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Table of contents

List of tables

List of figures

1 Background and objectives

The purpose of this report (Part 2 - Overcoming Barriers to the Adoption of Energy Efficient Technologies) is to feed into the proposed 2010 / 2001 United Nations Industrial Development organization (UNIDO) report "***If industrial energy efficiency pays, why is it not happening?"*** The purpose of this overall report is to scrutinize the evidence supporting the view that there are barriers to energy efficient technologies considered profitable, that these barriers can be overcome, and that there are various mechanisms through which to address these barriers, but these actions have yet to be fully explored in developing countries.

The purpose of this report is to examine policy options aimed at overcoming the barriers identified in the Part 1 report. Although the majority of literature assessing the effectiveness of policy and programmes on industrial energy efficiency comes from Organization of Economic Cooperation and Development (OECD) countries, the focus of this report will stem from the experiences of developing countries, as these countries are a priority for UNIDO's 2010/11 report. The specific objectives of this report are to:

1. Assess the effectiveness of policies and programmes aimed at encouraging the uptake of industrial energy efficient (IEE) technologies, especially in developing countries.
2. Determine some key considerations that can help to overcome barriers to energy efficiency and encourage the successful adoption of IEE technologies.
3. Provide some guidance for policy makers in assessing the strengths and limitations of industrial energy efficiency policy (while recognizing that providing overall policy prescriptions is difficult due to the varied contexts, technologies, sectors, etc.)

2 Methods and approach

2.1 Scope and Definitions

In preparing this report, we have identified a number of studies that describe and evaluate real-world policy measures for encouraging industrial energy efficiency (IEE). The policies are taken from a number of regions, but with particular focus on developing countries. The sample is intended to be illustrative and covers a wide range of *countries* (from emerging economies such as Mexico, China and India to smaller economies such as Kenya and Thailand), *sectors* (e.g. pulp and paper, coal / power generation, textiles), and *sizes* of firms (large firms and Small, Medium and Micro Enterprises (SMEs).

Emphasis has been given to SMEs in developing countries, since these are of particular interest to UNIDIO. The importance of the SME sector in developing countries cannot be over-emphasized. For instance in India, SMEs contribute about 45% of manufacturing output and 40% of experts, and employs more than 40 million people. While they cover a wide range, many SMEs are surprisingly energy intensive, with energy forming as much as 50% of production costs (Pal 2006; Sethi and Ghosh (eds) 2008). SMEs are particularly important areas to target for IEE in developing countries, including emerging economies. As an OECD/IEA report indicates, "in China and India, small-scale operations with relatively low efficiency continue to flourish, driven by transport constraints and local resource characteristics, e.g. poor coal and ore quality" (2007, pp.21).

At the same time, policies aimed at increasing IEE within larger industries in developing countries are also important due to their large share of output, energy consumption and carbon emissions. For example, Thiruchelvam *et al* (2003) highlight that large industries account for about 75% of carbon emissions in China, even though they only constitute about 0.21% of industries.

The policies reviewed here seek to overcome *barriers* to the adoption of energy efficient technologies, where a barrier is defined as: “a postulated mechanism that inhibits a decision or behaviour that appears to be both energy and economically efficient”. As indicated in our Part 1 report, many of the reasons for neglecting opportunities to improve energy efficiency may represent rational behaviour by firms and therefore not warrant policy intervention. In other cases, the barrier may represent a *market failure* as conventionally understood, but the costs of rectifying this failure may outweigh the benefits of doing so. In most cases, however, it is far from straightforward to establish either the *extent* to which opportunities are being neglected, the *reasons* for this or the *costs and benefits* of different types of policy intervention. While policies should ideally be based upon it thorough examination of IEE decision-making, in practice this is rarely possible. In this context, *ex post* evaluations of the effect of energy efficiency policies can be of great help.

The focus throughout is on the industrial sector, as distinct from the residential, public and commercial sectors. Following (McKane, *et al.*, 2008): "The industrial sector can be broadly defined as consisting of energy-intensive industries (e.g., iron and steel, chemicals, petroleum refining, cement, aluminium, pulp and paper) and light industries (e.g., food processing, textiles, wood products, printing and publishing, metal processing)". ‘Industry’ is further sub-divided into energy intensive and non-intensive categories (Energy intensive versus non-intensive sectors below).

Table 2.1 Energy-intensive versus non-intensive sectors

Energy intensive	Non-intensive
Cement, Automotive, Paper & Pulp, Aerospace, Shipping, Chemicals, Petrochemical, Pharmaceuticals, Refineries, Metals, Construction, Power generation	Baking, Food & Drink, Glass, ICT, Agriculture, Commercial, Textiles, Wood manufacture

Consistent with the Part 1 report, Part 2 also defines Small and Medium Enterprises (SMEs) as any enterprise with less than 250 employees (European Commission 2005). 'Industrialized' nations are defined as those that are high income Organization for Economic Cooperation and Development (OECD) members – which includes Japan and Korea in Asia, the United States and Canada in North America, Australia and New Zealand in Oceania, and 21 European countries (excluding three OECD members - Poland, Turkey and Mexico). Emerging economies, also referred to as middle-income economies, include the BRIMC nations – Brazil, Russia, India, Mexico and China (BRIMC).

For the purposes of this study, 'process energy' is that used directly in the production process, whereas generic energy is for non-key applications such as lighting, Heating, Ventilation and Air Conditioning (HVAC) and information technology.

2.2 Data collection

This study is based upon a review of a selection of studies drawn from both the academic and grey literature. The academic studies were selected via keyword search, which directed attention predominantly to specialist journals (e.g. *Energy Policy*, *Energy*, *Energy Economics, Journal of Cleaner Production*) as well as books such as Rock and Angel (2005). Sources for the grey literature search reflected the recommendations of experts in the field and drew mainly on: Lawrence Berkeley National Labs, European Council for an Energy Efficient Economy (ECEEE), United States (US) Department of Energy, US Environmental Protection Agency, Organization for Economic Cooperation and Development (OECD), International Energy Agency (IEA), United Nations Economic Commission for Asia and the Pacific (UNESCAP) and United Nations Industrial Development Organization (UNIDO).

As indicated above the focus of this study was to examine studies that were policy or programme evaluations in the area of IEE in developing countries. The selection of studies is intended to be illustrative rather than comprehensive.

2.3 Data Gaps

When conducting the literature review a number of data gaps surfaced. For instance, we were interested in determining the key policies and measures that can overcome barriers and encourage the successful adoption of IEE technologies. Common themes to emerge include the importance of engaging senior management on energy issues, awareness campaigns and policies to increase access to capital among others. That said, being able to determine key policy measures to overcome barriers in developing countries overall was difficult to ascertain with any confidence. This is because, first: IEE policies and programmes in developing countries have met with mixed success, depending on the sector, country or technologies targeted and upon particular features of the policy design; and second, the studies varied enormously on these fronts (e.g. different countries, sectors and types of firm). For these reasons, Section KOKO focuses more on "Key Considerations" overall as opposed to key policies and measures.

We also sought to identify how the distinction between generic and process energy use can affect the appropriate choice of policy options to overcome barriers, as well as the distinction between firms that were domestically owned versus those that were subsidiaries of a multinational or part of a joint venture. However, very few of the studies examined these distinctions

3 Framework of analysis

As indicated in our Part 1 report, there are numerous lenses through which to assess policy options to encourage industrial energy efficiency, including orthodox, transaction cost and behavioural economics and organizational theory[1]. Furthermore, some authors (Foxon, 2003) favour a systems perspective, whereby barriers and ways to overcome them are addressed at the macro-level. Such system-level barriers include carbon lock-in, dominant design, network effects, and path dependent technological trajectories. An economically-based framework is used here as, firstly, the majority of literature reviewed tends to view barriers to energy efficiency and policy options to overcome them in terms of orthodox or behavioural economics. Secondly, the focus of the UNIDO overall report is on an assessment of the adoption of

[1] See Montalvo, C. (2008). "General wisdom concerning the factors affecting the adoption of cleaner technologies: a survey 1990-2007" Journal of Cleaner Production

industrial energy efficient measures in terms of their profitability. A detailed overview of the Framework of Analysis can be found in our Part 1 Report.

To remind readers, in Part 1, when assessing the barriers to the adoption of IEE measures and technologies, we had two broad categories:

- barriers found at a micro level and which are easier to address at the level of the firm; and
- contextual factors or those aspects found at a more macro level.

