Environmental Goods and Services Series

Technology Transfer Issues in Environmental Goods and Services

An Illustrative Analysis of Sectors Relevant to Air-pollution and Renewable Energy

by Lynn Mytelka
United Nations University-Maastricht Economic and Social Research and Training Centre on Innovation and Technology (UNU-MERIT)

ICTSD
International Centre for Trade and Sustainable Development

Issue Paper No. 6

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International Environment House 2
7 Chemin de Balexert, 1219 Geneva, Switzerland
Tel: +41 22 917 8492 Fax: +41 22 917 8093
E-mail: ictsd@ictsd.ch Internet: www.ictsd.org

Chief Executive: Ricardo Meléndez-Ortiz
Programme Manager: Moustapha Kamal Gueye
Programme Officer: Mahesh Sugathan

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ICTSD welcomes feedback and comments on this document. These can be forwarded to Mahesh Sugathan, smahesh@ictsd.ch.

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ABBREVIATIONS AND ACRONYMS

APEC	Asian-Pacific Economic Cooperation
CDM	Clean Development Mechanism
DESA	United Nations Department of Economic and Social Affairs
EGS	Environmental goods and services
EPA	Environmental Protection Agency
EPPs	Environmentally Preferable Products
EST	Environmentally Sound Technology
EVSL	Early Voluntary Sectoral Liberalisation
FAO	Food and Agriculture Organization of the United Nations
FDI	Foreign Direct Investment
GATS	General Agreement on Trade in Services
ICE	Internal Combustion Engine
IPRs	Intellectual Property Rights
MNC	Multinational Corporation
OECD	Organisation for Economic Co-operation and Development
R&D	Research and Development
SUV	Sport Utility Vehicle
ToT	Transfer of Technology
TRIMS	Agreement on Trade-Related Investment Measures, WTO
TRIPS	Agreement on Trade-Related Aspects of Intellectual Property Rights, WTO
UNCED	United Nations Conference on Environment and Development
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
WHO	World Health Organization
WIPO	World Intellectual Property Organization
WTO	World Trade Organization

FOREWORD

Environmental goods and services (EGS) as a subset of goods and services was singled out for attention in the negotiating mandate adopted at the Fourth Ministerial Conference of the World Trade Organization (WTO) in November 2001. Increasing access to and use of EGS can yield a number of benefits including reducing air and water pollution, improving energy and resource efficiency and facilitating solid waste disposal. Gradual trade liberalisation and carefully managed market opening in these sectors can also be powerful tools for economic development by generating economic growth and employment and enabling the transfer of valuable skills, technology and know-how embedded in such goods and services. In short, well-managed trade liberalisation in EGS can facilitate the achievement of sustainable development goals laid out in global mandates such as the Johannesburg Plan of Implementation, the UN Millennium Development Goals (MDGs) and various multilateral environmental agreements.

Access to technology and know-how will play an important role in helping developing countries realise meaningful sustainable development benefits through trade and investment in EGS. However, ongoing negotiations on EGS have not yet addressed the issue of technology transfer in a meaningful way. On the one hand, it is assumed by a number of countries that environmental technologies will be diffused automatically once barriers to EGS are lowered, but on the other, many trade negotiators as well as experts do not see such an automatic link. They would prefer positive measures within the context of EGS and other WTO negotiations that would enable developing countries to meaningfully access and operate these technologies and eventually to build a domestic technological base and know-how as a stepping-stone to further innovation.

While transfer of technology is not explicitly mentioned in the EGS mandate in Paragraph 31 (iii) of the Doha Declaration, some trade negotiators feel that the issue should be addressed more meaningfully so that EGS negotiations deliver on sustainable development and not just on market access. However, there is some scepticism expressed on the extent to which the WTO can contribute to the process. So far, divergent opinions and priorities have held back constructive engagement on the issue not only in EGS negotiations, but also in the Working Group on Trade and Transfer of Technology within the WTO.

The paper by Lynn Mytelka argues, on the basis of empirical evidence and the conceptual evolution over the years of what constitutes technology transfer, that much can be done within EGS and other areas of WTO negotiations. This would, however, imply rethinking the mandate of EGS negotiations and steering the focus away from simply increasing market access for EGS to one that recognises and facilitates the importance of knowledge transfers including “tacit” knowledge embodied in services. Professor Mytelka clearly illustrates, through various examples and case studies, the impediments countries face in obtaining meaningful access to environmentally sound technologies (ESTs). The author questions whether it is feasible to expect the Doha WTO negotiating process to deliver more on the technology transfer front than has so far been achieved. The paper concludes that there are still other aspects of the mandate and the process of negotiating trade that could be rethought from a broader technology transfer and sustainable development perspective. These involve recognising the “public goods” element inherent in many ESTs and to open up opportunities for learning and capacity building and enhanced response capabilities in developing countries through flexibility, special and differential treatment and technical assistance. The paper calls for the identification of areas where such opportunities could be pursued, not only in EGS negotiations, but also in other areas of discussions such as subsidies, agriculture and Trade-Related Aspects of Intellectual Property Rights. In addition, the paper advocates positive measures that go beyond the negotiating framework, including the creation of a Knowledge Fund to bring benefits of learning and innovation in technologies that

respond to the critical needs of developing countries including the environment.

Dr. Lynn Krieger Mytelka is a Distinguished Research Professor at Carleton University, Ottawa, Canada, and former Director of the United Nations Institute for New Technologies (UNU-INTECH) (2000-2004), now part of UNU-MERIT where she is currently a Professorial Fellow and holds an Honorary Professorship in Development Economics at the University of Maastricht. Prior to that, she served as Director of the United Nations Conference on Trade and Development's Division on Investment, Technology and Enterprise Development (UNCTAD DITE) (1996-2000). Professor Mytelka has published extensively in the area of innovation, technological change and sustainable development and is a member of the International Livestock Research Institute's (ILRI) Science Advisory Panel and the International Confederation of Science Union's (ICSU) Committee on Scientific Planning and Review (CSPR)

The paper is part of a series of issue papers commissioned in the context of ICTSD's Environmental Goods and Services Project, to address a range of cross-cutting, country-specific and regional issues of relevance to the current EGS negotiations. The project aims to enhance developing countries' capacity to understand trade and sustainable development issue linkages with respect to EGS and reflect regional perspectives and priorities in regional and multilateral trade negotiations. We hope you will find this paper to be stimulating and informative reading and useful for your work.

Ricardo Meléndez-Ortiz
Chief Executive, ICTSD

EXECUTIVE SUMMARY

In much of the early development literature, "transfer of technology" (ToT) was conceptualised as the "transfer" of machinery and equipment from North to South through trade, aid and licensing or foreign direct investment (FDI). At first it was regarded as a cost free process. Research in the 1970s discovered that the financial costs of technology transfer stemmed from technology payments and the way in which technology is embedded in social and political institutions that affect the process of technological mastery. During the late 1970s and 1980s, despite the conventional wisdom that argued against "reinventing the wheel", effective ToT was increasingly conceptualised in terms of domestic capacity building in a small number of Asian and Latin American countries. This resulted in their ability not only to operate new technologies efficiently but also to modify, adapt and improve upon imported technology and to innovate in the development of new designs, production processes and products.

These were the firms and countries that proved better able to adjust as technology and competitive practices began to change. Four of these changes were of particular importance:

- The growing knowledge-intensity of production, not only in the so-called "high tech" industries, but across a wide spectrum of "traditional sectors";
- The emergence of innovation-based competition and its widespread diffusion through the process of trade and market liberalisation;
- The adoption of new global trade, intellectual property and investment rules that involved market opening; and
- Growing concern for the environment and its embodiment in international agreements.

These changes not only created new possibilities for wealth creation and sustainable development, but also new requirements for learning and technological mastery without which it has been difficult for most developing countries to enter export markets and sustain export growth.

The ability of developing countries to integrate into the new trading system, thus, increasingly depends upon a conceptualisation of ToT as a process that contributes to learning, domestic capacity building and innovation. Although this conceptualisation of the ToT process has been integrated into strategy documents and policies in many developed and developing countries, it has not been mainstreamed into WTO negotiations more generally and is notably absent from the mandate for negotiations on EGS, a sector in which goods and the tacit knowledge required for their design and operation, often embodied in services, are closely linked.

In the only paragraph (Paragraph 31) of the Doha Declaration linking trade and environment, the goal of developing a pattern of trade that contributes to sustainable development has been replaced by a much narrower focus on the goal of reducing tariff and non-tariff barriers for the sole purpose of expanding trade in EGS. Yet there is little empirical support for a direct and positive relationship between lower barriers to trade in EGS and environmental sustainability in developing countries. The narrowness of the negotiating mandate contained in Paragraph 31 also appears to be at variance with other parts of the Doha Declaration and with the earlier Marrakech Agreement. First, the recognition that market access alone has not brought about the inclusion of developing countries in the multilateral trading system is absent from Paragraph 31. Second, the acceptance that positive efforts to raise the supply response of developing countries will be necessary to ensure that they benefit from market opening is also missing in Paragraph 31. Third, this paragraph reduces opportunities for the introduction of technology transfer by making no mention of technical assistance or capacity building in developing countries. Fourth, in dealing with the relationship between trade and the environment,

the automation of the process and the assumption of a positive link between the removal of tariff barriers and sustainable development makes the issue of technology transfer appear superfluous and reflects an underlying conceptualisation of technology as embodied in goods and services. Moreover, the mandate within which the EGS negotiations have thus far been conducted and the objectives of these negotiations takes little account of the need to move beyond considerations of market access and deal directly with the development concerns expressed at Doha.

Is it realistic to have expected that the post-Doha WTO negotiating process would do more on the technology transfer front than had been the historical practice in this and other negotiating fora in the past? While the scope of this paper does not permit a systematic analysis of the accomplishments and failures of the multiplicity of technology transfer mechanisms proposed under various international agreements, it does provide illustrations of some of the impediments that persist and affect the transfer of environmentally sound technologies (ESTs): the difficulties in obtaining a licence for a chlorofluorocarbon (CFC) substitute in Korea; the problems associated with the transfer of publicly funded technology abroad, even when these are clean technologies with a potentially wide, globally important positive impact; the limited ToT to developing countries and the incentives it gives to producers and consumers in developed countries to maintain current patterns of “use up” or “clean up” that do not promote the development of ESTs. In view of these precedents, it would be unwise to expect that current EGS negotiations in the WTO can move things forward more rapidly than in the past, particularly in view of the narrowness of the negotiating mandate and its failure to reflect the evolution of thinking about the process of technology transfer and its goals.

Within EGS negotiations, there are still other aspects of the mandate and process of negotiating trade in EGS that need to be rethought from the broader technology transfer and development perspective. First, although Paragraph 31 recognises the distortions that result from subsidies, EGS negotiations, and negotiations on the subsidies that affect trade in them, are not being conducted in parallel. Second, there is a need to deal with the issue of “clean vs. cleaner” producers and processes. The decisions taken with respect to the designation of specific EGS for trade liberalisation will affect the choice sets that shape future research and development (R&D) decisions among producers of both agricultural and manufacturing goods. At issue is whether the EGS negotiations create incentives for a longer-term view or reinforce the current short-term perspective and, in this context, whether the process encourages the adoption of a single or multi-goal orientation. Currently, it does the former. Third is the problem of 'dual use' goods that have environmental and non-environmental uses. This is particularly important in EGS, which have a 'public goods' element to them and in agriculture, where they concern products such as biofuels that are already being exported.

There are also clean technologies whose production should be encouraged as a means to reduce dependence on carbon-based fuels. In developing countries, production of biofuels would also help to deal with the development-related rise in greenhouse gases and other pollutants as the use of the internal combustion engine dominates urban transport and carbon-based fuels are used to satisfy growing energy needs. One cannot ask these countries to sacrifice development on the altar of global warming for which they cannot be held responsible. How then to proceed?

This paper approached these issues from a perspective that emphasizes technology transfer as a channel for learning and capacity building that supports sustainable development in both socio-economic and environmental terms. From that perspective, it has drawn the following conclusions with respect to the EGS negotiations and the mandate and structure of WTO negotiations within which they are situated.

Technologies that are both clean and renewable have a "public goods" element to them. Encouraging their production and trade creates global environmental benefits in the form of reduced greenhouse gases and other sorts of environmental damage. However, for any given product or service, liberalised trade does not necessarily benefit all. On the contrary, from a development perspective, it is important to acknowledge that it can create both short- and long-term positive and negative effects. These depend upon the different response capacities of existing production and innovation systems and the extent to which complementary measures are put in place to deal with these differences.

