

# Globalization of eco-efficiency: GSSD on the WWW

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## Abstract

*This article presents a pragmatic strategy for accelerating the diffusion of advances in eco-efficiency, and for enhancing two-way communication between industry and its diverse constituencies. Attention is also given to means now available for developing countries to "leapfrog" in eco-efficiency and, at the same time, increase understanding in industrialized countries of market conditions in the developing world.*

## Résumé

*Cet article présente une stratégie pragmatique susceptible d'accélérer la diffusion des progrès obtenus en matière d'"éco-efficience" et de favoriser l'intercommunication entre l'industrie et ses diverses composantes. Il met également l'accent sur les nouveaux moyens dont disposent les pays en voie de développement pour "se lancer" dans l'éco-efficience et en même temps mieux sensibiliser le monde industrialisé aux conditions de marché prévalant dans les pays en voie de développement.*

## Resumen

*Este artículo presenta una estrategia pragmática para acelerar la difusión de avances en la eficacia ecológica y para intensificar la comunicación de dos vías entre la industria y sus diversos componentes. También se presta atención a los medios ahora disponibles por los países en vías de desarrollo para lanzarse en la eficacia ecológica, y a la vez, aumentar la comprensión en los países industrializados de las condiciones de mercado del mundo en vías de desarrollo.*

This special 20th anniversary issue of *Industry and Environment* review reflects many of the advances in the "new thinking" needed as we enter the 21st century. Looking back, the international community can be justifiably proud of its achievements to date in recognizing the strains we place on natural systems, and of the ways we are seeking to alleviate (perhaps even remediate) the most significant aspects of these strains. This review is also evidence of an emerging collaboration (perhaps even partnership) between industry, on the one hand, and international institutions on the other.

This is what has been done so far. Now we must take a next step by drawing upon new technology, innovative forms of communication and interaction, and the next generation of new thinking.

In this article we put forth a pragmatic strategy for accelerating the diffusion of advances in eco-efficiency to date, and for enhancing the two-way communication between industry and its diverse constituencies. Perhaps more importantly, we draw attention to means available now for enabling developing countries to "leapfrog" on eco-efficiency, while at the same time enhancing industrial countries' understanding of the diversity of market conditions in the developing world.

## Advances in eco-efficiency

Several contributions to this special issue address innovations in eco-efficiency, the emergence of

markets for such products, and industrial strategies towards sustainability in developing countries. Others put forth some imperatives for facilitating technology cooperation, for improving industry's input into sustainability strategies, and for bringing consumers (in all societies) into these broad deliberations.

These contributions all point to one critical imperative, namely the need to facilitate leapfrogging in technology worldwide. Related is the importance of taking account of both "soft" and "hard" technology in the course of leapfrogging efforts and perhaps even strategies.

## Leapfrogging needs

The basic meaning of leapfrogging is that we must avoid replicating the historical trajectory of the industrial West as the developing countries accelerate their own development and seek to meet their own needs and requirements. This is not a normative issue, nor is it a philosophical one. It is a strategic, pragmatic and practical imperative.

This imperative focuses attention on actions now to avoid putting in place "old-fashioned" technology. If there is to be effective technology cooperation (or transfer), then it must surely be positioned at the frontier of technology and not along the historical trajectory of known polluting products and processes.

What is needed is a mechanism for facilitating diffusion of information about eco-efficiency,

leapfrogging potentials, and the experiences to date.

## The information dimension

Before any reasonable individual (or firm) can be asked to "do something" (in this case engage in more eco-efficient practices), they must have access to robust information about what it is that this "thing" is about. It is our belief that more experience exists concerning industry efforts towards eco-efficiency than there is information about these efforts or assessments of this experience.

In this context, it is industry that constitutes the critical bottleneck by not effectively eliminating barriers to the diffusion of information on new thinking in business. By interfacing with new global electronic communication networks (based on *intelligence* in the technical sense), potentials for accelerating diffusion of information about eco-efficiency efforts are greatly enhanced.