The taxonomy of barriers was based upon Sorrell *et al* (2004) and distinguished between imperfect information, access to capital, hidden costs, risk and uncertainty, bounded rationality and split incentives. However, it was emphasized that these categories overlap and are to some extent interdependent. With respect to contextual factors, some key ones identified in the Part 1 study included energy subsidies (especially in developing countries), policy environments and sector norms. As noted in Part 1, some apparently contextual factors could be difficult to distinguish from the barriers indicated above. However, one distinction is that contextual factors remain largely beyond the influence of individual organizations. For example, managers may be predisposed to focus on strategic issues above those of energy efficiency as a response to competitive activity in the sector. Although this 'sector norm' can be thought of as a consequence of bounded rationality, managers may have limited scope to reconsider their options if a competitor's actions demand their immediate action.

The majority of studies on developing countries stress the fact that barriers prevalent in industrialized nations are similar but that they are more pronounced in developing countries. As indicated in Figure 3.1, the most common barriers cited in these studies were imperfect information and access to capital. In addition, contextual factors appear to play a greater role, notably subsidized energy prices, the lack of policies and programmes to encourage awareness, and there is no single agency with responsibility for energy efficiency. Masselink (2009)'s overview of studies on barriers in developing countries (including Shi 2003, Shi *et al* 2008, UNEP 2006, among others) also indicates a similar phenomenon.

In what follows, public policies to address barriers have been grouped into the following types (recognizing that these categories are not mutually exclusive):

A) Information policies

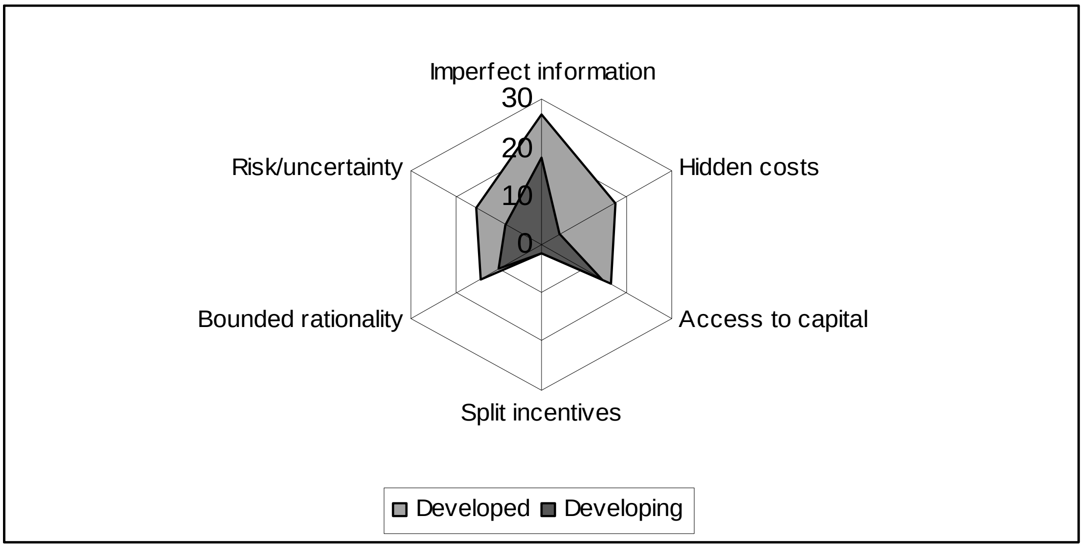
B) Financial and Investment policies

C) Institutional, regulatory and legal policies

D) Technology cooperation / transfer policies

The following four sections discuss each category of policy in turn. Each section defines the policy or programme type, provides some examples in developing countries and assesses their effectiveness. Most of the examples are taken from developing countries, although experience within OECD countries is also reported.

Figure 3.1 Prevalence of barriers to energy efficiency cited in studies focused on industrialized vs developing countries



4 Information policies

Our Part 1 report indicated that a lack to information (or imperfect information) was a key barrier to the adoption of IEE technologies in both OECD and developing nations. The importance of increasing information was also re-affirmed in studies focusing on policy options to overcome the identified barriers.

Increasing information is particularly important in developing countries. Luken and Van Rompaey's (2008) survey of 105 firms and 122 informants in nine developing countries, elicits some interesting insights. Participants were asked to rank key drivers for the adoption of cleaner process techniques and technologies (which includes energy efficiency technologies) in their specific industry. Interestingly, both groups (plant managers and informants) identified the high cost of production inputs as a reason for adopting these new technologies. Thus, the more information firms have regarding the costs associated with production and the ways to reduce these costs (including financially attractive options) can help instigate the use of more energy efficiency technologies within these industries. A number of interesting findings emerged under this heading from scrutiny of the studies.

4.1 Awareness and education campaigns

Regarding specific policies, numerous studies indicate the importance of **awareness and education campaigns** in encouraging the take-up of energy efficient technologies. It appears necessary to target: a) the management and technical personnel within the firms themselves; b) a broader range of stakeholders involved in a certain sector (e.g. trade associations, government departments); and c) the wider community at large. Efforts to convey this information can take a number of forms, including workshops and seminars, informal channels such as word of mouth and mass media campaigns through the television, radio and internet.

While not evaluating a specific policy or program, Adhikari *et al* (2008)'s study assessing potential opportunities for the Clean Development Mechanism (CDM) in Thailand, suggested – based on interviews with industry experts in that country -- that training programmes and promotional campaigns would help to encourage the adoption of IEE technologies, along with other potential CDM project technologies (e.g. wind and solar power). In addition, the study indicated that local demonstration projects would be particularly effective at encouraging adoption as people would find this more convincing than modelling results or technology implementation in a different context.

Ciccozzi *et al* (2002), in their study assessing UNEP project field activities to encourage cleaner production technologies (including energy efficiency) in firms in five developing countries (Guatemala, Nicaragua, Zimbabwe, Tanzania, and Vietnam), also indicate the importance of spreading awareness and educating key players in the sector and beyond. In addition, they note that that the financial sector needs to be explicitly targeted for awareness campaigns in these countries – educating the sector of the fact that IEE projects are profitable and can result in major economic opportunities in developing countries.

The Ciccozzi *et al* (2002) study also avows that concrete cases, informed by figures and 'hard' data are needed to help convince different stakeholders of the advantages involved in adopting energy efficient technologies.

The importance of engaging key players and spreading awareness of the benefits of IEE technologies is not new. For example, in Arburas' (1989) assessment of energy conservation policies in Jordan in the late 1980s, he also indicates the necessity of any energy efficiency policy honing in on awareness, especially targeting the top management level among firms.

4.2 Training for firm personnel

Another information policy highlighted by studies is **training for firm personnel (technical and senior management)**. Although similar to general awareness and education campaigns, training consists of deeper knowledge regarding energy efficiency, including certification courses, in-depth seminars and so on. Some studies suggest that tasks such as training and awareness raising "….are unlikely to produce direct savings, but are essential to creating a climate that is supportive of attempts to improve energy efficiency" (Sorrell *et al* 2004).

Ciccozzi *et al* (2002)'s study assessing the effectiveness of UNEP projects in five developing countries indicated the importance of developing not only technical skills but also financial management skills among firm staff (both senior management and technical personnel). In UNEP's projects, they created a group of cleaner production financing experts and advocates within each of these countries, which they attribute a strength of the program, as these people had strong ownership of different aspects of cleaner production.

4.3 Energy management systems

One area targeted for awareness and education, as well as more in-depth training is **energy management systems**, based on empirical evidence indicating more energy savings being realized with their use (Helgerud and Sandbakk, 2009; Motegi and Watson, 2005; Thollander and Ottosson, 2009). Energy management systems include the technical systems, trained staff and management systems that are required to conduct energy audits, gather energy data; maintain sub metering systems; analyse consumption data, compare to trends and relevant benchmarks, correct for influencing factors, identify faults and so on (Sorrell *et al*. 2004, p. 66).

Although not an assessment of a specific policy or program, Oztuk (2005)'s study on the textile sector in Turkey found that those firms which had more senior management engaged on energy efficiency were more likely to instigate EE aspects into their decision making processes. The study suggests that the most effective way to implement energy management systems is to "address the task [on IEE] company-wide, for example, by setting up an 'Energy Management Committee' and engaging the company head in energy efficiency efforts" (2005, pp. 2428).

4.4 Government agency for energy efficiency

A further information policy proposed to encourage the use of energy efficiency technologies within industry is the **creation of an agency, department or division devoted to energy efficiency within the government**. Here, this agency can serve as a focal point for industry to turn to for a number of issues such as information about EE technologies, as well as develop regulatory policies in consultation with relevant industry players (Clark 2000).

4.5 Technical assistance

Another role for policy would be to provide **technical assistance**, either directly or to facilitate firms' ability to acquire technical assistance from outside the firm; deemed particularly useful for SMEs. This assistance can come in various forms – such as through government programmes providing government staff to assist, or university students, or through more indirect means, such as through supporting the use of Energy Service Companies (ESCOs). This effectively amounts to outsourcing energy management to a specialist provider.