Mainstreaming the concept of technology transfer as a process that includes a flow of knowledge as well as goods and opens opportunities for learning and capacity building in developing countries within all negotiating venues will thus be needed. This will require an active search of goods and services under negotiation for opportunities to introduce flexibility, special and differential treatment and technical assistance and technology transfer that promote capacity building and enhance response capabilities. There may be a role for the WTO Working Group on Trade and Technology Transfer to identify areas within each of the negotiating fora where such opportunities might be pursued. Along with the adoption of a multi-goal approach in negotiations within the WTO, the mainstreaming of technology transfer provides a key to both the successful completion of a “development” round and to the use of trade as an incentive for producers to engage in innovation that goes beyond short-term, palliative environmental considerations.

Much time has been spent in trying to establish lists of environmentally “cleaner” products’ and in debating whether to include environmentally preferable processes. It might be preferable, therefore, to set a goal of achieving “clean” technologies straightaway. Clean technologies are simpler to measure and standards can be more easily defined, thus, paving the way for a “public goods” justification for the elimination of barriers to trade in such goods, provided that technology transfer enables developing countries to build their capacities to participate in the development, production and operation of such products and processes. While maintaining the “list” principal, one might thus define environmental products as those that meet at least one of the following two criteria: either they are clean products in an environmental sense, that is, they produce zero emissions or are biodegradable, for example, or they are made by a clean process. The latter might include using a clean energy source and renewable inputs or involve the reuse of its wastes in co-generation or in the production of by-products. Movement in this direction will, in the first instance, produce a far shorter list of tradable goods and services, but it will be one that provides a trade incentive for innovation into clean and renewable technologies and products.

Agricultural negotiations involve opportunities for trade-offs between tariffs and subsidies, whereas EGS negotiations do not. Yet, is the answer to either broaden EGS negotiations to include the same opportunities for trade-offs as those available in the agriculture-negotiating venue or, conversely, expand the mandate of agriculture negotiations to include agricultural commodities that also have the attributes of being important from an environmental perspective? Should the problem be conceptualised in narrow either/or alternatives? Perhaps there is a substantially different way to deal with such issues and, from a development perspective, strengthen opportunities for the achievement of both environmental and development goals. This is of special importance in the present conjuncture where negotiators have failed to reach agreement on any of the Doha issue areas and it leads to the need for further reflection on the form that negotiating processes have taken at the WTO, particularly from a development perspective. For the most part, negotiating venues have tended to form separate silos each of which then focuses solely on the specifics of that particular issue with distinct negotiating groups emerging in each venue. Opportunities to build conceptual coherence across negotiating venues or reconfigure the set of trade-offs, so as to enhance overall equity for

developing countries and ensure the promotion of cross-cutting development and environment goals, are largely absent. Creating a venue where this could take place would be a major new step for the WTO. A number of processes might be envisaged for such a venue. The WTO could undertake to achieve these goals by operating as a review process that identifies and negotiates specific mechanisms or measures to promote development goals in any given negotiating venue or across several negotiating venues. Alternatively, it could use a "conference" process to harmonise approaches being taken in two or more negotiating venues. Cross-cutting goals such as those relating to development and to the environment are excellent candidates for such processes.

Although patents are intended to stimulate the creation of new knowledge and its use in production, current systems of intellectual property rights (IPRs) offer only limited benefits to developing countries in this respect. Enhancing the possibility for the transfer of both tacit and embodied knowledge to developing countries, through the patent system, especially in areas with a potential to meet local development needs and global environmental concerns, would make a major difference. Efforts are currently underway to develop such an approach through, for example, partnerships in the development of drugs for neglected diseases in developing countries.

Another possible approach and one with broader import for environmental sustainability is the creation of a Knowledge Fund as a means to bring the benefits of learning and innovation to developing countries. The WTO, in collaboration with other international organisations, such as the Food and Agriculture Organization of the United Nations (FAO), United Nations Conference on Trade and Development (UNCTAD), the United Nations Environment Programme (UNEP), the United Nations Industrial Development Organization (UNIDO), the World Health Organization (WHO) and the World Intellectual Property Organization (WIPO), could promote the establishment of a Knowledge Fund as the repository of patents dealing with technologies that are critical to the fundamental needs for food, drugs and environmentally sound technologies in developing countries. The Knowledge Fund would also be endowed with the financial resources to work with enterprises and the public sector in these countries in order to ensure that the tacit knowledge required to work these patents locally is also transferred.

Patent holders would be encouraged to deposit patents of utility to developing countries in the Knowledge Fund. Alternatively, the form of making those patents available to developing countries might include placing patents in the public domain or granting to these countries, automatic and royalty-free licences for patents listed with the Knowledge Fund.

Knowledge Fund staff, in collaboration with business support services in the developing countries, would collaborate in identifying possible economic agents for the working of these patents locally and support the transfer of tacit and codified knowledge needed to manufacture quality products efficiently. Local business support services would maintain contact with producers and provide ongoing support for productivity and quality improvements. These activities of the Knowledge Fund would be supported by a levy of USD 100 on each patent application made by a non-resident in a developing country.

INTRODUCTION

The United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil, in June 1992 put "protection of the atmosphere" on the global agenda.[1] Since then, two public debates have ensued with regard to "who is responsible for airborne pollutants" and"who should pay the price of cutting back". Both of these debates are seriously flawed: the first, because it creates a view of the problem as a hostile dichotomy between "you" or "us"; the second, because it frames the debate in terms of exclusionary alternatives, such as the idea that cutting back on our consumption of hydrocarbons can only be accomplished at the expense of something else, for example, growth or equity. The reality, however, is that there is almost always a range of choices and it is how we frame the problem that widens or narrows these choices.

Obviously, there are some who think outside this box and in more systemic terms. The Geneva-based Business Council for Sustainable Development, for example, sees environmental issues less in terms of an end-of-the-pipe clean up than as part of a larger process in which investment in R&D is aimed at innovations that make production both cleaner and more competitive. This presupposes a decisional matrix that contains a "multi-goal" approach as opposed to the kind of single-goal dichotomies described above. [2]

Having said this, however, is not to deny that trade-offs need to be made, both in terms of costs and with regard to short- and long-term objectives. It is at this point that scholarly reconciliation of different needs intersects with hard bargaining in defence of special interests, many of which are short-term in nature. Negotiations within the WTO reflect a bit of both.

The objectives of the first three sections of this paper are to develop a broader conceptualisation of the technology transfer process and to open a discussion on the need for a multi-goal approach to EGS negotiations in the WTO. The last two sections analyse policies and practices with regard to trade and technology transfer in environmental goods and services from this perspective.

Section one briefly traces the evolution of technology transfer goals and processes and their impact on growth and development. It points to the persistent view of developing countries as "users" of technology produced elsewhere and a lack of attention in technology transfer processes designed to build the local knowledge base.

Section two analyses the new competitive conditions facing developing countries today as production across all industries becomes more knowledge-intensive and competition is based increasingly on both price and a continuous process of innovation. These changes challenge earlier conceptualisations of a passive technology transfer process and its production-oriented goals.

Section three analyses the spaces opened by WTO Agreements for negotiations on technology transfer in EGS that respond to these new needs for learning, capacity building and innovation that have resulted from the changed conditions discussed above. It concludes that the record of technology transfer through trade negotiations has been mediocre at best and that both the structure within which EGS negotiations are being carried out and the mandate for those negotiations, focused narrowly on market access in terms of tariff reductions and non-tariff barriers, leave little space for introducing supply-side considerations such as technological capability building or supply response capacity. There may, however, be ways around this, but whether they are achievable in today's negotiating climate is another matter.

Section four addresses the nature of EGS and the current policies and global practices that deal with them. It focuses on two sectors: air pollution control in the transport sector and renewable energy. Both are of particular concern

to developing countries. With regard to these environmental issues, the section illustrates the way in which the narrow focus on market access in current EGS negotiations limits opportunities for the development of technology transfer mechanisms that build domestic capabilities in developing countries. The lack of attention to environmental and development goals in the EGS negotiations, moreover, makes it more difficult to deal creatively with the issues of "clean vs. cleaner" products and processes in the transport sector, "dual use" products, including certain types of biofuels, and subsidies in the agricultural sector, which affect the incentives to move beyond palliative solutions to environmental pollution and towards more sustainable alternatives.

Section five draws conclusions as to whether opportunities for enhanced flows of technology through EGS negotiations within the WTO might be created. It argues that this is not likely to occur under the present structure and mandate for EGS negotiations and makes a case for adopting a broader perspective, a set of longer-term goals and processes for achieving them and a more integrated approach to EGS negotiations in the WTO. This conceptual reframing would reshape the dynamics of North-South negotiations on EGS to include a robust set of commitments, activities and partnerships that strengthen the knowledge base, encourage learning and innovation in the South and address the global importance of sustainable development.

1. TECHNOLOGY TRANSFER

In much of the conventional development literature since the 1950s, development has been viewed as an economic transformation in the productive structure marked by a shift away from agricultural goods and towards manufacturing. Those locked into hard trade negotiations on agricultural goods today, when many of the world's major exporters are among the most developed countries and research lies at the heart of the dynamic process that made this possible, would find this earlier view rather short sighted. Yet, for many decades, it has informed practices with regard to technology issues.Technology, for example, in most negotiating circles is still regarded as knowledge embodied in machinery and equipment and is believed to be context neutral.[3] From this perspective, ToT involves little more than moving a machine from point A to point B or importing cars, clothing or drugs. The confusion of the concept "transfer" of technology with the arms length purchase of machinery or the negotiated acquisition of technology through licensing, and the technology payments that were required as part of foreign investment packages, has also given many the impression that technology is a public good, available to all and costless to acquire.

This has contributed to the persistent belief, common in both developed and developing countries and despite the emergence of a few innovative imitators in the South, that developing countries are "technology users", importing knowledge embodied in machinery and equipment and/or licensing-in product and process technologies developed elsewhere (Mytelka, 1978, 2004; Kim, 1997, 2004; Katz, 1985; Lall, 2003). Thus, little, if any, attention has been paid to building upon indigenous knowledge, exercising creativity in the development of new products, processes, management routines or organisational structures that correspond to local conditions and needs. Furthermore, developing countries have not been envisaged as anything but passive recipients of technology from elsewhere (Katz, 1985) and "reinventing the wheel" in their case was thus deemed costly and unnecessary.

However, a number of factors are now contributing to the radical reshaping of this view of the technology transfer process. Some of these derive from a substantial body of research on the process of technology transfer to developing countries and the extent to which it has contributed to productivity growth, competitive cost structures and quality output. Others are the result of global competitive challenges to be discussed in the next section.

Relative to the industrial production frontier in the 1950s and 1960s, capital and technology were scarce factors of production in the developing world. Foreign direct investment or the licensing of product and process technologies thus became important vehicles for achieving rapid growth in productive capacity. Research in the 1970s and 1980s, however, uncovered the financial costs of "technology transfer" and also the failure of technology thus acquired to be automatically absorbed through learning by doing (Arrow, 1962) in the course of operating manufacturing plants.

Across much of the developing world, opportunities for learning were foregone where pre-investment decisions concerning technological choice and the design of plants and processes were left to foreign consulting engineering firms. Licensing and joint venture agreements paid little attention to technical upgrading or the development of managerial skills through continuous training and few linkages were established with domestic manufacturers for the production of spare parts and components. Many manufacturing firms suffered from the high costs of acquiring management, marketing, maintenance and repair services from abroad (Pack, 1987; Bell et al, 1980; Mytelka, 1985; Wangwe, 1992). Neither the tacit[4] knowledge within the firm nor the local services needed to operate plants efficiently could be counted upon to improve

products and processes or increase productivity and competitiveness. This significantly lowered the capability of firms in most developing countries to respond to opportunities for market access emerging through such mechanisms as the Lome and Cotonou Conventions and, later, the WTO.

Moreover, from an innovation perspective, the licensing of products and processes became a substitute for learning and innovation within the firm reducing the need for linkages to a local knowledge base as a means to stimulate a process of innovation in production (Mytelka, 1978). In such a context, trained scientists and engineers were mainly needed for the operation of a "technology" or a production process as opposed to its modification, adaptation, extension or transformation. In-house research, where it did take place, was for the most part limited to resolving short-term problems in the production process. This is particularly significant as the historical record in current "developed" countries shows that importing foreign technology and creating it locally are not alternatives but are complementary (Bell and Pavitt, 1992). In building technological capacity in the Japanese chemical and shipbuilding industries, for example, the licensing of technology was accompanied by large investments in developing the skills and know-how to assimilate, modify and improve upon imported technology. Learning through reverse engineering, domestic content requirements and procurement rules were also critical elements in this process.

