Energy efficient and environmentally sound industrial technologies in Asia

Part II: Industry's organizational structure and the role of external actors

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Abstract
The first part of this article (which appeared in the previous issue) described some technological changes that could be introduced in energy intensive and polluting industries in China, India, the Philippines and Sri Lanka. The second part goes on to analyse the effects of the organizational structure and of various external factors on the adoption of these changes in three industrial subsectors.

Résumé
La première partie de cet article (parue dans notre précédente édition) décrivait quelques-unes des modifications technologiques pouvant être apportées aux activités industrielles polluantes et grosses consommatrices d'énergie de la Chine, de l'Inde, des Philippines et du Sri Lanka. La seconde partie de l'article présentée ci-dessous analyse l'incidence de la structure organisationnelle et de divers facteurs externes sur la mise en úuvre de ces changements dans trois branches industrielles.

Resumen
La primera parte de este artículo (publicada en el número anterior), describía algunas de las modificaciones que pueden introducirse en las industrias de uso intensivo de energía y más contaminantes de China, India, Filipinas y Sri Lanka. En esta segunda parte, se analizan los efectos de la estructura organizativa y de otros factores externos en la adopción de dichas modificaciones, en tres sectores industriales.

Introduction

Part I of this article was devoted to assessing the economic viability of energy efficient and environmentally sound technologies (E^3STs) in four countries: China, India, the Philippines and Sri Lanka. Even when the right technology is selected, and subsequently implemented, the anticipated economic outcome or other benefits may not be realized due to problems internal to the enterprise, or to external parameters which are beyond its control. In Part II the organizational structure and role of various external actors in the adoption of E^3STs in these countries will be discussed. Using cross-country comparisons, several factors have been identified which either facilitate or hinder the adoption process. It is hoped that countries can learn from the success stories of others and develop cohesive policies to support and strengthen the implementation of E^3STs in their own industries.

Country situations

It is important to understand the general business environment prevailing and the system of governance in the four countries. A diagrammatic representation of the situation in each country is shown in Figure 1. In order to clearly present the activities of the various external actors, their status and their influence on enterprises, they are classified into four distinct groups: public authorities (central and local), private sector (local and international), general public, and bilateral/multilateral funding agencies (such as UNDP, World Bank, ADB, USAID, etc.).

As shown in Figure 1, most of the external actors in China operate under state patronage. A large number of enterprises are also owned by the state (or local authorities). Clearly distinguishing between internal and external actors is not easy, as functions and responsibilities sometimes overlap. The private sector plays a limited role in equipment supply, consultancy, information services, etc.

In India the private sector is active in finance, research and development, and other areas. However, most of the energy utilities are under state control and a number of state-owned enterprises are active in important economic areas.

The situations in the Philippines and Sri Lanka are quite similar (with some minor differences). The private sector is becoming active even in power generation and distribution. Most enterprises are operated by the private sector and many state-owned enterprises (all manufacturing establishments in the Philippines) have been privatized. The few remaining state-owned units in Sri Lanka are also being privatized.

Organizational environment

This section presents a cross-country comparison of major issues concerning industries' internal organization that influence the adoption of E^3STs. A few country-specific examples are cited in order to highlight some issues of greater importance.

Figure 2 compares the organizational structures of the enterprises analysed in the four countries, describing the nature of ownership, decision making processes, and organizational culture. The four countries are at different stages of transition from centrally planned to free market economies. In the Philippines, which has a fully liberalized economy, all enterprises are privately owned. In China, which is at an early stage of its market economy, most enterprises operate under state patronage. A somewhat mixed situation exists in India and Sri Lanka.

An enterprise's decision making process greatly depends on the nature of ownership. State-owned companies are more hierarchical, with a clear demarcation of functions. Different functional groups have specialized knowledge and skills to assist in the selection and adoption of technologies. However, the inherent bureaucracy of state-owned companies causes delays in the decision making process. Decision makers and implementers have a tendency to adhere to short-term plans which can show immediate results. In contrast, privately owned enterprises are rather quick in making decisions, irrespective of the country where they are located, although decisions are often taken by a handful of people at the management level.

Strong commitment to energy efficiency and environmental protection by top management is imperative for successful implementation of E^3ST projects. The commitment should percolate from management levels to each and every individual in the plant.