ESCOs can help firms to identify IEE opportunities and take on the financial burden of implementing feasible IEE options (See Ayres 2009 and Vine 2005 for further information). However, ESCOs may not always be applicable in a developing country context. For instance, the use of ESCOs was part of a Global Environmental Facility (GEF) project carried out in the Steel Re-Rolling Mill (SRRM) sector in India. This sector is dominated by family-owned, SMEs and is considered a priority area to improve energy efficiency. It is estimated that there are about 1200 firms in this sector and about 600 units run on a pulverized coal based re-heating furnace in India. About 30 units were targeted for the GEF project. Project activities consisted of providing information to firms about EcoTech options and technologies, benchmarking services for firms regarding energy efficient technologies, a resource centre, and assistance through the use of ESCOs. While the aim was to have 20 firms be involved, as of 2007, only a few were considering IEE investments. The reasons for this low rate are discussed in Section KOKO (technology transfer and cooperation). But one reason was because there was a mistrust between ESCOs (who were not so keen on investing in the SRRM sector due to high risk perceptions) and firm owners (who as noted above were family owned and not so keen on being audited by an ESCO) (Verbeken 2009).[2]

One programme considered successful at providing technical assistance comes from the United States (US) and is from their Department of Energy (DOE). The programme targets SMEs and has created a number of Industrial Assessment Centers (IAC's), housed within US universities. Engineering students from the centres are 'seconded' to SMEs to provide relevant technical assistance, such as conducting energy audits and assessing of potential EE projects). SMEs like the programme as there are no costs involved on their part and it also provides practical experience for the students. Many participating firms undertake the EE opportunities presented to them by the students, and some firms hire the students to continue working at their firm upon graduation (Alhourani and Saxena in press). Tonn and Martin (2000) conducted an assessment of the IAC programme and found that the programme helped to overcome informational barriers – there were significant changes in decision-making on energy efficiency within a relatively short period of time.

4.6 Network building

Another specific policy area is for the **government to facilitate the building of networks** on energy efficiency between firms, sector specialists, the government, academic sectors, trade associations, NGOs and other relevant groups. This area is particularly important in developing countries as a number of studies highlighted how the organizational culture can help or hinder the adoption of IEE technologies. Energy efficiency issues are a low priority within some organizations due to a lack of senior management engagement on the issue (Ozturk, 2005; Worrell and Price, 2001). Worrell (1995)'s study of the iron and steel sector in China also suggests the need for firms from developed and developing countries to work together in order to share the risk of adopting advanced IEE technologies.

The importance of networks also has parallels in the triple helix model from innovation studies where industry, the academic sector and governments at various levels (nation, region / state, and local) collaborate to develop and produce innovations. The argument is that those projects with more sources of leadership and support will be more than likely to succeed (Etzkowitz and Carvalho de Mello 2004).

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[2] Also see http://www.gefonline.org/projectDetails.cfm?projID=1240 and http://undpgefsteel.gov.in/EVENTS/NationalWorkshopGuwahati/tabid/107/Default.aspx

A GEF project aimed at encouraging the uptake of IEE technologies in the SRRM sector in India found that more communication was needed among private sector players (e.g. SRRM firms, domestic equipment manufacturers, trade associations, etc.) (Verbeken 2009). Similarly, Ciccozzi *et al* (2002) indicate that an asset of the UNEP cleaner production projects in five developing countries (Guatemala, Nicaragua, Zimbabwe, Tanzania and Vietnam) was the fact that strategic alliances were built with selected stakeholders. Agreements were established with local institutions hosting the training courses, which could then offer UNEP courses beyond the project life.

Van Oosterhout *et al* (2005)'s study of two small scale industries in Bolivia (stucco and micro breweries) assert that one advantage of a government programme aimed at encouraging small scale industries to use more efficient technologies was the use of domestic NGOs which served as a 'middle agent', offering subsidized loans to SMEs.

Finally, in a project run by the Energy Research Institute (ERI) at the University of Cape Town[3], networks between firms and organizations with industry expertise in OECD countries and large South African firms (South African Breweries, South African Pulp and Paper Industries and Anglogold's Elandsrand mine) helped those firms to "identify more than R 5 million of energy efficiency investment that would pay back in less than one year" (Spalding-Fecher 2003, p. 41).

5 Financial and investment policies

Another second key area for overcoming barriers is finance and investment policies. As indicated in our Part 1 report, difficulties in accessing capital were particularly pronounced in developing country SMEs. Financial incentives to assist with this problem include subsidies and low or no interest rate loans for energy efficiency investments.

Studies on the use of IEE technologies agree that targeting this area is key. However, looking at studies from developing countries indicates that there is variation regarding how important financial assistance is as a driver for change - it depends upon the context. For instance, Luken and Van Rompaey (2008) show that overall, in developing countries, financial incentives are not considered a key driver by firms and key informants (see Table 5.1 and Table 5.2). Other areas such as current and future governmental regulations were considered more important,

[3] See http://www.eri.uct.ac.za/

although there were differences in ranking depending on country and sector (e.g. Chinese pulp and paper firms ranked financial incentives higher).

Table 5.1 Perceived Drivers for EST Adoption by Plant Managers

Perceived drivers for EST adoption by plant managers

Drivers for EST adoption[a]		Pulp and paper				Textile		Leather		Iron and steel	Pulp and paper	Textiles	Leather	Total
		Brazil	China	India	Viet Nam	Thailand	Tunisia	Kenya	Zimbabwe	Mexico				
Government	Current regulations	**3.7**	3.7	**4.4**	3.6	3.6	4.0	2.8	3.5	3.4	**3.9**	3.8	3.2	3.5
	Financial incentives	1.0	3.3	1.5	3.0	2.1	–	2.5	1.1	1.4	2.2	2.1	1.8	2.0
	Future regulations	2.3	4.1	1.4	3.9	3.8	–	3.9	**4.0**	3.0	2.9	3.8	**4.0**	3.3
Markets	Environmental image	1.8	3.3	1.4	2.7	3.4	–	2.8	2.9	1.6	2.3	3.4	2.9	2.5
	High costs of production inputs	2.3	**4.4**	3.1	**4.6**	**4.3**	4.4	3.6	3.4	**4.6**	3.6	**4.4**	3.5	**3.9**
	Product specifications in foreign markets	2.0	2.8	1.1	3.0	3.3	3.5	2.6	2.0	1.9	2.2	3.4	2.3	2.5
	Requirement of owners and investors	2.7	2.5	1.1	3	3.1	–	**4.4**	3.3	2.9	2.3	3.1	3.9	2.9
	Supply chain demands	1.3	2.4	1.1	2.1	3.1	**4.5**	3.1	2.6	1.4	1.7	3.8	2.9	2.4
Community	Public pressure	2.2	2.8	3.2	3.3	2.3	–	2.9	2.5	1.0	2.9	2.3	2.7	2.5
	Peer pressure	1.2	2.8	1.4	3.1	2.1	–	1.8	2.0	1.0	2.1	2.1	1.9	1.9

[a] Highest rated driver for each country and sub-sector in bold.

Source: Luken and Van Rompaey 2008, p. S71 and S74

Table 5.2 Perceived Drivers for EST Adoption by Key Informants

Perceived drivers for EST adoption by key informants

Drivers for EST adoption[a]		Pulp and paper[b]				Textile[b]		Leather[b]		Iron and steel	Pulp and paper	Textiles	Leather	Total
		Brazil	China	India	Viet Nam	Thailand	Tunisia	Kenya	Zimbabwe	Mexico				
Government	Current regulations	**4.7**	**4.6**	**3.4**	3.8	**4.5**	**4.4**	3.4	3.1	3.0	**4.2**	**4.5**	3.2	**4.0**
	Financial incentives	2.0	2.7	1.2	3.0	3.1	2.9	2.8	3.0	2.3	2.2	3.0	2.9	2.6
	Future regulations	3.6	4.2	1.8	3.8	3.5	1.4	3.1	3.5	2.3	3.4	2.5	3.3	3.1
Markets	Environmental image	4.3	3	2.1	3.4	2.8	1.2	2.5	2.9	2.7	3.2	2.0	2.7	2.8
	High cost of production inputs	3.3	4.4	2.8	**5.0**	3.9	3.5	4.0	3.4	**4.0**	3.9	3.7	3.7	3.8
	Product specifications in foreign markets	3.9	3.1	1.0	3.8	3.8	3.5	3.6	**3.8**	3.3	3.0	3.7	**3.7**	3.3
	Requirement of owners and investors	3.0	2.3	1.2	2.4	3.3	1.1	2.1	2.2	1.7	2.2	2.2	2.2	2.2
	Supply chain demands	3.0	2	1.0	2.0	4.2	3.3	2.4	3.2	3.0	2.0	3.8	2.8	2.6
Community	Public pressure	3.3	2.2	3.3	2.8	3.0	2.1	**4.2**	2.2	3.0	2.9	2.6	3.2	2.9
	Peer pressure	2.0	2.0	1.3	2.0	2.6	1.9	2.7	2.1	2.0	1.8	2.3	2.4	2.1

[a] Highest rated driver for each country and sub-sector in bold.
[b] Sub-sector average only for business associations, technology centres and suppliers.