Despite the earlier belief that scarce resources should not be expended on "reinventing the wheel", a small number of developing countries, taking Japan as a model, did actively pursue a sustained strategy of learning and technological capability building involving policies to stimulate and support a continuous process of "learning to imitate" and reverse engineering. It was this process that proved so successful in the development of export capacity in textiles and clothing, steel, consumer electronics and pharmaceuticals, notably in a number of Asian countries (Ernst, Mytelka and Ganiatsos, 1998; Kim, 2004; Westphal, Kim and Dahlman,1985; Acharya, 1999). In these countries, effective ToT was increasingly conceptualised in terms of domestic capacity building and the resultant ability not only to operate new technologies efficiently but also to modify, adapt and improve upon imported technology and to innovate in the development of new designs, production processes and products. Similarly, in a number of Latin American countries, the development of critical engineering services in the petroleum and petrochemical, steel and synthetic fibre industries laid the basis for process innovations, productivity gains and higher product quality (Katz et al, 1987; Sercovich, 1987).

Nevertheless, the concept of ToT continues to be applied to the acquisition of technology embodied in products, such as cars and, more recently, drugs, as we have seen in post-Doha negotiations concerning the importation of retroviral drugs. A short-term perspective and production-oriented conceptualisation of the technology transfer process still shapes the objectives of negotiations in the WTO and both developed and developing countries appear to subscribe to it. However, it weakens their ability to press for space to develop new technologies locally, either through in-house research within the firm, linkages between local universities or research centres and domestic firms, or through processes of North-South collaborative research and technology development that build the local knowledge base in the South. Yet the competitive challenges that developing countries increasingly face make the adoption of a strategy of learning, capacity building and innovation critical for growth and sustainable development.

2. NEW COMPETITIVE CHALLENGES FOR DEVELOPING COUNTRIES

During the 1980s and 1990s, a number of changes in the global pattern of production and competition created new requirements for learning, technological capability building and innovation in developing countries. Four of these changes stand out in particular for their impact on the challenges and opportunities for technology transfer through negotiations at the WTO, notably through EGS negotiations. This section deals briefly with each of these.

2.1 The Growing Knowledge Intensity of Production

Over the past two decades, production has become increasingly more knowledge-intensive as investments in intangibles, such as R&D, software, design, engineering, training and marketing and management have played a greater role in the production of goods and services. Much of this has involved tacit rather than codified knowledge and mastery and has thus required a conscious effort at learning by doing, by using and by interacting (Mytelka, 1999). Indeed, where linkages were established to a wider set of knowledge inputs and the local knowledge base was deepened, these traditional industries have shown a remarkable robustness in the growth of output and exports.

Gradually, the knowledge-intensity of production has extended beyond the so-called high technology sectors[5] to reshape a broad spectrum of traditional industries in which developing countries play an active role in production and, increasingly, in exports. Among the most prominent of these are the shrimp, Nile perch and salmon fisheries in countries such as Chile, the Philippines and Uganda (Kiggundu, 2006); the flower enterprises in Colombia and Kenya (Mytelka and Bortagaray, 2005); and the textile and clothing firms across a large number of developing countries, including China and Thailand (Ernst et al, 1998). However, in each of these industries, continued success has been challenged by the need for research, technological development and innovation[6] in process engineering, product design and marketing activities as competitive conditions in these sectors change and new rules, such as sanitary and phyto-sanitary standards, are adopted in export markets. Figures 1 and 2 illustrate the range of linkages to the kinds of knowledge-based inputs that are now required to sustain export competitiveness in formerly traditional sectors.

Figure1

FOOD INDUSTRIES

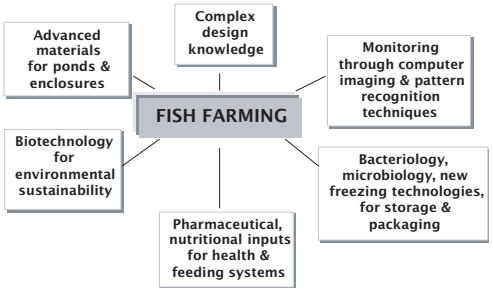
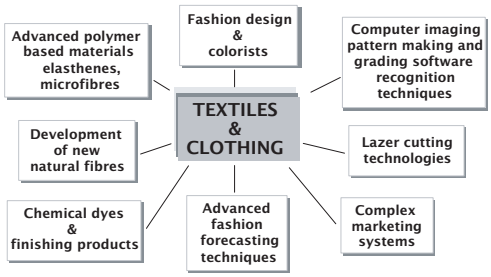


Figure2

TEXTILES AND CLOTHING



2.2 The Emergence of Innovation-based Competition

Within the context of more knowledge-intensive industries, firms began to compete not only on price but also on the basis of their ability to innovate. In information technology, generations of semi-conductor chips or software succeed each other in less than 18 months. In more traditional industries, such as textiles and clothing, design changes have turned commodities into diversified goods, while, in agriculture, brand names and trademarks have heightened the importance of product innovation in, for example, coffee and flowers (Mytelka, 2004).

Overtime, an innovation-based mode of competition became entrenched and rapidly diffused around the world through the process of trade liberalisation and the deregulation of domestic markets. This raised new issues and new challenges for policy makers and enterprises in the developing world with regard to innovation and competitiveness. In particular, it put into question earlier views of development as a linear process based on low wages and low skilled labour followed by a slow incremental process of catching up. When gaps between North and South, with rare exception, failed to narrow, a stimulus was provided for the emergence of new thinking about the need for learning and innovation as the core of a development process.

2.3 The Adoption of New Global Trade, Intellectual Property and Investment Rules

As the knowledge intensity of production increased and competition on the bases of both price and innovation became established, large firms began to develop new organisational models and employ a variety of strategies to create and internalise new knowledge or appropriate it for lengthy periods of time. In consumer-oriented knowledge-intensive industries, such as pharmaceuticals and the agro-industry, a systematic process of market segmentation through the establishment of brand name loyalty via advertising and trade marking became common. In these and other knowledge-intensive industries, a wave of mergers and acquisitions internalised new knowledge and turned it into a proprietary asset. By the end of the 1990s, mergers and acquisitions accounted for well over 50 percent of global FDI (UNCTAD, 1998, 2000). In science and research intensive sectors, such as chemicals and pharmaceuticals, pressure to strengthen patenting rules increased and through the WTO's Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) uniformity has been extended across countries and trade sanctions applied when these are violated.

Intellectual Property Rights

In a knowledge-based economy, the focus of knowledge creation and the forms through which knowledge is appropriated will increasingly shape opportunities for learning, for innovation and, thus, for growth and development. How do new trade, intellectual property and investment rules affect the process of technology transfer as a tool for learning and capacity building?

Initially, the importance of IPRs in technology transfer was said to reside in the licensing of a process or product patent for production in the domestic product or what was known as the "working" of a patent. Whether the firm was local or foreign was not relevant. The Paris Convention of the International Union for the Protection of Industrial Property thus adopted provisions for the compulsory working of patents and for compulsory licensing as remedies against the non-working of a patent within a set period of time. Produce and not merely use was the essence of the transfer of patented technology and the principal rationale for local patenting. This earlier view corresponds to the contemporary notion that the impact of knowledge accumulation on development derives from a process of learning by doing, using and by interacting that stimulates technological mastery and innovation.

Later, however, the Paris Convention was revised and "importing" a patented good replaced the need to "work" a patent. This effectively de-legitimised legislation enacted in a number of developing countries during the 1970s, which had required that patents be put into production within a specified number of years after which either a compulsory licensing process could be initiated or the patent would be terminated. As a result, few patents registered in developing countries are put into production and, where they are, licences have increasingly been granted only to the local affiliates of the patent-holding firms.[7] Thus data for the 1990s show that 70 percent of global royalty and licensing payments

were paid by affiliates to their parent firms (UNDP, 1999). From a learning and innovation perspective, the replacement of "working" by "importing" has the potential to significantly limit opportunities for technology spillover through the presence of firms that use these technologies in the domestic economy.

Even if compulsory licensing were to become more common, given the substantial complement of tacit knowledge required to operate processes efficiently and master the technology involved in producing new products, it is unlikely to be an effective instrument for technology transfer to most developing countries. Only in rare cases, where a developing country had substantial research and engineering capability, has the awarding of a compulsory licence led to benefits in the form of significantly cheaper prices for patented products.

Recent revisions to patent legislation, as required by TRIPS, have further reduced the positive impact of patenting on learning and innovation. Revisions that broaden the scope of patents, for example, inevitably narrow the path around an invention and limit opportunities for innovation. In a period when product life cycles have shortened dramatically, extending the duration of patents' lives adds to this problem by eliminating the commercial incentives to engage in reverse engineering, the classic form of knowledge spillover that contributed so significantly to rapid development in the textiles and clothing industry and the electronics industry in a number of Asian countries.[8]

If opportunities for entry and for learning through licensing have been substantially reduced in mature industrial technologies, the problem is even more acute in new wave technologies, which are science-based, research and patent intensive, systems embedded and disruptive technologies that have the potential to radically reshape a wide range of economic and social activities. Cases in point are biotechnology in its applications to agriculture and health care and the emerging hydrogen fuel cell technology in its application to energy and transport.

Though the application of new technologies with a positive impact on global health and the environment might be regarded as a potential candidate for technology transfer through licensing, there have been incidents where patent holders have refused to grant a licence. DuPont, for example, refused to grant licences for the production of chlorofluorocarbon substitutes to Korean and Indian firms that sought to meet the phase out requirements of ozone depleting substances as required by the Montreal Protocol of 1987. Conflicts also arose over efforts by South Africa and Thailand to secure compulsory licences for drugs to treat HIV. Both countries are seriously affected by the AIDS pandemic and are unable to afford the price of drugs produced in the United States (US). Attempts by a US and a Canadian company to produce a cheaper version of Zidovudine, known by its brand name, AZT, a mono-therapy then used in the treatment of HIV/AIDS, were halted following a law suit for patent infringement filed by Glaxo-Wellcome which held a monopoly on this drug.

Conflicts over issues such as compulsory licensing and parallel imports have continued despite efforts at the Fourth WTO Ministerial Conference in Doha, Qatar, to arrive at a consensus on the need to achieve development goals by introducing flexibility into TRIPS. New mechanisms will need to be developed to deal with these issues in future WTO negotiations. This is because these mechanisms will have a bearing on the extent to which EGS negotiations contribute to the building of response capacity in developing countries, a point to which we return in Section 5.

Partnerships

Paradoxically, the increased spending on R&D designed to cope with the emergence of a knowledge economy has accelerated the already rapid pace of technological change. This has added to the level of uncertainty and the rising costs and risks of knowledge production faced by firms in developed countries. Thus, vertical integration has become a limiting factor in adjusting to rapid change and uncertainty. On the other hand, flexibility, in the form of

partnerships and networks for the production of goods, services and knowledge, has gained in importance.

Figure 3 illustrates the wide range of forms that are currently being used to organise production. The variety of business-related functions now open to externalisation has created new opportunities for production and export by firms in the developing world that consciously sought to master imported technology and build capabilities at home. Understanding the life cycle of products in these sectors and the changing strategies of foreign firms has strengthened local bargaining capabilities. It was also critical in transforming one-way relationships into two-way partnerships that deepened knowledge flows and enabled local firms to innovate as competitive conditions changed.

Figure 3
New Forms of Organisation in Production and Trade

	R&D	**Goods and Services**
ONE-WAY Relationships	Licensing Cross-licensing Commercialisation of public sector R&D	Sub-contracting Mergers & acquisitions Joint ventures Original equipment manufacturer User-producer networks
TWO-WAY Partnerships	R&D consortia User-producer networks Inter-firm technology collaboration University-industry partnerships	Co-production Standardisation of Components across models Modularisation New forms of sub-contracting

Source: Adapted from Mytelka, 1993.

In addition to strategies of externalisation, multinational corporations (MNCs) have also increased their investments abroad. Although developing countries are increasingly "open for business", they have attracted relatively little FDI. Furthermore, since the mid-1980s their situation has worsened.

