ICTSD Project on Trade and Sustainable Energy




Linking Trade, Climate Change and Energy

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FOREWORD

Climate change has emerged as one of the greatest threats to sustainable development. While a great deal of attention has been paid to greenhouse gas emissions from energy consumption, very little analytical work has been conducted to explore the impact of international trade flows on global warming and the role of trade policies and international regulatory frameworks as possible solutions. The International Centre for Trade and Sustainable Development (ICTSD) is proud to release this special collection of issue briefs addressing this emerging policy area, produced by ICTSD analysts and a wide range of other contributors on the occasion of the United Nations Climate Change Conference in Nairobi, held 6-17 November 2006.

The global economy is dependent upon oil and other fossil fuels, and this dependency (of producers and consumers alike) is fed through international trade. Weaning ourselves off carbon without causing economic dislocation poses a tremendous challenge. Governments must move quickly to make a rapid transition in the sources of energy on which we rely, whilst balancing social, economic, and environmental concerns.

Reversing global warming requires citizen action and corporate responsibility, public and private investment, and the implementation of effective regulatory regimes. Part of the good news is that, while in the past, the economy vs. environment debate has hampered progress on the environment, many policy-makers now realise that a concerted effort to ensure that economic activity is sustainable is the most cost-effective strategy. A consensus is emerging that technology innovation and transfer can play a major role in protecting the environment while fostering economic development, but achieving the right balance between private and public action is daunting.

Trade liberalisation and the mitigation of and adaptation to climate change are currently managed under separate and complex legal regimes. The integration of these regimes is essential to ensure that domestic and international measures to address climate change and the international trade system are mutually supportive. Infusing climate-friendly measures – including incentives such as climate standards, strategically targeted subsidies and liberalisation in environmental goods and services – within the various trade regimes could make a major contribution toward a sustainable energy transition, and climate change mitigation and adaptation.

This special collection of issue briefs begins with an introduction that summarises ICTSD's analysis of the key links between three broad areas that are too frequently addressed in isolation from each other: trade, climate change and energy. The second section explains more specifically some of the most important issues facing policy-makers concerned with international policy on energy and trade, including the specific circumstances in Asia and especially China. The final section focuses on bioenergy, looking both at the global picture and at experiences in Africa, Asia and Brazil.

The collection features a contribution by Ted Turner, a leader in the growing movement in support of clean energy and the chairman of the United Nations Foundation. We are also pleased to present other authors from a range of perspectives. Focusing on the potential of biofuels to simultaneously provide economic opportunity and reverse global warming, such new voices set the stage for the issues explored here.

All contributions represent the views of the authors, and do not necessarily reflect the official positions of the organisations with which they are affiliated.

Erwin Rose and Moustapha Kamal Gueye produced and edited this publication. Mr. Rose has served as a senior trade and environment negotiator for the United States. Dr. Gueye leads ICTSD's environment programme.

This collection builds upon work that ICTSD has initiated on the links between trade, climate change and energy. It inaugurates a new series on Trade and Sustainable Energy that will include publications that address a range of cross-cutting, regional and country-specific topics. We hope you will find these papers to be stimulating, informative and useful. We welcome your comments.

Ricardo Meléndez-Ortiz
Chief Executive, ICTSD

PART 1 EXPLORING THE LINKS

Trade, Climate Change and the Transition to a Sustainable Energy Future: Framing the Debate

Malena Sell
International Centre for Trade and Sustainable Development

In order to embark on the transition to a sustainable energy future – a future in which greenhouse gas concentration would be stabilized at a level that prevents dangerous interference with the climate system – governments and the private sector, civil society and international organisations must understand and address the challenges posed by developments in the global energy sector. Trade policy strategies must also deal with these processes in a comprehensive manner. Failure to manage the transition will not only lead to negative environmental, social and economic impacts, but could also result in political conflicts and violence as a consequence of power struggles over access to dwindling energy resources. The multilateral trading system will be directly and indirectly impacted by the transition to a sustainable energy future, and will in turn exert substantial influence on the necessary and far-reaching transition.

The changing energy landscape

Increasing energy consumption, driven particularly by the rapid growth of emerging economies such as China and India, as well as volatile and rising oil prices and growing concerns over energy security are forcing a re-alignment of the global energy sector. Patterns of investment and technology flows in this sector are shifting in response to the scarcity of reserves, fostering the emergence of new actors and new strategies in the energy business.

The International Energy Agency projects that energy demand and prices will continue to soar, with the world set to use 60 percent more energy in 2030 than at present. Renewable energies such as solar, wind, geothermal and modern biomass are on the rise, with wind power being the fastest growing energy source in the world. However, incentives and investments in renewables continue to be insufficient to forge a fundamental overhaul of the energy sector.

The entry into the World Trade Organization (WTO) of the oil-exporting countries, most notably Organization of Petroleum Exporting Countries (OPEC) members but also Russia and Central Asian countries, is also inducing structural changes to the trade and use of energy. With half of the world's oil reserves, the accession negotiations of these countries are in effect a bargain between energy exporters and importers. Their entry could mark a reduction in OPEC's strategic control over the current pricing and production trends of the oil industry and may prove significant for the international trade and use of energy. It may also have implications for how the WTO treats the environment, and thus may affect global action on climate change. Once the OPEC countries become WTO Members, they may lobby to have energy sources disciplined by WTO rules. WTO Members may therefore have to tackle head-on the issues of distinguishing between energy sources that emit high levels of greenhouse gases (fossil fuels) and those that do not (renewable energy).

Reducing greenhouse gas emissions must therefore be seen in the context of growing consumption demand, diversifying energy sources, economic growth in developing countries that is repositioning financial and political power, and a globalising economy that is in the process of transforming international trade patterns and therefore subject to unpredictable and new stresses that can have worldwide impact.

Global climate policy

Measures to address climate change under the United Nations Framework Convention on Climate Change (UNFCCC), especially after the current Kyoto Protocol commitments expire in 2012, will require fundamental socio-economic adjustment in production and trade across sectors and countries. At the global level, liberalising trade and the mitigation of and adaptation to climate change are currently managed under separate legal regimes. The integration of climate-friendly measures, including incentives such as climate standards and strategically targeted subsidies, within the multilateral trading system needs to be approached both strategically and comprehensively in order to be successful. Countries need to be able to enact trade policies that support the aims of the UNFCCC and Kyoto Protocol, i.e. that favour sustainable energy sources over fossil fuels. In doing so, they must also abide by their commitments under the WTO agreements.

The UNFCCC and the Kyoto Protocol can be aligned with WTO commitments in most cases. However, it is important to note that the UNFCCC does not mandate specific policies and measures but sets targets that countries must reach through their own policies. The climate change convention and the Kyoto Protocol state that these "should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade." Parties should further seek to implement these measures in ways that minimise adverse trade effects.

Other than the provisions for emissions trading, the Kyoto Protocol does not contain specific trade obligations. Some of the measures available to parties in the implementation of the Protocol, however, may have trade effects in certain cases: subsidies for renewable energy or research and development; carbon taxes; climate-friendly standards and labels for goods and services such as fuel efficiency in automobile engines; regulatory quotas on renewable energy use; and government regulations that favour products and processes that are environmentally preferable because they cause less harm to the climate.

WTO rules – through disciplines on subsidies, border measures, technical requirements, government procurement and taxes – determine the options that countries have to use economic and other regulatory tools. Therefore, it is also important for countries to actively pursue in trade negotiations the right to retain and expand the necessary policy space allowing them the flexibility to enact policy in support of climate change mitigation and adaptation.

Making the WTO work for sustainable energy

The Doha Round of trade negotiations – originally set to be completed by the beginning of 2005 – is currently suspended. This situation is not without precedent, as trade rounds often have been drawn-out affairs including periods of 'reflection'. As such, the suspension of trade talks provides a chance to evaluate opportunities to use the negotiations to ensure that multilateral trade rules support climate change policy. In addition, the ever-increasing regional and bilateral trade treaties among countries may also contain provisions that impact energy and climate policy.

Agriculture

The WTO Agreement on Agriculture and negotiations in this area will affect carbon management globally, and the overhaul of agricultural subsidies provides an opportunity to promote genuinely sustainable practices. The atmospheric carbon balance is significantly affected by agricultural land-use worldwide, and global production patterns are expected to change following trade reform.

If land is converted from forest to agricultural use, carbon is released to the atmosphere through fires and/or the loss of carbon-absorbing trees, which exacerbates the greenhouse effect. Agriculture does bind carbon in crops and soil, and certain practices do more to sequester carbon, such as no-till or low-till agriculture, use of shelterbelts and terracing of slopes. The promotion of practices that increase carbon sequestration could potentially be expanded following reform of the 'Green Box', which harbours environmental measures (although "Green Box" is a trade term that refers to permissible actions, not explicitly to the environment). The production of feedstock for bio-fuels – clean-burning, carbon-neutral fuels derived from agricultural crops that can be used to partially replace liquid petroleum products – also represents an emerging opportunity within agriculture.

Subsidies

Overall, subsidy reform suggests potentially beneficial outcomes; based on the experience in the agriculture and fisheries negotiations, the feasibility of disciplining energy subsidies in the WTO context could be explored.

The WTO subsidies agreement sets the ground rules for permitted subsidies in the trade context. Subsidies should not target exports, should be general rather than aimed at specific industries, and should not lead to discrimination against 'like' imported products. Examining the subsidies and other incentive schemes countries use or are planning to use to support renewable energy and energy efficiency, and ensuring that these are permissible within the WTO framework is an important exercise. A now-expired clause in the subsidies agreement specified that certain environmental subsidies were non-actionable. In current or future negotiations, countries may want to consider reactivating this clause due to future need for subsidies aimed to help reach climate objectives.

As countries choose different energy paths in the short to medium terms, some will be facing higher upfront costs. Countries taking on carbon reduction commitments may experience some negative competitiveness effects, and there have been some calls – among parliamentarians, for example – for the use of border tax adjustments (BTAs) to offset such effects with regard to countries that are not limiting their emissions under the Kyoto regime or under other future regimes. BTAs are controversial and are unlikely to come to the fore during the first commitment period. As both non-parties and parties to Kyoto prepare for the next phase of climate policy, discussions related to BTAs will become more important. So far, soft diplomacy and 'carrots' to encourage co-operation has been the prevailing tactic. However, 'sticks' such as BTAs might become part of the discussion at some stage.

Environmental goods and services

Negotiations on the accelerated liberalisation of environmental goods and services (EGS) with a view to phasing out tariffs and non-tariff barriers also have the potential to support the expansion of sustainable energy. Para 31 (iii) of the Doha Ministerial Declaration calls for "the reduction or, as appropriate, elimination of tariff and non-tariff barriers to environmental goods and services." Members have also agreed to reduce or eliminate tariff peaks, high tariffs, and tariff escalation, as well as non-tariff barriers, in particular on products of export interest to developing countries.

Increased trade in and dissemination of renewable energy technologies stand out in this regard. Three types of possible environmental goods leading to positive climate outcomes can be envisaged: low-carbon fuels such as ethanol or biodiesel; renewable technologies such as solar cells or wind turbines; or energy-efficient 'environmentally preferable products' such as efficient refrigerators. Some countries have also suggested that EGS could facilitate the improvement of thermal and environmental efficiency in the use of fossil fuels in industry and households, and could support the progressive shift from fuels with very high emissions to fuels producing lower climate impacts. As such, EGS can function as an incentive for innovation both for new energies and for new technologies to make better use of energy. The intellectual property regimes that affect the transfer of these technologies should be further explored to enhance technology transfer to developing countries, including aspects relating to both innovation and implementation.

Standards and labelling

At the WTO, the Agreement on Technical Barriers to Trade is the main instrument that deals with standards, technical regulations and labelling. The fundamental principle is that countries have the flexibility to set standards at their discretion – as long as these standards are not discriminatory, and do not cause unnecessary obstacles to trade. Exceptions apply for standards that fulfil legitimate objectives such as protection of the environment or human health. Standards should be transparently developed and applied, and notified to the WTO.

A more proactive and coherent approach to standards in both the climate and trade regimes could provide significant potential for effective climate solutions. The preference of the trade regime for internationally agreed standards provides the impetus for the climate regime to focus more on international consistency, and a move in this direction would make the two regimes more mutually supportive – the trade regime could become a forum directly supporting the implementation of climate change standards. In addition, for developing countries, standard-setting is closely related to value creation for products of export interest. Improved market access based on climate standards could be an important consideration.

Conclusion

Using WTO jurisprudence to guide their policies, and trade negotiations to advance their aims, UNFCC and Kyoto Parties can stake out the necessary policy space to give them the flexibility to reduce their greenhouse gas emissions. Parties are already hemmed in by a multitude of barriers: a rigid energy market, an entrenched set of actors resistant to change, a dearth of renewable energy technology, small economies of scale, and consumers habituated to fossil fuel-style footprints. Halting global warming will require innovative policies in the form of both carrots and sticks. The experience of Brazil and other leaders has demonstrated that government policy plays a far larger role in renewable development than financial or natural resources. Understanding the linkages between trade, energy and climate change offers great hope, but acting on that knowledge will require strong leadership and co-operation among governments and all stakeholders.

PART 2 ENERGY AND TRADE, POLICY AND POLITICS

Transition to a Sustainable Energy Future: Global Trade Rules and Energy Policies

Yulia Selivanova
Energy Charter Secretariat

With increasing economic globalisation, the issues related to international regulation of energy and natural resources policies are receiving a great deal of attention. Moreover, the economic growth and increasing geographical mismatch between demand and production have led to increased international trade in oil and gas. This makes a discussion of the relevance of World Trade Organization (WTO) rules to trade in energy extremely pertinent.