Source: Luken and Van Rompaey 2008, p. S71 and S74

5.1 Subsidies

One specific example of a popular financial incentive includes **subsidies** that the government can provide for firms to adoption IEE technologies. Subsidies for industry, a type of financial incentive, include grants, low or no interest rate loans, tax credits and tax deductions, among others (Worrell *et al*. 2009).

One example of reducing a tax rebate with the aim of encouraging IEE comes from China. The Ministry of Finance in China had tax rebates available to Chinese firms for exports of low-value-added but high energy-intensive products, but reduced much of these rebates in September 2006 in order to decrease energy use from these industries and to encourage a more macro level change, aimed at moving away from producing less energy-intensive products in the country (Price, Wang *et al*. 2009).

Although China and India also offer financial assistance to SMEs to pursue IEE activities (e.g. interest free or low interest loans, tax reductions, duty exemptions, etc.), many SMEs do not capitalize on these programmes as they are perceived as not worth the risk. One facet exacerbating risk perception is due to the uncertainty of energy prices (Thiruchelvam *et al*. 2003).

5.2 Energy efficiency funds and low interest loans

Another specific way to provide financial assistance to firms through policies and programmes is through the creation of **energy efficiency funds and low interest loans**. While these have been placed in a separate category, they can also be considered types of subsidies. The purpose of these tools is to provide finance at a lower cost to industry (versus obtaining a loan or funds from a commercial bank) for energy efficiency investments (Gillingham, Newell and Palmer 2006). The funds can be administered through a private organization, a government agency, or an international organization.

Access to finances can be a key factor in encouraging adoption of IEE technologies. For instance, one programme considered not so successful comes from the Asian Development Bank (ADB) in India, where only 4 of 11 firms involved in the project achieved their energy efficiency target of 18%. This IEE programme aimed at providing favourable loans to Indian firms in order to encourage the uptake of IEE technologies. Loans were provided by the state-owned Industrial Development Bank of India (IDBI) between 1995-1997 and targeted the iron and steel, cement, chemical, fertilizer, pulp and paper, sugar and textile sectors (ADB 2005). One reason for a lack of success was due to the nature of these industries. In India, energy efficiency is rarely treated as a separate area of business, therefore making it difficult to assess any potential EE gains. Also the amount of money offered for EE projects through these loans was small (e.g. a few hundred thousand dollars versus usual investments these sectors undertake in the millions) (ADB 2005).

A useful example from the developing world comes from Sri Lanka, where Thiruchelvam *et al* (2003) highlight a Pollution Control and Abatement Fund (PCAF) established in 1995 (US$5 million) by the domestic government to help industrial firms move towards EE, as well as other pollution reducing measures. Technical assistance (reimbursement of up to 75% of costs of consultancy services) and a credit component (loan at zero real rate of interest up to $US128, 000 per industry, to be paid over 7 years maximum) were the two parts to this programme. This programme is considered successful in terms of numbers; with over 75 firms involved as of 2003.

Another example of a successful publicly-administered energy efficiency loan programme comes from the United States (US). Here, the State of Texas created the LoanSTAR programme administered by their state office on energy conservation. The loan was substantially below market interest rates and was initially established through creating an energy efficiency fund. An important feature of the fund is that it is consistently replenished as initial loans are paid off. It was created in 1989 and as of 2007, had generated 127 loans to public institutions and was estimated to have saved more than US$100 million in energy costs (US EPA 2009).

6 Institutional, regulatory and legal policies

A fourth area of policies concerns those to do with institutions, regulations and legal rules. Many studies underscore the importance of government engagement in all areas but particularly in the areas of regulation, institutions and legal policies in order to elicit change at a larger scale.

Studies that evaluate IEE policies globally also echo this view. For example Ciccozzi *et al* (2002), assessed UNEP clean production projects in five developing countries and found that government engagement in framing regulation and ensuring enforcement was key to success, while Birner and Martinot (2005)'s evaluation of ten GEF projects on energy efficiency found that "…new institutions and regulatory changes are among the most important outcomes for sustained market transformation" (2005, p. 1777).

6.1 Development of codes, standards and product labelling

One specific policy espoused by studies as being particularly important is the **development of codes, standards and product labelling.** Several developing countries have developed standards and labelling schemes for IEE technologies, including China and the Philippines. India has also established a voluntary labelling programme for EE technologies, including those used in industry (Thiruchelvam *et al*. 2003). One particularly important EE standard is the Chinese Motor Systems Energy Conservation Programme which includes minimum efficiency standards for motors, voluntary labelling for green motors, the development of motor management guidelines, technical assistance and training, and financing for investment in new motor systems (EEPC India).

China established the Energy Conservation Law of January 1998, encouraging IEE technologies. In addition consultations on the Energy Law were finalized in 2008 and the law is expected to come into force soon as it has been submitted to the National People's Congress. The coal mining industry has been highlighted as an area to target for efficiency and productivity improvements (Fang *et al*. 2009). Although the majority of Fang *et al* (2009)'s policy recommendations stem from a modelling assessment of the Chinese coal sector, they also show real evidence that changes are happening in the Chinese coal mining industry as a result of China's various laws and regulations.

6.2 Elimination of energy subsidies

A key area highlighted by the studies reviewed is to **eliminate or at least reduce energy subsidies** to encourage the adoption of IEE technologies (Ayres 2009). Energy subsidies are found globally but are particularly important in developing countries, including both fossil fuel exporting nations (like Mexico and Venezuela) and fuel importing nations. Subsidies are used for all types of consumer and fuel, but appear especially important for industrial electricity use (Lohani and Azimi, 1992; Park and Labys, 1994); UNESCAP 2001). At the same time, it is important to recognize that eliminating energy subsidies in developing countries without putting other measures in place – for instance to assist certain vulnerable parts of the population -- is bound to have some unpopular ramifications for policy makers.

Arburas' (1989) evaluation of the effectiveness of energy conservation policies in Jordan between indicated that the elimination of subsidies greatly helped that country in improving IEE. However, this was necessarily complemented by other demand management measures, such as technical assistance and educational efforts.

However, there are a few examples in developing countries where industry paid high energy prices as a consequence of subsidies to other consumers. This encouraged the self-generation of electricity, typically from smaller and less efficient plants (Yang, 2006).

Adhikari *et al*. (2008)'s study of the CDM in Thailand suggested that a lack of energy subsidies was a barrier for the adoption of all the proposed technologies, including IEE. However, more information is needed here. It is not clear from the study exactly ***why*** energy subsidies would bring about more use of IEE technologies – perhaps because with subsidies the price of energy would be more predictable, causing less uncertainty and therefore less risk to firms seeking to adopt newer IEE technologies.

6.3 Mandatory energy efficiency targets and energy audits

Other government policies that are considered useful include **mandatory energy efficiency targets and mandatory energy audits**. For example, US EPA and DOE's Lead by Example Guide provides information on these types of programmes in the United States. A number of countries in Asia including China, the Philippines and Vietnam have made energy audits mandatory for high energy-intensive, large scale industries, while in India and Sri Lanka similar regulations are being considered (Thiruchelvam *et al*. 2003).

However, making something mandatory does not always equate to the increased use of IEE technologies. For instance, Price *et al* (2009) highlight the fact that in China although many technicians had received training in energy audits, "the audits were relatively weak and shallow since there is no unified auditing standard, auditing entities do not have enough personnel, and capacity is weak. There is especially a lack of ability related to the analysis of energy-saving potential" (2009, pp.1205).

6.4 Voluntary agreements on energy efficiency

A further policy suggested as being important is **voluntary or negotiated agreements on energy efficiency** between industry and government (whether federal, state or local level). This approach is widely used in industrialized nations (Mazurek 2002). An example of a voluntary programme comes from the United States where the US Department of Energy was mandated in the Energy Policy Act of 1992 to create a national database of voluntary reductions in greenhouse gas (GHG) emissions from 1987 onward, as well as a national inventory of GHGs. Through this database companies can "make public commitments to future reductions, set goals, and thereby improve its public image" (Gillingham, Newell and Palmer 2006, p. 175).

