrial purchasers identify energy efficient motors. Examples of labels for energy efficient motors from four countries are shown in figure 5.

Benchmarking provides a means to compare the energy use within one company or plant to that of other similar facilities producing similar products. Benchmarking can be used to compare plants, processes or systems. For example, systems such as compressed air systems can be benchmarked to evaluate energy efficiency, such as Germany's REN Strom programme. Benchmarks are typically employed as part of negotiated agreements and are supplied to all participating companies. Those companies participating in the negotiated agreement then agree to achieve the efficiency level of the top 10 per cent of plants.

Monitoring and targeting (M&T) is a tool that often provides useful information when implementing other energy efficiency measures, thus making them more effective. It also ensures accountability by providing feedback on performance improvement measures that have been implemented, assessing energy savings achieved. It can also be an effective tool to change corporate thinking about energy saving at all levels from corporate management to operational staff and, as such, can lock in efficiency gains through a strategy that influences corporate culture and promotes behaviour modification. M&T has a long history in the UK, which launched a national programme in 1980. Over 50 industry sector studies have demonstrated the benefits of monitoring and targeting. These benefits include:

- Energy savings of 5 to 15 per cent with similar reductions in emissions of CO_2 and other pollutants;
- Coordination of energy management policy through targeting of initiatives that achieve the maximum benefit;

- Assisting with financing for energy efficiency projects, through determination of baseline energy use levels for energy efficiency project proposals, and verification of savings (critical for performance contracting by ESCOs);
- Improved product and service costing, through better understanding of the energy content of products and services;
- Improved budgeting, by providing improved data for the accurate projection of future energy use.

Apart from the UK, the World Bank and others have supported activities that apply the M&T approach in improving energy efficiency in the industrial sector in Brazil, Peru, Colombia, and Slovakia. A recent European Commission Green Paper on energy has set a target of reducing EU energy consumption by 20 per cent compared to projections for 2020.

Websites for industrial energy efficiency are proliferating rapidly and contain tools, guidebooks, information and links on energy efficiency programmes, policies, technologies, financing and technical assistance. The EU's CORDIS website provides access to information on available support programmes, databases and reports, while its ManagEnergy website has similar tools and includes links to over 400 energy agencies, events and partner searching capabilities. Sweden's STEM website includes a calendar of energy efficiency events online (Galitsky, Price and Worrell, 2004).

An overview of industrial sector energy efficiency program products and services of industrialized countries is presented in table 4.

Market transformation policies and programmes for energy efficiency have been widely employed by industrialized countries and in recent years are being increasingly adopted by developing countries and economies in transition. Market transformation programmes for energy efficiency a) intervene strategically in the market, b) create long-lasting changes in the structure or functioning of the market, and c) lead to widespread adoption of energy efficient products, services and practices. Market transformation efforts that have been employed to "push" technology innovation include a range of measures such as promoting technology transfer for domestic manufacturing, adopting minimum energy performance standards for energy consuming equipment, developing voluntary agreements with manufacturers, developing new lines of distribution through electric utilities or retailers, and arranging soft financing terms for manufacturers. Other efforts have been designed to "pull" the market; these have included helping consumers to make informed purchase decisions through media campaigns or point-of purchase aids such as energy efficiency labelling, lowering prices via subsidy or rebate, encouraging bulk purchase/procurement, establishing buy-back or recycling programmes, and providing financing of purchases through banks or utility bills. To date, a host of market transformation initiatives have been implemented in a number of countries that targeted residential appliances (e.g., lighting, refrigerators, and air conditioners), commercial buildings, industrial sectors, and government facilities.

POLICIES FOR SUPPLY-SIDE EFFICIENCY IN ENERGY INDUSTRIES:

Both developed and developing countries have pursued regulatory reform and liberalization of the electric power industry. They have done so in the expectation that such reform and restructuring could yield important benefits, namely improving economic efficiency, lowering costs and consumer prices and stimulating economic growth and competitiveness. These expectations have to some extent been realized. For example, in some formerly public-owned companies, labour productivity has improved by up to 60 per cent and generating costs in some cases have declined by 40 per cent. In other countries, availability of generating plants has improved significantly (from 60 per cent to 87 per cent), customer outages have been reduced, distribution company productivity has improved, and prices have been reduced by 13-20 per cent in electricity markets (OECD, 2000). Wider economic benefits are also possible, given that electricity is an input to almost all productive activities. However, the impact of market liberalization on long-term investments in generating capacity is not yet fully clear, particularly in developing countries.