Energy resources are distributed highly unevenly around the globe. The Middle East is the world's largest oil-producing region and is expected to play an even greater role in the future.[1] Of the world's proven oil reserves, 69 percent was held by members of the Organization of the Petroleum Exporting Countries (OPEC) as of January 2005.[2] This dominance allows OPEC countries to influence the world oil price. Russia, Norway, Mexico, and Kazakhstan are the world's largest non-OPEC net oil exporters. In most major non-OPEC countries, governments generally have little control over production levels as oil sectors are owned by private companies, which react to demand signals, exploring and increasing extraction when prices are high.

The prevailing high oil prices encourage non-OPEC production of conventional and non-conventional oil. High oil prices are also likely to encourage the implementation of policies that reduce air pollution and greenhouse gas (GHG) emissions and enhance energy security. The higher the price of oil, the greater the likelihood that alternative energy technology development will be promoted. Some renewable energy technologies are close to becoming commercially viable, while others occupy niche positions. Although development of renewable energy technologies on a wide-spread commercial basis is not expected in the short-term, high oil prices and technological developments will increase the opportunities for such energy sources.

Oil-exporting countries are vulnerable to oil price fluctuations. A sharp decrease in the price of oil during 1998-1999 led many oil-exporting countries to begin economic reforms aimed at diversifying their domestic sectors and reducing their economic reliance on oil. Moreover, WTO accession has given an additional push for domestic reforms in energy-endowed countries.

Gas resources are more widely spread than oil. Substantial global gas reserves are located in the Middle East (34 percent), but also in Europe and the Former Soviet Union (42 percent). With higher transportation costs, natural gas trade patterns tend to be more regionally-oriented than for oil.

Energy-exporting countries are concerned about the security of demand or the security of revenue. They have therefore often expressed concern that high consumption and excise taxes imposed on energy products and materials by importing countries reduce their revenues. However, as long as these taxes are applied in a non-discriminatory manner, they are generally in line with WTO rules.

Energy and the WTO

Specific disciplines on trade in energy did not form part of the original General Agreement on Tariffs and Trade (GATT). One of the possible reasons for this is the initial non-participation of energy exporters. Moreover, the issue was heavily politicised due to the strategic nature of energy products. State energy practices affecting natural resources and energy have been sensitive and controversial issues. Security considerations greatly influence trade policy in the energy sector.[3]

During the Uruguay Round of trade talks, some countries attempted to include provisions that would reduce opportunities for exporting countries to impose restrictions on energy exports.[4] However, the attempts to negotiate such specific provisions were not successful because resource-endowed countries were apprehensive of binding rules on trade in natural resources.

It is, however, commonly accepted that WTO rules apply to energy products, although these rules are arguably not well-designed to solve some trade-related problems in the sector. Traditionally, WTO rules have been devised to address import barriers more than export barriers. In energy trade, however, restrictions apply more to export barriers. Concerns over security of energy supply generally lead to relatively low import duties. At the same time, export duties on energy materials and products constitute an important source of revenue for energy-exporting countries. Furthermore, existing multilateral trade rules do not substantially address the issues related to restrictive practices of monopolies dominant in the energy sector, nor do they help resolve transit-related problems.

WTO rules, energy and climate change policies

The impact of energy use on the environment makes promotion of energy efficiency an important issue, especially following the obligations of some countries under environmental agreements, such as Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCC). The implementation of climate change policies, including support of renewable energy and certain types of taxation, raises the question as to how these measures need to be implemented so as not to be in conflict with WTO rules.

Therefore, a new policy concern has arisen: how policies to combat climate change can be affected by the WTO. Article 3, paragraph 5 of the UNFCC states that: "Measures taken to combat climate change, including unilateral ones, should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade." The Kyoto Protocol provides that its parties "shall strive to implement policies and measures …in such a way as to minimize adverse effects, including… effects on international trade" (Article 2).

WTO rules and disciplines that can affect energy and climate policies include taxation, border adjustment measures, subsidies and rules on technical regulations and standards. Financial support to producers of renewable energy might fall under WTO subsidies rules. Furthermore, energy taxes and all domestic laws and regulations should not be applied in a discriminatory manner. Technical regulations and standards to promote the efficient use of energy should be non-discriminatory and cannot constitute unnecessary obstacles to trade.

Energy taxation

The WTO national treatment requirement exists with respect to internal taxes and charges, laws and regulations treatment. Internal taxes for imported energy material and products must be no higher than those for domestically originated 'like' energy material and products. Carbon dioxide and energy taxes can be applied directly to fuels, to electricity and downstream industries that use energy as input – on the basis of the amount of carbon dioxide emitted or energy consumed in their production.[5]

The WTO dispute settlement system has dealt with environmental taxes. Firstly, the European Commission (EC) challenged the United States' tax on automobiles. The measure was introduced to create an incentive to purchase more fuel-efficient cars. Because most cars affected by the measure were European, the EC claimed that the tax was inconsistent with Article III: 2 of GATT. However, the Panel found that fuel-inefficient imported cars were not like fuel-efficient domestic cars, and could therefore be treated less favourably.

A crucial question arises as to whether countries could discriminate between energy goods and materials on the basis of the technologies used in their production. They might wish to impose lower taxes on goods and materials that have been produced using environmentally friendly technologies. This question is especially complicated if final goods possess identical physical characteristics and have the same end-use, e.g. electricity generated by nuclear power or renewable sources.

Border tax adjustments

When states with high standards of environmental policies impose high energy taxes, the energy-intensive products produced in these countries become less competitive compared with foreign products that are not subject to such regulations. Therefore, these countries might sometimes choose to refund these taxes to companies upon exportation. In addition, governments might wish to impose additional taxes on imports of products from countries that do not adhere to such high levels of environmental protection.

WTO rules do not clearly define the eligibility of some border tax adjustments. Under the Agreement on Subsidies and Countervailing Measures (SCM), prior-stage cumulative indirect taxes can be exempted at the border when levied on inputs that are consumed in the production of the exported product, i.e. inputs that are physically incorporated, energy, fuels and oil used in the production process.[6] The adjustment does not pose a problem when it is an energy tax on the product itself which is being levied or reimbursed at the border, such as a tax on an energy material or product.

Opinion is divided however on whether border tax adjustments are permitted under WTO law for taxable inputs that are not physically incorporated in the final product. For instance, it is not clear if a tax on carbon dioxide emissions during production can be adjusted.

Subsidies

Subsidies can be used by states to promote certain energy efficient methods of production. Considering that some renewable sources are not currently commercially viable, the question of using different support schemes for renewable energy is important.

Such programs cannot be contingent upon export performance (or they will fall under the category of prohibited subsidies). If such subsidies are found to be specific to certain enterprises, industries or groups thereof, they would be considered actionable and products benefiting from such subsidies can be countervailed. Alternatively, a WTO Member can request a withdrawal of such subsidies if they cause adverse effects.

Limiting the subsidy to producers of renewable energy would possibly meet the criteria of specificity. For instance, if the government decides to grant financial support to energy production plants using renewable energies, this program would be deemed specific, i.e. an actionable subsidy.

The question then arises as to how to design programs aimed at attaining environmental objectives without the associated financial support being considered an actionable subsidy. A possible solution might be to devise objective criteria or conditions governing the eligibility for, and the amount of, a subsidy, make eligibility automatic, and monitor to ensure that such criteria and conditions are strictly adhered to. Such criteria and conditions must be transparent and clear. For instance, possible criteria could be a certain level of carbon dioxide emissions during the production process. Although it is possible to devise programs encouraging energy-efficient use in general, attempts to directly support renewable industries are more likely than not to fall into the category of actionable subsidies.

Technical regulations and standards

Technical regulations and standards are important tools to increase the efficient use of energy and reduce GHG emissions.[7] Most countries belonging to the Organisation for Economic Co-operation and Development (OECD) use voluntary labelling to promote energy efficiency and reduce emissions. For instance, the Nordic Swan labelling scheme sets criteria for oil burners. The EU proofs-of-origin schemes for electricity from renewable sources are mandatory and constitute a technical regulation. Many technical regulations are related to the transportation of energy products.

The WTO Agreement on Technical Barriers to Trade prohibits discrimination through technical regulations. Moreover, technical regulations, standards and conformity assessment procedures should not create unnecessary obstacles to trade or be used as protectionist tools. The requirement of non-discrimination is applicable in relation to 'like' products. It is not clear whether the differentiation between goods based on the efficiency of production could be a violation of WTO rules.

Conclusion

The WTO rules fully apply to trade in energy products and materials, although they were not specifically designed to tackle energy-related issues. Policies related to energy need to be reconciled with environmental and climate change objectives. The UNFCCC and Kyoto Protocol create the framework within which their parties devise their own domestic policies. These policies need to be in line with countries' multilateral trade commitments. In general, multilateral trade and climate change frameworks are mutually supportive. The main issue, however, lies in the way in which countries implement their climate change policies. Measures such as support programs for renewable energy, energy taxation and technical regulations related to energy need to be implemented in ways that would not result in a conflict with WTO rules.

Energy Efficiency Standards: Benchmarking and Options for Harmonisation

Paul Waide
International Energy Agency

This paper reviews product energy performance standards and labels as they apply to domestic electrical appliances and discusses their development and value. The paper explores the trade-offs involved in the use of product energy efficiency standards and labels to satisfy climate, energy and macro-economic objectives while minimising transaction costs to international trade. Finally, the paper discusses options to reduce unwanted trade barriers through increased harmonisation and benchmarking of requirements. The paper focuses on household and electrical appliances, which are produced and consumed both in industrialised and, increasingly, in developing countries. Cars, trucks and motors are also major consumers of energy, and vehicle fuel-economy regulations and motor performance targets have been established by several countries, but are not examined here.

Growing recognition of the importance and potential of energy efficiency

Public policy in a large number of countries belonging to the Organisation for Economic Co-operation and Development (OECD) as well as non-OECD countries clearly reflects a preference for energy-efficient goods. Such preferences are manifested through regulations that establish a minimum energy performance standard (MEPS) for household electrical appliances and office equipment, requirements to display labels indicating the relative energy performance of the good for sale, and voluntary labelling schemes that indicate certain goods as exhibiting a superior energy performance to competing products on the market. In 2005, some 57 countries, with a combined population of 4.4 billion, had energy performance standards or labels for one or more energy-using products, and many more countries were in the process of developing such schemes, while the scope of most existing schemes was also being enlarged.

Minimum energy performance requirements

Today virtually all OECD country governments regulate the minimum energy performance of at least one, and usually several, household energy-using appliances and types of office equipment. The most common approach is to impose mandatory MEPS, which remove the least efficient appliances from sale; however, some countries (most notably, the EU, Switzerland, Japan and Korea) have also used energy performance targets, under which manufacturers are instructed, or voluntarily agree, to attain some prescribed energy performance thresholds for their products. The prescribed energy efficiency thresholds may either be a minimum level that all products must meet or a sales- or production-weighted target level that products must attain on average. Among non-OECD countries, China, Chinese Taipei, India, Iran, Israel, Jamaica, Malaysia, the Philippines, Russia, Saudi Arabia, Singapore, Sri Lanka, Thailand and Tunisia regulate the energy performance of at least one household appliance. Many other countries, particularly in South America and South-east Asia but also in parts of non-OECD Europe, Africa and the Middle-East, are in the process of developing energy performance regulations for appliances.

Mandatory energy information labels

Most countries that regulate MEPS also require energy information labels to be displayed on the same products. The exceptions, as of 2005, were Chinese Taipei, Ghana and Saudi Arabia, all of which regulated MEPS but do not yet require energy information labels. Today, mandatory energy information labels are required by all OECD and EU member countries, and by a growing number (at least 14) of non-OECD countries, for at least one product, and more often for several. Typically, the main piece of information provided by a mandatory energy information label is the appliance's estimated energy consumption in kilowatt-hours (kWh) per year, or per operating cycle (or the Energy Efficiency Ratio for room air conditioners), which is derived from standard tests.

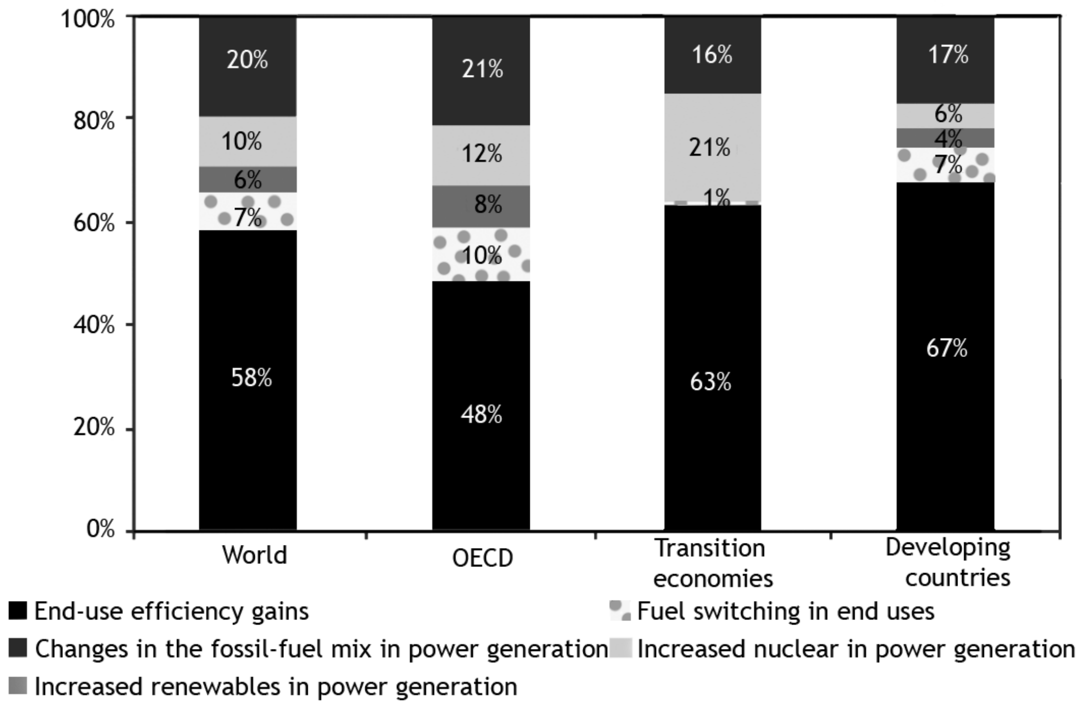
Increasingly popular are the use of visual aids, such as dials or bars, to facilitate quick a comparison between different appliances and the identification of the most efficient models. The EU's energy labelling framework Directive (Council Directive 92/75/EEC), for example, expresses relative energy performance on a scale from G (lowest efficiency) to A (highest efficiency). The EU energy label has recently been adopted in Russia, Turkey, Bulgaria, Croatia, Romania and South Africa. Other countries, including Argentina, Brazil, China, Columbia, Iran, Israel and Tunisia, have utilised some aspects of the EU energy label in their own labelling schemes.