Between 1986 and 1991, average annual FDI flows amounted to USD 159,331 million, only 18.3 percent of which went to developing countries. Forty-eight percent of this amount went to just five developing countries: China, Hong Kong, Malaysia, Mexico and Singapore, while a mere 0.5 percent went to the least developed countries, a share that has remained fairly constant over the years. Despite rising average annual FDI flows over that decade,

the situation of all but a handful of developing countries worsened. By the end of the millennium (1997–2001), average annual FDI flows had reached USD 897,576 million but the developing country share had declined to 23.3 percent with the top five recipients: Argentina, Brazil, China, Hong Kong and Mexico accounting for 58.8 percent of this figure. Over the next three years (2002-2004) average annual FDI inflows fell to USD 665,624 million. Of this, developing countries received a total of USD 185,030 million, an increase of 4.5 percent, almost all of which (61.9 percent) went to the top five recipients: Brazil, China, Hong Kong, Mexico and Singapore (UNCTAD, 2005).

The use of FDI as a vehicle for the organisation of production in developing country markets has also varied in its strategic objectives from enclave extractive investments, where production was destined for export, to domestic market-oriented production and later to export-oriented manufacturing and sub-contracted service, including research activities. Each of these creates different opportunities for learning and innovation and requires conscious efforts to put in place the policies and support structures needed to attract the type of foreign investment of importance to the host country. Figure 4 presents a typology of these foreign investment strategies and policies. As the example of Costa Rica illustrates, although the TRIMS agreement has limited the use of policy instruments that previously shaped the behaviour of multinational firms in host country environments, there nonetheless remains space to develop innovation-oriented FDI strategies (Mytelka and Barclay, 2005).

Figure 4
Differentiating Innovation-oriented FDI Strategies and Policies

	Production-oriented	**Export-oriented**	**Innovation-oriented**
FDI Strategy	Passive, "open for business", adoption of a favourable investment regime; promotional incentives to "attract" but not "orient" FDI.	Targeted attraction strategy: Targeting companies for export potential; high level of pre-investment and after care service.	FDI as part of a broader development strategy. Pro-active: Balancing of targeting and policies designed to stimulate learning, upgrading and technology spillover.
FDI Policy Objectives	Focus on short-term goals of increasing domestic manufacturing output and employment.	Focus on short-term goals of increasing employment through exports; little attention paid to technological mastery to adjust as competitive conditions change.	Longer-term dynamic perspective on learning and innovation within the firm and broader technology spillover across the sector.
Capability Building	Learning to operate plants and production processes; static focus on codified knowledge and routine practices.	Learning to meet quality standards and and delivery times. Develop the flexibility and skills to deal with generational changes in products and processes.	Learning to innovate by creating linkages to the local knowledge base and partnerships for continuous upgrading.

Source: Adapted from Mytelka and Barclay, 2005.

As the share of reinvested earning and mergers and acquisitions in FDI inflows rises and MNCs increasingly resort to domestic borrowing, FDI's role in development needs to be rethought (UNCTAD, various years). With the exception of countries endowed with large and dynamic domestic markets such as China or critical resources, including knowledge resources, such as India and Singapore, most developing countries have tended to pursue passive production-oriented FDI strategies that cannot be expected to attract investment that builds the knowledge base and encourages learning and innovation in local firms. Some knowledge spillovers may occur through labour mobility changes in the domestic competitive environment and demonstration effects as the Kenyan case illustrates (Gachino, 2006). But Kenya, like most developing countries, receives relatively little FDI[9] and competition to attract such investment is stiff.

In the absence of a foreign investment promotion strategy that is innovation-oriented, reliance on foreign investment as a principal vehicle for technology transfer is unlikely to prove effective.

2.4 Growing Concern for the Environment and its Embodiment in International Agreements

Although attention had been paid for some time to the impact of water and air pollution on health, the need to dispose of growing amounts of hazardous wastes and the damage to the environment resulting from the destruction of forest cover or strip-mining, have remained mostly localised problems. National regulatory measures thus varied considerably across countries. For example, catalytic converters and lead-free petrol, which have long been obligatory in countries in the North, have only recently been legislated in many developing countries and even then, regulations have not been fully implemented.[10]

The discovery of an ozone hole in the Earth's atmosphere, however, galvanised public concern about the environment on a global scale and led to the first of a series of major international agreements.[11] From 1985 to 1997, five international conventions and protocols were signed. These reflected a growing recognition that developing countries would need substantial assistance in dealing with environmental issues. Technology transfer figured importantly here and Agenda 21 adopted at the UNCED devoted a full chapter (Chapter 34) to co-operation for the transfer of ESTs and capacity building in the South.

In the wake of UNCED and in light of the subsequent high growth rate in the larger developing economies that was expected to significantly increase demand for mainly carbon-based energy sources and the growing use of private transport across the developing world, many came to believe that it was in the global interest to encourage the transfer of ESTs to the developing world. Access to technology, technology transfer or the diffusion of new technology was thus explicitly mentioned in a number of conventions.[12] In the late 1990s, studies carried out by UNCTAD, UNEP and other United Nations agencies were undertaken with a view to providing guidance on policy initiatives that might be taken by developed and/or developing countries to stimulate the transfer of ESTs. Public procurement strategies that involve tendering and/or negotiated procurement, for example, might be used to stimulate the transfer and development of ESTs (UNCTAD, 1997). The existence of publicly funded ESTs in the North might also provide a pool of technology useful for developing countries, provided that existing government policies do not impede the development of this technology or its diffusion (UNCTAD, UNEP and DESA, 1998). Fuel cell technology, a clean technology for use in the energy and transport sectors, developed at a public sector research institute in the United States, for example, found no takers among firms in that country. But transfer to a firm in Australia hit up against policies that required "substantial manufacturing" in the United States (Clark and Paolucci, 1997).[13]

3. THE WTO AGREEMENTS

While transfer of technology is not explicitly mentioned in the EGS negotiating mandate reflected in Paragraph 31 (iii) of the Doha Declaration, it was clearly a key concern of developing countries at the Doha Ministerial meeting. This concern led to the multiple references to technical co-operation and capacity building throughout the documents.[14] For example, Paragraph 38 confirms "…that technical cooperation and capacity building are core elements of the development dimension of the multilateral trading system" and "… welcome(s) and endorse(s) the New Strategy for WTO Technical Cooperation for Capacity Building, Growth and Integration". Paragraph 42 recognises that "…the integration of the LDCs into the multilateral trading system requires meaningful market access, support for the diversification of their production and export base, and trade-related technical assistance and capacity building." Despite its limited mandate, the importance of technology transfer is also acknowledged in the creation of a Working Group on Trade and Technology Transfer.

Paragraph 31 of the Doha agreement commits the participants to open negotiations in three areas: "(i) the relationship between existing WTO rules and specific trade obligations set out in multilateral environmental agreements (MEAs)…[but these are] …limited in scope to the applicability of such existing WTO rules as among parties to the MEA in question; (ii) procedures for regular information exchange between MEA Secretariats and the relevant WTO committees… [and] (iii) the reduction or, as appropriate, elimination of tariff and non-tariff barriers to environmental goods and services." Only the latter point sets a goal for these negotiations, which is narrowly focused on market access. The singularity of this focus on the reduction and/ or elimination of tariff and non-tariff barriers to trade in environmental goods and services appears to be at variance with the broader set of goals contained in the preamble to the Marrakech Agreement Establishing the World Trade Organization signed in April 1994.

In Marrakech, the parties recognised "…that there is need for positive efforts designed to ensure that developing countries…secure a share in the growth in international trade…" Moreover, they linked the expansion of trade in goods and services to "…the optimal use of the world's resources in accordance with the objective of sustainable development, seeking both to protect and preserve the environment and to enhance the means for doing so in a manner consistent with their respective needs and concerns at different levels of economic development (Marrakech Agreement, Preamble). Paragraph 31 of the Doha agreement no longer seeks to expand trade "in accordance with the objective of sustainable development" but narrows the focus of negotiations to "the reduction or elimination of barriers to trade". It makes no mention of the kinds of positive efforts needed to ensure that this benefits developing countries or the environment. There is simply a statement that this is being done "(w)ith a view to enhancing the mutual supportiveness of trade and environment", which again says nothing about the objective of sustainable development or how it will be achieved. The assumption that this will automatically result from lowering or eliminating tariffs can hardly be accepted as credible in light of the considerable amount of research that has been undertaken into the factors that affect firms' decisions to invest in the development of clean products and shape the parameters within which they choose end-of-pipe solutions as opposed to clean technologies.

This research points invariably to the importance of policies in this process, even if the relative weight of regulatory policy and policies creating incentives to move towards a clean technology solution is still debated.[15] Thus, in the one paragraph linking trade and environment, the goal of developing a pattern of trade that contributes to sustainable development has been replaced by a much narrower focus on the goal of reducing tariff and non-tariff barriers for the sole purpose of expanding trade in EGS.

In addition to the lack of empirical support for a direct and positive relationship between lower barriers to trade in EGS and environmental sustainability, the assumptions made in Paragraph 31 and the negotiating mandate that it contains also appear to be at variance with other parts of the Doha Declaration and with the earlier Marrakech Agreement in four ways. First, the recognition in these earlier documents that market access alone has not brought about the inclusion of developing countries in the multilateral trading system is absent from Paragraph 31. Second, the acceptance that positive efforts to raise the supply response of developing countries will be necessary to ensure that they benefit from market opening is also missing in Paragraph 31. Third, this paragraph reduces opportunities for the introduction of technology transfer by making no mention of technical assistance or capacity building in developing countries. Fourth, in dealing with the relationship between trade and the environment, the assumption of an automatic positive link between the removal of tariff barriers and sustainable development makes the issue of technology transfer appear superfluous and reflects an underlying conceptualisation of technology as something that is simply embodied in goods and services.

Under these conditions, is it possible, to introduce capacity building, supply responsiveness and technical assistance into the EGS negotiations as presently conceptualised and structured? Can this be done by linking negotiations across differing venues? More fundamental still, are there grounds for re-interpreting capacity building, supply responsiveness and technical assistance as components of a technology transfer process that involves more than simply trade? These questions will be taken up in the following two sections. What seems clear from the above analysis, however, is that the evolution of the concept "technology transfer" towards one that includes flows of knowledge as well as goods thus creating opportunities for learning and innovation (that support wealth creation in developing countries), which is already taking place in the capitals of many developing countries, has not been mainstreamed into WTO negotiations on EGS.

An evaluation of the opportunities for technology transfer offered by WTO negotiations on EGS, however, requires more than a close reading of the agreements themselves. A brief examination of the process of EGS negotiations to date, the practice of trade in environmental goods and services and the operation of existing mechanisms for the transfer of ESTs can provide an important complement of information that supports the arguments advanced above and might suggest a new approach to dealing with the issue of technology transfer in EGS.

4. ENVIRONMENTAL GOODS AND SERVICES: PROBLEMS, ISSUES AND PRACTICES

During the 1970s, attention in the Organisation for Economic Co-operation and Development (OECD) was drawn to the emergence of a set of economic activities that were perceived to be distinct from those in the manufacturing sector. Data on what became known as the "services industry" was broken down into a set of generic categories (Figure 5).

Figure 5
G7 Service Exports

		2003 Billions of USD	Average Annual Change % 1998-2003
200	TOTAL SERVICES	863.2	4.1
205	Transportation	163.0	2.4
206	Sea transport	54.9	5.8
210	Air transport	69.5	0.4
214	Other transport	38.6	2.1
236	Travel	216.8	1.6
245	Communications services	18.3	5.7
249	Construction services	17.4	-5.9
253	Insurance	29.0	18.6
260	Financial	55.2	7.1
262	Computer and information services	26.2	12.3
266	Royalties and licence fees	81.6	7.1
268	Other business services	206.5	6.2
287	Personal, cultural and recreational services	17.6	7.6
291	Government services, n.i.e.	31.5	-0.23

Source: OECD (2005).

Several of these categories relate directly to the changes in production and competition that were discussed in Section 2. These include new organisational models in which a wide range of business services are sub-contracted, the growing knowledge-intensity of production coupled with the internationalisation of production that has given rise to higher royalties and licensing fees and the role that information and communications technologies has come to play in industrialised economies. Others involve what have traditionally been location-specific and highly labour intensive activities, such as industrial cleaning, waste collection and disposal, education, wholesale and retail trade, hairdressing, restaurants and local transport and trucking. The services industry thus lacks coherence and the implications for the adoption of a common approach in negotiation is difficult at best.

Since data collection began, the value of "service" exports has risen. In 2003, total service exports of OECD Member countries amounted to USD 1.4 trillion, constituting 21.8 percent of total exports of goods and services (Figure 5). Nonetheless, OECD documents regard service exports as "relatively minor" when compared to "the contribution of services in the domestic economies of member countries…" (OECD, 2005.)