Negotiated agreements are contracts between government and industry that include negotiated targets with time schedules and commitments on the part of all participating parties (Worrell *et al*. 2009). These may either be completely voluntary; voluntary but to be replaced by mandatory alternatives if considered ineffective; or voluntary but accompanied by other mandatory programmes, such as a carbon tax (Price 2005 cited in Worrell *et al*. 2009). Hu (2007) examine a negotiated agreement programme between the government of Shandong province in China and two iron and steel companies. The provincial government targeted the iron and steel sector as energy efficiency evaluation is easier in this sector versus other sectors (e.g. the chemical industry) and because the EE potential is significant is such an energy-intensive sector. These two enterprises were targeted as they had made EE improvements in the past, were keen on EE opportunities and are two of the top iron and steel producers in China.

The7 programme was initiated in 2003, and the government and the firms agreed upon a series of EE goals. The firms undertook a series of actions to meet their EE goals including:

- Creating a group within each company, led by the General Manager, charged with reaching the goals agreed upon in the voluntary agreements;
- Establishing monthly energy saving meetings where progress and problems were identified and addressed;
- Establishing energy management and evaluation systems, which were regularly assessed;
- Establishing a statistical reporting system to determine how well they were meeting their voluntary agreement goal; and
- Investing in more EE opportunities versus a business as usual scenario (Hu *et al*. 2009).

The two firms met their one-year goal in 2004, and both exceeded their three-year EE goal in 2006. It would be interesting to determine how these companies are doing in terms of meeting their EE goals now because although the provincial government was required to provide firms with incentives including technical information, financial aid and recognition, the provincial government only provided recognition,. The firms were nominated as being “The Pilot Enterprise of EE Voluntary Agreement” in China, which was publicized widely (Hu 2007).

Hu (2007) emphasizes that central government engagement on voluntary agreements is key, but also there is a need to engage sector associations more, in order to make these programmes broader, touching on more firms as the government has only a certain capacity. They also point out that other studies (in Chinese) indicate that Chinese negotiated agreements are often not accompanied by complementary mandatory policies. This is an important weakness and contrast with many agreements in industrialized nations.

Eichhorst and Bongardt (2009) provide an assessment of a voluntary agreement programme in Nanjing, China. This programme sought to implement voluntary agreements based on a similar model used in the Netherlands. Here the Dutch agency (SenterNovem) received a grant as a part of the Asia Pro Eco programme from the EuropeAid office of the European Union. A local Environmental Protection Bureau (EPB) in Nanjing was the key governmental player in this project, working with three firms in Nanjing (steel, cement and power generation). Agreements between the government and the firms were negotiated independently and consisted of energy intensity reduction targets in the order of 3-5%, using different measures (e.g. waste heat recovery, improved boilers, etc.) deemed most appropriate for the individual firm.

This study indicates a similar finding to Hu *et al* (2009) in that voluntary agreements on EE in Nanjing complemented more stringent policy on EE at the national level – they were viewed as a way in which to locally implement policies made at a more macro level. One key advantage of the programme was the fact that "by lifting industry on a more equal power level with government authorities, voluntary agreements showed to be an effective policy instrument" (Eichhorst and Bongardt 2009, pp.1039).

Another strength of the programme was the fact that specific actions firms undertook – including the creation of Energy Action Teams (which included a member from senior management) and the creation of Energy Action Plans with the aid of Nanjing's EPB – helped companies feel more ownership of the initiative and assign responsibilities within the company to achieve the agreed upon goals (Eichhorst and Bongardt 2009).

Another highly touted IEE programme from China is the Top-1000 Enterprises Programme, which formed part of 11^{th} Five-Year plan (2006-2010). This programme has a goal of reducing the baseline demand of participating companies by the equivalent of 260 million tonnes of CO_2. The firms involved are large and energy intensive, accounting for one third of the national energy consumption and almost half of industrial energy consumption. Some government agencies also have procurement programmes requiring energy efficient products (Wang and Watson 2009). This programme – while mandatory – also uses voluntary agreements between government and industries as mechanisms to achieve targets agreed at the national level (Eichhorst and Bongardt 2009). The savings achieved and challenges faced by the programme are summarized in Box 6.1. The challenges resulting part from time constraints as the programme was established very quickly. Price *et al* (2009) suggest that more efforts need to be placed on capacity building within firms.

Box 6.1 China's Top-1000 Enterprises Programme

Actions into Energy Savings

- the Top-1000 enterprises is estimated to have saved about 58 Mtce in 2008
- Savings are attributed to:
    - Increased attention to energy management (95% of enterprises involved in the programme established full or part time energy managers
    - Closure of small, inefficient production processes within firms
    - Implementation of various small-scale retrofit projects (e.g. renovating fans and pumps)

Programme Challenges

- Unrealized potential due to a number of problems including
    - Targets were not based on a detailed assessment of the energy savings potential of each firm or sector
    - No systemic base to collect or disseminate EE information to participants
    - No Third Party review of reported results from the programme

Source: Price, Wang *et al* (2009), pp. 1208

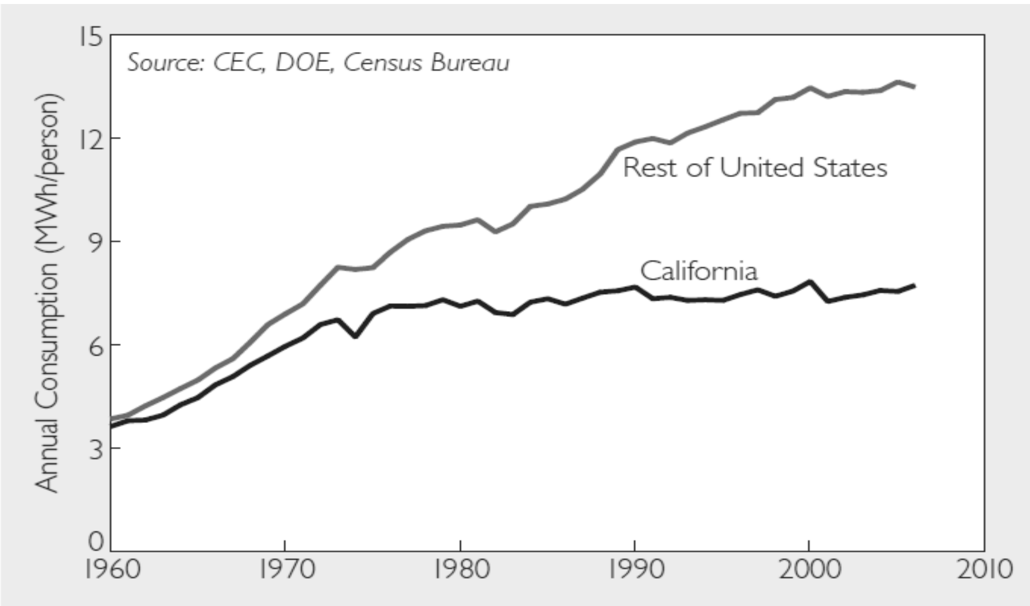
Finally, one example of a voluntary programme with mixed reviews comes is the US Green Lights Program, administered by the EPA. This was initiated in 1991 and called upon governments, businesses and industries to install EE lighting over a five year period, but "only where profitable and where lighting quality is maintained or improved" (Liu and Liptak 1997, pp. 181). While the EPA considers the programme to be a major success other analysis (such as by the US-federal government General Accounting Office) suggest otherwise. For instance, the GAO questioned the basis by which the EPA was making their assumptions (as the EPA claimed the programme – involving over 2300 participants – saw rates of return of 50% on their EE lighting projects which led to savings of about US$100 million per year). Conducting a survey, the GAO found that of the businesses involved in the program, a little more than 25% were likely to have installed EE lighting regardless of the programme (three writers). In addition, the GAO questioned the timing of some of the EE lighting – because using data from the US' industrial and commercial building survey conducted every four years by the US DOE's Energy Information Administration (EIA) indicated that floor space (including EE lighting) had been upgraded in a number of businesses and industries prior to the programme (Mazurek 2002).

6.5 Demand-side management programmes

Demand side management programmes (DSM) are programmes undertaken by utilities "to change patterns of customer electricity use and thereby modify the pattern of the utility's load, but this definition has grown to include the promotion of energy efficiency and conservation" (Gillingham, Newell and Palmer 2006, pp. 167). DSM programmes generally encompass policies and programmes found to increase information and / or access to capital (e.g. cash rebates, low cost loans, information programmes, etc.).[4] DSM programmes apply mainly to regulated monopolies and allow profits to be linked to providing the best service at the least cost rather than electricity sales.

DSM programmes are particularly well established in California where they contain provisions to help lower-income customers' deal with electricity price hikes. The programmes have helped reduce per-capita electricity consumption in California to well below the US average (Figure 6.1). In this state, the main rationale for pursuing DSM was concerns about energy security in the aftermath of the oil shocks of the 1970s (Shaw 2009). Some have criticized the Californian programmes for increasing the average costs of electricity and increasing electricity imports (which are more carbon-intensive) (Shaw 2009).