Despite this voluntary adoption of identical or similar labelling formats across many countries and cultures, there are many other countries which have adopted different labelling formats. Research into the public understanding and effectiveness of energy labels shows that labels using multiple efficiency categories or classes are more effective at stimulating efficiency gains than those that simply present the efficiency or energy as numerical values or on a continuous scale. Research also shows that there can be significant cultural differences which may render some types of label designs much more effective than others in specific local contexts. This is a powerful reason not to harmonise the appearance of labels across countries without first testing to make sure they remain effective instruments at communicating efficiency benefits.

Seal-of-approval and other voluntary labels

Seal-of-approval labels are voluntary and selective, and are awarded only to products that meet relatively strict environmental requirements, such as those related to energy performance. Many of these labels are administered by governments and are closely co-ordinated with their corresponding mandatory energy labelling programmes. Examples include Canada's Environmental Choice[M] Programme, the EU's Eco-label award scheme, China's Great Wall energy certification label, India's Ecomark scheme, Korea's Energy Boy label, Singapore's Green Labelling Scheme, Chinese Taipei's Greenmark, and the US' Energy Star program. In addition, there are several voluntary labelling schemes administered by non-profit organisations,; administered jointly by representatives of governmental and non-governmental organisations; and in Australia and Thailand, associations of gas and electric utilities, respectively, sponsor their own voluntary energy labelling schemes.

Figure 1: Contributory factors in CO_2 reduction, 2002-2030



Improvements in end-use efficiency can contribute more than 50 percent of the emission reductions; increased use of renewables can contribute about 20 percent.

Climate change and equipment energy efficiency: the case for stronger standards and labelling schemes

Impact of existing equipment energy efficiency policies

After transportation, household and office electrical appliances represent the world's fastest-growing segment of total energy consumption. The International Energy Agency (IEA) has estimated that appliance efficiency policies put in place in OECD countries between 1990 and 2002 are on course to save 292 Terawatt-hours (TWh) of residential electricity demand in 2010 and 393 TWh in 2020 (some 13.5 percent of the forecast total residential electricity consumption). This is set to avoid over 146 million tonnes (Mt) of carbon dioxide (CO_2) emissions per year in 2010 and 240 Mt CO_2/year in 2030 at a net benefit to society of between US$69 and US$215 per tonne of CO_2 avoided, depending on the region. In the case of lighting, the impacts of energy efficiency standards and labelling schemes are even more impressive. The IEA estimates that globally, current policies saved 334TWh of electricity demand in 2005 and are on course to avoid 745 TWh of demand in 2030.

Energy and climate change implications: the potential to save more

Decarbonising the energy sector can only be achieved by a combination of efforts to use lower carbon energy sources and use less energy. Low or zero-carbon alternatives such as hydropower, nuclear power and renewables, face cost, availability or other constraints that limit their rate of adoption. By contrast, improved end-use energy efficiency offers the principal opportunity to lower the rate of growth in CO_2 emissions in the near term without significant increases in the cost of energy services (see Figure 1). The power sector is the main source of energy-related CO_2 emissions and this power is used in a variety of electrical end-uses. The cost-effective savings potentials in these end-uses vary from almost 40 percent for lighting (which accounts for about 19 percent of global electricity use; IEA 2006), to about 25 percent for motors and drives (which account for about 40 percent of global electricity use). When all the relevant factors are taken into account, at the current time it typically costs between 3 and 6 times more to purchase a kWh of electricity than it does to avoid needing it through the preferential purchase of more efficient electrical equipment.

Determining the energy performance of a product

Energy performance is not a universally defined quotient, such as acceleration or density, and each class of appliance requires its own method for measuring it. Across countries, these methods (which include 'test procedures' but also involve definitions of energy efficiency) and the associated performance requirements can often vary in ways that are not always trivial.

The reconciliation of these differences in definitions and requirements across a large number of countries would be a major undertaking although the degree of disparity that exists varies depending on the product. Furthermore, while some of these differences are simply the result of the development of independent regulatory traditions, others reflect genuine local physical differences in how a product is used that affect its energy performance.

Any multilateral decision to begin developing internationally agreed criteria for relatively energy-efficient goods, based on comparable test procedures, would therefore need to be justified by an expectation that the net benefits of increased trade in the goods concerned would be large enough to outweigh the inconvenience of doing so. It is important, therefore, to identify the degree of commonality that already exists, the sources and rationale for any differences identified, and the institutional and financial costs of producing a common international performance rating system. These costs need to be weighed against the possible benefits, which depend on: the potential size of each product's international market, the contribution that the product makes to world energy consumption and the spread

Figure 2: Comparison of conventional light bulbs and energy-efficient (compact fluorescent lamps - CFLs)

	Incand-escent 	CFL 
Initial cost of bulb Efficacy	US$0.5 12lm/W	US$10 60 lm/W
Lifespan For 10000 hours use	1000 hours	10000 hours
Electricity cost Cost of lamps	US$75 US$5	US$15 US$10
Total cost of ownership	**US$80**	**US$25**

of energy performance among the different models on offer within the same product class, and the degree to which tariff and non-tariff barriers are currently restricting trade.

Towards common reference energy performance standards

Since for the majority of cases, energy-efficient goods cannot be distinguished simply via their appearance, enforcement of regulations requires that their performance be determinable via testing. As argued above, the most immediately obvious approach would be to require a common efficiency threshold to be attained regardless of where the good is to be sold. This would require agreement on:

1. the use of either common, or mutually convertible energy performance test procedures;
2. common or mutually convertible energy-efficiency metrics and product categories; and
3. common energy-efficiency thresholds.

In order to illustrate the modalities to be addressed for each of these steps, they are now discussed below in relation to the following products: refrigerator-freezers, air conditioners, compact fluorescent lamps and computers.

Product categories and efficiency metrics

The product categories and efficiency metrics applied are directly equivalent between countries for computers and CFLs. The differences in the evolution of national markets means that these are not easily comparable, although in recent years there has been a tendency for countries developing new metrics to harmonise them with existing ones. For example, Argentina, China, Russia, South Africa, Tunisia and Turkey have harmonised their metrics with the EU's efficiency metric for refrigerators and freezers. Despite the considerable difficulties in converting between refrigerator-freezer test procedures and efficiency metrics, it is still possible providing that accuracy is not paramount and only indicative results are required. Such a simplified conversion algorithm has been developed and applied to help establish Australian MEPS requirements.

Adoption of common energy efficiency thresholds

For reasons that have been outlined above, internationally applied MEPS or energy labelling efficiency thresholds are rarely common or harmonised between different programs. Computers are rarely subject to MEPS, and only Japan and Russia (with an obsolete requirement) currently specify MEPS levels. Voluntary endorsement labels for computers are far more common than mandatory requirements, be they labels or MEPS, largely because of the rapid pace at which the technology is evolving. The majority of countries that have requirements have harmonised them with the US' Energy Star, which has become a kind of international standard for this product. This includes Australia, Canada, the EU, Japan and Korea.

Room air conditioners and refrigerator-freezers are the products which are most commonly subject to MEPS and mandatory energy labels, and in both cases a wide diversity of thresholds is applied. In the case of room air conditioners there has been almost no attempt to harmonise efficiency thresholds for MEPS or labelling beyond national or regional program boundaries (e.g. North American Free Trade Agreement, EU, China, Japan, Korea, Australia-New Zealand). A sole exception is the matching of the Australia-New Zealand MEPS requirements with Korea's.

A growing number of experts have called for a major rethinking of current test procedures in the area of energy performance – not only because of non-comparability between national testing standards but also because many of the tests are not keeping up with changes in technology, particularly the incorporation of microcontrollers (IEA, 2003). A microcontroller can be used to sense when an appliance is about to be tested and thus boost its performance during the test, while leaving actual energy use in common situations unchanged. According to Meier (2001), "nearly all energy test procedures are obsolete and cause serious misrepresentations of energy consumption." Developing new national and international test standards – which would probably need to combine tests of both hardware and software – if co-ordinated with work on developing conversion algorithms, could, Meier concludes, create "an excellent opportunity for all countries to harmonise their energy test procedures while addressing a serious technical shortcoming."

REFERENCES:

IEA (2003), *Cool Appliances: Policy Strategies for Energy Efficient Homes*, OECD Publications, Paris.

IEA (2006), *Light's Labour's Lost: Policies for Energy-Efficient Lighting*, OECD Publications, Paris.

Meier, Alan (2001), "Energy testing for appliances", in Wiel, Stephen and James E. McMahon (eds.), *Energy-Efficiency Labels and Standards: A Guidebook for Appliances, Equipment, and Lighting*, Collaborative Labeling and Appliance Standards Program, Washington, D.C., pp. 55-70

Climate Change Benefits from Liberalisation of Environmental Goods and Services

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This article will highlight the significance of trade and trade rules on environmental goods and services (EGS) and climate change mitigation. It will highlight the importance of the World Trade Organization (WTO) negotiations and the main challenges within them that appear relevant to climate-friendly EGS. It will then provide illustrative examples of goods relevant to climate change that have been proposed by WTO Members and highlight the controversy surrounding some of these. The article will conclude by touching on alternatives to the WTO-led approach that could also ensure mutual supportiveness between EGS trade and climate change objectives.

WTO negotiations on EGS

Paragraph 31 (iii) of the WTO's Doha Ministerial declaration, for the first time provided a distinct and separate mandate for EGS negotiations, thereby giving it prominent visibility within the negotiating mandate as compared to other categories of goods and services.

Paragraph 31 (iii) of the Doha Ministerial Declaration calls for the "the reduction or, as appropriate, elimination of tariff and non-tariff barriers to environmental goods and services."

However, the mandate provides no indication of the pace, depth or sequencing of liberalisation of EGS, relative to other goods and services. The Committee on Trade and Environment was given the responsibility to identify and define the scope of environmental goods to be negotiated. Of the three issues included within the first WTO negotiating mandate on trade and environment, EGS has so far received the greatest number of submissions by WTO members.

The concept and scope of EGS

There is no universally accepted definition of environmental goods and services (EGS). However these goods and services could, by a rule of thumb, be conceptualised in two ways. The *first* is the narrow, conventional conception that focuses on treating a specific environmental problem through the end-use of a particular good or service. This characterises the traditional classification of EGS and includes goods and services such as wastewater treatment equipment or solid waste disposal services.

The *second* conceptualisation is broader and includes within its ambit environmentally preferable products (EPPs) and services. UNCTAD (1995) defines EPPs as products which cause significantly less "environmental harm" at some stage of their "life cycle" than alternative products that serve the same purpose, or products the production and sale of which contribute significantly to the preservation of the environment.[1] Thus, the environmental benefits may arise from the (more environmentally benign) production method, during the course of it use (through lesser pollution and energy-consumption) or during the disposal stage of the product.

The OECD and Eurostat definition of the environment industry includes "activities which produce goods and services to measure, prevent, limit, minimise or correct environmental damage to water, air and soil, as well as problems related to waste, noise and ecosystems."[2] The OECD has categorised these goods and services under three broad headings: pollution management, cleaner technologies and products, and resource management. The category of resource management includes goods and services relevant to renewable energy as well as heat/energy saving and management.

From the perspective of cutting greenhouse gas emissions, perhaps the relevant universe of goods and services to be considered by policy makers should be various types of fuel that emit less or no greenhouse gas emissions. In addition they would include those technologies and goods that would not only draw upon sources of renewable energy but also assist in more efficient use of energy or fuels – in other words, those contributing to energy efficiency. "Clean" fuels and technologies that reduce emissions of pollutants such as sulphur dioxide may not lead to greenhouse gas reductions, while other fuels and technologies could do both. Thus defining the scope of EGS relevant to climate change objectives should be the starting point for domestic trade and environmental policy-makers and international negotiators.

The significance of EGS trade liberalisation and trade rules

How does trade in EGS come into the picture and how can it be made supportive of furthering climate change objectives? It may be useful to identify some key areas of interface whereby trade liberalisation and trade rules of EGS can help the attainment of climate change objectives. This can happen:

- *Through lowering the cost of access of goods and services by the reduction of tariffs and other barriers to trade.*
- *Through creating an advantage for environmentally preferable products and services.* For instance, higher tariffs on coal as opposed to wind-turbines could provide an advantage in the market to wind energy.
- *If trade rules negotiated (including those specific to EGS) are supportive of or do not constrain domestic and international policies or measures aimed at mitigating greenhouse gases.*

These interfaces are significant not only at the multilateral level, but also through regional, bilateral and even unilateral initiatives on trade.