Even if the adoption of E^3STs makes economic sense, successful implementation may not be possible unless the right organizational environment is created. The most important aspect is to assure the motivation of employees of all categories.

Motivation could take various forms, such as rewards, participation in decision making, a sense of recognition, better job opportunities, and career development.

In all four countries priority is given to increasing output rather than to improving efficiency through energy conservation, waste minimization, environmental protection, etc. This is partly attributable to governments' overprotection of industries for socio-economic reasons, so that they are insulated and shielded from international competition. Another important reason is the inadequacy of employee skills needed to use new technologies and processes. Human resource development is therefore a must. Productivity figures for selected enterprises in these countries are shown in Table 1, clearly highlighting the merits of a well planned productivity improvement drive.

Implementation of E^3STs has sometimes failed due to inadequate knowledge of the plant's design parameters or improper installation and operation of equipment. Enterprises in China and India have matured in technical expertise through experience and knowledge gained in a wide range of industries. In China this expertise is further strengthened by the cooperation of ministries and institutions capable of providing information and experts if needed. The Philippines and Sri Lanka have difficulty building up expertise due to the nonexistence of large industrial bases and the lack of cooperation among subsectors. The few enterprises with a successful track record have basically built up their capabilities through their own initiatives.

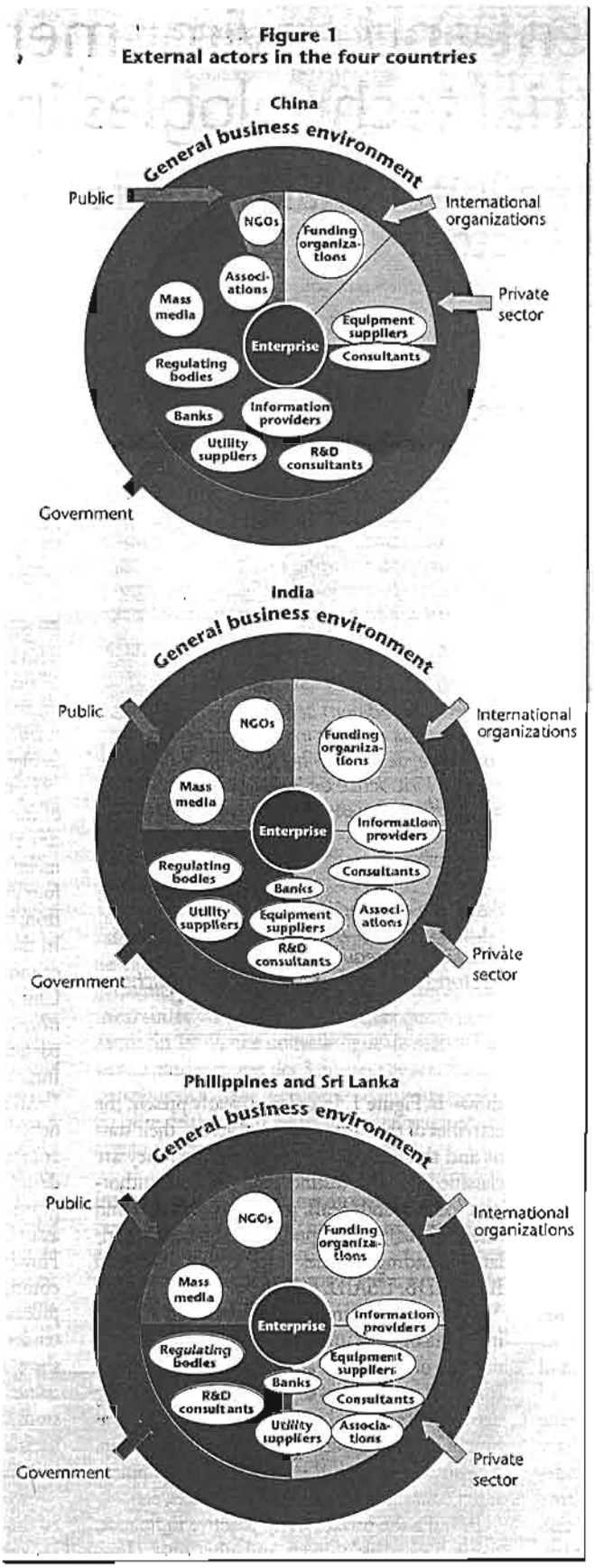
Energy efficient technologies in the cement industry are well developed. The industries analysed in the four countries have adopted most of them. Automation of processes has contributed to higher productivity.