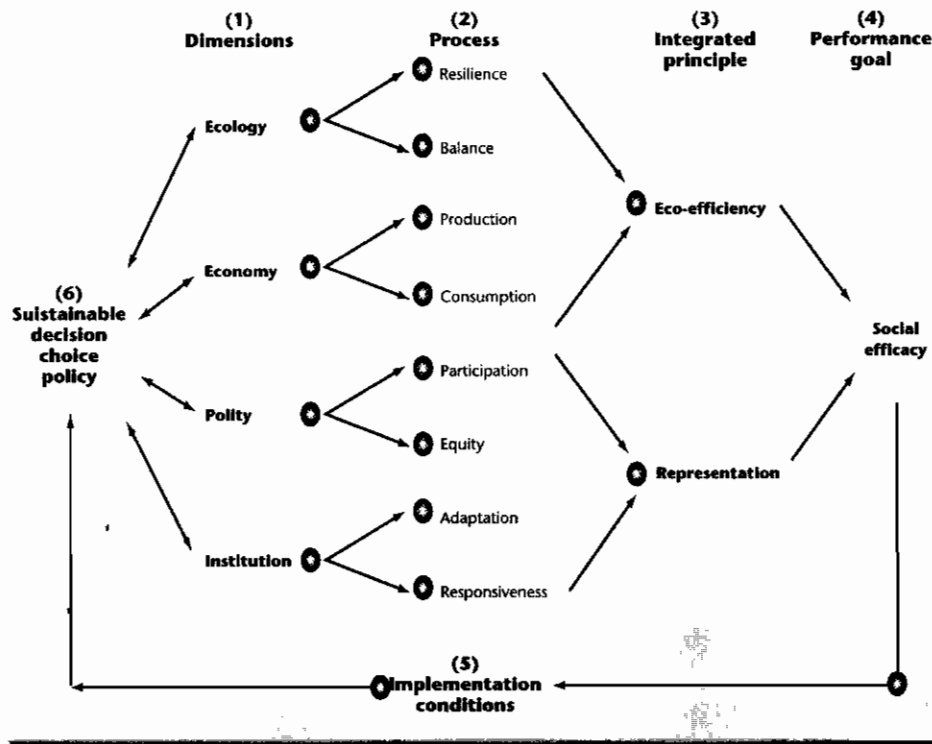
The notion of diffusion in this context assumes two dimensions. First is that of communication, i.e. from industry to the international community (and this is basically a one-way exchange). Second is that of conferencing, i.e. from the international community – developing and industrial countries alike – back to industry (and this is a two-way dialogue).

To date, advances in electronic communication have greatly reduced the costs of global transactions. However, such communications have also been largely one-way. Effective information diffusion must involve two-way exchanges in which the recipient also becomes a sender. This ability to conference is especially crucial as business and industry in developing countries seek to respond to experiences in the industrial West and, more importantly, seek to share with industrial countries their own experiences.

For countries like India, China and Brazil, among others, where markets are diverse, consumers are diffuse in their orientation, and purchasing power may be on the verge of a take-off, industry in the West cannot afford to tune out and engage only in one-way communication. The imperative of two-way conferencing is far from a luxury. It is basically good business, fundamental to rational strategy.

The mechanism proposed here draws on technological advances at the Massachusetts Institute of Technology's Artificial Intelligence Laboratory, in conjunction with new thinking on sustainability at MIT's Technology and Development

**Figure 1**  
**Sustainability as a process**



Programme. These advances are ongoing – innovation has no terminal point – and notice of such advances must be diffused to the international community in order to enhance global access on an “equal rights” basis.

**Sustainability and eco-efficiency**  
**New thinking on sustainability**

The new thinking embeds considerations of eco-efficiency in a broader context by locating them within an integrated perspective on development. Figure 1 shows the structure of this new perspective. It begins with the view that sustainable development means meeting the needs and demands of people without undermining the resilience of life-supporting properties.

This means that we must consider sustainability as a dynamic transformation composed of four distinct elements or parts. These are:

- ◆ the *dimensions* of sustainability (i.e. what are we being sustainable about?);
- ◆ the *processes* of sustainability (i.e. what is being done and how should it be done?);
- ◆ the basic *principles* (i.e. what criteria should we use to determine if we are moving in the right direction?); and
- ◆ the *sustainability output* (i.e. what do we want societies to do that they are not doing today?).

It also means that when thinking of sustainability in developmental (i.e. transformation) terms, we must take into account the *decisions* – of both the private and the public sectors – that must be informed by these four elements. In Figure 1 there is an explicit feedback mechanism relating various pieces of the overall sustainability dynamics.