Trade and climate-change related challenges under EGS negotiations

Progress has proven elusive, and prior to the suspension of WTO negotiations in July 2006, a number of issues surfaced in EGS talks that have proven difficult to resolve. Some of those that are particularly relevant for climate change initiatives are discussed below.

Relativity in environmental-friendliness

Qatar has proposed that energy-efficient technologies such as combined-cycle natural-gas-fired generation systems and advanced gas-turbine systems be considered EGS. Qatar bases its argument on climate change objectives and points to the recognition of natural gas in Kyoto Protocol negotiations as part of the solution to stabilize greenhouse gases in the atmosphere (TN/TE/W/19 accessible at http://docsonline.wto.org).

The main problem with regard to lowering tariffs on natural-gas based technologies is that tariffs once lowered and bound subsequent to WTO negotiations cannot be raised again. The environmental-friendliness of natural gas is relative to fossil fuels such as coal and oil but not to wind power or hydrogen. If friendlier fuels such as hydrogen become economically viable in the future, they would not enjoy any special trade advantages over natural gas as tariffs on the latter would be low or zero.

Legitimate policy measures vs non-tariff barriers

This brings one to the question of non-tariff measures. Could incentives such as subsidies provided to a carbon-friendly fuel or technology be viewed as a non-tariff barrier (NTB) to less friendly fuels and challenged under WTO rules? Again, much will depend on how a WTO panel judges the two fuels or technologies to be 'like'. Incentives to 'like products' or 'close substitutes' may attract penalties under WTO subsidy rules. Subsidies to corn grown for ethanol, for instance, could affect final prices and be subject to potential challenge under WTO subsidy rules on agriculture.

Within the context of EGS negotiations, countries are also concerned about non-tariff barriers to products such as wind-turbines that could hamper trade and affect implementation of climate change measures. The trouble is that identifying the full range of non-tariff barriers will be difficult within the limited timeframe laid out for the Doha Round. NTBs could range from technical standards and labelling to cumbersome customs procedures. They can also evolve and change rapidly.

Changing technology

'Energy-efficiency' of products is also a relative and evolving concept. Energy-efficiency can improve with time as technology changes. Thus, if tariffs are reduced to zero on products such as energy-efficient dishwashers, they cannot be raised again once a more energy-efficient dishwasher is introduced the following year. Leaving aside the debate on whether energy-efficient and non-energy-efficient products are 'like', trade-based discrimination on the basis of energy efficiency may be difficult to manage. In cases where products can be clearly distinguished, such as ordinary light-bulbs and light-emitting diodes (LEDs), applying differential treatment may be easier.

'Dual-use'

EGS negotiations have also been plagued by concerns with regard to products that could have both environmental and non-environmental uses. For instance a pipe could be an input into a Clean Development Mechanism project under the Kyoto Protocol, as well as used in oil drilling. Should a pipe therefore be liberalised? Many developing countries, particularly those with established domestic industries are wary about liberalising products with 'dual' or 'multiple' uses through EGS negotiations. Similarly, in environmental services negotiations many countries do not want to cluster services such as 'environmental engineering' or 'environmental research and development' under a single category of environmental services, preferring instead to discuss them within their parent categories such as 'engineering services' or 'research and development' services'.

Proposals for 'Climate-Friendly EGS'

WTO Members have so far submitted 480 products as proposed EGS. It has primarily been developed countries, with the exception of Qatar, Chinese Taipei and Korea, that have made these proposals. (For further details on products and product categories submitted, please refer to WTO Secretariat Document-TN/TE/W/63 accessible at http://docsonline.wto.org). With regard to fuels, in addition to natural gas-based fuels submitted by Qatar, Canada has included hydrogen and biodiesel, and New Zealand-methanol and bio diesel. Some Members have also proposed solar panels, hydraulic plants, wind-turbines, gas turbines and bio-energy generated from waste.

While Brazil has called for the inclusion of ethanol, it has not submitted any formal list of products. So far, ethanol derived from farm crops has been categorised as an agricultural product. It may be worthwhile in this context for negotiations on environmental goods to consider agricultural products if they are relevant for climate change objectives.

Countries have also included products such as glass insulation (Japan and New Zealand), fluorescent lamps (Japan, Canada, New Zealand and the United States) and solar water heaters. Other products, while perhaps beneficial for purposes of climate change mitigation, have generated controversy as proposed environmental goods. These include bicycles and their spare parts (Switzerland) and electric rail locomotives (European Commission).

Commitments on environmental services have been less ambitious, but as part of updating existing classifications, some Members have included a category called "Protection of ambient air and climate". However few developing countries so far have formally made commitments as part of environmental services. Experts are also unsure about whether cross-border carbon trading could be included as an environmental service. WTO Members could include other services such as afforestation services that have positive implications for climate change.

Alternatives to multilateral trade approaches on EGS and concluding remarks

Countries are always free to pursue unilateral, bilateral and regional trade initiatives on EGS in a manner supportive of climate change mitigation. The key issue is that any positive environmental impacts through such initiatives will be on a less-than-global scale unless all the major countries jointly put in place unilateral measures or together pursue regional approaches. Unilateral efforts may not lead to predictable lowering of tariffs and non-tariff barriers to EGS, unlike bilateral, regional or multilateral trade agreements.

However the difficulties in securing consensus at the WTO implies that bilateral or regional initiatives could be more fruitful in the short-term and provide models for rule-making that could offer lessons for future multilateral negotiations. Whatever approaches countries pursue, the key challenges pertaining to climate-friendly EGS arising within the WTO negotiations can also emerge within bilateral and regional negotiations. Innovative approaches, modalities and rule-making will be needed to overcome these challenges.

A notable feature of bilateral and regional trade negotiations is that there may exist no special mandate on EGS to serve as a 'guide' unless the parties to the negotiations decide to include one. Thus it will be up to the policy-makers and trade negotiators concerned to identify and focus attention on greenhouse gas-reducing goods and services and to ensure that trade rules facilitate, rather than constrain, domestic, regional and international climate change mitigation efforts. This implies that trade negotiators are fully aware of the relevant provisions of the Kyoto Protocol as well as the WTO rules and avoid potential conflicts. Likewise, environmental negotiators and policy-makers must be aware of the implications of existing WTO rules while conducting negotiations on climate change.

Constant communication between goods and services negotiators, as well as between trade and environmental policy-makers and other stakeholders, is vital to ensure that EGS initiatives will be meaningful for climate change benefits.

Asia and the Pacific: Policies for a Sustainable Energy Transition

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This paper addresses the question as to how can policy-makers approach decision-making that will ease the transition to a post-fossil fuel era, without causing major social disruption or environmental harm?[1] It examines the competitiveness of renewable energy (RE), focusing on the policy framework and market conditions under which renewables operate. The findings demonstrate that for RE to become more competitive, policies are needed to correct the imperfect market conditions that presently handicap renewables. Such policies require the removal of the perverse subsidies that are currently provided to non-renewables, the provision of seed funding for RE projects, and the creation of market mechanisms to guarantee a share of the market and fair prices. The study underscores the critical importance of a supportive policy framework and suitable market conditions. It also shows that *RE policies in developing countries should first focus on areas with no electricity grid*, even though this may require sustained subsidies for many years. With economies of scale and improved technology, plus increasing prices of non-renewables, RE policies and market development can then turn to areas with electricity grids with lower, although still substantial, subsidy costs.

This analysis is based on a study of 28 innovative practices from a dozen countries in Asia. The key factors involved in these good practice cases were reviewed and analysed following a pattern-matching that used more than 540 formatted codes representing possible enabling or impeding factors in policy development and implementation. Details on the case studies and the methodology applied in this research can be found at a dedicated website.[2]

Meeting the energy demand of Asia: can it be sustainable?

The total primary energy supply (TPES) for the Asia-Pacific region is projected to more than double to 5,569 million tonnes of oil equivalent (Mtoe) in 2020, up from 2,671 Mtoe in 1997. Meeting the future energy demand and consumption without significantly changing current electricity generation technologies would have major environmental implications, especially in relation to climate change and global warming, not to mention the huge investment requirements.

For a large proportion of rural populations, as well as poor urban communities, biomass in the form of firewood, charcoal, crop residues and animal wastes is the main source of energy for cooking and heating. This makes combustible renewable energy and waste account for 92.5 percent of total RE consumed in developing countries of Asia – excluding Australia, China, Japan, Korea and New Zealand (IEA, 2005) – while the contribution of hydroelectricity represents four percent, and that of geothermal, solar, wind, and tides collectively accounts for 3.5 percent of all RE. Combined, all RE sources contribute 32.7 percent of the TPES in Asia. In China, RE accounts for 17.1 percent of TPES, of which combustible RE and waste represent 90 percent and hydroelectricity ten percent.

In the Bali Declaration on Asia-Pacific Perspectives on Energy and Sustainable Development and other regional policy initiatives, countries in Asia and the Pacific have stressed the urgent need for initiating policies and strategies to facilitate the optimal commercial exploitation of renewable energy resources. In reality, large-scale introduction of renewable energies has remained limited due to various internal, external, technical, institutional and financial constraints. These relate to the high initial costs of such technologies, geographical and seasonal variations in energy resources, insufficient energy market development and a weak regulatory framework.

Addressing key barriers to market penetration of renewable energies in Asia

Efforts to move towards a sustainable energy transition have focused on changing the pricing and market conditions while putting in place a range of institutional and promotional mechanisms at various levels of governance, both in the public and private sectors.

Pricing and market conditions. It is well recognised that current markets in energy services do not take into account the environmental and social benefits associated with RE – in fact, there is no market for the positive externalities created by RE (von Moltke et al. 2004). While intervention is needed to change policy and market conditions in support of renewable sources of energy, such intervention would differ according to whether they relate to grid-connected or non-grid connected areas. In areas with a connection to electricity grids, RE faces an uphill battle because of past subsidies by the state on establishing the grid and the sunk costs in existing technologies such as coal and oil. In non-grid areas, RE may have an advantage as the only and often most appropriate form of electrification, which may also lead to income generation.

For *grid-connected areas*, common policies for market creation have included (i) price-or quantity setting; (ii) cost reduction; (iii) public investment and market facilitation; and (iv) power grid access. In many cases, positive discrimination to create a 'level playing field' has gone in parallel with subsidy reform on oil, coal, gas and nuclear power. In China, the world's largest producer and consumer of coal, coal price reform (which started in 1996), together with a tax on high-sulphur coal to encourage a switch to natural gas and RE, contributed to a five percent reduction in coal use between 1997 and 2001 (Brown, 2003).

In *non-grid connected areas*, the focus of policies has been to create and nurture new markets for RE. The provision of *financial incentives* to producers or consumers of RE was a prime instrument to that effect, with a major concern being how to optimise and minimise the use of subsidies. Three types of policies have been applied in developing countries of Asia with a view to minimising and optimising the use of subsidies: (i) competitive approaches in the provision of subsidies, e.g. through bidding; (ii) financing models that combine the provision of a subsidy with loan ownership; and (iii) public financial support that leads to long-term private investment and market growth. Successful examples of the gradual reduction and phase-out of subsidies as economies of scale are achieved were found under solar-powered homes programs in Japan (New Energy Foundation) and Australia (Australian Greenhouse Office, Department of the Environment and Heritage).

Pricing Policy. All countries included in this study have developed new policies to create market conditions favourable to RE. These policies have proven effective in enabling RE projects to attract investment, increasing their share in energy markets, and increasing their affordability. The case studies demonstrate successful practices in using innovative financing for the promotion of RE, especially in non-grid connected areas, by combining funding from the public sector, the private sector and the end-user. While public spending remains important (43 percent), there is a significant role for private sector investment (39 percent). Perhaps most surprisingly, the rate of user payment (50 percent) represents a strong indication of willingness of consumers, even at very low income levels, to pay for reliable products and services, when flexible financing terms are provided (see Table 1).

Table 1: Who is investing in renewable energy?

Variables	Total
Funding	86%
National government	43%
External sources	29%
Local government involvement	36%
Private sector	39%
Users pay	50%

Note: % refers to the total number of cases.

The experience in the countries studied indicates that early-stage public financial support can effectively contribute to the emergence of a market for RE. In the Western Province of Inner Mongolia in China, a policy of incentives to support the growth of the market for small wind turbines was implemented between 1986 and 1999, providing a subsidy of about US$60 in 1986 and US$25 in 1999 for the purchase price of a 300-watt (W) wind turbine system. By 2000, a local small wind turbine industry had already emerged, making Inner Mongolia the largest market for small-sized wind turbines in China – with 90 percent of small wind turbines produced and installed nationwide.

In the Indian state of West Bengal, the market for solar photovoltaic (PV) mini-grids has been promoted through a combination of the national government subsidy for RE, state subsidy, and local area development funds in the ratio of 70:20:10 respectively. In addition, each consumer invests about US$45 towards application fees for receiving the connection and internal wiring. The monthly fixed tariff is about US$2.50 for consuming 18–20 killowatt-hours (kWh) of electricity.

Table 2: Main elements of policy content

Variables	Total
Policy content	89%
Command and control	36%
Incentives/disincentives	36%
Market-based instruments	82%
Aimed at producer behavior	50%
Choice of energy sources	14%
Producer subsidies	18%
Green procurement	11%
Aimed at consumer behavior	25%
Subsidies/cross subsidy	11%
Creation of new markets	39%
Facilitating market creation	29%
Preferential treatment	7%
Seed funding	14%

Note: % refers to the total number of cases.