A number of trends in business practices appear to account for the "relatively minor" role that

a distinct set of service sector activities is now playing in manufacturing. One is the need for suppliers to be close to their customers. According to the OECD, this has led firms "to establish a commercial presence" in countries in which they seek to trade (OECD, 2005), although cross-border mobility of service workers can be an alternative channel for the provision of services in some industries and for some activities, for example, in engineering design or plant and machinery maintenance.

A second lies in "the characteristics of those entities usually described as services that they cannot be traded separately from their production." (OECD, 2005.) The latter originates in both the increasing role of service firms as providers of intermediate inputs and the consequent "…importance of the interaction between manufacturing and services" as well as the increased "share of services activities that is necessary for or complementary to manufacturing goods production." (Wölfl, 2005.)

"The production of a car, for instance, would not be possible without services activities such as market research, technical research and development and design, human resource management, control and business consulting. Moreover, a car is often sold in a package that includes financing, which may be provided directly by the car producer or indirectly via subcontracting. Second, the past two decades have seen an increasing trend towards the outsourcing of business related services, such as research and development, financing or logistics. Services have been contracted to existing specialised service providers, or are provided by a newly created firm or spin-off from a manufacturing firm that can provide the services at lower cost or higher quality." (Wölfl, 2005.)

These trends have a bearing on the definition of an "environmental industry" and on the issue of technology transfer in EGS.

4.1 Defining an Environmental Goods and Services Industry

In the early 1990s, an interest in defining an environmental goods and services industry emerged out of the statistical problems encountered by Eurostat and the OECD in connection with their mandate to monitor economic activities in their member states and out of their work on environmental policy and industrial competitiveness. These were developed countries then facing the growing consequences of industrialisation in the form of air and water pollution, high levels of noise, wastes of all sorts and land degradation. In the OECD, attention was particularly drawn to end-of-pipe solutions and clean up activities. This oriented their definition towards an industry composed of environmental products and thus firms that provided the environmental "equipment" for:

- Waste-water treatment
- Waste management and recycling
- Air-pollution control
- Noise reduction
- Monitoring and research
- Natural resource conservation
- Urban amenities,
- Firms providing related environmental services (OECD, 1996)

For the OECD, the boundaries of an environmental goods and services industry were shaped by "end use" and lists were drawn up on the basis of products rather than production processes and methods. Whether designed for illustrative purposes, as stressed by the OECD Secretariat (Steenblik, 2005) or as a proposed set of negotiating guidelines, the OECD was first in the market with such a list and had a strong interest in seeing environmental goods and services on the WTO negotiating table. The OECD list thus came to have a powerful impact in shaping the negotiations.

The end use approach adopted in the OECD led to the initial exclusion from their list of products such as organic foods or eco-certified

goods that clearly contribute to environmental goals. As demand for such goods is growing, some view this as a missed opportunity for developing countries (Araya, 2003). From an innovation perspective, it is clear that the end use approach provides little encouragement for those seeking to pursue a more thorough transformation of production processes, rather than simply engage in the development of products that offer marginal changes in levels of pollution or are for post-hoc clean up.

Given the end use approach to the identification of environmental products in the OECD list, one might have expected that the service component of the environmental industry would have been restricted more narrowly to these products. This has not been the case and "a growing range of other environmental services" (OECD, 1996), or rather services that have been re-conceptualised as environmental services, have been placed on the negotiating table. Like the services industry as a whole, the boundaries of environmental services and the activities it might include are contentious[16] and the distinction between environmental and other services is problematic. The debate over "clean vs. cleaner" thus revolves more around "environmentally preferable products" (EPPs) products while excluding technological processes and production methods that give rise to "clean" products. More curious still is the way this has given rise to the identification of products, such as cotton and other natural fibres, which have been long exported by developing countries, as offering opportunities for gains from EGS negotiations.[17]

4.2 Clean vs. Cleaner

Defining the environmental "industry" for statistical accounting purposes is not the same as identifying products and processes that are environmentally sustainable and for which special treatment to encourage their production, commercialisation and use might be seen as desirable. The narrower definition is single-goal oriented and tends to be biased towards "what is" rather than "what might become". The point is not that new products and new activities cannot always be added to the list, but rather that the methodology for doing so is not clear and this creates opportunities for politicising such decisions and/or falling back on easier solutions such as "just leave them out". It is the latter, which prevailed in thinking within the OECD with respect to the issue of "clean vs. cleaner" technologies. With regard to the former, however, standards can be set. With regard to the latter, the basis for decision is unclear, especially as innovations that produce cleaner technologies may have been developed strategically for other purposes as, for example, the development of a product with a marketing objective in mind or a process that is more efficient, reduces costs or eliminates dependence on a scarce resource.

At issue here is the adoption of a single versus a multi-goal approach in EGS negotiations and the policy decision at the national level as to whether to create incentives and where to place these. Should a manufactured good that produces a positive environmental effect as a by-product of R&D driven by considerations of a purely economic or strategic nature be granted market access on the same terms as a product designed and produced with a multi-goal objective – reducing pollution and enhancing efficiency, for example. The debate over air pollution, especially in urban environments where personal motor vehicles have triumphed over public transportation is a case in point.

The case of air pollution

Leaving aside the strategic decision that must be taken at national levels concerning individual versus collective transportation,[18] if EGS negotiations are to have a positive impact on the reduction of green house gases, they will need to address the various options to reduce the level of urban pollution, much of which is currently generated by the internal combustion engine (ICE), despite the introduction of end-of-

pipe solutions such as the catalytic converter, several decades ago. Catalytic converts continue to figure in lists of environmental goods under discussion.

Looking to improvements that go beyond end-of-pipe solutions produces the following sorts of medium- and long-term options. One is to focus research on the efficiency of combustion in gasoline engines to reduce emissions. Substantial publicly funded research in the US has been devoted to this option over the past decade. This can produce a cleaner, but not a clean technology.

A second is to convert gasoline engines to natural gas, a less polluting fuel. For developing countries that have natural gas, this is a solution that can be relatively quickly implemented. It is particularly appropriate for urban areas where the problem of air pollution is most acute and where the amount of investment needed to create a gas distribution network, especially if the focus is on bus and taxi fleets, is much lower. Relatively simple conversion kits already exist and a strategy can be put in place for developing countries to import and then to build domestic capacity to manufacture and install these kits. Policies to promote their use would not conflict with existing WTO disciplines. This option, like the one above, reduces air pollution but is neither a clean fuel nor does it produce a clean transport technology.

A third approach has been the development and export of electric cars, which figure on some of the environmental products lists. Only a few companies currently manufacture electric cars. Two of these are in the developing world. One is the Indian company, Reva, which has begun to export its vehicles.[19] Reva cars are designed for use in cities like Bangalore or Shanghai where traffic is so dense that drivers can rarely accelerate, distances driven are short and price is critical (Gentleman, 2006). Once petrol prices returned to a lower level after the oil price hikes of the 1970s and in view of the need for additional R&D to ensure the power, rapid acceleration and flexibility for long distance driving that comparable internal combustion engines provide, wholly electric vehicles did not find a robust market in the North. This, however, may now be changing if oil prices remain at or near 2006 levels. Does this provide the basis for increased public sector funding for R&D on new batteries and electric-based "drive by wire" systems and would these new technologies be regarded as "public goods" or, if traded, as unfairly subsidised?

A fourth option emerged in the development of hybrid vehicles, which contain an electric battery in addition to a petrol-driven engine and can run on either petrol or batteries alone or on a combination of both.[20] In 1997, Toyota Motor Company was first in the market with a hybrid, the Prius, initially sold only in Japan. In 2001, a newer model that corresponded to foreign consumer preference made exports to the US possible. Until the recent spike in oil prices, however, the takeoff in Prius sales in the American market depended upon tax incentives to buyers that bridged the price differential with comparable ICE models.

Once introduced into the American market, the hybrid vehicle changed the rules of the game for other car manufacturers. Able to meet emissions standards of the future, with the performance characteristics of pure petrol engines and the advantage of substantial fuel economy, the Prius became the car to beat. Within a year, Honda's version of a hybrid went on sale in the US and was followed by Ford and other car manufacturers who are carrying out research on new hybrid technologies and developing new hybrid models for their existing product line. Purchasers of hybrids currently receive tax incentives of between USD 2,000 and USD 3,600 for the Prius and seven other hybrids made by these three manufacturers. Wedded to heavy, gas-guzzling Sport Utility Vehicles (SUVs), for which no tax penalties have been put in place, the emergence of hybrids seemed like a godsend in a period of rising oil prices. Over the past two years, however, "Consumer Reports", a product-rating publication, tested 303 vehicles in real-life town and motorway driving and found that

nine out of ten of them failed to achieve the fuel efficiency claimed for them in tests by America's Environmental Protection Agency (EPA). "In some cases, the shortfall was as high as 50% and the worst offenders were the hybrids." (Economist, 2006.) Nevertheless, new firms are entering the hybrid market, especially for SUVs.

Because hybrids burn less gasoline in the stop and go conditions of urban driving, they are cleaner than internal combustion engines, but should incentives for the creation and diffusion of hybrid vehicles be encouraged and, if so, how should these products be treated in international trade? From among developing countries producing and exporting cars, car parts and components, none currently has the capacity to participate in the production or trade in hybrid vehicles, parts or components.

A fifth option introduced in Brazil several years ago and now being promoted within the European Union, replaces the petrol engine with a flexible fuel engine that can function using any number of different types of fuels including petrol-biofuel blends as well as 100 percent bio-based fuels such as ethanol. In Brazil, the engine's development was subsidised by public sector funds. By 2004, there were 1.3 million flex-fuel vehicles on Brazilian roads out of 22 million light vehicles (ANFAVEA, 2004). Although this is not a totally "clean" technology, when operating on 100 percent ethanol produced from sugar cane juice as in Brazil, the engine produces low emissions affording a drastic reduction in atmospheric CO2 and produces no particulates or SOx. It does, however, produce NOx and aldehydes similar to the levels in petrol powered engines (Teixeira et al, 2006). Variations on the biofuels that can be used in these engines as well as further research on such fuels, however, is likely to reduce these emissions. The utility of this option for developing countries in the short- and medium-term is enhanced, moreover, by the support this approach offers to the sustainability of the fuel input process from an economic, social and environmental perspective, a point to which we will return in the discussion on dual use products in Section 4.3.

In the longer-term there is yet a sixth option, the possibility that hydrogen fuel cell vehicles, in which the petrol engine is replaced by a hydrogen fuel cell, will become commercially available over the next 15 to 20 years. Hydrogen fuel cells reverse the long known process of electrolysis, which uses energy to split water into its components. Instead, hydrogen fuel cells combine hydrogen and oxygen thus generating an electric current. In the proton exchange membrane (PEM) fuel cells that are the current focus of research in applications of this technology in the transport sector, the process is electrochemical and involves an ion exchange polymer membrane as the electrolyte and electrodes of a fine metal mesh on which a platinum catalyst is deposited. The PEM fuel cell can thus convert hydrogen directly into electricity without combustion or moving parts making hydrogen fuel cell vehicles virtually pollution free.

The overall utility of hydrogen fuel cell vehicles in reducing greenhouse gases globally, however, depends upon the way the hydrogen itself is produced. If this takes place through renewable processes that are carbon-neutral, such as coupling wind power to electrolysers that split water molecules into hydrogen and oxygen, a technology currently being tested at hydrogen re-fuelling stations in Toronto and Amsterdam, for example, or through "clean" electricity to the home, the overall impact will be significant. Liberalised trade in such goods and in the related design and maintenance services would likely stimulate their use for both stationery power and transportation. Unlike most of the currently available options, hydrogen fuel cell vehicles are an environmentally "clean" product[21] from the standpoint of air pollution. Moreover, the fuel can be produced by a clean and renewable process.

As a step in this direction, a number of car manufacturers, Toyota, for example, are working to develop hybrid vehicles that keep the batteries but replace the petrol engine with a hydrogen fuel cell. Movement in this direction is accelerating. At the Los Angeles auto show in

November 2006, Ford, which is testing a fleet of 30 hydrogen fuel cell powered cars, introduced a prototype hybrid SUV that uses a 60 kW Ballard Power Systems fuel cell plus a 50 kW battery and has a range of 350 miles.[22] The prototype is one of a series of fuel cell vehicles partially funded by the United States Department of Energy. In contrast, Honda announced in January 2006, that it expects to begin commercial production of its fuel cell FCX vehicle within the next three to four years and Daimler-Chrysler has been testing its fuel cell bus in a number of large cities around the world for the past several years. Among developing countries, China has built its first fuel cell bus and through a partnership with Ballard Power Systems, anticipates having 10 to 20 of these operating in a testing and demonstration programme in Shanghai within the next few years.