The improvement in efficiency after privatization of four South American distribution companies is summarized in Table 5. These improvements were measured in terms of the change in performance between the date of privatization and a point in time approximately five years later (ten years in the case of Chile). The four companies showed substantial improvements in performance according to all the indicators. These improvements show the benefit of having private management focus on commercial performance, which has been a major weakness of state-owned utilities.

Another area of significant potential energy savings in the electricity sector lies in the reduction of transmission and distribution losses, which in many developing countries are high due to technical and non-technical losses. For example, at the end of 2005, India had 122,275 MW of installed capacity but only 66 per cent of that capacity was available due to inefficient transmission and distribution[11]. The result was frequent power shortages and load shedding. Although the generating capacity is set to increase, the transmission and distribution sector remains congested and inadequate with losses amounting to approximately 25 per cent, compared to less than 15 per cent which is an acceptable rate in most developing countries[12] and approximately 5 per cent in developed countries. Countries facing a similar challenge to that posed in India might consider a number of possible solutions, including:

- Attracting further investment for transmission infrastructure through easing licensing requirements for entering the transmission and distribution business[13].
- Strengthening metering, billing and enforcement efforts as a means of reducing the high level of electricity theft.
- Introducing availability based tariffs to improve grid discipline and reduce transmission losses.
- Promoting distributed generation to both industrial parks and remote locations to avoid transmission losses.
- Raising consumer awareness regarding practical energy conservation measures and the benefits of choosing energy efficient appliances.
- Increasing the percentage of renewable sources in the energy mix to provide more options for decentralized generation and to reduce emissions[14].

Combined heat and power, or cogeneration, represents another clean energy path for industry. Worldwide, 65 per cent of fuel energy consumed in electricity generation is lost as waste heat. Building or adapting power plants for cogeneration of electricity and heat can reduce those losses to 20-30 per cent. After generating electricity, the waste heat can be recovered and then used for, among other things, process steam, space heating, air conditioning, water cooling and product drying. Alternatively, clustering of industrial enterprises in industrial parks facilitates opportunities for cogeneration of electricity using waste heat from industrial processes. Auto-production of electricity by industry has the co-benefit of reducing peak load on the electricity network. Installed cogeneration capacity in 2004 amounted to 6,926 GW and has been growing at between 2.5 to 3.0 per cent annually[15]. The share of cogeneration in global electricity generation is just over 7 per cent, despite its enormous potential. Furthermore, most industrial cogeneration is on-site and thus avoids transmission losses, reduces energy costs and security vulnerabilities, and improves reliability and power quality. By significantly reducing the environmental footprint of industry, cogeneration plays a central role in enhancing corporate environmental responsibility. While significant potential for expansion of cogeneration capacity exists, it is typically constrained by outdated framework policies for the electricity sector and by electric utilities that perceive cogeneration as a threat to their sales of electricity and, therefore, their revenue. The extent of cogeneration in selected countries is shown in Figure 6.

The petroleum refining industry provides fuel to practically every economic sector with the largest shares going to the transport sector and chemical industry. Refineries themselves are large consumers of energy with approximately 50 per cent of operating costs attributable to energy needs. The United States accounts for about one quarter of all refinery capacity in the world and this industry is the largest industrial energy user in the country. Competitive benchmarking data indicates that most petroleum refineries can economically improve energy efficiency by 10-20 per cent. A number of refining companies have adopted energy management programmes that are yielding significant results. BP has implemented a GHG emission reduction programme that reduced its global emissions to 10 per cent below 1990 levels after just five years. ExxonMobil identified over 200 best practices for processes and equipment that are reducing energy use by 15 per cent. All the refineries operating in the Netherlands participated in Long Term Voluntary Agreements that concluded in 2000 and achieved a total energy efficiency improvement of 17 per cent.