Many industries are found to have made commitments to environmental protection in order to obtain support from international lending institutions and to become acceptable to the adjacent communities. However, actions are taken on a "piecemeal" or "per need" basis. Environmental protection and management in various industries in the four countries vary depending on the ability to acquire funds, technical knowledge, and the environmental regulations in effect. In the Philippines and Sri Lanka, personnel are less competent to deal with a plant's environmental concerns. Environmental functions are often performed by a technical person as an add-on assignment. One commendable Indian company has increased environmental management capability by creating a division at both corporate and plant level for handling environmental matters. Environmental protection is introduced and applied at all levels of the corporation and plant divisions. Depending on the type of industry response to environmental regulations, some have achieved positive impacts while others consider their actions as "money down the drain".

In many industrial establishments there is a lack of interdisciplinary interaction. As a result, well coordinated and cohesive attempts are not made regarding issues such as adoption of E^3STs, which requires expertise from several spheres including accounts and finance, administration, engineering and purchasing. Employee suggestions are also valuable for implmementing plant improvements. Employees who are familiar with the performance of each and every piece of equipment are normally in a strong position to suggest improvements. What is necessary is complete harmony among the different actors, including those at floor level within the organization, so that they can then contribute equally and to the best of their ability.

While striving to create the right organizational environment, enterprises should effectively interact with all supportive external actors in order to successfully implement E^3STs.

Figure 1
External actors in the four countries



Role of external actors

This section summarizes the important role played by the external actors who can influence the adoption of E^3STs. Findings of cross-country comparison are presented, with a few country-specific examples given to highlight certain observations.

Government

Though China's economic system is in gradual transition from "centrally planned" to "market oriented", most activities are still controlled and performed by the state. It is somewhat difficult to differentiate the role of the government as is done in other countries.

In the past decade China introduced a series of policies, regulations and standards on energy conservation and environmental protection which played an important role in improving energy efficiency and controlling environmental pollution. However, past experience shows that policies, laws and plans are likely to be meaningless and hard to implement without good guiding principles and appropriate institutions for effective supervision. The government has now issued some new policies to take advantage of market mechanisms and promote E^3STs, such as increasing energy prices and levying waste discharge fees. These policies have produced better results in terms of energy conservation and environmental protection. The industrial development policy also gives priority to encouraging technological innovations to save energy, water and raw materials and to the adoption of clean technologies.

In India the government has been performing legislating, regulating, administering and control functions. Before economic liberalization, its role

was based more on restricting the freedom of individuals than on facilitating growth. The liberalization of the last five years has reduced the restrictive role the government was playing through inhibiting the natural instinct of individuals towards growth and progress.

In the Philippines tariff structures, investment incentives, financial assistance and environmental protection are the major factors that have affected industry and the extent of its adoption of E^3STs. Investment priority plans have been designed to provide incentives, such as tax concessions and holidays, to pioneering as well as non-pioneering (traditional) industries. Environmentally friendly and energy efficient technologies were not, however, included. Industrial restructuring programmes have been developed since 1991 in selected subsectors, led by the Development Bank of the Philippines. The objective is to prepare industries to compete with the country's ASEAN neighbours.

In Sri Lanka there are several drawbacks affecting the process of E^3ST adoption. National productivity is rated as among the lowest in Asia. As the cost of technology is more or less the same as in other countries, Sri Lankan enterprises will never be able to adopt E^3STs and compete in the global market unless productivity is improved to the level of competing countries. An industrial productivity improvement drive recently launched by the government needs to be further strengthened and continued with vigour and vitality, so as to have a spill-over effect on other economic sectors and society. Though a lot of encouragement, support services and facilities are provided by state agencies in order to set up new industries, with time the facilitation role played by some of them gradually tends to decline.

Regulatory authorities

Before 1990, Chinese environmental protection policy encouraged enterprises to adopt end-of-pipe technologies. Since 1994, the Chinese environmental legislative system has made great progress by adopting new methods such as cleaner production, total quantity control of pollutant emission, pollutant emission licensing and regional environmental impact assessment. Enforcement tools include fines levied on the enterprise or its head, orders to cease operations, and deadlines for compliance. However, enforcement is not effective in some cases where enterprises belong to the government.