Market Creation. The findings indicate that market transformation initiatives have been introduced in most countries, with a view to creating a more 'level playing field' for RE (see Table 2). Price and market guarantee mechanisms, along with target-based RE generation, are common policy instruments. The analysis indicates that market-based instruments (82 percent) and the creation of market mechanisms (39 percent) are given greater emphasis than other factors. In particular, market-based instruments which aim at producer and consumer behavioural changes seem to be keys to success. For creating RE markets, seed funds and preferential treatment for industries were found to be critical instruments.

The private sector and non-governmental organisations have been pioneering the transition to alternative energies (see Table 3). Private sector institutions (75 percent), including financial entities, manufacturers, generators, distributors and energy service companies, contribute on the technological, financing and marketing fronts. In many cases, the private sector intervenes through concession contracts concluded with central or local governments. Dozens of renewable energy service companies (RESCOs) have been set up to provide the services of sale, installation and maintenance of household solar PV systems in China and India, as well as solar water heating in India.

Table 3: Actors driving the energy transition at the national level

Variables	Total
Stakeholders	93%
Civic engagement and public participation	93%
Private sector involvement	75%
Multiple stakeholders	64%

Note: % refers to the total number of cases.

Conclusions

The findings confirm that transforming policy and market conditions in the energy sector is a critical element in the transition to a post-fossil fuel era. The cases reviewed illustrate that policies creating a more 'level playing field' can be effective in enhancing the competitiveness of renewable sources of energy against conventional sources. The case studies indicate that policies to create a level playing field in non-grid areas tend to focus on increasing the amount of support to RE, whereas in grid-connected areas, they tend to focus on altering market conditions in a way that makes RE projects more viable. This has been undertaken largely through new subsidies, incentives, and mechanisms guaranteeing RE a fair price and/or access to a market. The findings confirm that a RE policy with clearly targeted objectives and policy processes helps lead to prompt actions by industries to mitigate environmental problems by adopting RE.

The study also indicates that 'leapfrogging' to RE is possible in non-grid areas of developing countries, but that subsidies might be required until economic development allows affordability to be achieved. In grid areas, RE faces an uphill battle because of past subsidies by the state in establishing the grid and the sunk costs in existing technologies. Therefore, in markets already competitive due to the presence of grids, policies should aim at creating a level playing field over the medium term by changing the policy and market conditions under which RE has to compete.

REFERENCES:

Brown, L. R. (2003) *Plan B: Rescuing a Planet under Stress and a Civilisation in Trouble,* New York: W.W. Norton & Co.

IEA (International Energy Agency). (2005) *Renewables Information* - 2005. Paris. IEA.

Von Moltke, A., McKee C., and Morgan T. 2004. Energy Subsidies: Lessons Learned in Assessing their Impact and Designing Policy Reforms. United Nations Environment Programme and Greenleaf Publishing: United Kingdom.

China's Challenges in Energy, Trade and Environment

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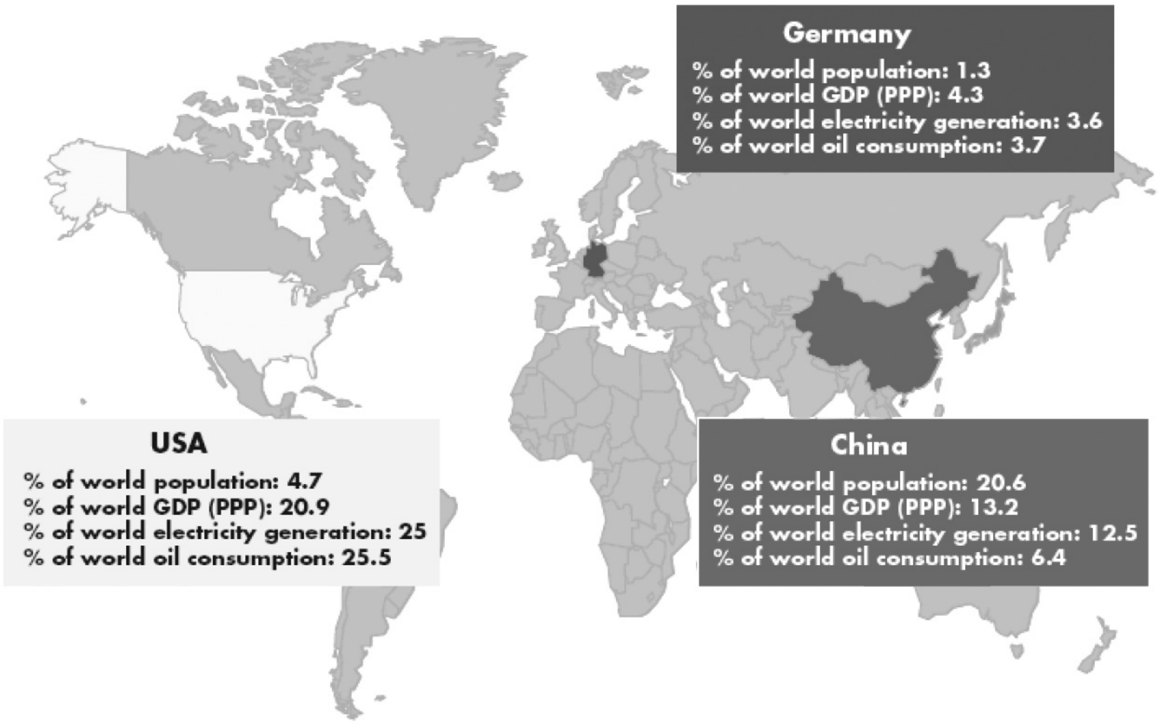
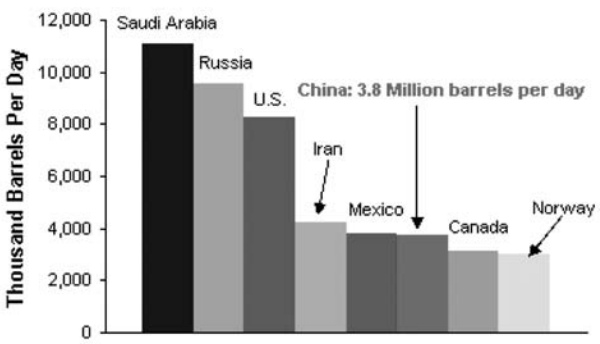
Along with its strong economic growth, China's demand for energy is surging rapidly. Since 1990, China's primary energy consumption (PEC) has risen more than 70 percent. As shown in Figure 1, one point is clear from the comparison between China, Germany, and the United States: proportionate to its population and economic size, China's upward energy consumption is inevitable.

Figure 1: Comparing China internationally



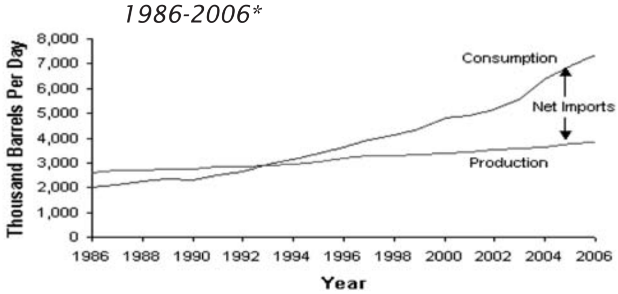
Source: db- research (2005), International Monetary Fund (2005), World Factbook [2005]

Figure 2: Top world oil producers, 2005



Source: EIA International Petroleum Monthly

*Figure 3: China's oil production and consumption, 1986-2006**



Source: EIA International Petroleum
** 2006 is Jan-Aug only*

China's energy structure and trade

Oil

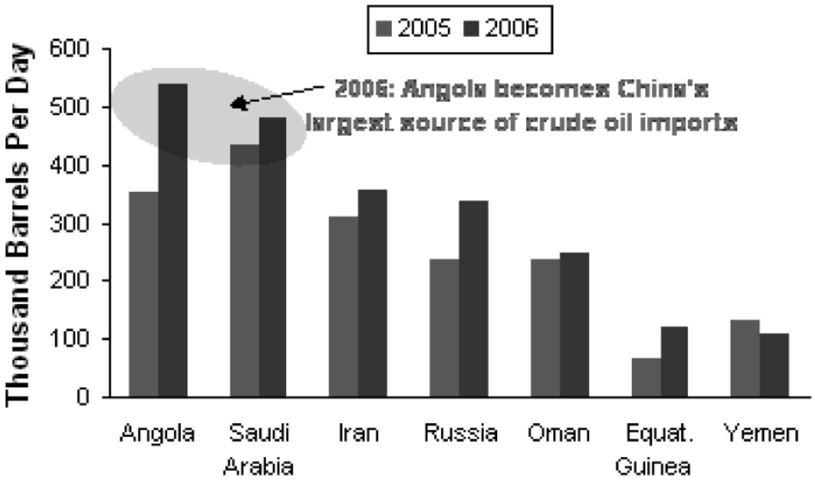
China is the world's second-largest consumer of oil behind the United States, and the third-largest net importer of oil after the US and Japan. China also produces a significant amount of oil and was the world's sixth-largest oil producer in 2005 (see Figure 2). As a net oil importer since 1993, China's petroleum industry is focused on meeting domestic demand (see Figure 3).

For 2006, the International Energy Agency forecasts that China's increase in oil demand will represent 38 percent of the world total.

In February 2006, Angola surpassed Saudi Arabia as China's largest source of crude oil imports (see Figure 4). According to one industry report, in May 2006 China imported 750,000 barrels per day (bbl/d) of crude oil from Angola, a 70 percent increase from the same month in 2005. According to the same report, between January and May 2006 China received 46 percent of its crude oil imports from the Middle East and 32 percent from Africa, while its neighbours in the Asia-Pacific region only supplied 5 percent of China's imports.

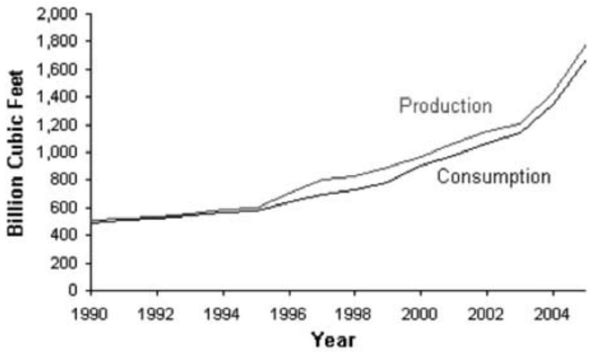
In 2004, natural gas accounted for only three percent of China's energy consumption. However, analysts expect China's natural gas production and consumption to rise in the coming years, following recent trends (see Figure 5).

*Figure 4: Top sources of China's crude oil imports, 2005 and 2006**



Source: FACTS, Inc. China Oil and Gas Monthly
**2006 data is January through June only*

Figure 5: China's natural gas production and consumption, 1999-2005

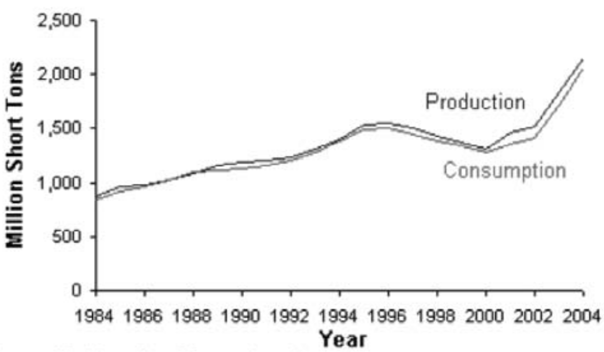


Source: 1990-2004: EIA; 2005: FACTS, Inc China Oil and Gas Monthly

Coal

China is the largest producer and consumer of coal in the world. Coal makes up 69 percent of China's total primary energy consumption. China holds an estimated 126.2 billion short tons of recoverable coal reserves, the third-largest in the world behind the United States and Russia. In 2004, China consumed 2.1 billion short tons of coal, representing more than one-third of the world total and a 46 percent increase since 2002. Coal consumption has been on the rise in China over the last five years, reversing the decline seen from 1997 to 2000 (see Figure 6).

Figure 6: China's coal production and consumption, 1984-2004



Source: EIA International Energy Annual

Electricity

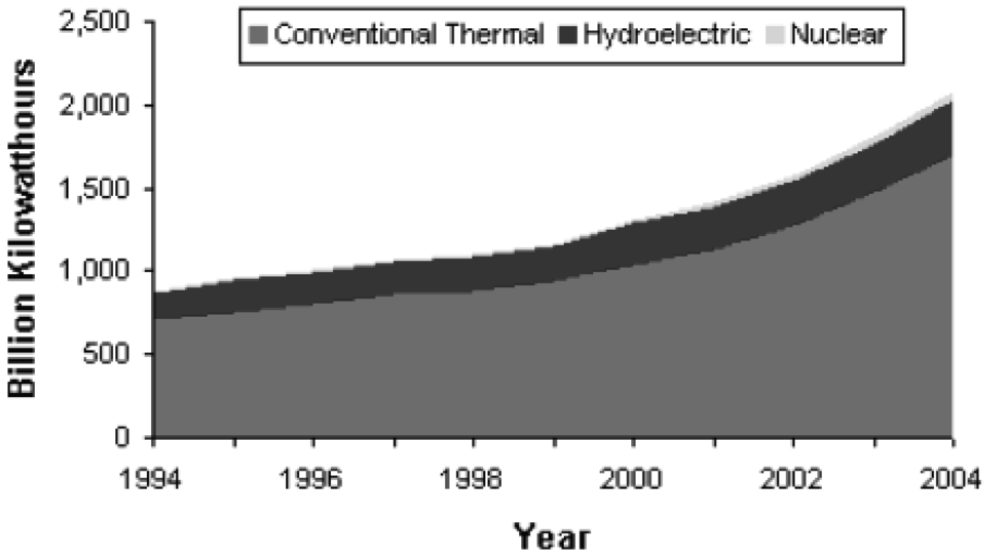
China's electricity generation continues to be dominated by fossil fuel sources, particularly coal (see Figure 7). The Chinese government has made the expansion of natural gas-fired power plants a priority. In 2004, China had a total installed electricity generating capacity of 391.4 gigawatts (GW), 74 percent of which came from conventional thermal sources. In 2004, China generated 2,080 billion kilowatt-hours (Bkwh) and consumed 1,927 Bkwh of electricity. Since 2000, both electricity generation and consumption have increased by 60 percent.