With respect to *implementation* almost everyone agrees that at the international level we must

pay special attention to transparency, legitimacy, and universality. This means that information about sustainability (and eco-efficiency) must be readily available and understandable. It also means that activities and investments that are conducive to sustainability must be viewed by all parties as legitimate, that is, of benefit to them specifically. And it means that we must consider customized sustainability strategies for different socio-economic contexts (what works for Chad may not work for China).

Figure 1 shows the overall logic of the new thinking and how basic ideas are developed to generate a change from conventional modes of development to more sustainable ones. In this overall dynamic, eco-efficiency seeks to recognize economic efficiency with ecological resilience. It is a necessary, but not sufficient, element in the overall dynamics towards sustainability.

But by being necessary, eco-efficiency is also critical. The reason is this: In both theory and practice, the pursuit of eco-efficiency constitutes a powerful leverage point for industry. This is the leverage whereby advances in innovation intersect with (perhaps even translate into) increases in social responsibility.

**Technology gaps and eco-efficiency**

There are major technology gaps which, individually and jointly, fundamentally undermine access to “new” and “better” technology for all economies, including the developing countries. To simplify a complex calculus, these are:

- ◆ a gap between innovation and commercialization in both the North and the South (i.e. taking innovations into the marketplace);
- ◆ a gap between technology levels of the North

and the South (i.e. differences in technologies used in industrial and in developing countries);

- ◆ a gap between technology levels of countries within the South (i.e. differences among the developing countries).

**Technology priorities for eco-efficiency**

The challenge for each country is to proceed along its own trajectory of sustainability, making the best and most effective uses of its natural and socio-economic endowments through the expansion of its overall technological and institutional capabilities. For all countries there are two crucial and interconnected priorities. These are to: (a) *strengthen technology capacity* by reducing technology gaps and strengthening institutional performance; and (b) *acquire “best technologies”* through technology cooperation and access.

Together, capacity-building and access to the “best” foreign technology are key requisites for sustainable development. And accelerating the development of the best technology is a priority of global proportions. Developing countries are in the unique position of avoiding the historical mistakes in the development trajectories of the industrial countries. They need better access to information about existing technologies; they need the cooperation of industry in the North to avoid the use of detrimental or excessively hazardous technologies; and they must cooperate among themselves to help develop improved indigenous technologies.

To be effective, however, any action towards greater eco-efficiency must be tailored to the needs and requirements of all key stakeholders. Diversity is a reality in the international community. Interests and priorities are country-specific, industry-specific, sector-specific, and often even firm-specific.

**Supply and demand**

In this context, we see that industry has made considerable advances in *supply*, towards greater eco-efficiency of products and processes. To some extent this has been a reaction to the demands of the international community for new and better performance. Notions of best practice have proliferated, as have industrial efforts towards greater environmental responsibility. This supply must be expanded to meet growing needs and demands worldwide.

But there is another set of *demands* that, for all practical purposes, are not being met at present. And these are the demands for coherent information about industrial strategies related to eco-efficiency. To date, industry has used conventional modes of communication (speeches, articles, written words, some diagrams, etc.) that are of a one-way sort. Industry has not made any effective advances in exploiting innovations in electronic communication, tele-networking, or use of even the most conventional of mediums (such as the World Wide Web on the Internet).

In this sense, industry is behind the times. It is not making use of innovations and new ideas which are now readily available. (Below we draw attention to the White House efforts in that direc-

tion that far exceed the efforts of industry in reaching out and "being understood.")

In this special issue for the 20th anniversary of *Industry and Environment*, it is fitting to draw attention to this demand and to propose a strategy for globalizing industry's efforts towards eco-efficiency. We are now entering the 21st century; but we must appreciate the challenges placed upon us and the opportunities afforded by advanced technology in electronics and global networking.

The demand we believe is in existence worldwide can be met to some extent by the supply of innovative technologies. Here we focus on worldwide electronic networking, conferencing and communication.

**Advanced information technology for leapfrogging**

Information technology is no longer restricted to industrial countries either in innovations or in applications. The key principle, therefore, is that developing countries can, and should, be enabled to leapfrog the knowledge-related technologies by having access to state-of-the-art information systems, making these adaptive to their own inputs and requirements.