In the Philippines the low fines for violating or failing to comply with regulations do not reflect the internal or external costs of pollution prevention and management.

It appears that environmental authorities in Sri Lanka have generally opted for the stringent standards in effect in the developed world, without paying due attention to their economic implications, the availability of the technology, or the compatibility of existing processes, utilities and manpower.

Financial institutions

In all four countries the high cost of capital absorbs most of the profits generated by a project. Several credit lines funded by international institutions are available through development banks or as grants for restructuring of industries, environmental protection and demand side management.

In India financial institutions have several engineers and technocrats who look at proposals from technological and environmental angles to determine whether a project is eligible to receive financial support. Some development banks are active in funding the R&D needs of Indian industry (Figure 3).

In Sri Lanka special schemes with very attractive financing conditions (zero interest with a grant component for consultations) are available for E^3ST adoption. However, enterprises consider the contributions towards technical evaluation received from funding organizations as rather inadequate.

The Chinese financing system is quite different from that in the other countries, due to the important role of the state. The State Planning Commission and Ministry of Finance make five-year investment plans. Thereafter, local authorities or project implementing agencies make yearly investment plans, especially for large investments. Large projects (investment over US$ 1 million) must be listed in the investment plans of various ministries. Other projects must also be listed in local government, subsectoral and other investment plans. Irrespective of the extent of investment, the enterprise should come up with two-thirds of the total with the remainder being offered by banks or other financing agencies. Once the project is listed in any of the investment plans, banks are under a statutory obligation to sanction loans. Other projects must negotiate with banks for funding as in other countries. It is difficult, however, to obtain a loan for a project which is not listed in investment plans if the payback period exceeds three years.

Strategies adopted to comply with environmental regulations

- In China some industries would rather pay fines than adopt clean technologies, as it is cheaper than building a pollution control facility. Some enterprises pass on the cost of the fine to the consumer.
- One company in India devised an integrated environmental management system which resulted in zero waste generation. The effluent of a pulp and paper plant is used to irrigate a sugar plantation whose cane is milled in a sugar mill. The residue (bagasse) is supplied to the pulp and paper plant.
- In the Philippines a large company has installed electrostatic precipitators and dust filters that can reduce particulate emissions three times below the standards in effect, though with no economic returns. The company has received awards from some NGOs and built a positive green public image.
- A pulp and paper company in Sri Lanka has replaced paddy straw with waste paper as raw material, in order to avoid problems associated with the treatment of effluent discharges.

Figure 2
Enterprises' internal organizational structures

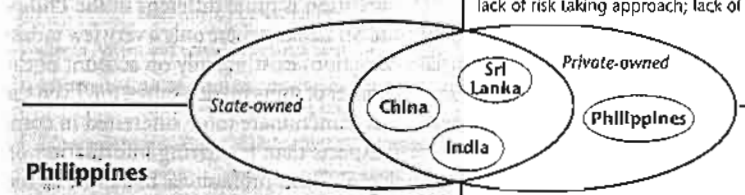
China

Structure and decision making:
General manager appointed by the employees' representative assembly or the board; employees influence manager's decision; short term of office by the manager, decision making done by the board; all phases of decision making need approval by the local and/or central government.
Culture:
Employees' welfare comes before anything else; risk averse; work more to receive more

India

Structure and decision making:
- State-owned: functional groups with specialized knowledge and skills; bureaucratic; strong bottom-up communication; suggestions come from all levels.
- Private-owned: owner takes control of the whole business and acts as CEO; top-down approach; investment decisions made only by CEO.

Culture:
Customer satisfaction; housekeeping and cleanliness; employee or community welfare; feeling of belonging; lack of risk taking approach; lack of entrepreneurship.