Conventional thermal. Conventional thermal sources are expected to remain the dominant fuel for electricity generation in the coming years, with many power projects under construction or planned that will use coal or natural gas. China's eleventh five-year plan, covering the period 2005-2010, calls for the country to increase the share of natural gas and other cleaner technologies into the country's energy mix.

Hydroelectric. In 2004, China was the world's second-largest producer of hydroelectric power behind Canada. In the same year, China generated 328 Bkwh of electricity from hydroelectric sources, representing 15.8 percent of its total generation. This figure is likely to increase given the number of large-scale hydroelectric projects planned or under construction in China. The largest power project under construction is the Three Gorges Dam, which will include 26 separate 700-MW generators, for a total of 18.2 GW. When completed, it will be the largest hydroelectric dam in the world. The Three Gorges project already has several units in operation, but the project is not expected to be fully completed until 2009. Another large hydropower project involves a series of dams on the upper portion of the Yellow River. Shaanxi, Qinghai, and Gansu provinces have joined to create the Yellow River Hydroelectric Development Corporation, with plans for the eventual construction of 25 generating stations with a combined installed capacity of 15.8 GW.

Nuclear. China is also actively promoting nuclear power as a clean and efficient source of electricity generation. Although it makes up only a small fraction of China's installed generating capacity, many of the major developments taking place in the Chinese electricity sector recently involve nuclear power. Independent sources forecast that China will add between 15 and 30 GW of new nuclear energy capac-

Figure 7: Electricity generation in China by type, 1994-2004



Source: EIA International Energy Annual

ity by 2020, but even with this expansion, nuclear power will only represent between 2.5 and 4.5 percent of total installed generating capacity.

Energy and environment

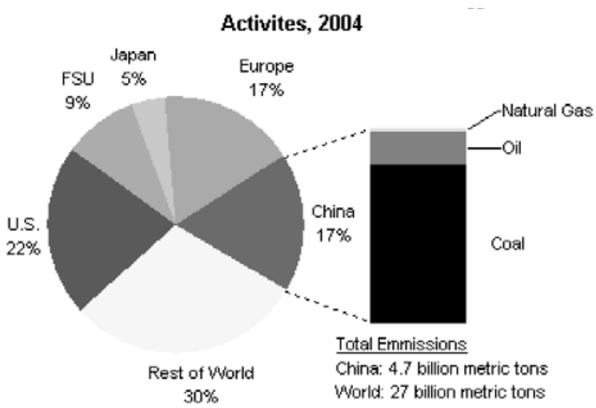
China's rapid economic growth over the last two decades has brought with it severe energy-related environmental problems. Pollution from fossil fuel combustion is damaging human health, air and water quality, agriculture, and ultimately the economy. Many of China's cities are among the most polluted in the world. China is the world's second-largest source of carbon dioxide emissions behind the United States (see Figure 8). It is predicted that China will experience the largest growth in carbon dioxide emissions between now and the year 2030.

China is a non-Annex I country under the United Nations Framework Convention on Climate Change, meaning that it is not bound to any greenhouse gas (GHG) emissions reduction targets set under the Kyoto Protocol.

Although not primarily prompted by climate change concerns, China has made remarkable progress in reducing energy subsidies since the mid-1980s. This is particularly the case for subsidies to the coal sector. Subsidy rates for coal have fallen from 61 percent in 1984 to 11 percent in 1995. At the same time, China removed price controls on coal, and encouraged the development of private coal mines. This subsidy reform has produced multiple benefits. The economic performance of coal mines has improved rapidly, reducing government spending and – along with other policy reforms and technological change – contributing to energy conservation and environmental protection. Energy intensity has fallen by 30 percent since 1985, leading to energy consumption (in oil equivalents) and CO_2 emissions, respectively, 0.3 billion metric tons and 1.1 billion metric tons less than if the reform had not taken place.

Recently, the Chinese government has taken several steps to improve environmental conditions in the country. Chief among these is the new Law on Renewable Energy, which took effect on January 1, 2006. The new law seeks to promote cleaner energy technologies, with a stated goal of increasing the use of renewable energy to ten percent of the country's electricity consumption by 2010 (up from roughly 3 percent in 2003).

Figure 8: Carbon dioxide emissions from energy activities, 2004



Source: EIA International Energy Annual

Concluding remarks

Many of the energy and environmental challenges facing China are common for all developing countries. Some of these could be addressed through the liberalisation of environmental goods and services (EGS), especially the transfer of technology in both energy efficiency and renewable energy. Industrial countries should prioritize technology support strategies for developing countries. In the EGS negotiations at the World Trade Organization, governments should drive home the importance of achieving global sustainable development objectives rather than merely commercial export interests.

In order to strengthen its technological and managerial capability in environmental fields, China should protect intellectual property rights more comprehensively. China also needs to strike the right balance between its desire to develop its own homegrown versions and strong demand to embrace more quickly much of the new technology originating abroad. Like most of the policy challenges discussed in this article, this is not a challenge peculiar to China, but the scale in question makes the need to promote sustainable energy in China quite urgent.

PART 3 BIOFUELS: HOPE OR HYPE?

Biofuels, Agriculture, and the Developing World

Ted Turner

United Nations Foundation

For decades agricultural subsidies have been a barrier to global progress on trade and poverty alleviation, and now they are the central barrier to conclusion of the World Trade Organization's Doha round of negotiations. After years of fighting this uphill battle, the time is ripe to look at this problem differently. A new approach to the future of agriculture – one that recognises the emerging opportunity of bio-based energy production – could break the logjam, fulfil Doha's promise for alleviating poverty, and open the door to solutions for oil dependence and global warming. That is what I call a business opportunity.

The barriers that wealthy countries have created to protect their domestic agriculture markets are significant – to the tune of almost US$2 billion a week. In the US, government farm supports account for 16 percent of total farmer income; in Europe, 32 percent; in Japan, 56 percent.

What do these subsidies mean to the developing world? Cotton farmers in Burkina Faso can produce a pound (roughly 500 grams) of cotton for 21 cents, while US cotton farmers need 72 cents. The Burkina Faso farmers should be making a good living as a result, but they're not – because subsidies cancel out their advantage.

Because of these subsidies, farmers in developing countries are desperately poor; *without* these subsidies, some farmers in the developed world would have to find a different line of business. This sounds like a political problem without a solution. But it's not – because agriculture is changing.

Farmers have always grown crops for food and fibre. Today, farmers can grow crops for food, fibre, and fuel. There is now a huge and growing unmet demand for farm products like palm, soy, and rapeseed oil that can be made into biodiesel, and for corn, sugar beets, and sugar cane that can be converted into ethanol. Even more exciting prospects involve fast-growing grasses and non-edible oils, which can be produced abundantly alongside conventional crops, and governments should invest in speeding up the initial production of fuels like ethanol from cellulose. Because the demand for transportation fuels is so large, biofuels offer farmers in all countries – rich and poor – huge market opportunities.

Biofuels also offer an opportunity to do something for the earth and for humanity. If they are produced in an environmentally sustainable way, they are far better for the planet than fossil fuels. They can dramatically cut greenhouse gas emissions. And biofuels are renewable. You don't have to spend billions of dollars probing the ocean depths for oil. You simply plant more seeds.

While all nations – and their farmers – will profit, poor countries stand to benefit most – because they suffer disproportionately from the high price of oil. By investing in biofuels, developing nations can produce their own domestic transportation fuels, cut their energy costs, create new jobs in their rural economies, and ultimately, build their export markets. If developing nations convert part of their agricultural output to fuel, they will be entering a market with higher prices and rising demand.

The impediments to this course should not be ignored – including difficult issues of land ownership, governance, and infrastructure. But bioenergy development offers poor countries the chance to reduce their expensive oil dependence and better attract the kind of foreign investment that can modernise their farming practices – and increase, not decrease, their food production. In addition, higher income will allow them to buy food they were not able to afford before.

Understanding this future, and the role biofuels will play, offers a basis for ending the Doha stalemate. Agriculture is changing from an industry that faces limited demand to an industry that faces *un*limited demand. Since subsidies are a response to lower prices caused by limited demand, subsidies – in the future – could become unnecessary.

Over the next decade, developed countries should phase out tariffs and reduce subsidies for food and fibre crops and instead support the development of biofuels. In this market of unmet demand, the effect of government incentives would be totally different from what it is today. Support for domestic production would not displace foreign competitors or reduce the prices paid abroad. Farmers' incomes would be assured not by subsidies and tariffs, but by market forces. That's why it makes so little sense to lose the Doha round over agriculture subsidies. We shouldn't throw away the future to cling to the past.

If we want to change public policy, we have to change public opinion. Governments and trade negotiators need to explain to their constituencies, particularly their farmers, how Doha – bolstered by an international commitment to support the production of biofuels – is in everyone's best interest. This isn't just about fighting poverty, or addressing climate change, or expanding trade, or raising living standards; it's about all of these things together. And it matters too much to give it all up. We have to get everyone back to the table, restart the negotiations, and make this deal work.

Biofuels and Trade: Peril and Promise for Policy-makers

Matthew Stilwell and Erwin Rose
Institute for Governance & Sustainable Development

The biofuels business is booming, with implications for agriculture and energy, environment, development and trade. Biofuels offer countries the potential to curb carbon dioxide emissions, reduce dependence on foreign fuels, and maintain domestic jobs and production in the agricultural sector. The promise of biofuels – particularly ethanol and biodiesel – has inspired everyone from government ministers to merchant bankers, car manufacturers to canola farmers.

Produced from sugar cane, cassava, wheat, maize and other starches, ethanol serves as a supplement to traditional petrol. Produced from canola, soybean, palm, jatropha and other vegetable oils and animal fats, biodiesel serves as a supplement to traditional diesel fuel. Both can be blended with their traditional counterpart or used 'neat' to power cars, trucks and other forms of transport. The conversion of these agricultural commodities to energy products could potentially link both industries – and revolutionise them.

The promise of biofuels…

Supporters of biofuels sing a number of praises. Security can be enhanced by reducing dependence on foreign energy supplies. As political strife, supply constraints, inclement weather and cartels drive up the price of oil, interest in biological alternatives is blossoming. While unlikely to replace fossil fuels, ethanol and biodiesel can supplement traditional fuels, helping to reduce dependence and increase energy security.[1]

Biofuels also offer environmental advantages. Climate change demands a shift from fossil to less carbon-intensive fuels. Local air pollution, such as particulates, hydrocarbons and carbon-monoxide, favours biofuels over their conventional competitors. And re-use of waste vegetable oils for fuel (e.g. from cooking) is cheaper and better for the environment. Carbon dioxide emission from biofuels varies widely, depending on the feedstock used, production processes, by-products and land-use changes – but under most scenarios is more favourable than fossil fuels.[2]

Biofuels could also bolster flagging agricultural markets, increasing demand, jobs and trade. By coupling with energy markets, farmers are transforming their industry from food production with limited returns to energy feedstock production with high prices and almost unlimited demand. In turn, by coupling with the agricultural markets, energy suppliers are discovering new inputs and opportunities – and new competitors. For countries like Brazil with considerable production capacity, biofuels present an interesting option for energy diversification and rural development.[3]

Biofuels – as an emerging commodity – are also a major earner for businesses and investors. The profitability of biofuels will depend on a range of factors including energy demand (which is growing) and other markets for feedstocks (e.g. food), by-products and traditional fossil fuels. It is generally assumed that increased production and trade will raise the price of feedstocks, but that the effects may vary markedly across crops. In general, the outlook for biofuels is assumed to be positive. As a result, business leaders such as Sir Richard Branson and Ted Turner are animated by new possibilities of "doing well by doing good".

… and the perils

Yet the picture is not all rosy. The benefits of biofuels have in some cases been overstated and critics have pointed – and rightly so – to a range of concerns. Most of these concerns can be addressed through sound policies, but the challenge of doing so should not be underestimated.

Supplying expanding energy markets will require a massive increase in the production of soybeans, sugar and other biofuel feedstocks. Intensifying agricultural production on existing land and increasing the use of irrigation and fertilizer risks further degrading soils and disrupting the water and nitrogen cycles. Extending production to new lands supplants other land-uses and can threaten marginal lands and forests, releasing carbon dioxide, destroying habitat and endangering biodiversity. Understanding the environmental effects of biofuels requires a careful analysis of impacts across their whole life-cycle from planting and production to the end-of-the-tailpipe.