Access to, and innovations in, information technology – including expanding the uses of computer capabilities – must be supported by major strides in literacy rates and overall levels of education. Already we have seen how many of the rapidly industrializing countries are competing successfully with industrial countries in software development and data management techniques. Generally in developing countries it is the more

advanced computer technology that is being introduced, rather than the "old" technology.

Competitive market conditions among suppliers (as well as software manufacturers) ensure sales of the newest technology at the lowest prices. For the less developed countries, access to the use of, rather than innovations in, information technology is expanding rapidly. For the least developed countries, advances in information technology are of use principally in relation to government and decision-making, and business and industry, rather than for broader dissemination.

**Two-way and real-time technology**

Advances in *two-way information technology* and conferencing capability create the basis for the next phase in technology diffusion: with the direct participation of users, the development and transfer of technology effectively becomes an incidence of, and exercise in, technology cooperation. Such advances provide opportunities for developing countries to influence, even shape, the international community's ideas and actions towards sustainable development. The reason is this:

New computer-based information technology, supported by global communication networks, allows users all over the world to make their views known, in real time, about an issue at hand and, more importantly, allows users to transmit information about their own experiences to others. This capability eliminates the need for lengthy evaluations of technologies, investments or experiences by outsiders, since immediate feedback can now be obtained from the affected community, i.e. the stakeholders in question.

Both the role and the experiences of developing countries are of special relevance to advances in the area of information systems pertaining to dimensions of and processes towards sustainable development. Their contributions to, and inputs on, concepts, actions and projects are of commercial value. Both the participation and the involvement of the developing countries would be critical for the success of two-way, real-time approaches.

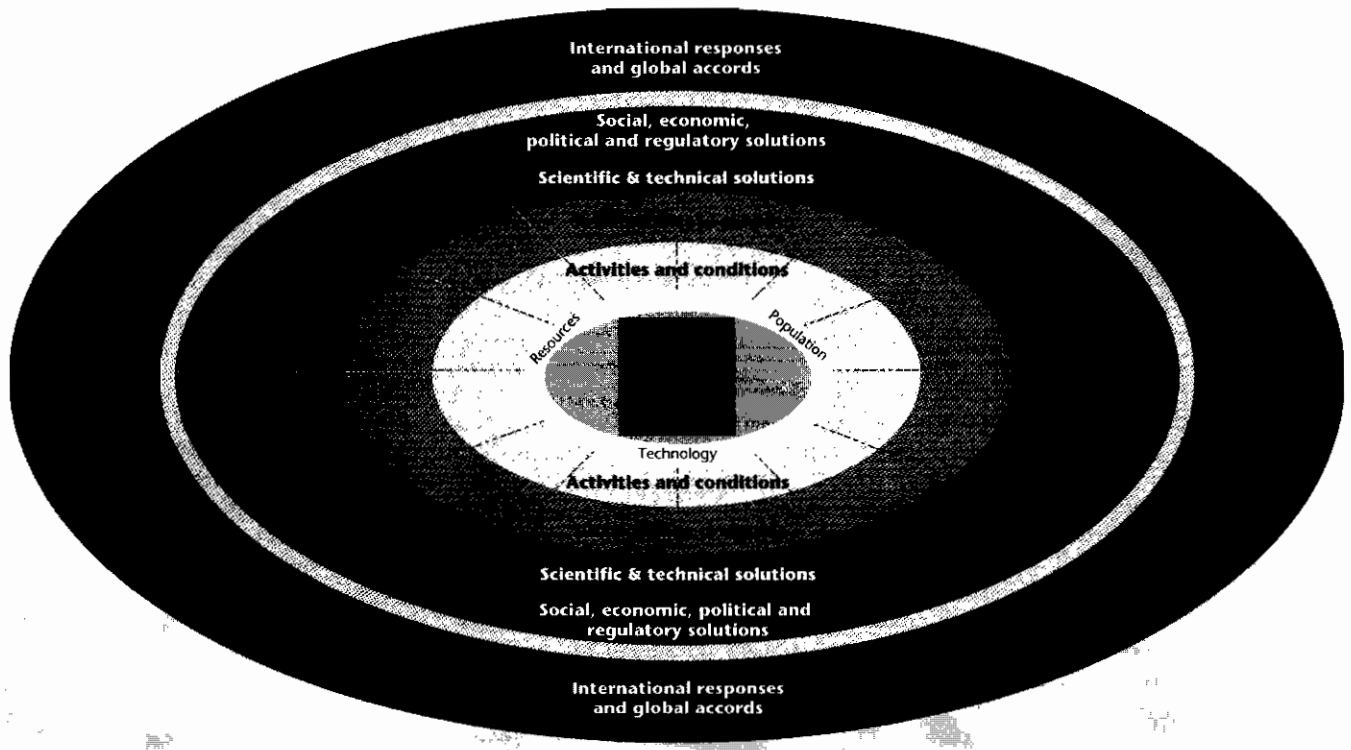
More importantly, as two-way information technology systems, their optimal use depends on the participation of the users themselves. Since the value and volume of information are augmented by the stakeholders and participants from the South, this feature in itself enhances the value of partnerships in knowledge-building and information-sharing.