Philippines

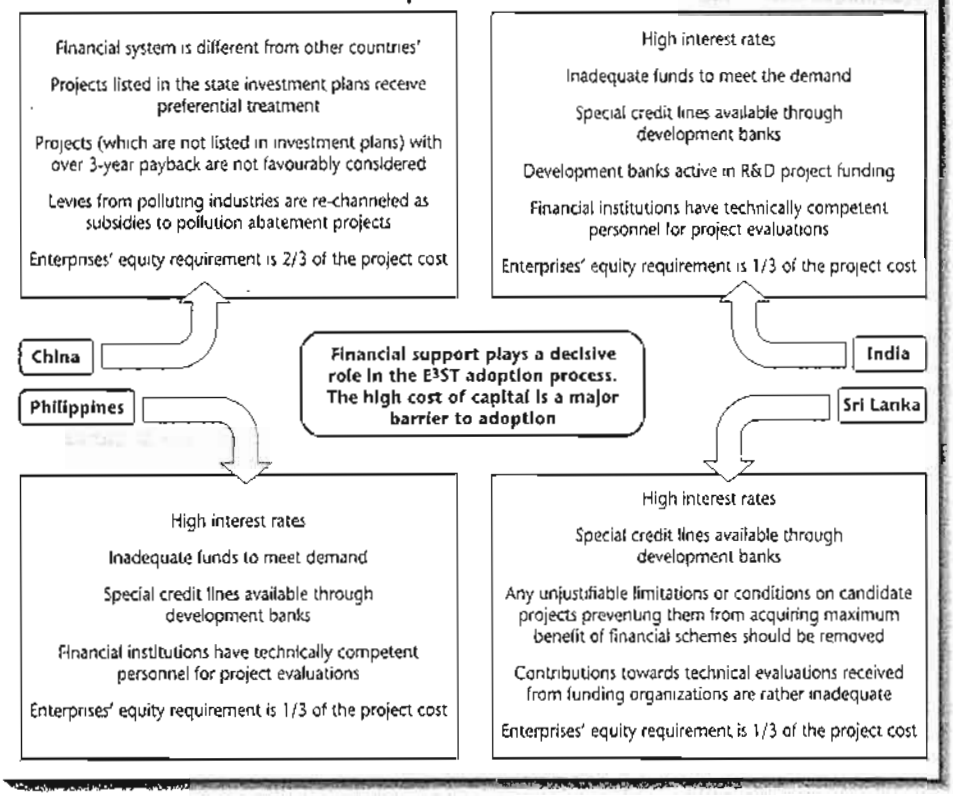
Structure and decision making:
Functional groups with specialized knowledge and skills; technically competent plant manager coming from the ranks; combined top-down and bottom-up management; decisions made by CEO in small companies and by the board in bigger ones.
Culture:
Employees' safety given high priority; suggestion boxes; confidentiality of information maintained; active association members; regular company get-together.

Sri Lanka

Structure and decision making:
- State-owned: hierarchical; clear demarcation of functions; job specialization; slow decision making process; lack of interaction and cooperation among functional groups; short term of office of appointed chief executives; lack of authority, responsibility and accountability by top executives.
- Private-owned: flat organizational structures; lack of specialization; undue interference from superiors; fast decison making and progressing.

Culture:
- State-owned: use of corporation to pursue personal interest; hiring of personnel by influence.
- Private-owned: top management decides for the corporation; rank and file contributions not sought or encouraged.

Figure 3
Cross-country comparison of financial environment



R&D and consulting agencies

From the perspective of the intended beneficiaries, the expected goods have not been delivered by R&D organizations in Sri Lanka. There are various reasons for this, some of which are indeed beyond these organizations' control. There are quite a few private consultants who are capable and competent to guide industries during the adoption of E^3STs, but a majority are too commercial, levy exorbitant charges, and sometimes express too much optimism concerning the outcome. One way to help guarantee performance consistent with the efficiency and level of output projected by consultants is to insist on their financial commitment to the project's implementation, or on their sharing profits (or savings) in lieu of consulting charges.

In India the work of R&D institutions is often considered unsuited to industries' present needs. Therefore, full use is not made of these institutions' capabilities. Indian consultants generally have wider experience than their counterparts in several other parts of the world. Unfortunately, most Indian enterprises are unwilling to pay reasonable professional fees to local consultants. If a payment is made or agreed upon, the client may expect the consultant to provide solutions to all kinds of problems.

In China most R&D organizations are handicapped by lack of interaction with industry, poor knowledge of the market, and inability to assess industries' needs. A new organizational mechanism is needed in order to derive full commercial value from researchers' efforts. Another difficulty faced by researchers is the inability to assign a suitable cost to the technologies they develop. Though R&D organizations lack the capability to develop new E^3STs, they are comparatively better informed than industrial enterprises about existing E^3STs.