Although infrastructure for the delivery of hydrogen to fuel cell vehicles is not widely available, oil companies see the new technology as being phased in gradually and several of these have already embarked on building refuelling stations in areas where there are strong incentives to move into a clean technology. With the exception of Brazil, China and India, however, most developing countries have little knowledge about this emerging technology and would be ill-prepared to benefit from it in the absence of capacity building efforts.

As the above illustrates, with the possible exception of hydrogen fuel cells that represent a clean technology and might lead to the production of a clean vehicle, most of the efforts under way will produce a "cleaner" technology. These efforts are stimulated as much by competitive pressures and the currently high price of petrol, as by environmental concerns. Even then, however, there are some significant differences between these initiatives from a longer-term innovation perspective. Initiatives that preserve the internal combustion engine or carbon-based fuels such as oil and natural gas (Methanol) are focusing on short-term goals that maintain our existing petroleum-based consumption patterns. Others, that replace oil and gas with renewable sources or carriers of energy (bio-fuels and hydrogen) shift the technological trajectory in a more positive direction but would require further analysis as they may have negative social and environmental impact in the future. Moving forward on this issue would thus require careful consideration of our longer-term goals and the development of a methodology that would keep these in focus. Participating in this new wave of technological change would also raise the issue of technology transfer and capacity building in developing countries as a means to ensure the broader global benefits of reducing greenhouse gases. The public good element in ESTs is thus central to the positive outcomes of EGS negotiations.

4.3 The Goal of Negotiations on Environmental Goods and Services

The current EGS negotiating focus in the WTO is on market access. From this perspective, the question of how one would distinguish purely economic objectives or company strategies from the broader goal of environmental sustainability looms large. This was also the question posed by the OECD in its first attempt to define and delimit the environmental industry in 1992 (OECD, 1996; WTO, 2003b) and the answer was to provisionally exclude cleaner technologies from the list. However, should such a distinction necessarily be made if environmental sustainability contains an element of a public good and any contribution to it should be encouraged?

The European Commission (EC) posed the issue somewhat differently. Instead of accepting the creation of pollution as inherent in an industrialisation process and thus focusing on ways to monitor, reduce and clean it up, the EC sought to encourage the movement, then gaining ground, for a reduction in pollution through more transformational technological changes. Its definition of eco-industries thus includes "cleaner production" technologies. Neither approach, however, takes into consideration the needs and interests of the parties in either the short- or long-term. This is a particularly serious problem for developing countries where new

technologies will require considerable effort at domestic capacity building.

Even the Asia-Pacific Economic Cooperation (APEC) negotiations, which attempted to take some of the needs and interests of the parties into consideration by calling for the nomination of products by harmonised systems codes from a list of sectors comprising environmental goods along the lines specified in the OECD list for Early Voluntary Sectoral Liberalisation (EVSL), did not deal with technology transfer as a basis for negotiating the selection of the final list of goods. The only move towards the introduction of a measure of flexibility in the APEC approach came in the attempt to respond to the "product-specific concerns raised by individual economies in each sector…" by allowing for a delay in the elimination of some tariffs "until 2005 for a small number of products, or by 2007 in the case of developing economies." (WTO, 2003b.) In terms of capacity building, a short time span such as this would have made little, if any, difference for developing countries. Even then the process could not be brought to a successful conclusion.

Two important points emerge from the above discussion. First, in a "development round" a multi-goal perspective is critically needed. Second, from a negotiating perspective, the public goods aspect of clean or even cleaner technologies is an important point of departure in the design of a multi-goal oriented negotiating process since it brings together a set of economic and environmental goals that might be achievable simultaneously. Being clear about the goals of negotiations on EGS, moreover, is a priority issue in widening or narrowing opportunities for technology transfer that might contribute to learning, the building of supply capacity and the ability to innovate in the production of environmental goods and thus sustain exports. If the goal of negotiations is simply to expand trade in a set of products designated as "environmental goods", as is current practice in the "list approach", opportunities for technology transfer of this sort would be narrower than if the intent is to expand trade in EGS "with the objective of sustainable development" and with a view to ensuring "that developing countries… secure a share in the growth in international trade." (Marrakech Agreement: Preamble.) The public goods element in environmental goods and the objective of sustainable development through trade are what distinguish EGS from other traded goods.

Both India's environmental project approach and Argentina's proposal for a combination of the EPA and list approaches come closest to establishing sustainable development as the goal of negotiations on environmental goods and services. Of the 16 countries on record, however, 10 had submitted lists and only six had expressed support for an EPA and an integrated EPA/list approach (Yu, 2007). The latter group, however, included Argentina, Brazil, China, Cuba, India and Venezuela. Since the negotiations prior to the Hong Kong Ministerial meeting were focused on lists, the larger number of subscribers to the list approach might only reflect the interest of this set of 10 countries in participating in the process of establishing a list and not necessarily the objection to an approach which strengthens the contribution of trade in environmental goods and services to sustainable development. A closer look at variations in the way a multi-goal approach could be incorporated into EGS negotiations is needed.

4.4 Dual Use Products: Bringing Sustainability Back In

The issue of dual use products has received far more attention in regard to manufactured goods than agricultural commodities. The former have the potential to be used for military purposes or are often generic inputs into a final product, for example, pipes used in a water-treatment plant or tires used on hydrogen fuel cell vehicles. Can products such as these be considered environmental goods?

In their negotiations on environmental goods and services, APEC member countries were

particularly sensitive to the "dual use" issue. They reasoned that, while some items might have a use, even an important use, in an environmental context, they might also be used in other industries, with the result that the effects of tariff liberalisation would not be limited to the environment sector (WTO, 2003b). The large number of manufactured goods from the industrialised countries that might qualify for "environmental goods" treatment in market entry negotiations would intensify the pressures for survival facing the smaller firms in developing countries and render more difficult new local entrants who lack the size and years of moving up the learning curve and down the price curve that exporters from industrialised countries have enjoyed. A development-oriented approach that seeks to ensure the meaningful integration of developing countries into the international trading environment must take such concerns seriously.

While maintaining the "list principle", there are possibilities to create a more rational, multi-goal oriented set of criteria for determining environmental products. One way might be to define environmental products as those that meet at least one of the following two criteria: either they are clean products in an environmental sense, that is, they produce zero emissions or are biodegradable, for example, or they are made by a clean process. The latter might include using a clean energy source and renewable inputs, or involve the reuse of its wastes in co-generation or in the production of by-products. If we follow this "alternative" approach, neither pipes nor tyres could be classified as an environmental product or be given a special trade status as an EPP, if it were not a "clean" product or made with a "clean" process, each of which would have a number of agreed upon determinates.

Movement in this direction will produce a far shorter list of tradable goods and services but one that provides a trade incentive for innovation into clean and renewable technologies and products. It also has the potential to encourage "project-oriented" strategies that reduce air pollution through the introduction of cleaner and more sustainable technologies in developing countries. For example, using the concept of special and differential treatment, developing countries could be stimulated to implement programmes for the transformation of existing goods into cleaner products by allowing the inclusion of such goods on a list for EVSL by developed countries. This would create an incentive for the transfer of technology to accelerate this process, stimulate the use of the CDM mechanism for this purpose and thus benefit both developing country exporters and developed country importers.

Lowering the level of pollution and creating environmental sustainability are key long-term goals embedded in the above definition. Its use would reduce the large number of products that could qualify for "environmental goods" status, not on protectionist grounds but to favour longer-term environmental goals and reinforce a move away from the "use up" and "clean up" approaches that have characterised the technology pathway and pattern of consumption in much of the developed world since the industrial revolution. For example, both APEC and OECD lists that deal with air pollution are mainly post hoc management oriented (clean up). They include air handling equipment, catalytic converters, chemical recovery systems, separators/precipitators, scrubbers and odour control equipment. Sustainable solutions to transport sector pollution are not dealt with under this category and only slip in under management, heat and energy savings, which again features catalysts along with heat exchange units, fuel other than oil or gas, electric cars and fuel cells.

Renewable energy is dealt with in terms of the energy source used in "plants". However, it does not distinguish plants that generate energy from environmentally polluting substances such as methanol, from those using sustainable and renewable sources of energy such as solar, wind, tidal or geothermal power. Furthermore, it does not differentiate renewable or carbon-neutral inputs, such as bio-ethanol made from sugar cane

or cassava, from carbon-based fuels, such as methanol (natural gas) whether produced from oil or coal. Although it also includes hydroelectric plants as an environmental product, it neither deals with the environmental damage created by large dams nor does it stress as EPPs micro-hydro installations or co-generation and stationary power units using hydrogen fuel cells.

In addition to the broader definitional issue, there are also a number of specific issues to raise with respect to dual use products in the agricultural sector. Two of these are particularly important. One deals with the proper venue for these negotiations and the other with their development impact.

With regard to the former, WTO negotiations on agriculture involve opportunities for trade-offs between tariffs and subsidies whereas EGS negotiations do not. In this case, should EGS negotiations be broadened to include the same opportunities for trade-offs as those available in the agricultural negotiating venue or, conversely, should agriculture negotiations be expanded to include agricultural commodities that also have the attributes of being important from an environmental goods perspective? Going beyond this either/or approach, there may be a substantially different way to deal with such issues, but this would involve broader rethinking of the structure of negotiations within the WTO.

With regard to the latter, adopting a "single use" criterion in environmental goods negotiations when dealing with agricultural commodities runs the risk of re-focusing agriculture in developing countries on monocultures and creating an incentive for research into dedicated crops. This would have a negative effect on development in rural areas by augmenting the vulnerability of farmers in the South to fluctuations in the market for which the particular variety that they plant is dedicated. The absence of insurance schemes for farmers in the South increases the risk involved and may create a disincentive for farmers to move towards environmentally sustainable crops.

The triple use of cassava as a food crop, an input into animal feed and a renewable fuel in Colombia, is a case in point. In the domestic feed market, it must compete with large-scale mechanised production of cassava and cassava chips in Brazil as well as subsidised corn imports from the United States (Mytelka and Bortagaray, 2005). In the fuel market it could lead to the redevelopment of the sugar sector. However, encouraging small-scale farmers to move into higher value added markets, whether feed or fuel, will require an expansion of publicly funded research on the development of new varieties of cassava, new drying processes for feed and new fermentation processes for fuel. Rural development strategies that strengthen knowledge flows and provide other forms of support to smallholder farm cooperatives that produce dried feed inputs or the future cassava-based fuel plants would have to be developed. As oil prices rise, the production of biofuels in the developing world needs to be encouraged. Indeed, large numbers of developing countries are already considering this option. Technology transfer will be an important factor in their success.

4.5 Subsidies on Agriculture–based Biofuels: Where Should this Issue be Negotiated?

Related to the above is the question of how one can deal with tariffs on a clean technology/ renewable energy product from a developing country to the world's largest economy? More broadly still, where, within the WTO should negotiations on the issue of subsidies that affect a clean technology/renewable energy product be held, particularly when it is an agricultural product? This is the case of "bio" ethanol produced in Brazil and exported to the United States.

Bio-ethanol was first produced in Brazil during the 1970s. It was developed as part of a multi-

goal strategy to support the use of renewable energy sources and reduce dependence on gasoline imports. The data suggest that while sugar-based ethanol, when first developed, was highly subsidised in Brazil, the disappearance of the domestic market in the wake of a sharp decline in oil prices led to the elimination of subsidies on the fuel and their use to develop a flex-fuel engine that can run on a wide variety of fuels. It is not clear whether purchasers of flex-fuel cars receive a tax incentive similar to that used to stimulate the purchase of hybrids in the United States.

Brazil currently produces more ethanol than any other country except the United States and is the largest exporter of fuel ethanol. In the 2003-2004 crop year, 12.5 billion litres of ethanol produced from sugar cane juice were consumed in the domestic market and 0.7 billion litres were exported. Sugar cane plantations are spread over some 5.6 million hectares in Brazil (Teixeira et al, 2006). "According to Leite (2005) Brazil can increase its production of ethanol ten-fold by utilizing only 30% of available arable land of 90 million ha that can be utilized with low environmental impact." (Teixeira et al, 2006.) How much environmental impact there would be from such an expansion in sugar cane production, however, is subject to debate and Teixeira himself has pointed to the greater environmental, economic and social sustainability of moving towards a more decentralised and multi-input bio-fuel such as biodiesel which would strengthen the smallholder sector.[23]

Moving to the production of biofuels locally, however, is not as efficient a solution for energy problems in many other countries, because of the low efficiency of photosynthesis and the low energy balance in the production of biofuels from other organic matter. In the case of Brazil, for example, the "energy balance from ethanol produced through fermentation of sugarcane juice is 700%. In contrast, ethanol production from corn affords only 20% more energy than is used to produce the alcohol." In addition, the co-generation of electricity from sugar cane bagasse has made progress in recent years, thus reducing the costs of production (Teixeira et al, 2006). Support for research and development activities locally and capacity building through technology transfer can lead to improvements in the energy balance in other developing countries.