Two-way communication capability expands potentials for participation of stakeholders in all countries, at all levels of development, related to any issue over which access to information is relevant. Both the access and contribution of developing countries to innovations in information technology will accelerate their own rates of technology change.

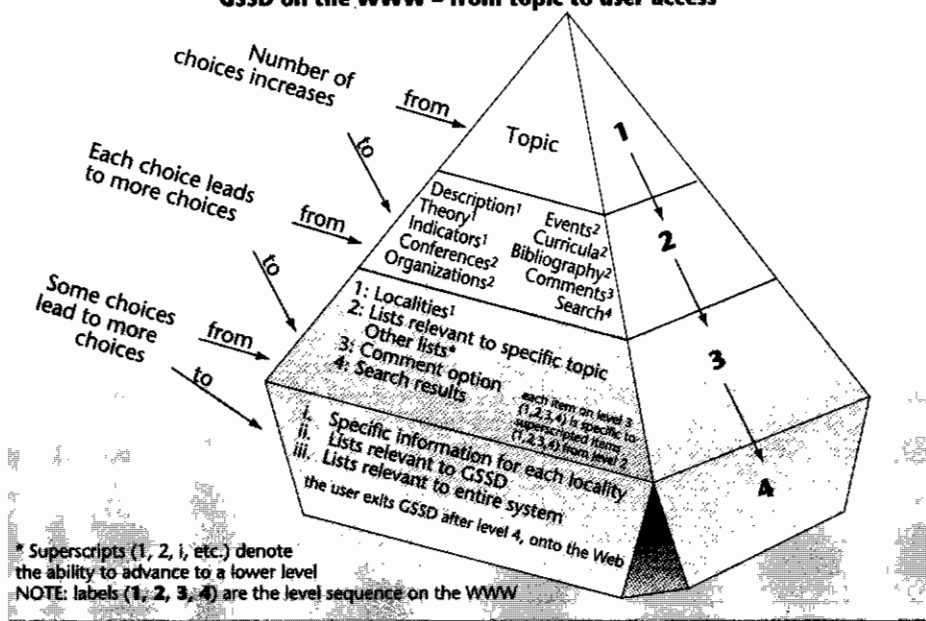
**Access to eco-efficiency experiences**

Improved communication can enhance the diffusion of information on best practices in energy technology, pollution control or clean manufacturing. Access to best practice enhances prospects for implementation where they are most needed. With improved communication, developed countries would be able to obtain a better understanding of the nature and urgency of the problems in developing countries.

**Figure 2**  
**Integrated sustainability framework**



**Figure 3**  
GSSD on the WWW - from topic to user access



conduct of intellectual discussion, policy deliberation, and diffusion of experiences related to effective investment strategies.

### What is the GSSD design?

In terms of overall product design, GSSD consists of:

- ◆ *conceptual framework*, which represents an integrated view on sustainability issues (Figure 2);
- ◆ *application* in terms of user access (Figure 3), system input, and wide-area networking;
- ◆ *implementation* in terms of an adaptive code, enhanced flexibility, and user responsiveness; and
- ◆ *alpha system* (no-theory option) for technicians, engineers, industrialists, etc. who prefer to focus on actual products and processes rather than market structure, socio-economic contexts, regulatory issues, and so forth.