Figure 6.1 Electricity use per capita, California and the rest of the United States, 1960-2006elctricity use



Source: Flavin, Building a Low Carbon Economy, State of the World 2008, p. 89

[4] See Gillingham, Newell and Palmer 2006 for more information

A number of developing countries including China and the Philippines have created DSM programmes as a part of their national energy policy (Thiruchelvam *et al*. 2003). Birner and Martinot (2005), assess the effectiveness of a number of GEF projects, including IEE projects, and highlight a number of challenges regarding implementing DSM. Specifically, their evaluation of a GEF demand side management (DSM) project in Thailand indicated that the electricity utility (which was involved in wholesale of electricity) lacked the necessary relationships with consumers (which would also include some smaller scale industry as well as commercial and residential customers) because it did not sell power directly to them. This is also related to the importance of building networks to increase information flow among players. Also, the DSM programme was considered more successful in households versus the industry and commercial sectors. Programmes targeting industry (e.g. trying to encourage firms to adopt more efficient motors) "did not achieve much, largely due to the lack of access to viable financing sources in the industrial and commercial sectors for the investments required" (Birner and Martinot 2005, p. 1768).

6.6 Recognition programmes

In addition, **recognition programmes** have also been touted as relevant policy mechanisms to encourage the uptake of IEE technologies. Recognition programmes are essentially government programmes in which to award enterprises for their energy efficiency efforts. These programmes can consist of a contest and awards ceremony, including a media event and media exposure, a recognition certificate, etc. One programme indicated by many EE experts as being useful is the Leadership in Energy and Environmental Design (LEED) Green Building Rating System, which is a set of voluntary sustainable building standards, established by the United States Green Building Council but used in a number of countries.[5]

Using guidance from the 2001 Energy Conservation Act, in 2002 the Government of India created the Bureau of Energy Efficiency (BEE) under the Ministry of Power. The mandate of the BEE is to help develop policies and programmes to reduce the energy intensity of the Indian economy. Its two key roles are in the areas of regulation (e.g. creating codes and standards) and awareness (e.g. establishing energy conservation campaigns).

One scheme BEE is charged with is the annual National Energy Conservation Awards, which has been in place since 1991 (Figure 6.2). In this programme, enterprises from a number of

[5] See http://www.usgbc.org/DisplayPage.aspx?CategoryID=19

sectors submit a questionnaire to the BEE and are entered into a contest, judged by government officials, with an awards ceremony.

Figure 6.2 India's BEE National Energy Conservation Award Programme Poster 2009

Source: <http://www.bee-india.nic.in/EC_Award/2009/BEE_awadr_adv_ENG.pdf>

Voluntary agreements between iron and steel firms and the provincial government in Shandong province in China included recognition of energy efficiency efforts, with extensive media coverage. This recognition was the only thing the provincial government provided despite the fact that other incentives including financial and technical assistance were mentioned in the agreement. For this reason, it would be interesting to follow up with these firms to determine how well they are meeting their EE goals now (2009) because energy savings results up until 2006 were noted in the study.

7 Technology co-operation and transfer policies

Another key area of policies considered pertinent to the adoption of IEE technologies, particularly in developing countries are **technology cooperation and transfer policies**. These policies cover a range of issues including innovation, trade and competitiveness and industrialization. They are particularly important in developing countries because ownership of a number of IEE technologies is foreign and foreign exchange is required to purchase them. This is particular case in those countries not a part of the BRIC since they have a much weaker manufacturing base. As Ayres (2009) suggests, in a number of developing countries, there are powerful groups which prefer to use available foreign exchange on luxury items – such as cars – rather than to purchase IEE technologies. In addition, in the BRIC countries, some domestic industry producing IEE technologies may be concerned about the introduction of foreign technologies into the domestic market – even if these foreign technologies may be more energy efficient (and thus desirable by firms).

Technology as defined here includes processes (e.g. organizational and management practices, production processes), knowledge (tacit and codified) and products (e.g. physical equipment, artefact), also termed “software” and “hardware” (IPCC, 1996; Lall, 1995; Teece, 2005). Technology transfer can be viewed as the flow of products, processes and knowledge between various stakeholders involved in the development, production and use of technologies. A number of authors (including myself) uncomfortable with the term transfer, prefer to term the concept *technology cooperation*, to better capture the fact that these flows are not one way, but rather occur in multiple directions between partners (Heaton *et al*. 1994; Martinot *et al*. 1997; Mallett 2007). Regardless of whether coined ‘transfer’ or ‘cooperation’, one key premise of this view – in contrast to traditional technology transfer studies emphasizing equipment and skills transfer – is that in order for technology cooperation to be sustainable it must be a part of technological capacity development (Ockwell *et al*. 2007). Technological capacity is the ability of a firm, country, etc. to elicit technical change (Rogers 2003).

Absorptive capacity is also important in ensuring successful technology cooperation. This concept focuses more on firms’ attributes including entrepreneurial spirit, risk taking, etc. Basically it is the notion that you can provide a firm with equipment, the know how to maintain and fix it, and the know why in terms of why it works to spur the seeds of new technology development, but it is also dependent on how the firm responds to this information (van den Bosch, Wijk *et al*. 2003). This theme was noted in a few studies on the barriers to IEE technologies in developing countries (e.g. Park and Labys 1994, and Lohani and Azimi 1992), indicating that high tariffs on foreign EE technologies served as a disincentive for local manufacturers to acquire these technologies, as well as those assessing policy options.

At the same time, there must be ways in which to address firms' concerns that own the IEE technology. Concerns could include the fact that any Intellectual Property Rights (IPRs) may be infringed upon; firms purchasing the technology on credit (in the case of equipment or training of local workers by foreign engineers for example) will not eventually pay; etc.

The process of technology cooperation comes in many forms including joint ventures, agreements between a subsidiary and a multinational corporation, governments, community organizations, international organizations and partners in developing countries, etc. In fact, technology transfer in the area of industrial energy efficiency technologies, as well as other energy and environmental areas, is rather prevalent. However, as Forsyth (1999) suggests, it may not seem that way as often companies do not necessarily use the term "technology transfer" to describe what they are doing. Technology cooperation can also be more formal, such as through the purchase of a technology license or through a Technology Transfer Agreement, or more informal, such as through exchanges between technical personnel at conferences.

Finally, it is important to revisit what exactly is meant by technology transfer or cooperation because although there is an increasing shift regarding the concept of technology transfer, recognizing that it is a broader, more comprehensive process, some "'myths regarding technology transfer" continue to persist (Van Tildenburg *et al*. 2009). One myth for example is that technology transfer consists only of technology flows coming from industrialized to developing nations. While this may be the most prevalent case, as indicated above, there are multiple directions for technology flows, and opportunities for sharing from developing to other developing or industrialized nations.

For instance, in our Part 1 report examining barriers in the cement sector (p. *), cement kilns are more efficient in some developing countries such as China and India (as well as Japan, Australia and New Zealand), versus countries of the former Soviet Union, and even North America, as companies have been reluctant to adopt newer, more efficient kilns due to low energy prices, among other factors (CSI, 2007). An OECD / IEA report also indicates that speaking about the aluminium and cement industries globally, "the most efficient aluminium smelters are in Africa and some of the most efficient cement kilns are in India" (2007, pp. 21).

This facet – that some industries in developing countries are more recent, and so they sometimes incorporate newer, more energy efficient technologies versus their industry counterparts in OECD countries -- is also recognized in other IEE studies (e.g. Worrell *et al*. 2009).

7.1 Policies from the developing world

Many developing countries have some form of technology transfer and cooperation policies. These can range from duties on some foreign manufactured goods in Africa in an effort to encourage local industry development in these areas to active research and development programmes targeting indigenous energy efficiency technologies which have been encouraged in the policies of a number of Asian countries including India, Sri Lanka, Vietnam, China and the Philippines (Thiruchelvam *et al* 2003).

One mechanism through which to promote IEE technologies in developing countries is through the activities of the Global Environmental Facility (GEF). The GEF was launched as a pilot project of the World Bank in 1991. It was restructured in 1994, consisting of a Governing Council, a Secretariat housed within the World Bank, a Scientific and Technical Advisory Panel (STAP), and three Implementing Agencies, responsible for developing and implementing projects (Verbeken 2009).

According to Verbeken (2009)'s study of technology transfer within the GEF, as of 2008, the organization had funded over 30 projects to encourage the adoption of IEE technologies in developing countries. While not all of these projects have had evaluations conducted at present, a number of lessons learned have emerged from some.