Reports on the level of subsidies that affect ethanol production are contradictory and need to be verified by further research. But most sources confirm that Brazilian ethanol costs less to produce than ethanol distilled from corn in the United States and that subsidies have been eliminated. Brazil exports to the United States, where ethanol production from corn is subsidised. Yet Brazil's exports to the United States face import duties of USD 0.54 cents a gallon.

Agricultural subsidy issues are already under negotiation but the subsidy process is a cross-cutting one that also affects agricultural products whose end use is environmental. Separating negotiations on agricultural products from their potential use as environmental goods and from the effects of subsidies on both, is to limit the opportunities for trade-offs and allow the broader development issues of flexibility, special and differential treatment, technology transfer and capacity building to slip off the negotiating table. Dealing with these issues in trade negotiations will require the development of a negotiating space in which differences across negotiating venues can be harmonised.

4.6 Policies and Practices to Foster Technology Transfer and Build Domestic Capacity

Section 2 discussed some of the characteristics of new forms of two-way partnerships with domestic as well as foreign partners and new innovation-oriented FDI strategies and policies designed to create incentives for the kind of technology transfer that contributes to building

domestic capacity. These policies and practices require action at the national level and are all well within WTO rules and disciplines. This, however, does not mean that they are widely practised.

In the case of foreign direct investment (FDI), for example, remarkably few developing countries have made a concerted effort to introduce such policies and practices. Worse still, competitive pressure to attract foreign investment through fiscal and financial incentives and the offer of a low wage labour force creates disincentives for smaller market developing countries to pursue such avenues on their own. Interestingly enough, this problem also affects developed countries. Regional policies that reduce such "beggar-thy-neighbour" approaches might be one mutually advantageous solution.

The attraction of FDI and the creation of partnerships that open opportunities for technology transfer and capacity building would also benefit from a large number of policy options, many of which have been adopted by developing countries that practice a conscious strategy of technological mastery. Among the most common policies are those aimed at strengthening the requisite knowledge base, putting in place policies to stimulate learning and innovation and the support structures needed to sustain these processes and creating space for start ups to emerge and small- and medium-sized enterprises to grow. Costa Rica (in environmental protection), Singapore (in pharmaceuticals) and South Africa (in the energy industry) are among a number of developing countries that are successfully implementing such strategies. Many developing countries, however, do not have the resources to implement them. Currently there are few international treaties that contain provisions and the financing needed to promote movement in this direction.

CDM projects and the South African automobile industry: What can we learn from them?

The clean development mechanism is the primary technology transfer vehicle of the Kyoto Protocol, yet it is not focused on the transfer of technology but on emissions. It got off to a slow start because of the difficulty in meeting the criteria for project approval, particularly the requirement that the project shows "additionality". This necessitates the carrying out of a baseline survey against which to benchmark reductions in emissions. A study of CDM projects carried out in 2005 drew the conclusion that, although sustainable development criteria have been developed by Designated National Authorities in developing countries, "…CDM meets their needs for sustainable development only slightly. Currently, a large share of CDM is HFC deconstruction and methane recovery projects." (Sugiyama, Yamaguchi and Yamagata, 2005.)

Under the CDM, it is possible to earn credits for not harvesting timber because forests are a carbon sink. The mechanism thus creates an incentive for an industrialised country to protect a forest in a developing country in order to earn such credits. The consequences of this are threefold: foregone revenue losses to those in the developing country concerned that result from not harvesting trees; little or no transfer of technology whether embodied in products or as knowledge transfers and capacity building, and incentives to companies and consumers in the North to maintain consumption habits and practices which lead to an increased use of hydrocarbon based fuels and processes rather than a shift to alternatives. Partnerships such as these are "lose-lose" relationships.

Yet there can be partnerships where learning and capacity building do take place. In Section 2.3 these were discussed as "two-way" partnerships. Innovation-oriented FDI strategies and policies were one way to achieve this. The automobile industry in South Africa illustrates these possibilities and their relationship to the EGS negotiations.

In the post apartheid period, government incentives were redirected to encourage exports of automobile parts and components as well as assembled vehicles. Considerable new investment in vehicle assembly took place.

Toyota, which holds a 23.6 percent share of the domestic market, expanded its production capacity, upgrading plant and equipment to meet internationally competitive standards. Through its joint venture with Cataler Corporation of Japan, catalytic converters were then produced for use in Toyota's products in South Africa and the aim is "to become the fourth source of exhaust catalysts for the Toyota global manufacturing network (Hartzenberg and Munadzikwa, 2002). Volkswagen, which holds a 22.6 percent share of the domestic market, also upgraded and expanded production. It now exports the Golf 4 to Europe (Hartzenberg and Munadzikwa, 2002). Daimler Chrysler, Ford and BMW have moved in a similar direction. Exports of automobile and car parts have thus expanded dramatically from USD 121 million in 1988 to approximately USD 2.45 billion in 1999 (Hartzenberg and Munadzikwa, 2002).

What is even more impressive, however, is the role that tacit knowledge transfers have played in the technology transfer process. Recent research involving interviews with a large number of firms in the South African automobile and car parts industry, suggests that a key factor in the expansion of this industry is the nature of inter-firm linkages. These, using the categories introduced in Section 2.2 are "two-way partnerships" in which assemblers "…consult with their suppliers when designing new products". This includes consultations on product design and product specifications as well as the provision of technical assistance to suppliers by their customers, which has helped to improve quality (Barnes cited in Hartzenberg and Mundadzikwa, 2002).

The question now is whether the South African industry can take the next step forward and build hybrid vehicles. These have been on the road for nearly a decade, but only China has a commitment from Toyota to build a hybrid assembly plant in that country. Local production of hybrids provides a set of learning opportunities for those developing countries that have a programme to master imported technology and thus can learn about the electric batteries and drive trains that will be part of future electric and hydrogen fuel cell vehicles. An innovation-oriented FDI strategy is clearly needed here, but so, too, is the willingness of firms in the North to transfer EST.

4.7 Developing Country Exports of Environmental Goods and Services

Most developing countries, however, participate little in the growing trade in EGS. Based on the OECD list, global exports of EGS in 2002 amounted to some USD 238 billion. The size of the global environmental industry (as distinct from exports) was an estimated USD 607 billion in 2005. Of this amount, the United States, Japan and Western Europe accounted for 84 percent (Yu, 2007). Most developing countries that export EGS do so across a very limited range of products. In 2001, Chile, for example, exported USD 438 million worth of environmental goods and services. This amounted to about 2-4 percent of Chile's total exports. "Some 85% of the export value was accounted for by just one product: methanol." (Kennett and Steenblik, 2005.) Methanol, however, is not a carbon-neutral (clean) or renewable fuel since it is made mainly from natural gas. Kenya exported "…efficient wood stoves…mineral water and even wild game harvested from sustainably run ranches." (Kennett and Steenblik, 2005.) Other studies identify items from among the core list of environmentally preferable products (Class B EGS) as being of particular export interest to developing countries. These would include biodegradable natural fibres, such as jute or sisal, natural dyes, natural rubber, ethanol and other clean/renewable fuels (Hamwey, 2005).

The issue here is the limited use to which developing countries can put market access given the range and quantity of environmental goods they export and the relatively important gains that will accrue to the small number of industrialised countries that currently account for the bulk of environmental goods exports. This is acknowledged in a recent OECD Trade

and Environment Working paper in the following terms.

"For importing countries, fewer and lower barriers to trade in EGS can translate into greater access to the most efficient, diverse and least expensive goods and services on the global market. For exporters, liberalisation can create new market opportunities and spur development of globally competitive industries dedicated to environmental improvements (e.g., via technology development or diffusion) (Kennett and Steenblik, 2005)."

This nicely sums up the problem for developing countries, if the EGS negotiations remain squarely focused upon market access. The current process casts these countries solely in the role of technology users whose main gain from EGS negotiations is to buy goods more cheaply from abroad. Yet this is something they could do in the absence of WTO negotiations by simply lowering their own tariff barriers unilaterally. What then is the value added from doing so through WTO EGS negotiations?

Industrialised countries depend upon further market opening to spur the growth of their environmental industry, deepen their knowledge base and generate net additions to current and potentially future wealth from these dynamic processes. They are the beneficiaries of multiple benefits. Clearly the gains are far greater for industrialised countries. What is the counterpart for all but a very few of the developing countries that have some capacity now to export EGS and the possibility of ramping upon production and exports in response to greater market access?

5 EGS NEGOTIATIONS: NEW OPPORTUNITIES FOR TECHNOLOGY TRANSFER OR MORE OF THE SAME?

This paper has focused on the EGS negotiations at the WTO. It situated these negotiations within a context that has effectively narrowed opportunities for achieving development goals through EGS negotiations. That context largely ignores the emerging consensus, in both the business and the development literature, on the critical role that tacit knowledge plays in manufacturing. This has led to closer scrutiny of the distinction drawn between goods and business-related services in the General Agreement on Trade in Services (GATS) negotiations, on the one hand, and to a growing awareness of the need to include knowledge in technology transfer processes if the goal is to build the kind of capacity that enables developing countries to participate meaningfully in the international trading system. The Doha Declaration acknowledged that for all but a small number of developing countries, introducing a development dimension into multilateral trade negotiations would require active support for the diversification of the production and export base in these countries, along with the technical assistance and capacity building needed for a continuous response capability as tastes, technology and competitive conditions change. The context within which EGS negotiations have thus far been conducted, however, takes little account of the need to move beyond considerations of market access and thus to deal directly with these development concerns.

Is it realistic to have expected that the post-Doha WTO negotiating process would do more on the technology transfer front than had been the historical practice in this and other negotiating fora in the past? While the scope of this paper did not permit a systematic analysis of the accomplishments and failures of the multiplicity of technology transfer mechanisms proposed under various international agreements, it did provide illustrations of some of the impediments that persist and affect the transfer of ESTs: the difficulties in obtaining a licence for a CFC substitute in Korea; the problems associated with the transfer of publicly funded technology abroad, even when these are clean technologies with a potentially wide, globally important positive impact; and the limited transfer of technology to developing countries and the incentives it gives to producers and consumers in developed countries to maintain current patterns of ”use up” or ”clean up” that do not promote the development of ESTs. In view of these precedents, it would be unwise to expect that current EGS negotiations in the WTO can move things forward more rapidly than in the past, particularly in view of the narrowness of the negotiating mandate and its failure to reflect the evolution of thinking about the process of technology transfer and its goals.

Curiously, the business world has been more realistic than negotiators at the WTO. Even when plant design, construction and start-up, whether as turnkey projects or joint ventures, were largely in the hands of foreign consulting firms, contractual agreements were often signed for management and technical assistance, thus acknowledging the fundamental importance of tacit knowledge in the use of products and the operation of processes. This coupling of machinery purchases and the construction, operation and maintenance of production processes with technological, management and marketing services has particular relevance in the EGS negotiations. In this sector, goods and the tacit knowledge required for their design and operation, often embodied in services, are closely linked. Re-conceptualising the technology transfer process to include tacit knowledge and capacity building opens an important pathway towards learning and innovation through which participation in international trade can be sustained. In this sense, introducing the issue of technology transfer will, also, be essential in future development-oriented negotiations within the WTO, whether the venue is agriculture, the Negotiating Group on Market Access for Non-Agricultural Goods (NAMA), GATS, the Agreement on Trade-related Investment Measures (TRIMS), TRIPS or EGS.