In terms of implementation, GSSD consists of (1) a *conceptual interface*, which is a coherent way of thinking about sustainability issues (see the hierarchical and embedded structure of Figure 2), (2) coupled with an *intelligent-adaptive server* (definition above), (3) implementing streamlined access to WWW via a user interface (such as Netscape) guided by the design in Figure 3 for targeting a particular topic, technology, or focus of inquiry, (4) with subject-driven rules for *search conduct*, and (5) filtered with "quality" criteria for directing users to information.

For users who prefer the spaghetti-plate strategy (or the filing cabinet format), an *alpha option* is available to by-pass any semblance of social science theory pertaining to sustainability and skate unimpeded through the crevices of the WWW. This practice of "following the blue line chain" – which is the essence of the World Wide Web – is consistent with the no-theory option. As noted, industry users who seek information or wish to diffuse target-specific cases or experiences might prefer the (no-theory) alpha option.

### GSSD for globalizing eco-efficiency

#### Market creation

Successful expansion of eco-efficient products and processes for commercial purposes rests on two conditions. These are, first, the existence of a *potential market*, i.e. there must be buyers and sellers for knowledge and skills that are being produced (or that are being planned for); and, second, *direct exchange*, i.e. there must be buyers and sellers who interact directly with each other as each recognizes the needs of the other.

Knowledge and skills conducive to eco-efficiency – in mechanical and organizational terms – must be viewed as *needed and wanted* by all parties. They cannot be viewed as goods of non-commercial value, but must be viewed as highly valued elements in the economy's overall portfolio of assets and must be treated as such. By definition, this can happen only if all parties to the exchange actually do gain from the exchange – the generation, creation, buying and selling of knowledge and skills.

To the extent that industry does indeed have a "portfolio" of experiences with respect to eco-efficiency, it would be extremely worthwhile if these

With improved communication, greater knowledge can be obtained by both developed and developing countries about possibilities of commercial ventures.

And, by improving communications about action, experience and expectations between supplier and receiver of technology, there will be greater transparency in the exchange and the overall quality of the exchange will be upgraded. So, too, improved two-way communication could facilitate patentable, indigenous knowledge emerging from innovations in, or the conditions unique to, developing countries. That may facilitate the development and diffusion of patentable knowledge in the South.

Two-way and real-time information technology and communication capability expands potentials for participation of stakeholders in all countries, at all levels of development, related to any issue over which access to information is relevant.

### GSSD in WWW

#### What is GSSD?

In technical parlance, The Global System for Sustainable Development (GSSD) is an effort to provide some intelligent and adaptive order to both access to, and contents of, sustainability materials available to the international community in various electronic and other forms, most notably on the World Wide Web portion of the Internet. It is also an effort to engage the research and policy communities in different parts of the world in sorting out the sustainability "spaghetti-plate" into some semblance of intellectual order and analytical coherence.

In practical terms, GSSD is an electronic agent interface between users, on the one hand, and the World Wide Web on the other. The interface is *intelligent* in the sense that it is responsive and adaptive to user needs. The users are two kinds: those that seek access to information (such as normal users all over the world); and those that

seek to input information (such as industry, with eco-efficient experiences as reflected in several articles in this special issue).

#### What is an intelligent system?

An intelligent system in this context is one that streamlines maintenance through use of *advanced authoring tools* (which means automating maintenance tasks and reducing dependence on human interventions unless explicitly required) and *enhanced applicability* (which means automatic generation of WWW pages, automatic updating of data bases, and applications of wide-area networking).

The combination serves to reduce the transaction costs (not to mention inconvenience) of global electronic communication inherent in WWW conventions, modalities, and types of uses. Researchers at the MIT Artificial Intelligence Laboratory, pioneers in applications of intelligent systems, have extended the basic server capabilities devoted to the White House initiative on reinventing government for specific application to sustainability issues.

The globalization of this technology enhances leapfrogging potentials and increases access of developing country users to "frontiers" of electronic and related technologies. Access to such frontiers is for purposes of reducing transaction costs (in time, information bottlenecks, etc.) in relation to access to eco-efficient products and processes.

As an intelligent system, GSSD is especially useful for interactions (two-way communication) between users (industry, private sector, governments, researchers, etc.) in industrial countries and those in the more advanced of developing countries, where the private sector plays a crucial role as investors and as participants in the market place.