Intermediary organizations (associations and professional bodies)

There are well established industrial associations in China and India, owing to their massive industrial bases. These associations are involved in many spheres of the technological and economic activities of their respective industrial sectors and they also take the lead in E^3ST promotion. Being a part of the state, associations in China are influential in every aspect and actively participate in the decision making process affecting industrial growth. Indian industrial associations do not enjoy such privileges as their Chinese counterparts, even though they are dynamic and powerful.

The situation is quite different in the Philippines and Sri Lanka, where only a very few industrial associations exist, mainly on account of the small number of units in each subsector. Even the few which functionare more interested in commercial aspects than in sharing information on technologies. Other professional bodies are far too general in their approach, and sector-specific technology transfer is somewhat lacking.

Information centres

In Sri Lanka a number of organizations have been established to disseminate technological and marketing information. They are mostly sponsored by international organizations and trade associations of industrialized countries. For example, the USAEP (United States-Asia Environmental Partnership) is one such effective and efficient organization. A shortcoming is its restriction to information from the United States. Sri Lankan enterprises could immensely benefit from the establishment of similar organizations (or the reorientation of existing ones) in order to create links with India and the European Union.

In India conventional R&D organizations and industrial associations normally perform this function. Furthermore, most of the technocrats employed by industries are quite knowledgeable and keep abreast of the latest technological developments in developed countries.

The system in China is very different. Chinese enterprises learn about advanced technologies mainly from academic journals and papers published by local R&D organizations in Chinese. These publications provide only the details of technologies, with no information on their suppliers. Chinese enterprises face difficulties concerning the international exchange of technical information due to the language barrier and the absence of an official channel. Usually such contacts are made through academic institutions. This slows down the process of information exchange and diffusion of E^3STs. Prior to the adoption of a new technology, R&D organizations and universities are entrusted with the task of studying and grasping it. Once they are thoroughly familiar with the technology, indigenous manufacturers are mobilized to manufacture the equipment. In many cases equipment manufactured locally costs one-third of an imported unit. Many research institutions are now setting up their own technical service units to meet the increasing demand for new technologies.

Equipment suppliers

Foreign suppliers have access to Chinese enterprises through various means including bilateral cooperation between governments, the offer of financial and technical assistance to Chinese R&D organizations, and supplying of equipment on loan and through the creation of local repre-

Bad news spreads fast

A few years ago the idea of using energy efficient devices became common in urban India. There was widespread use of fluorescent lamps, then there was talk of substituting more efficient electronic ballasts for the conventional magnetic ones used with fluorescent lamps. Capacitance-type regulators became popular for regulating the speed of ventilating fans, replacing the standard resistance-type. Then there was a backlash. The electronic ballasts did not even last a few months. They burned a few weeks after installation, then the fluorescent lights stopped functioning. The negative impact of this particular product was so great that any talk of energy conservation elicited derisive references to electronic ballasts. Though other products, like energy efficient fan speed regulators, did the job effectively, they could not counter the negative impact.

Table 1
Productivity in selected industries (tonnes of product per capita)

Industry	China	India	Philippines	Sri Lanka
Cement	297	813	3507*	369
Iron and steel	533	123	-	108
Pulp and paper	32	28	97	18

* Excluding staff from corporate office who conduct engineering studies and training for the plant. Staff from corporate office are being shared with other cement plants owned by the company.

Investment channels for environmental protection in China

Provisions must be made in the investment plan for pollution control in new construction, expansion or renovation of projects. Enterprises have to invest 7% of annual renovation funds (depreciation allowance) in pollution control. The percentage can be even greater in the case of highly polluting projects. Additional profits made from energy and material conservation within a period of five years can be used to undertake further pollution control measures. Special funds for pollution control were obtained in 1988. "Pollutant levies" by the State Planning Commission and local authorities were used for the protection of socially, economically and culturally important areas. Effluent levies collected from polluting industries are re-channeled as subsidies to enterprises prepared to invest in pollution abatement.

sentative agencies. In order to reduce the cost of equipment, many of them now enter into collaboration with Chinese enterprises. Indigenous manufactures usually acquire technologies either from local R&D organizations or from foreign companies. They remain competitive in the market owing to low manufacturing costs.

In India a reasonably good infrastructure exists for equipment manufacturing. With the liberalization of the economy in 1991, several manufacturers have acquired technology for process equipment through collaboration with foreign equipment manufacturers or technology providers.