CONCLUSIONS: POLICIES FOR PROMOTING ENERGY EFFICIENCY

It seems clear that the new drivers for industrial energy efficiency – in particular, higher energy prices and concerns about climate change – are going to remain with us for some time. The eco-design of more energy efficient industrial products that is being mandated by environmental directives in major markets will only become more stringent over time.

While there is broad experience and history of innovation in industrial energy efficiency policies in developed countries, there remains much potential for further improvement. Moreover, while some developing countries have shown notable improvements in energy efficiency, there is an urgent need for wider diffusion of industrial energy efficiency policies and application of technologies in developing countries.

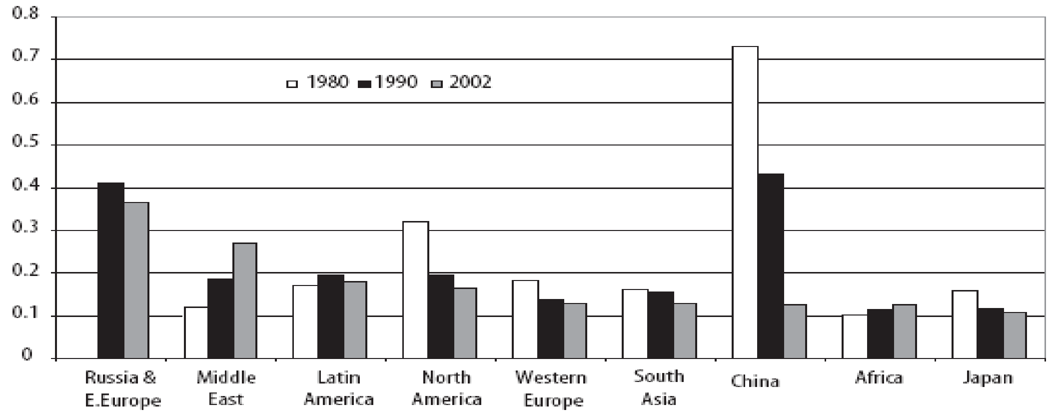
Public procurement also provides a public mechanism for promoting recycling by increasing demand for recycled material. The United States Federal Government and many local authorities require procurement of recycled-content paper for themselves and contractors, as well as more general recycled-content requirements for other procurement. To assist government procurement agents, the US Environmental Protection Agency has developed standards for recycled content for a range of products and lists of products meeting those standards. Such requirements for government procurement not only increase demand directly, but also provide a model and incentive for procurement requirements by industry, other institutions and households. Making government standards and databases publicly available also helps other institutional consumers in buying recycled products. This increases demand for recycled material, which raises prices, which encourages commercial recycling and helps pay for municipal recycling.

Governments can also intervene in some cases to increase the prices of raw materials, thus increasing the economic incentive for industrial material efficiency and recycling. In many countries, for example, wood comes in part from national forests, and policies controlling access to those public resources can increase the price of wood products, including paper. Restricting logging on public land, reducing government support for logging operations, or increasing "stumpage fees" will tend to increase the cost of virgin paper and other wood products.

Stronger environmental laws on mining, including requirements for remediation of the land after mining is exhausted, with financial guarantees to cover the costs of environmental damage and clean-up, would internalize the environmental costs of mining, raise the price of minerals, and promote material efficiency and recycling.