Here our purpose is to highlight the importance of *intelligence* in thinking about sustainability and eco-efficiency, and of *globalization* in the

were made available to potential users and to the international community, more broadly defined.

**Towards a globalization strategy**

Clearly some things must be done to accelerate the transition to greater eco-efficiency. At least four imperatives are critical at this point in time:

- ◆ *protecting profitability*: this means that industry must invariably pay continued attention to its own viability. Without basic survival, there is no potential for profit; and without some basic profit, there is no possibility of expanding investments in eco-efficient products, processes, ventures or initiatives;

- ◆ *reducing transaction costs*: this means recognizing the need for minimizing efforts involved in obtaining information about specific eco-efficient initiatives (and eco-efficiency in general), about access to experiences promoted by specific firms, about implementation, follow-up, and new innovations, and so forth. At issue here is ease of access to publicly available information (not to proprietary knowledge);

- ◆ *eliminating technology barriers*: this means identifying the *real* obstacles and then devising approaches to barrier reduction; and

- ◆ *facilitating leapfrogging*: as a consequence of the above three factors, the constraints to information about leapfrogging would be reduced. More realistic (possibly effective) positioning on leapfrogging trajectories could then result.

In this process, specific action can be taken by (a) business and industry, (b) international institutions and governments, and (c) institutions of

science and technology.

Business and industry should seek to facilitate diffusion of publicly available information on eco-efficiency experience. This necessitates going beyond the use of conventional communication technologies (printed materials, facsimiles, reproductions, speeches, etc.) to wide-area networking using advances in communication technologies. Established associations, such as the International Chamber of Commerce or the World Business Council for Sustainable Development, could provide the nodal points for communication to buttress the initiatives of individual members.

International institutions, most notably UNEP, could use their good offices to facilitate the availability of relevant materials for conversion to electronic formatting (and, to some extent, coordinate with business and industry on the form and format of jointly relevant materials). International institutions should also make use of their wide networks in developing countries to facilitate the two-way communications relevant to the information technologies at hand.

Finally, institutions of science and technology, such as MIT, which are committed to the internationalization of knowledge and the diffusion of scientific advances, should find effective means of outreach to both the private and public sectors regarding advances in technology. It is in this last vein that the GSSD can best be utilized.

**Practical step: GSSD Consortium**

As the Global System for Sustainable Development moves from the prototype (and beta) phase

to full operation on a worldwide basis, oversight of the system requires multi-party participation that reflects the interests and priorities of critical stakeholders. It is at this stage that the wide participation and representation of interests would enhance the globalization of eco-efficiency experiences. To the extent that the international community considers eco-efficiency initiatives as of global importance, collaborative strategies for diffusion of new thinking would be most appropriate.

Using GSSD (in terms of soft and hard technology) as an example, we propose that one effective mode of collaboration might be in the form of a Consortium of participants which jointly represent the insights, interests and innovations of various members in the globalization of eco-efficiency. In its design, such a Consortium must address eco-efficiency issues in terms of theory, policy and practice. It is also the case that stakeholders might wish to better explain themselves and their positions to the international community as a whole.

It is also imperative that participation in a collaborative initiative for wide-area networking draw upon the private and public sectors, in both developing and industrial countries. Two-way – and multi-party – communication is essential if feedback is to be ensured, and if evaluation of eco-efficiency initiatives is to be undertaken effectively. Therein lie added reasons for collaborative activities in supporting communication about, and facilitating diffusion of, eco-efficiency strategies. ◆

# Industrial production and environmental protection in the Brazilian chemical industry

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## Abstract

*In Brazil in recent years, a balance has been sought between environmental protection and the need to provide products and services. The Brazilian chemical industry is the largest in a developing country and the eighth largest in the world. Through its version of the Canadian "Responsible Care" programme, Atuação Responsável (Responsible Action), the chemical industry is making improvements in the health, safety and environmental areas.*

## Résumé

*Ces dernières années, le Brésil a cherché un juste équilibre entre la protection de l'environnement et la nécessaire production de biens et de services. L'industrie chimique, numéro un pour les pays en voie de développement, occupe le huitième rang au niveau mondial. A travers sa version du programme canadien "Responsible Care", Atuação Responsável (Action Responsable), ce secteur obtient de réelles améliorations dans les domaines de la santé, de la sécurité et de l'environnement.*