In the Philippines foreign equipment suppliers have a prominent role in promoting E^3STs. There are no indigenous manufacturers. The suppliers conduct regular seminars and workshops to introduce new technologies, processes and equipment and thus become the sole source of information on E^3STs. All suppliers provide before-sales services such as plant evaluations and cost-benefit analysis with respect to the adoption of E^3STs, and some are even willing to agree to equity participation.

The lack of equipment suppliers or their agents has been a serious constraint for Sri Lankan industries in regard to obtaining technical and financial information for use in feasibility analysis. Though India has many suppliers of its own and agents of almost all world-renowned equipment manufacturers, neighbouring Sri Lanka has not benefited due to the absence of a proper informational channel.

Energy utilities

In the Philippines, though there is no longer a shortage, unstable electricity supply causes severe hardships for industries. Voltage-sensitive equipment, such as electrostatic precipitators in the cement industry, have difficulty operating with grid power. The inconsistent and inferior quality of fuel containing a high percentage of sulphur has led to corrosion problems in boilers, kilns and furnaces (Figure 4).

In India the Petroleum Conservation Research Agency (PCRA), established under state patronage, assists industries to decrease oil consumption. It aims at reducing the national dependence on imported oil, which is around 60% at the current level of consumption.

In China electricity generation and distribution are managed by the state. A quota system for units (kWh) consumed within a given time (usually a month), and restrictions on time of usage, are in force. Quota entitlement for the following year depends on the utilization level of the current year. Once the quota is allocated, any additional requirement needs to be purchased at a very high tariff. This system tends to discourage consumers from undertaking energy saving measures, since they fear that their quota will be reduced. Electricity distributors in certain areas have offered concessional tariffs for the adopters of E^3STs (e.g. DC arc furnaces). The shortage of electricity due to lack of generating capacity has become a major barrier to industrial growth in India and China.

Non-governmental organizations (NGOs)

NGOs have contributed in many ways to social improvement, economic development and environmental protection. It is felt, however, that the impact of their efforts might be enhanced if they could view the issues in a broader perspective, rather than working somewhat in isolation and confining themselves to particular issues. This remark is increasingly applicable to NGOs operating in the field of environmental protection.

The Filipino NGO, Pollution Control Association of the Philippines, Inc. (PCAPI), is considered an exception. It works hand-in-hand with the government to protect the environment. To show appreciation for its rational contribution to environmental protection, it has been offered a position representing industries on the Technical Committee on Formulation of Environmental Standards.

Conclusions

Having analysed the different roles of actors both internal and external to an enterprise, the following observations could be made concerning the successful promotion and implementation of E^3STs.

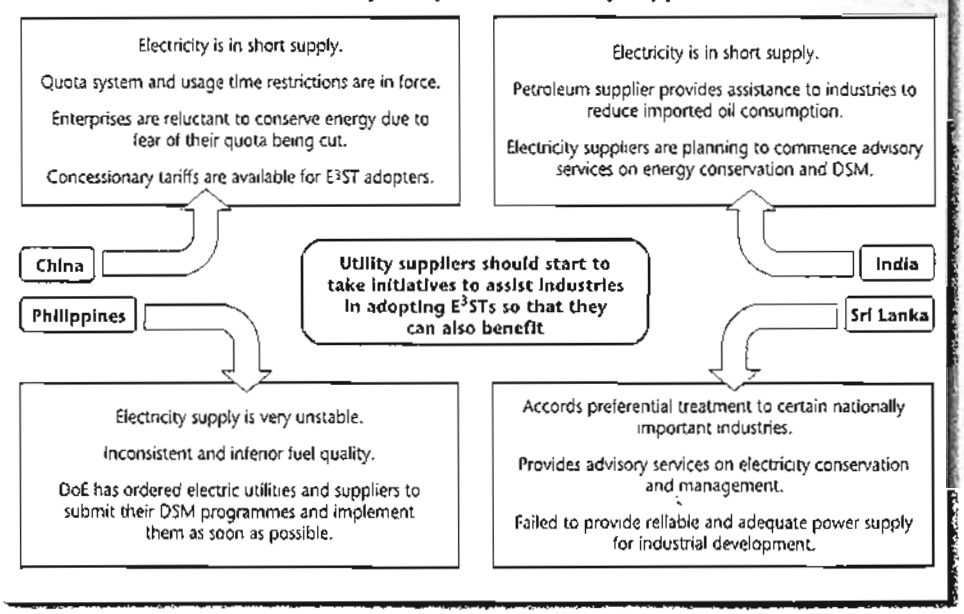
The anticipated economic or other benefits of E^3ST adoption may not be realized if the right organizational environment does not prevail at the plant level, where the different actors within the enterprise could contribute to the best of their abilities to achieving a common goal. The most important aspect is to assure the motivation of employees of all categories.