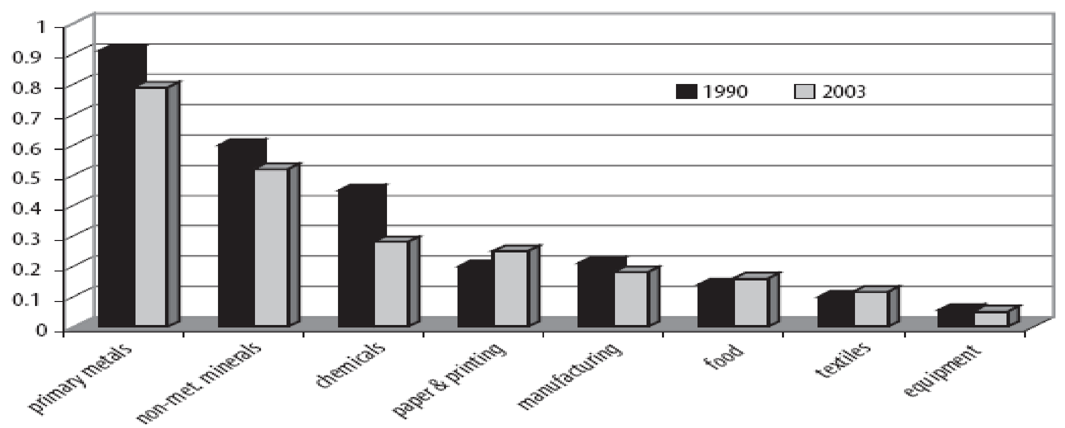
Finally, governments can facilitate industrial recycling by promoting waste exchanges and industrial ecology that link industries producing a certain type of waste product with other industries that can use those waste products as inputs.

Figure 1. Regional variation in industrial energy intensity [Kg oil equivalent/industrial output (1995 US $ ppp)]



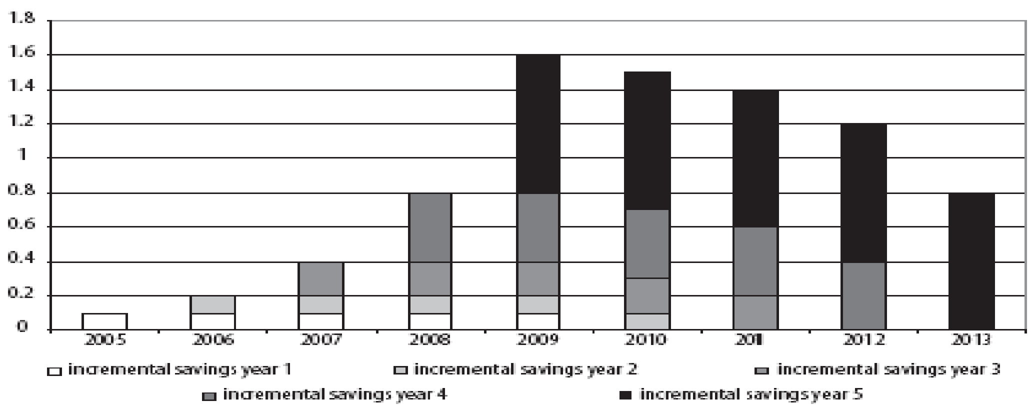
Source: World Energy Council using data from Enerdata.

Figure 2. Energy intensities by sub-sector in the EU-15 (Kg oil equivalent per euro, 1995)



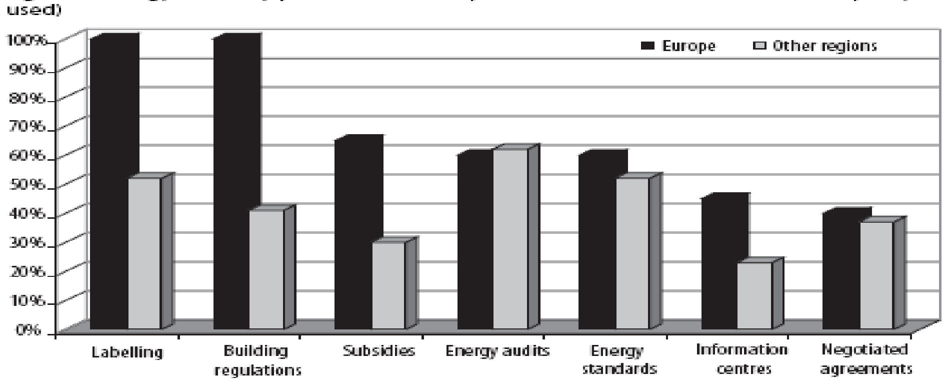
Source: Odyssee and Enerdata.