For example, in a GEF project aimed at encouraging the adoption of more efficient boilers in the coal industry (smaller power plants) in China had a number of strengths and weaknesses. One criticism of the project was that it took too long to get up and running. In this case, the project began in 1994, but technology licenses between the boiler manufacturers (largely based in industrialized nations) and auxiliary equipment manufacturers (generally in China) happened only between 1997-2000. This eight-year period saw a number of changes in personnel and responsible agencies. As Adhikarai *et al* (2008) point out, the original Chinese government agency charged with oversight of the project, the Ministry of Machinery, became reorganized over the time period and was no longer a ministry. One reason for the delay was because companies that 'owned' much of the technology were reluctant to engage in the project, due to

IP concerns. “The project had to engage in several rounds of international competitive bidding for technology licenses, as the interest and willingness of foreign suppliers to transfer technical know-how proved elusive or fickle” (Birner and Martinot 2005, p. 1770).

Other reasons for the delay include the fact that the GEF offered only a small amount of money (on a per firm basis) to pay for technology licenses, and the money offered was only a one-time deal, rather than opportunities for ongoing improvements of the technologies – so many firms, with state of the art technology, found it not to be worth it. Also, one technical issue was the fact that the boilers burn raw Chinese coal (not a normal requirement for boilers designed outside of China). Moreover, the bureaucracy involved (through the World Bank, acting as the GEF project implementing agency) further delayed contracts. A further aspect also considered key in the delay was the fact that many boiler manufacturers did not agree with the terms offered by the Chinese. A key sticking point was that the Chinese government, rather than an individual firm, would own the license. As indicated above, this concerned a number of potential firms regarding IP issues even though the Chinese government would select Chinese firms to receive the license but the foreign supplier had to agree on the selection and would receive royalties (Birner and Martinot 2005).

At the same time, Birner and Martinot (2005) indicate that the GEF project had a positive effect on the industrial boiler market as people in China became aware of these more efficient technologies, and some firms outside the programme adopted them.

Another GEF project aimed at encouraging the use of IEE practices and technologies in the Steel Re-Rolling Mills (SRRM) in India also highlights some technology transfer strengths and weaknesses. The project was discussed in Section 4.1.5 in relation to ESCOs. But there are other aspects important to understand.

To recap, project activities consisted of providing information to firms about EcoTech options and technologies, benchmarking services for firms regarding energy efficient technologies, a resource centre, and assistance through the use of ESCOs, and while the hope was to have 20 of 30 firms actively participate in the program, only nine were involved and only a few of the nine were even considering EE investments.

There were a number of challenges to the programme. In addition to their being reluctance on the part of ESCOs and firm owners to engage with one another, benchmarking India’s SRRM firms against international steel process was not as applicable as the technologies in India were out of date and the sizes of plants were much smaller. Other factors hindering the project's success included the fact that as of 2007 the steel industry in India was booming – increasing production to keep pace demand was considered key, rather than EE projects, which could require time in which the equipment was not in operation. Based on these outcomes, some recommendations from project evaluators included a focus on engaging local players and on capacity building – not just among SRRM units, but also domestic equipment providers, consultant and other key industry players. Another recommendation was that rather than focusing on state-of-the-art technologies, attention on more appropriate package of technologies should be encouraged. Finally, project evaluators echoed similar views to SPRU's notion that technology transfer must include longer term capacity building efforts; a part of a wider process of building up technological capacity and indigenous innovation in developing countries (Verbeken 2009).

Two projects from TERI regarding the adoption of IEE technologies among Indian SMEs in the glass and foundry sectors respectively also provide some insights. One attribute of the project that was considered a strength was the fact that there were a number of domestic and international players working together, each playing a distinctive role. Foreign players included the British firms and the British trade associations involved in leading edge technologies in these sectors at the time of project implementation (1990s-2000s), as well as the Swiss Agency for Development and Cooperation (SDC). The respected Indian environmental institution TERI served as a conduit to facilitate the flow of equipment, skills and knowledge from the foreigners to the Indian SMEs.

One way in which these projects attempted to address any potential intellectual property rights (IPRs) was through how SDC designed their bilateral assistance programme. Basically, the idea of SDC was to initiate technology cooperation at an early stage of the technology development cycle – recognizing that major modifications would be needed to the British designs to adapt them to the Indian environment – making the technology unique. British partners were willing to provide their equipment and expertise to these other players. SDC and TERI's agreement indicated that both groups would decide whether or not to patent innovations resulting from their cooperation. Ultimately, SDC and TERI decided not to patent the resulting innovations in the interest of further disseminating these technologies (Pal 2006; Sethi and Ghosh 2008 (eds)). That said, the fact that these partners came together at an early stage and agreed on how to address potential IPR issues, is considered one success of the project. Other work on low carbon energy technologies in India including hybrid vehicles and solar photovoltaic technologies, also indicates that early collaboration is a promising area to ensure successful technology cooperation (Mallett *et al*. 2009).

In the glass sector, in 2008 about half of the around 80 pot furnace units in the SME cluster of the project (the glass sector in Firozabad) were using the TERI design, while another 30 were using the concept. In the foundry sector however, only about 1% of SMEs were using the TERI design. That said, there were two important differences between the two TERI projects. First of all, the glass project was concentrated in one area - the city of Firozabad, where nearly all glass bangles in India are made as well as other low value glass items (e.g. bowls, lamp shades, etc.) (Sethi and Ghosh (eds) 2008), versus the foundry industry which has a number of different clusters in different parts of the country (e.g. the Howrah cluster in Eastern India makes low value iron castings like manhole covers and pipes and the Rajkot cluster in western India mainly produces grey iron castings for the local diesel engine industry (Pal 2006). Secondly, related to **Section 4.3** (institutional, regulatory and legal policies), in December 1996, the Indian Supreme Court ruled that industries located within the Taj Trapezium Zone (TTZ), and area 10 400 km2 surrounding the Taj Mahal and which includes the city of Firozabad switch from coal to other alternative fuels and they were given one year to do so. As the cluster had been based in the city for many generations (see. Sethi and Ghosh (eds) 2008, p. 19 for further details).

8 Key considerations for successful IEE policies in developing countries

A wide range of energy efficiency policies have been introduced with in developing countries, but they appear to have met with mixed success. Evaluation is generally either absent or poor and the available studies vary widely in their methodological quality. However, a number of considerations have emerged from this review of literature which can provide some guidance to policy makers, practitioners and academics working in this area.

8.1 Systemic or sector-wide approach to IEE policies are more effective

The first key consideration is that **systemic or sector-wide approaches** to IEE policies have been more effective. For instance, Ciccozzi *et al* (2002) assess five UNEP projects in developing countries and stress the need for complementary strategies and measures for the participating sectors (i.e. not only individual firms, but also governments, academia, the media and trade associations). In a similar manner, Thiruchelvam *et al* (2003), in their study of Asian SMEs, argue that a systemic, targeted approach is needed, tailored specifically to SMEs in order to help with the adoption of IEE technologies. A recent well-known example of addressing EE at the systemic level (industry and beyond) is the phasing out of incandescent lights (through prohibiting their sale, etc.) in a number of countries after 2010 (Ayres 2009).