## Resumen

*En Brasil, en los últimos años, se ha buscado un equilibrio entre la protección medioambiental y la necesidad de ofrecer productos y servicios. La industria química de Brasil es la mayor en un país en vías de desarrollo y la octava más importante del mundo. A través de su versión del programa canadiense de "Responsible Care", Atuação Responsável (Actuación Responsable), la industria química está mejorando en los apartados de seguridad, salud y medio ambiente.*

## Introduction

Brazil has the largest chemical industry of any developing country and the eighth largest in the world. Annual net sales in the Brazilian chemical industry, *lato sensu*, reach the order of US \$24 billion. In 1994, considering only the segments surveyed by ABIQUIM (the Brazilian Chemical Industry Association), this sector produced more than 26 million tonnes of chemical products, registering growth of 8.1 per cent over 1993 production (see **Figure 1**). The ABIQUIM survey did not include the segments of plastic transformation, pharmaceutical products, paints, enamel and varnishes, fine and specialized chemicals, detergent soaps, cosmetics and perfumes, agricultural pesticides, artificial and synthetic fibers, or fertilizers (see **Figure 2**). The three main petrochemical complexes in Brazil together have a production capacity of 2.1 million tonnes of ethylene per year.

The history of the Brazilian chemical industry is relatively recent. It started to expand in the 1950s. The most important phase began in the 1970s, with massive investment in petrochemical factories. Owing to geographic characteristics and development patterns, most of Brazil's chemical industry has been located along 5000 kilometres of the coastline. However, it is concentrated in the developed industrial regions of several Brazilian

states. With the opening of the Brazilian market to international competition in 1990, a new phase began, in which companies started to follow international concepts and standards.

## Development of the Brazilian chemical industry

The first companies created or installed in Brazil in the 1950s were attracted by the growing industrialization taking place, which was stimulated by governmental decisions that sought to lead the country into a new development pattern that would transform the agrarian economy to an industrial one. These companies sought to meet the demand for basic products with relatively simple technology which could be supplied by local producers, especially in the southeastern part of the country. In this way some national companies emerged, as well as industrial units of large foreign companies.

With the creation of Petrobrás, the state-owned petroleum company, in 1953 the supply of raw materials for petrochemicals allowed the first producers of thermoplastics and other petrochemical products to begin operations with growing product and plant sophistication. At this time the first large industrial area was developed at the city of Cubatão, located in the state of São Paulo. This complex contains not only chemical industries,

but also a refinery, a steel mill, a cement factory, and other types of industries.

The choice of Cubatão for this first large industrial area basically resulted from an economic analysis that took into consideration its strategic position near Brazil's largest industrial and consumer region, the metropolitan area of São Paulo. It is also next to Santos, Brazil's largest port, which has a good transport system and infrastructure and abundant electric energy. Another fundamental point was the availability of a population capable of meeting the needs of an industry with a high level of technology.

Unfortunately, hardly any attention was paid to environmental questions. The environmental impact of locating industries in this problematic region with its heavy rainfall, a climate which hinders the dispersion of atmospheric pollutants, limitations on obtaining water for industrial use and its later discharge, etc. was not properly considered. At the time there were no legal requirements or voluntary standards for emissions, which made it difficult to justify installing efficient control equipments. Building of an integrated liquid effluent treatment unit to serve all companies was not considered.

In addition, important questions were not addressed with regard to urban and industrial zoning, which allowed siting of highly polluting industries near urban communities. Most of these communities became densely populated (and poor), lacking adequate infrastructure to support the inhabitants.

When the Cubatão complex was built, it is true that environmental issues did not have the importance or visibility they have today in Brazil and all over the world. Federal and state legislation did not exist at the time (the introduction of important laws began in the 1970s); São Paulo's state environment agency, Cetesb, had not been created; and there were no non-governmental organizations concerned with the region's environment.

As the result of inadequate planning, the pollution indexes at Cubatão reached very high levels some years later, requiring the adoption of strict measures. Cetesb installed a sophisticated system to monitor local atmospheric conditions and avoid critical conditions. On numerous occasions, companies were obliged to stop their operations until air quality returned to acceptable levels. But measures of this type did not solve the problem. In 1984, a programme was adopted to control