Food security may also become a major issue. Maize, soybeans, sugar and other crops can serve as biofuel feedstocks, as animal feeds, or as food for human consumption. As energy prices increase, producers exploring multiple markets may respond by shifting existing output of maize or soy from food to fuel use. Or they may shift production from food to non-food feedstocks (e.g. jatropha). In each case, increased prices and reduced supplies may have adverse effects on the poor and hungry, particularly in net food-importing countries.

Broader concerns also arise in relation to poverty. In many countries, a shift towards agricultural-based fuels will raise questions about access to energy, management of agricultural lands, and control of water and other agricultural inputs. Increasing feedstock production, for instance, will often draw water from other agricultural, industrial and urban uses. A majority of the world's poorest live on agricultural land. They often lack access to energy, water and food. They are vulnerable to changes in the economy and ecosystems. Consequently, the way in which the transition towards agricultural-based fuels is managed will have profound implications for efforts to meet the poor's basic needs, advance their freedoms, secure their human rights to food and water, and to achieve international targets like the Millennium Development Goals.

Managing the biofuel transition

Faced with the challenge of climate change, moving from carbon-intensive fossil fuels towards renewable fuel sources is an unavoidable imperative. Though biofuels present both promises and perils, they will form an increasing part of our future. The challenge then is to manage the transition wisely.

Getting the best from biofuels will require the right combination of markets, incentives and institutions at the local, national and international levels. As markets for biofuels grow, so too will their international trade. Getting domestic policies right and ensuring trade rules are supportive is therefore an urgent priority.

Domestically, policy-makers need to carefully diagnose their constituencies' prospects as consumers and producers of biofuels, their current and future energy demands, and the relative benefits and burdens of biofuels versus other energy options. Policies for biofuels will form one part of a package of policies required to manage a transition in the agriculture, energy and related sectors.

In designing biofuel policies, policy-makers have a range of available tools. These include taxes and subsidies, information measures (e.g. labelling) and border measures such as tariffs and quotas, as well as simply mandatory biofuel use.

They can promote *supply* of biofuels by supporting research, production and distribution through, for example, low-cost loans, subsidies and tax incentives.

They can promote *demand* for biofuels by encouraging substitution by consumers away from traditional fuels through, for example, fuel tax exemptions, government procurement policies and biofuel use targets.

A third focus is the development of technical regulations, standards and certification for biofuels and other new energy products. These are required to inform consumers, and to provide incentives for biofuel production that is environmentally and socially sustainable.

The development of new policies also provides policy-makers with an opportunity to correct existing policy and market failures that skew energy and agricultural markets and may undermine biofuel development. Perverse energy subsidies and externalised costs, for instance, depress petroleum prices and retard the adoption of energy alternatives. Agricultural policies, too, skew the price of some agricultural commodities versus others, encouraging farmers to invest in economically or environmentally unsound feedstocks.

In the United States, for example, the extent to which fossil fuels and subsidies are used in the production of some biofuel feedstocks (e.g. maize) casts into doubt both their economic efficiency and environmental sustainability. At the same time, subsidies may be required in some countries to correct market failures and address environmental, energy and food security concerns.

Currently there is relatively minimal trade in ethanol, and even less in biodiesel. But as production increases so too will trade, and with it calls for harmonisation of standards and additional trade liberalisation. Addressing these issues will require co-operation at both the domestic and international levels.

Biofuels and international trade

A number of organisations are promoting the development of strong and harmonised international standards for biofuels. Standards can help to promote energy efficiency, ensure environmental and social sustainability, and support efforts to promote capacity building and compliance. Co-operation on harmonisation through organisations such as the International Organization for Standardization, and various private initiatives led by nongovernmental organisations and industry, can also ensure that exporters are not faced with numerous competing requirements in export markets, and that developing country concerns are addressed.

At the World Trade Organization (WTO), issues relating to biofuels arise in negotiations on agricultural and industrial products, and on trade in environmental goods and services. Biofuel-related technology transfer may turn up in discussions about intellectual property; biofuel incentive measures in discussions on subsidies; and biofuel standards may turn up in discussions of technical barriers. A key challenge will be to balance calls for liberalisation with efforts to develop the rules required to govern biofuel and related markets. On the one hand, strong rules are required to ensure social and environmental sustainability, on the other, efforts are required to prevent protectionism, particularly in rich countries.

Liberalising trade in biofuels and biofuel-related technology should therefore be carefully studied. WTO discussions have historically focused more on removing barriers to the flow of goods into rather than out of countries. Yet energy security depends as much on access to energy supplies as to energy markets. So issues will likely arise about export as well as import barriers.[4]

Ethanol and biodiesel, by some quirk of classification, fall on opposite sides of the line drawn between the WTO's agriculture and industrial negotiations. Ethanol, produced from plants, is clearly an agricultural product. But biodiesel, falling in a different part of the 'harmonised system' of product classification, is characterised as a chemical.[5] Though similar, ethanol and biodiesel are thus likely to be subject to different trade disciplines, influencing the respective policies available to policy-makers. Ethanol may also be disqualified from WTO discussions designed to liberalise trade in environmental goods and services, which focus currently on industrial products.

One particular concern about trade rules is that national measures favouring some biofuel feedstocks over others – based on whether their production or process methods are sustainable or unsustainable – could be challenged under WTO rules on non-discrimination or technical barriers.[6] Uncertainty about how these and other trade disciplines apply to domestic policies could also discourage, or "chill," the development of robust rules designed to spur sustainable biofuel industries.

In a multitude of ways, energy is unlike other sectors. It provides us with heat and light. It transports us around our neighbourhoods and the globe. It powers industry and drives all areas of economic development. So the potential benefits of trade liberalisation and rules should be carefully assessed in light of specific market and country characteristics – not simply assumed.

If the WTO is to meet its stated goals of raising standards of living, increasing the share of international trade for developing countries and supporting sustainable development, then any discussion of biofuels should be framed not merely in commercial terms, but in light of the paramount considerations of energy security, development and environmental sustainability for all its Members, especially developing countries.

All governments must examine carefully how to balance protection and liberalisation, while acting quickly to respond to the climate crisis. Experimenting with biofuel strategies will require flexibility, with appropriate treatment in international trade disciplines and domestic policy. In trade forums, consideration could be given to using discussions of special products and special and differential treatment to promote pro-poor and pro-development outcomes in developing countries.

Like all major transitions in human history, the transition to a low-carbon energy economy will create benefits and burdens, winners and losers. In a world serving as home to over 6 billion people, and faced with growing populations, expanding energy demands and declining ecosystem services, the management of this transformation will require a careful and conscious effort. Promoting a considered and coherent approach among the different actors working on biofuels constitutes an essential step in this direction.

Trade and Sustainable Development Implications of the Emerging Biofuels Market[1]

Simonetta Zarrilli
United Nations Conference on Trade and Development

The sharp increase in the price of petroleum products, the finite nature of fossil fuels, and growing environmental concerns especially related to greenhouse gas emissions and health and safety considerations are forcing the search for new energy sources and alternative ways to power the world's motor vehicles. Biofuels – fuels derived from biomass – may offer a promising alternative. Some analysts estimate that substituting up to 20 percent of mineral fuels consumed worldwide with biofuels is feasible by 2020.

Several developed and developing countries are establishing regulatory frameworks for biofuels, including blending targets. They are also providing various kinds of subsidies and incentives to support nascent biofuel industries. These developments are expected to spur a sustained worldwide demand and supply of biofuels in the years to come.

Increased production, use and international trade of biofuels may slow down the process of global warming and provide an opportunity for developing countries to diversify their agricultural production, raise the incomes of their rural communities and improve the quality of life of their populations. The uptake of biofuels may also enhance energy security and reduce expenditure on imported fossil energy.

Achieving efficiency in biofuel production

Efficiency considerations indicate that feedstock and biofuel production has to take place in the most competitive countries. Several developing countries – with land to devote to biomass production, a favourable climate in which to grow them, and low-cost farm labour – already are or may become efficient producers. Energy security considerations, however, may prompt less-efficient countries to engage in biofuel production irrespective of economic and environmental considerations.

Growth in international trade of biofuels

Ethanol – an alcohol produced by the biological fermentation of carbohydrates derived from plant material – can be used directly in cars designed to run on pure ethanol or blended with gasoline to make 'gasohol'. Ethanol features today as a very dynamic commodity with production and international trade recording strong growth. Global production of ethanol from sugarcane, maize and sugar beet increased from less than 20 billion litres in 2000 to over 40 billion litres in 2005. This represents around 3 percent of global gasoline use. Production is forecast to almost double again by 2010.

Brazil is the world's largest ethanol producer. Its 16 billion litres of 2005 production represented some 36 percent of the global total. The 15 billion litres of ethanol produced in the United States accounted for one-third of global production. China and India are distant third and fourth producers at 9 percent and 4 percent of world production, respectively.[2] International trade in ethanol underwent a strong expansion, from very limited exports in 2000 led by the US and the EU, to a dynamic market in 2004 largely dominated by Brazil. Today Brazil exports around 2.5 billion litres of ethanol and has about a 50 percent market share of global ethanol exports, with India and the US as its main export markets.

Other developing countries have benefited from the dynamism of the sector, including by taking advantage of existing preferential trade arrangements. South-South trade and transfer of technology are taking place. Conversely, there appears to be little international trade in ethanol feedstocks. Subsidies are likely to contribute to the expansion of domestically produced feedstocks in developed countries.

Biodiesel is a synthetic diesel-like fuel produced from vegetable oils, animal fats or recycled cooking grease. It can be used directly as fuel, which requires some engine modifications, or blended with petroleum diesel and used in diesel engines with few or no modifications. Biodiesel production outside of the EU is still limited and this explains the absence of significant international biodiesel trade. However, recent heavy investments in several countries indicate that production and international trade are poised to grow. Trade in biodiesel feedstocks is on the rise: the traditional structure of the plant-oil industry may also explain this trend. At present, biodiesel accounts for less than 0.2 percent of the diesel consumed for transport.

International trade in biofuels and related feedstocks may provide win-win opportunities to all countries: for several importing countries it is a necessary precondition for meeting their self-imposed blending targets; for exporting countries, especially small and medium-sized developing countries, export markets are necessary to initiate their industries. Nevertheless, biofuels face tariffs and non-tariff measures. These measures can offset lower production costs in producing countries, represent significant barriers to international trade, and have negative repercussions on investments in the sector. Moreover, export performance is often penalised by the graduation of the successful exporting countries from the preferential schemes. A more liberal trade regime would greatly contribute to the achievement of the economic, energy, environmental and social goals that countries are pursuing.

Making biofuel certification simple, fair and effective

With considerable increases in feedstocks trade expected, the sustainability of biomass production is becoming an increasingly important issue. Sustainability criteria are currently being considered for biofuels and related feedstocks. Certification systems that attest compliance with the established criteria would then be developed and certificates or labels would become preconditions for entering certain markets, especially developed markets where consumers may be particularly sensitive to environmental and/or social issues.

Concerns related to feedstock production relate to the risk that increasing biofuel demand will lead to the cultivation of previously uncultivated land. This could include land with a high environmental value or high level of stored carbon. There may be other cases in which the cultivation of biofuel raw materials could jeopardise the environmental advantages of biofuels. For example, some contractual arrangements with farmers may impose unfair working conditions on them. Some believe that these characteristics should be properly reflected in a system of certificates.

While ensuring sustainability is a legitimate goal, applying labelling or certification to feedstocks and biofuels remains complex. To ensure that certification does not become an obstacle to international trade, especially from developing countries, sustainability criteria should be developed through a transparent and fair process where countries, both producing and consuming, are effectively represented. To this end, support is needed to improve developing country capacity to play an active role in the development of criteria.

Criteria and related certification schemes must be easy to apply and flexible enough to take account of local conditions. Measures to ensure conformity can also act as powerful non-tariff barriers if they impose costly, time-consuming, and unnecessary tests or duplicative conformity assessment procedures. Developing countries have traditionally encountered difficulties in getting certificates issued by their domestic certification bodies recognised by the importing countries. In most cases they have had to rely on the expensive services provided by international certification companies. If certification or labelling requirements are established, they should be coupled with financing and technical assistance to improve the capacity and credibility of developing country certification bodies while enlarging certification access to medium and small-sized companies. In this context it is also worth recalling that no labelling schemes exist for fossil fuels or nuclear energy.

Maximising the sustainable development benefits of biofuels

Despite the potential of biofuels to contribute to sustainable development, their large-scale production in developing countries also entails challenges. Four issues have to be addressed: (i) the effect on other land-uses of production of energy crops; (ii) effects on food prices, particularly for net food-importing developing countries; (iii) the inclusion of small producers to ensure that they benefit from the new dynamism of the sector; and (iv) access to new energy technology to ensure the promotion of appropriate technology in developing countries.

The first concern involves land being increasingly devoted to fuel crops, with diversion from other purposes such as food and feed production, forestry, animal grazing or conservation. In the mind of some observers, this is a threat to the availability of suitable land for all purposes and engaging in large-scale energy-crop plantations may require a trade-off between lower food self-sufficiency for higher energy self-sufficiency. The subject of the possible competitive uses of land for the production of food, feed or fibre – as opposed to energy production – has been extensively studied in Brazil. In sugarcane production regions, evidence indicates that, contrary to competing with other crops, sugarcane production has favourable effects on other crops. This synergy is the result of two factors: (i) the additional income generated through sugarcane agro-industrial activity capitalizes agriculture and improves the general conditions for producing other crops; and (ii) the high productivity of cane per unit of land enables a significant production of cane, with a relatively small land occupation.[3]

Biodiesel can be produced from non-edible plants, such as Jatropha trees, which grow on marginal, degraded and even desert soils unfit for food or feed production. In the future, the plant's entire biomass will likely be transformed into fuels, as opposed to the small fraction currently used to produce energy. Cellulose-rich residues of agricultural production, such as straw, will increasingly be used as feedstocks. On the other hand, once the energy content is extracted from a plant, the residues can have a variety of applications, including as organic fertilizers, thus contributing to agriculture production. Agricultural production may also serve food and energy needs simultaneously. In the case of sugarcane, for example, sugar for human consumption is first extracted. Molasses is used to produce biofuels, and residues (bagasse) are burnt to produce electricity. Modern biotechnology can increase crop yields and modify plant characteristics to enhance their conversion to fuels. All these developments indicate that the risk of competition between crops for food as opposed to crops for energy may be less serious than perceived at present.