Figure 3. White certificate electricity savings target and evolution of savings in Italy (million tons of oil equivalent)



Source: Odyssee and Enerdata. Source: Pavan, M., White Certificates can foster ESCO development. In: ESCOs in Europe conference, 6–8 October 2005. Vienna.
Note: The data for this chart were compiled by WEC-ADEME from a survey of 63 countries. Energy savings projects are expected to contribute to the achievement of targets for up to five years, therefore the chart begins in 2005 and ends in 2013.

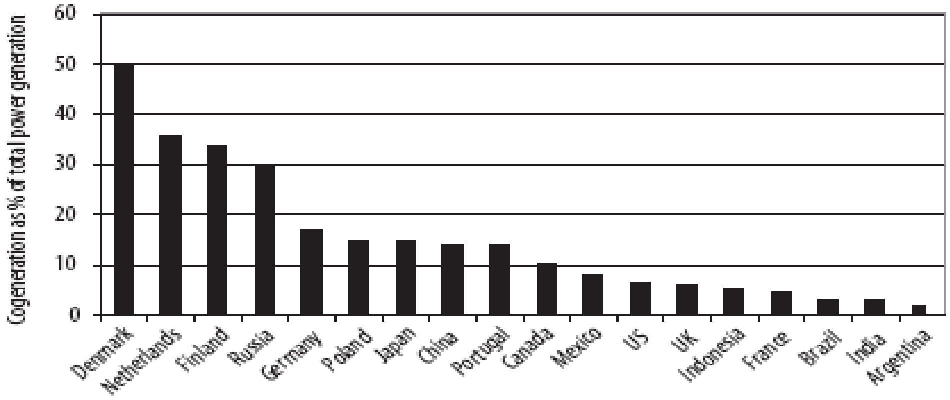
Figure 4. Energy efficiency policies – most frequent measures (% of countries where policy is used)



Source: François Moisan, Energy efficiency: a worldwide review – Indicators, policies and evaluation, World Energy Council – French Agency for Environment and Energy Management, 2006.

Figure 5. Energy efficiency labels for motors from China, Colombia, Singapore and Thailand, respectively.

Figure 6. Extent of cogeneration in selected countries in 2004



Source: World Survey of Decentralized Energy 2005, World Alliance for Decentralized Energy, 2005.

Table 1.
Pollution levies in selected countries

Country	Administrative/ civil penalties	Criminal penalties	Remarks
Australia	X		Currently under review
Austria	X	X	Fines depend on income of violator
Czech Rep.		X	In addition to fines and imprisonment, other sanctions may be imposed
Denmark	X	X	Civil penalties are under consideration
Finland		X	Fines set according to discretion of court
France		X	Fines doubled for repeat offenses
Germany	X	X	In corporate cases, managers may be imprisoned
Greece	X	X	
Hungary		X	Imprisonment is typically applied
Ireland	X	X	Fines unlimited under some statutes
Portugal	X	X	
Slovakia	X	X	Fines doubled for repeat offences
Spain		X	
Netherlands	X	X	Civil penalties are under consideration
UK	X	X	Civil penalties are under consideration
USA	X	X	Fines vary depending on statute; doubled for repeat offences

Source: adapted from Price et al. (2005).

Table 2.
Taxes and fiscal incentives promoting industrial energy efficiency in selected countries

Country	Taxes or Fees			Fiscal Incentives				
	Energy or CO_2 tax	Pollution levy	Public benefits charge	Subsidies or grants	Subsidized audits	Soft public loans	Innovative private funds	Technology tax relief
OECD								
Australia		A/C	X	X	X		E	EX
Austria	X	A/C, CR		X	X		E	
Canada					X		E, RF	AD
Denmark	X	CR		X	X			
Finland	X	CR		X	X		E	
Fraance	X	CR		X	X		GF, IF	
Germany	X	AC, CR		X	X	X	E, IF	EX, R
Hungary		CR		X	X	X	E, GF	
Italy	X			X	X		E	R
Japan		X		X	X		E	AD, R
Korea					X	X	E	R
Mexico				X	X	X	E, IF	
Netherlands	X	CR		X	X			AD, R
UK	X	CR		X	X	X	E, VC	R
USA		A/C, CR	X	X	X	X	E	EX
Non-OECD								
Brazil					X		GF, RF	R
Egypt					X	X	E	R
Indonesia					X			
Jordan				X	X	X	E	R
Philippines					X	X	E	R
Thailand				X	X	X	E, RF	
Tunisia				X	X		E	