In July 2006, trade negotiations at the WTO came to a halt primarily as a result of deep divisions among the Members over agricultural subsidies. They did not resume again until February 2007 following a series of informal discussions. It is unclear whether EGS negotiations formed part of these discussions, but the number of unresolved issues in these negotiations remains significant. In addition to the importance that a re-conceptualisation of the technology transfer process has for the success of the Doha Development Round as a whole, there are still other aspects of the mandate and process of negotiating trade in EGS that need to be rethought from the broader technology transfer and development perspective outlined above. First, although Paragraph 31 recognises the distortions that result from subsidies, EGS negotiations and negotiations on the subsidies that affect trade in environmental goods and services are not being conducted in parallel. Second is the need to deal with the issue of clean vs. cleaner products and processes. The decisions taken with respect to the designation of specific EGS for trade liberalisation will affect the choice sets that shape future R&D decisions among producers of both agricultural and manufacturing goods. At issue is whether the EGS negotiations create incentives for a longer-term view or reinforces the current short-term perspective and, in this context, whether the process encourages the adoption of a single or multi-goal orientation. Currently, it does the former. Third is the problem of dual use goods. This is particularly important in EGS, which have a "public goods" element to them and in agriculture, where they concern products such as biofuels that are already being exported. These are also clean technologies whose production should be encouraged as a means to reduce dependence on carbon-based fuels. In developing countries, production of biofuels would also help to deal with the development-related rise in greenhouse gases and other pollutants as the use of the internal combustion engine dominates urban transport and carbon-based fuels are used to satisfy growing energy needs. One cannot ask these countries to sacrifice development on the altar of global warming for which they cannot be held responsible. How then to proceed?

This paper approached these issues from a perspective that emphasizes technology transfer as a channel for learning and capacity building as a means to support sustainable development in both socio-economic and environmental terms. From that perspective, it drew the following four conclusions with respect to rethinking the EGS negotiations and the mandate and structure of WTO negotiations within which they are situated.

(i) Technologies that are both clean and renewable have a public goods element to them. Encouraging their production and trade creates global environmental benefits in the form of reduced greenhouse gases and other sorts of environmental damage. But for any given product or service, liberalised trade does not necessarily benefit all. On the contrary, from a development perspective, it is important to acknowledge that it can create both short- and long-term positive and negative effects. These depend upon the response capacity of existing production and innovation systems and the extent to which complementary measures are put in place to deal with these differences. Mainstreaming the concept of technology transfer as a process that includes a flow of knowledge as well as goods and opens opportunities for learning and capacity building in developing countries within all negotiating venues will thus be needed. This will require an active search within goods and services under negotiation for opportunities to introduce flexibility, special and differential treatment, technical assistance and technology transfer that promotes capacity building and enhances response capabilities. Although there was a lack of attention to the Working Group on Trade and Technology Transfer (WGTTT) at the Hong Kong Ministerial meeting and the Report of the Group on its work in 2006 showed a continued division among its members with respect to the kinds of ToT issues that should be discussed in the WGTTT (WTO, 2005), it might be useful for this Group, in the context of its existing mandate, to take up the task of identifying

areas within each of the negotiating fora where opportunities for technology transfer might be pursued. Along with the adoption of a multi-goal approach in negotiations within the WTO, the mainstreaming of technology transfer provides a key to both the successful completion of a "development" round and to the use of trade as an incentive for producers to engage in innovation that goes beyond short-term, palliative environmental considerations.

(ii) Much time has been spent in trying to establish lists of environmentally "cleaner products" and in debating whether to include EPPs in such a list. It might be preferable, therefore, to set a goal of achieving "clean" technologies straightaway. Clean technologies are simpler to measure and standards can be more easily defined, thus, paving the way for a "public goods" justification for the elimination of barriers to trade in such goods, provided that technology transfer enables developing countries to build their capacities to participate in the development, production and operation of such products and processes.

While maintaining the "list" principle, one might thus define environmentally preferable products as those that meet at least one of the following two criteria: either they are clean products in an environmental sense, that is, they produce zero emissions or are biodegradable, for example, or they are made by a clean process. The latter might include using a clean energy source and renewable inputs or involve the reuse of its wastes in co-generation or in the production of by-products. Movement in this direction will, in the first instance, produce a far shorter list of tradable goods and services but one that provides a trade incentive for innovation into clean and renewable technologies and products.

This approach, however, also has the potential to encourage "project-oriented" strategies that reduce air pollution through the introduction of cleaner and more sustainable technologies in developing countries. For example, using the concept of special and differential treatment, developing countries could be stimulated to implement programmes for the transformation of existing goods into cleaner products by allowing the inclusion of such goods on a list for Early Voluntary Sectoral Liberalisation by developed countries. This would create an incentive for the transfer of technology to accelerate this process, stimulate the use of the CDM mechanism for this purpose and thus benefit both developing country exporters and developed country importers.

Moreover, lowering the level of pollution and creating environmental sustainability are key long-term goals embedded in the above definition. Its use would reduce the large number of products that could qualify for "environmental goods" status, not on protectionist grounds but to favour longer-term environmental goals and reinforce a move away from the "use up" and "clean up" approaches that have characterised the technology pathway and pattern of consumption in much of the developed world since the industrial revolution.

(iii) Agricultural negotiations involve opportunities for trade-offs between tariffs and subsidies, whereas EGS negotiations do not. Yet is the answer to either broaden EGS negotiations to include the same opportunities for trade-offs as those available in agriculture negotiations or, conversely, to expand the mandate of agriculture negotiations to include agricultural commodities that also have the attributes of being important from an environmental perspective? More broadly still must the solution to problems such as these be conceptualised within dichotomous alternatives that narrow the range of choices? Perhaps there is a substantially different way to deal with such issues and from a development perspective strengthens

opportunities for the achievement of both environmental and developmental goals. This is of special importance in the present conjuncture where negotiators have failed to reach agreement on any of the Doha issue areas and it leads to the need for further reflection on the form that negotiating processes have taken at the WTO, particularly from a development perspective. For the most part, negotiating venues have tended to form separate groupings, each of which then focuses solely on the specifics of that particular issue with distinct negotiating groups emerging in each venue. Opportunities to build conceptual coherence across negotiating venues or reconfigure the set of trade-offs so as to enhance overall equity for developing countries and ensure the promotion of cross-cutting development and environment goals are largely absent. Creating a venue where this could take place would be a major new step for the WTO. A number of processes might be envisaged for such a venue. It could undertake to achieve these goals by operating as a review process that identifies and negotiates specific mechanisms or measures to promote development goals in any given negotiating venue or across several negotiating venues. Alternatively, it could use a "conference" process to harmonise approaches being taken in two or more negotiating venues. Cross-cutting goals such as those relating to development and to the environment are excellent candidates for such processes.

(iv) Although patents are intended to stimulate the creation of new knowledge and its use in production, current systems of IPRs offer only limited benefits to developing countries in this respect. Enhancing the possibility for the transfer of both tacit and embodied knowledge to developing countries, through the patent system, especially in areas with a potential to meet local development needs and global environmental concerns, would make a major difference. Efforts are currently underway to develop such an approach through, for example, partnerships in the development of drugs for neglected diseases in developing countries.

Another possible approach and one with broader import for environmental sustainability is the creation of a Knowledge Fund as a means to bring the benefits of learning and innovation to developing countries. The WTO, in collaboration with other international organisations, such as FAO, UNCTAD, UNEP, UNIDO, WHO and WIPO, could promote the establishment of a Knowledge Fund as the repository of patents dealing with technologies that are critical to the fundamental needs for food, drugs and environmentally sound technologies in developing countries. The Knowledge Fund would also be endowed with the financial resources to work with enterprises and the public sector in these countries in order to ensure that the tacit knowledge required to work these patents locally is also transferred.

Patent holders would be encouraged to deposit patents of utility to developing countries in the Knowledge Fund. Alternatively, the form of making those patents available to developing countries might include placing patents in the public domain or granting to these countries, automatic and royalty-free licences for patents listed with the Knowledge Fund.

Knowledge Fund staff, in collaboration with business support services in the developing countries, would collaborate in identifying possible economic agents for the working of these patents locally and support the transfer of tacit and codified knowledge needed to manufacture quality products efficiently. Local business support services would maintain contact with producers and provide ongoing support for productivity and quality improvements. The activities of the Knowledge Fund would be supported by a levy of USD 100 on each patent application made by a non-resident in a developing country.

ENDNOTES

1 The Rio Conference adopted, Agenda 21, an action plan for the 1990s and the 21st century aimed at realising a transition to sustainable development within the context of a global partnership for environment and development.

2 Work carried out at the United Nations University Institute for New Technologies (now UNU-MERIT), (Parto and Herbert-Copley, 2007), takes a similar approach in dealing with the issue of environmental regulation and industrial innovation in developed and developing countries.

3 In the early 1980s and with regard to technology in the North, it had already become quite clear that tacit knowledge and contextual factors shaped the efficiency and effectiveness with which machinery and production processes operated in industries such as machine tools (Noble, 1984) and automobiles (Womack et al, 1990).

4 Some aspects of knowledge are well articulated and can be codified into drawings and plans, written up in books and taught in schools. Others are largely tacit, learned in the course of doing an activity such as research or operating a machine. Transfer of tacit knowledge generally takes place through training and apprenticeship (Dosi, 1988).

5 The third quarter of the 20th century was marked by the introduction of ”new wave technologies”, such as information and telecommunications technologies (ICTs), biotechnology and its application in pharmaceuticals and agriculture and the technologies of the hydrogen economy. These technologies shared a number of characteristics – a base in scientific research, patent intensity and systems embeddedness that require a significantly different model of «catching up”. In these science-based technologies, tertiary education and research are needed from the outset, not only to engage in production but also for policy-making (Mytelka, 2004). Care must be taken, however, to avoid simply pumping up the supply of research without developing a strategy to stimulate its take-up in production, i.e., innovation. For a discussion of this point in the biopharmaceutical sector in developing countries, (see Mytelka, 2007).

6 The conventional literature associates innovation with the kind of activity undertaken by firms at the knowledge frontier. But innovation is much more than this and here will be defined more broadly “as the process by which firms master and implement the design and production of goods and services that are new to them, irrespective of whether or not they are new to their competitors – domestic or foreign (Mytelka, 1999).

7 Technology that is close to the frontier is rarely licensed to firms that are not vertically integrated with the patent holder and, when it is, the costs are high. Korean semi-conductor firms are said to pay up to 30 percent of their revenue in royalties (Dodgson, 2000).

8 See, for example, the discussion on the importance of reverse engineering in Korean manufacturing development (Kim, 2004) and in the emergence of India’s generic drugs industry (Acharya, 1999; Chaturvedi, 2002).

9 According to data from the World Bank World Development indicators database, in 2003, net inflows of FDI into Kenya amounted to only 0.6 percent of Gross Domestic Product. Obtained from www.worldbank.org.

10 On lead-free gas in the Islamic Republic of Iran, see UNCTAD, 2005. On the use of catalytic converters on cars sold in the domestic market, see Kari and Rasiah, 2006.

11 These included the Vienna Convention for the Protection of the Ozone Layer (1985), the 1987 Montreal Protocol on Substances that Deplete the Ozone Layers, the 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, the 1992 Convention on Biological Diversity, the 1992 United Nations Framework Convention on Climate Change (UNFCCC) and the 1997 Kyoto Protocol to the UNFCCC.

12 For example, see the Montreal Protocol, the Convention on Biological Diversity and the Clean Development Mechanism (CDM) under the Kyoto protocol to the UNFCCC. The Global Environment Facility (GEF) has been the source of additional revenues for the transfer of ESTs.

13 Eventually the technology was commercialised through the creation of an international consortium that included an American firm.

14 See Para 41 of the Doha Declaration, which provides a list of these.

15 See, for example, recent studies by Yarime, M. (2003). Office of Technology Policy and Parto, S. and Herbert-Copley, B. (2007).

16 For a similar conclusion from a different perspective see Chaytor, B. (2003).

17 See section 4.7.

18 This has led, amongst others, to the development of bus corridors in Curitiba, Bogota and Mexico City; the extension of the metro system in Cairo; the development of a regional public transport network (RER) in Paris; and light rail in the corridor linking Newark, Jersey City, Hoboken and New York City.

19 Leaving aside golf carts and other speciality vehicles, the other is a Chinese company, Shandong Jindalu, which recently began to export electric three-wheeled vehicles. A Norwegian firm, ElBil Norge, produces fewer cars than Reva and a French firm, Axiam, has only just begun production (Gentleman, 2006).

20 Latecomers to the market initially produced less efficient hybrids that could not run on electric power alone.

21 For more detailed information on HFCVs and alternatives see the “hydrogen fuel cell exchange”, obtained from www.unu.merit.edu.

22 Obtained from http://media.ford.com.

23 “Biofuels are also an opportunity for small communities to become self-suffient in energy. Attempts to substitute diesel by vegetable oils from Jatropha in power generators, grain mills or water pumps is already successful in some rural communities.” Jatropha oil can also be processed into biodiesel for the domestic or export markets or turned into soap. Unlike many other crops whose use as a fuel competed with its use as a food, “Jatropha is not suited for human consumption.” (UNCTAD, 2006.)

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