Human resource development helps employees acquire the skills required to grasp and implement technologies, and thereafter to monitor and maintain these technologies in order to ensure continued benefits throughout their life span.

In many industrial establishments interdisciplinary interaction does not take place. Hence, well coordinated and cohesive actions are not taken on issues such as the adoption of E^3STs, which requires expertise from many fields.

The role of national authorities is critical in encouraging industry to adopt E^3STs, especially when the technology is not financially attractive or when the industry has difficulties sourcing technologies and equipment, raising funds, etc. It is the duty of the state to create a business environment conducive to making investment decisions. It is

Figure 4
Cross-country comparison of utility suppliers



equally important for the state to play a non-interventionist but supportive role, equipped with appropriate regulatory and market-oriented mechanisms. In other words, the state could act as the prime catalyst in this process to induce and stimulate other external actors with whom industry needs to interact. As the driver of the economy, the state should direct its authorities to formulate policies, regulations and incentives, etc. by maintaining a fine balance between industrial development and environmental protection while keeping in line with its overall development strategies.

Other important external actors could play very supportive roles. For example, R&D organizations and professional bodies could help the industry learn about and "indigenize" foreign technologies, while also helping them with applied research to tackle technological problems and improve existing processes.

Regulatory bodies need to have a realistic approach to adopting standards, without overlooking their implications for affordability by the industry and the national economy. A pragmatic approach would be a step-by-step adoption of standards while guiding industry and allowing it to prepare for new challenges.

Equipment and utility suppliers could be of great assistance through providing vital information on technologies and processes.

Once economic viability is assured and the right organizational environment is established at plant level, industry ought to interact effectively with all the supportive external organizations that contribute in many ways and capacities to successful E^3ST adoption.

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Cleaner production – the key to implementing Shanghai's sustainable development strategy

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Abstract

The Shanghai Municipal Government has adopted a sustainable development approach to meet its long-term development goals. Cleaner production is considered an essential part of the technological modernization of the Shanghai area. The Municipal Bureau of Environmental Protection and the Shanghai Economic Commission are currently preparing a "Framework Plan for Promoting Cleaner Production in Shanghai".

Résumé

Pour atteindre ses objectifs de développement à long terme, la municipalité de Shanghai a adopté une politique de développement durable, dans laquelle la Production plus propre est considérée comme un principe essentiel de la modernisation technologique de la ville. Les services municipaux de protection de l'environnement et la commission économique de la ville travaillent à l'élaboration d'un « Plan cadre pour promouvoir la Production plus propre à Shanghai ».

Resumen

El Gobierno municipal de Shanghai se ha adherido a las pautas de desarrollo sostenible, con el fin de alcanzar los objetivos que se había fijado a largo plazo. Y, puesto que la producción más limpia se considera una de los pilares de la modernización tecnológica del área, la Oficina Municipal de Protección Medioambiental, junto con el Comité de Asuntos Económicos de la ciudad, están elaborando en la actualidad un "Plan Marco para la Promoción de una Producción más Limpia en Shanghai".

Following the 1992 Rio Conference on Environment and Development, the sustainable development concept was widely accepted by all participating nations. Looking back on the lessons learned from our long history of urban development, Shanghai, like many other cities, has recognized that sustainable development is essential for pursuing sound urban development. Since Shanghai is an industrial city, cleaner production is viewed as the right direction for further economic growth and as a means achieving sustainable development goals.

Shanghai is China's largest industrial city, with a population of some 13 million and an area of approximately 6340 sq km. It is one of the country's most important industrial bases. Recently Shanghai's economy has been booming, with an average growth rate of around 14% over the past four years. This growth has enabled Shanghai to resume its position as one of Asia's major business and finance centres. More than 38 million tonnes