Sources: World Energy Council 2004, Energy Efficiency: A Worldwide Review — Indicators, Policies, Evaluation, *London; Galitsky, Price and Worrell (2004).*
Obs.: X = program exists; A/C = administrative/civil penalties; CR = criminal penalties; E = ESCOs; GF = guarantee fund; RF = revolving fund; VC = venture capital; AD = accelerated depreciation; R = reduction; EX = exemption.

Table 3. Selected voluntary/negotiated agreements with industry

Country	Agreement	Program years	Incentives								Penalties			
			Government and public recognition	Information	Assistance and training	Energy audits	Financial assistance & incentives	Emissions trading	Relief for exemption from regs & taxes	Reduced/avoided energy/GHG taxes	More stringent env. permitting	Increased regs	Penalty/fee	Energy or CO_2 tax
Completely voluntary														
Australia	Greenhouse Challenge	1996-present	X	X	X									
China (Taipei)	Energy Auditing Programme	2002-2020	X	X	X	X								
Finland	Promotion of Energy Conservation in Industry	1997-present	X	X	X	X	X							
Korea, Rep.	Energy Conservation & Reduction of GHG Emissions	1998-present	X	X	X		X							
USA	Climate Vision	2003-present	X	X	X	X								
With threat of regulations or taxes														
France	AERES Negotiated Agreements	2002-present	X		X			X					X	
Germany	Agreement on Climate Protection	2000-2012							X	X				
Japan	Keidanren Voluntary Action Plan on the Environment	1997-present	X											
Netherlands	Benchmarking Covenants	2001-2012	X	X			X		X		X			
Energy/GHG taxes or regulations														
Canada	Large Final Emitters Programme	2003-2012		X	X	X		X	X			X	X	
Denmark	Industrial Energy Efficiency	1993-present		X	X	X	X			X				X
New Zealand	Negotiated Greenhouse Agreements	2003-2012						X		X				X
Switzerland	CO_2 Law Voluntary Measures	2000-2012						X		X				X
UK	Climate Change Agreements	2001-2013	X	X	X	X	X	X		X				X

Source: Price (2005).

Table 4.
Overview of industrial sector energy efficiency program products and services of industrialized countries

	Australia	Canada	Denmark	EU	France	Germany	Japan	Netherlands	Norway	Sweden	Switzerland	UK	USA
Audits/assessments							X	X		X		X	X
Benchmarking			X			X		X	X			X	
Case studies	X	X		X			X	X	X	X		X	X
Demonstration: commercialized technologies			X		X	X	X	X			X	X	
Demonstration: emerging technologies		X		X	X			X		X			X
Energy awareness promotion materials	X	X	X		X		X		X	X	X	X	
Fact sheets	X			X						X	X	X	X
Industry profiles		X		X				X	X				X
Reports/guidebooks	X	X		X		X	X	X	X	X	X	X	X
Tools and software	X	X	X	X		X		X	X			X	X
Verification	X	X		X	X	X		X	X				X
Visions/roadmaps	X	X					X	X		X			X

Source: Galitsky, Price and Worrell (2004).

Table 5.
Improvement in performance of four South American electricity distribution companies

Performance criteria	Peru Luz Del Sur	Argentina Edesur	Argentina Edenor	Chile Chilectra
Year privatized	1994	1992	1992	1987
Energy sales (GWh/y)	+19%	+79%	+82%	+26%
Reduction in energy losses	-50%	-68%	-63%	-70%
No. of employees	-43%	-60%	-63%	-9%
Customers/employee	+135%	+180%	+215%	+37%
Net receivables (days)	-27%	-38%	n/a	-68%
Provisions for bad debts, % of sales	-65%	-35%	n/a	-88%

Source: Bacon and Besant-Jones (2001).

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