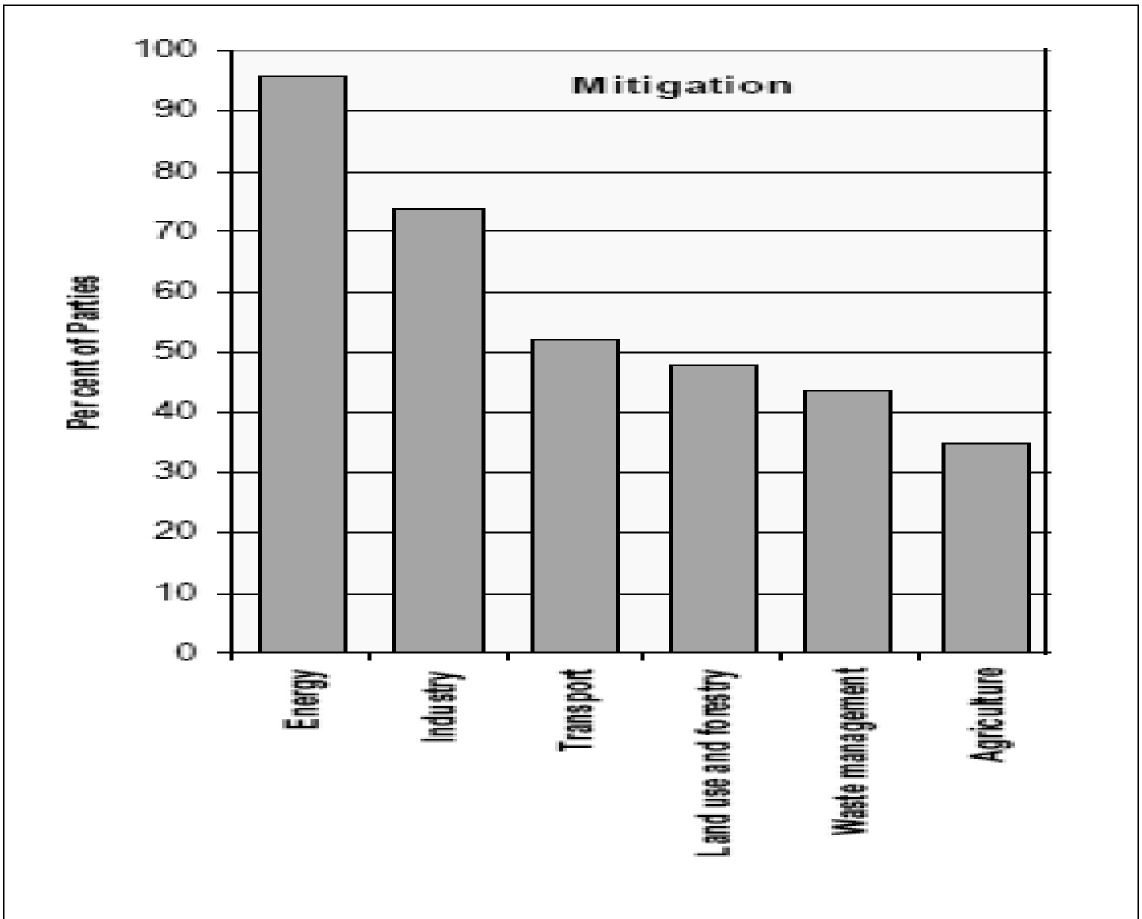
Addressing IEE in this way is particularly important in developing countries because on a day-to-day basis, many firms give little thought to energy efficiency and environmental pollution. Rather, decisions on what technology or fuel to use are based on convenience, availability of supply and knowledge of price, acceptability, etc. (Thiruchelvam *et al*. 2003).

Of the studies assessing policies and programmes in Section 4, many of the more successful ones included partnerships involving various sectors – public, private, academic and communities -- and engagement at the local level. This finding is particularly important because policies and programmes on IEE in developing nations are often established by federal or state governmental agencies, or international organizations. In assessing the effectiveness of several projects involving cleaner production, Evans and Hamner (2003) assert that “engaging local community organizations is key”. Furthermore it is important to focus on actors from various sectors. Using evidence from their project assessment, Evans and Hamner also argue that behaviour change as much as technology change promotes cleaner production.

8.2 IEE policies are a high priority for technology transfer for a number of developing countries

Under the United Nations Framework Convention on Climate Change (UNFCCC), a number of developing countries (23) identified priority technologies to help them mitigate and adapt to the effects of climate change through a Technology Needs Assessment (TNA) exercise. As shown in Figure 8.1below, **energy** (92 % of Parties) and **industry** (79 %) were the two most commonly cited priority areas for mitigation technologies versus other sectors such as agriculture and forestry (33%) and waste management (29%). Within industry, specific areas noted by developing countries were industrial energy efficiency technologies generally speaking, boilers, high efficiency motors, furnaces, and sectors noted by Parties were cement, steel, bread baking and mining (UNFCCC 2006, p. 11).

Figure 8.1 Key sectors indicated by developing countries as being priority to help mitigate climate change effects



Source, UNFCCC, Synthesis report on technology needs identified by Parties not included in Annex I to the Convention, FCCC/SBSTA/2006/INF.1, p. 7.

In Adhikari *et al* (2008)'s survey of priority technologies for the CDM in Thailand a similar story emerged - IEE technologies were considered the most important type of technology (25 stakeholders ranked electricity for industry as high and very high and 22 stakeholders ranked IEE as high and very high). "Since, there is a huge consumption of energy in the industrial processes; almost every stakeholder thinks that energy efficiency techniques should be implemented in every industrial process so that the consumption could be minimized to certain extent." (2008, p. 2128).

8.3 IEE policies must have a long-term time horizon

A similar theme among studies in developing countries (e.g. see Verbeken 2009 noting a GEF project on EE in Malaysia for example) regarding IEE policies and programmes stresses the need for policy makers to approach promotion of energy efficiency using a time horizon of decades, and to continue efforts, rather than stopping and starting programmes depending on the political personnel in power, in order to see real progress in this area.

8.4 International IEE programmes make a difference

This examination of studies assessing the effectiveness of IEE policies and programmes also indicate that the implementation of these projects in and of themselves have generally had a positive effect on encouraging uptake of these technologies. In developing countries, where domestic governments may not have the capacity or initiative to take on these policies and programmes, **international programmes are particularly key in instigating IEE change among firms** (e.g. such as those conducted by UN agencies such as UNIDO or UNEP).

For instance, Birner and Martinot (2005) assert that in three of the ten GEF EE projects (not only industry but some across the board) the projects themselves affected change within markets in the following ways: a) the projects increased expectations among industry players that there would be more interest and investment in EE products; b) the projects increased awareness regarding energy savings possibilities, and c) the projects encouraged players to "increase their market presence, develop prototypes, and act to position their products to take advantage of the project" (2005, p. 1777).

Thiruchelvam *et al* (2003) also provide an example of a successful project run by UNIDO in partnership with the Swedish International Development Cooperation Agency (SIDA) and the Department of Science, Technology and Environment (DOSTE) in Vietnam from 1995-1997. In this case study, there were five demonstration projects in food, paper and textile processing facilities. These projects were considered successful because the returns were quick and savings were substantial (a total investment of US$242, 000 for all five projects was required, the average pay back period was three months and total savings were about US$962, 000 per year).

Thiruchelvam *et al* (2003) also provide examples from India and Sri Lanka of low cost / quick return EE projects targeting SMEs, but it is not clear which agency was responsible for running these projects (e.g. a domestic or international agency). See Box 6.1 below.

Box 6.1 Two examples of energy efficiency projects in SMEs (India and Sri Lanka)

Low investment, quick returns

Country: India	
Program: Replacement of conventional motors with energy efficient motors in ring frames in spinning mills (textile industry)	
Outcome	
Investment:	US $575
Savings:	US $426 per annum
Payback period:	16 months
Country: Sri Lanka	
Program: Providing ceramic wool insulation to prevent heat loss in a biomass fired kiln in roof tile industry	
Outcome:	
Investment:	US $1400
Savings:	US $ 1110 per annum 50% saving of fire wood, 50% reduction on dust and emissions resulting in a cleaner environment
Payback period:	15 months

Source: Thiruchelvam *et al*. (2003), p. 982.

Another mechanism through which to promote the transfer of IEE technologies is through the CDM. However, less attention was placed on this area as another contributor to the UNIDO report (Joachim Schleich, Wolfgang Eichhammer and Tobias Fleiter) is undertaking research in this area. Nevertheless, it is important to understand that for many EE projects to happen in developing countries, the CDM is considered a critical channel. For example, although not targeting industry specifically, the country of Ghana has made important strides to develop and implement an appliance standard (no other African nation, except for South Africa, has done as much work in this area). But, any attempts at creating an appliance standard in Ghana require financial investment and political will, as well as more technical issues such as a local appliance testing lab facility. Any such lab would likely require the use of technology from elsewhere, as well as a budget and start up funds. The CDM could prove to be one such channel through which Ghana could see such a lab comes to fruition (Koizumi 2007).

8.5 IEE policies must be tailored to the specific needs of the country and sector

One key message that has been reverberating through the various studies examining IEE policies and programmes in developing countries is the importance of tailoring IEE policies to the context. For example, as indicated in the examination of studies assessing the barriers to the use of IEE technologies in the cement sector globally in our Part 1 report, and noted again in Part 2, a key concern for industry stakeholders was to keep the ceramic kilns operating – shutting them down to install energy efficient equipment would negatively affect their integrity. Other studies also reiterate this view, such as Worrell *et al* (2009), who states that when examining IEE policies and programmes, it is important to establish “whether the benefits to society outweigh the cost of these programmes or whether other instruments would have been more cost effective has to be evaluated on a case by case basis" (2009, p. 18).

For example, Rock and Angel (2005)'s book examining a number of industries in East Asia indicate that, generally speaking, empirical evidence points to the importance of firm level learning in order to ensure real energy efficiency and environmental improvements in the use of foreign technologies. However, they acknowledge that firm level learning is dependent on a number of factors including how the sector is structured, the path dependency of firms, the openness of an economy to receive foreign investment, technology and trade, etc. One sector-specific aspect they note is particular to the cement industry, which consolidated at a global scale in the 1980s, affording opportunities for firms worldwide to learn.

Another aspect related to the particular situation of a country comes from a study in China which asserts that many firms in China (whether public or private sector) are used to following government programmes as that country is highly centralized and the government has played a dominant role (EEPC India).

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