On the second issue, food prices are a major concern of poor people in developing countries, especially net food-importing developing countries (NFIDCs). If an expanding global biofuels market drives up commodity prices, the ability of consumers in NFIDCs to buy food may be imperilled. It is indeed possible that the price of crops used for biofuel production may increase. However, in the longer term, the income effects from energy crop cultivation and from having food prices rise from the present artificially low levels may offset the short-term negative impacts on poor consumers in developing countries.

The third main development concern relates to whether small and local producers will be able to benefit from the new dynamism of the sector. It is notable that there are economies of scale in the cultivation of many energy crops and in the transformation of feedstocks to biofuels. Most bioethanol feedstocks exhibit large economies of scale. For biodiesel crops there may be options for more decentralised production and processing. To facilitate small farmers' involvement, organisational support can be provided to help them participate fully in this production. Contract farming arrangements or co-operatives may be a suitable means of ensuring the participation of small producers. Promotion of small-scale production may be conducive to the creation of sustainable livelihoods, whereas large-scale export production might generate income but provide fewer livelihoods.

Finally, getting involved in research and development (R&D) and switching from crop to biofuel production will increasingly require relevant technology. The energy technology which has been used so far is by and large regarded as a mature and rather simple technology that developing countries can easily handle and accommodate to domestic needs. 'Next generation' technology, however, may become considerably more complex and expensive. It is questionable if most developing countries will be able to obtain such technology. The interaction of strong intellectual property regimes with access to technology, especially in developing countries, may also be problematic.

Developing country involvement throughout the whole biofuels production chain and the setting up of appropriate regulatory frameworks seem to be the key conditions for ensuring economic growth and diversification, as well as sustainable development. Possible instruments to make this happen include support to small producers and co-operatives; use of public procurement for increasing the market share of small producers and co-operatives; development and implementation of competition law; transfer of technology; and investment in R&D. Social equity, geographical distribution and poverty impacts should be essential components of domestic biofuels policies and not an afterthought. Environmental assessment of expanded production of energy crops should be a key element of domestic biofuel strategies. Depending on the specific agricultural, environmental, economic and energetic conditions that countries enjoy, biofuels can provide different options. They may be the ideal solution for some countries, but obviously not for all.

Certification as a Tool for Sustainable Bioenergy[1]

Jean-Philippe Denruyter and Jane Earley
WWF

Scientists now generally agree that in order to avoid dangerous climate change, global warming should stay below a 2° Celsius increase above pre-industrial temperatures. To attain this objective, global greenhouse gas (GHG) emissions would need to be cut by at least 50 percent in the coming decades. This can only be achieved through a variety of ambitious measures and policies on a global scale. These include, among others, significant improvements in energy efficiency and reduced consumption of energy across all sectors of society, combined with reduced deforestation and a growth in the production and use of a wide range of renewable energies. At the same time, a drastic reduction is needed in the use of fossil fuels, such as oil and coal. Bioenergy is expected to contribute substantially to the world's renewable energy mix in the coming years. WWF supports the development of bioenergy, provided this happens in a sustainable way.

This article discusses approaches that could ensure that the production of bioenergy is done in ways that are environmentally, socially and economically sustainable. The article analyses and proposes several criteria that could be taken into account for the development of certification schemes that would reward bioenergy procurers employing sustainable production methods. As demand for bioenergies grows, there is likely to be an increase in interest in certifying and/or labelling bioenergies.

Criteria for the certification of sustainable energy may be applied by government programs, such as those that provide subsidies, tax breaks, or other advantages for cleaner energy. Various initiatives on environmental and social assurance have been developed. For instance, the United Kingdom and the Netherlands are setting up certification schemes for local production and imports of biofuels. These initiatives should be encouraged, although in the future it would be desirable to see such initiatives taking place on a multinational basis. Consumers will also increasingly look for ecolabelling of energy supplies for heating and cooking fuel for their homes, or in selecting biofuels for automobiles. Accordingly, the issues raised here will be considered in programs at local, national, and international levels, and in both mandatory public programs and voluntary private sector initiatives.

Why do we need certification of bioenergy?

There is no doubt that the current hike in the price of oil has caused many countries to rethink their energy strategies. This has happened in the past, in the wake of the previous disturbances of the oil markets in the 1970s. Energy security is also of major concern around most of the globe. Against this backdrop, the demand for bioenergy has risen exponentially, especially for fuel ethanol and biodiesel.

There are good reasons for this increased demand. Bioenergy can be produced cheaply in many places, and with present technology can supply some of the increase in energy consumption that has led to increased greenhouse gas emissions. Clearly, bioenergy can contribute to the global energy portfolio in a greater percentage than had previously been considered and planned. However, if the bioenergy is not produced sustainably, its net positive contribution could be offset by: (i) carbon emissions equal to or greater than their present level; (ii) degradation of land important to the preservation of biodiversity; (iii) problems of soil mining and soil erosion; and (iv) intense pressure on scarce water resources.

Ensuring that agricultural production is sustainable is not a novel endeavour. Farmers and fishers have historically strived to maintain conditions on their land and in their waters that will enable them to continue to reap benefits from it. But population pressures, local and regional conflicts, overuse of chemicals, the sheer scale of modern agribusiness operations, and a number of other factors have grown to influence global agricultural supply chains in ways that can negatively affect sustainable management practices. For the most part, the environmental and social costs of global natural resources management are not effectively internalised.

Concerns regarding the effects of biofuels

WWF has particular concerns regarding:

- *Where bioenergy feedstocks are produced*: ensuring the integrity of high conservation value forests, floodplains, natural and semi-natural grasslands as habitats meeting the needs of the biodiversity they harbour;
- *How bioenergy feedstocks are produced*: using agricultural and forestry management techniques that can guarantee the integrity and/or improvement of soil and water resources;
- *The GHG emissions and carbon losses resulting from the production, processing and distribution of bioenergy*: ensuring that the technologies and management systems comply with good practice and can demonstrate they deliver GHG savings over conventional fuels; and
- *Food, land and water displacement*: Current biofuel commodities are also food and feed crops. The interest in biofuels has already led to price increases for many of these crops, which can challenge the capacity of the communities that depend on them to continue sourcing them for their own needs.

Certification as a tool to promote sustainability

Commodity certification is a relatively new concept, since most certification of agricultural goods has been designed for those goods that will be differentiated, and will therefore reach niche markets. But certification of the commodities that are produced in large volumes as feedstocks for bioenergy is already in place for some commodities, and is underway for others.

Such programs, and the new ones emerging, have many elements in common, but are also different in terms of their coverage, focus, and performance. Although they differ, they can all provide many advantages to purchasers and users of bioenergy who are concerned about sustainability. These include systems that can:

- enable verification of the source of the product;
- identify the method of production;
- report on the GHG emissions performance and energy balance of the product;

- report on how and to what extent key environmental goals were reached;
- report on how and to what extent key social goals were reached; and
- use the value chain to encourage good performance.

A good certification system for commodities being produced at scale will also have several other advantages. These include:

- a robust stakeholder process;
- a focus on key environmental and social effects;
- performance-based metrics to facilitate verification; and
- a verification process that conforms to relevant international standards.

A focus on key environmental and social goals will differ by commodity, because commodities vary in terms of where and how they are produced. Different environmental and social problems may be encountered in the production, processing and distribution of different commodities. However, if the key problems associated with each commodity are the focus of the certification, the programs will be simple and easy to apply.

Verification programs that conform to relevant standards, such as those of the International Organization for Standardization and the World Trade Organization, eliminate confusion and potential conflicts of interest, and provide consistency and transparency to both producers and users.

Critical energy and environmental criteria

Environmental criteria for bioenergy certification should address the key energy and environmental effects of bioenergy production. These include:

- GHG emissions;
- energy balance; and
- crop-specific and production-specific environmental effects.

Bioenergy use often sequesters much more greenhouse gas than it emits and can produce exponentially larger amounts of energy than is required for cultivation and processing. However, each feedstock is different. Many crops produce their best yields in specific regions of the world or require certain soil or water conditions. Some bioenergy crops only have a positive energy yield if other parts of the plant are used for energy production as well, such as bagasse from sugarcane and sorghum. Utilising agricultural-based biomass can compete in some ways with other uses including food for humans or livestock, building materials, or raw materials for industry. In order for biomass resources to be used most efficiently and effectively, all of these factors must be considered.

Carbon sequestration and energy balance are separate concepts which, while related, should be expressed separately for GHG accounting purposes.

Crop-specific and production-specific environmental effects of bioenergy feedstock production will also vary widely. Some crops, such as sugar cane, can have an adverse effect on water supplies if they are grown where they need irrigation, but have very little effect on water supplies where the culture is rain-fed. Others, like oil palm, can have negative effects on biodiversity if they are grown on land converted from primary forest, but can have positive biodiversity effects if grown on abandoned land. Likewise, if crops are rotated with other crops or grown without contributing to soil mining, soil erosion or the depletion of organic matter, they can make a positive contribution.

Social and economic criteria

Certification of bioenergy must also address critical social and economic criteria. These include the key social and economic issues associated with each crop. As with key environmental issues, these will vary somewhat from crop to crop, and from region to region.

Although social criteria for bioenergy production will differ, they will be rooted in international norms: the conventions of the International Labour Organization, and the extent to which agricultural production systems adhere to them. As with the environmental criteria, metric-based performance standards could be used to measure performance against objective social baseline performance, rewarding those who can demonstrate adherence and improvement.

Social criteria will also be rooted in the broader economic conditions under which bioenergy will be produced. In some countries, production of agricultural crops for bioenergy use may compete for land with production of the same or other crops for food. This could result in higher food prices. Certification criteria for bioenergy production would rate such crops in such places lower than the same crops in regions where such competition is not problematic.

Additionally, the provision of subsidies to producers of bioenergy crops, where those subsidies result in harm to otherwise competitive producers in developing countries, would ideally not be rewarded under a bioenergy certification program that incorporates standards for economic justice. Finally, certification of production systems that reward local communities for settlement of land rights and tenure disputes, fair treatment of migrant labour and inclusion of small farmers in bioenergy production systems would provide producers with the economic benefits accruing from participating in the system and provide consumers with the satisfaction that they are not contributing to social injustice.

Greenhouse gas certification under the Kyoto Protocol

WWF sees a key role for the United Nations Framework Convention on Climate Change. A reduction of GHG emissions has been mandated through the Kyoto Protocol. Under the current system, GHG leakage cannot be avoided when international bioenergy trade occurs, as no GHG accounting system exists for bioenergy. The Protocol provides a multinational legal spur to solve this problem, as governments adopt national legislation to implement policies that achieve their Kyoto commitments. Great care must be taken to ensure that national policies that discriminate among biofuels based on GHG emissions must be tailored carefully to ensure compatibility with international trade rules.

Moving forward

Certification of sustainable production is not the only way to help improve the sustainability of agricultural practices, but it is potentially a first step to encourage producers to achieve higher standards of production in areas where such performance is not defined, not encouraged, not enforced, and/or not compensated by the market.

Bio-ethanol from Sugarcane and Sweet Sorghum in Southern Africa: Agro-Industrial Development, Import Substitution and Export Diversification[1]

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Modern Bioenergy for the Southern African development community region

Biomass accounts for the greatest share of primary energy consumption among renewable sources and represents the main source of energy in sub-Saharan Africa. However, nearly all of this biomass is consumed for traditional uses in cooking, heating, and for small industries, in the form of fuel wood, charcoal, and residues from agricultural and industrial production. Adoption of more efficient and higher quality 'modern' bioenergy options is an important element in the global transition to clean and sustainable energy.

On average, biomass in tropical and sub-tropical climates is five times more productive, in terms of photosynthetic efficiency, than biomass produced in temperate regions. Sub-Saharan Africa has significant bioenergy potential due to low population densities in many areas, large areas of suitable cropland and pasture land, and the low productivity of existing agricultural production systems. The lack of employment opportunities in rural areas and the high labour intensity of bioenergy – relative to other energy supply options – suggest excellent opportunities for rural development.

Harnessing the potential of modern bioenergy requires regional co-ordination with respect to economic policy, trade, resource practices and regulations. As a large region encompassing fourteen countries that is undergoing a process of economic integration, the Southern African Development Community (SADC) is therefore of special interest. The land available in the region is quite significant; and the percentage of land cultivated is relatively low (see Table 1). The process of economic integration in SADC can both facilitate, and benefit from, the expanded production of modern biomass and biofuels. The domestic benefits will include health improvements, reduced regional emissions, and the creation of rural livelihoods. The macroeconomic impacts include foreign exchange savings and reduced dependence on imported sources of energy. There is also significant potential for greenhouse gas (GHG) emission reductions from expanded use of modern bioenergy.

Fuel ethanol production

The case of bio-ethanol is of special interest for southern Africa due to the region's long experience with sugarcane and the impact of recent competitive pressures that have increased economic incentives for sugar producers to diversify into bioenergy and other areas. The possibility of developing an export market for bio-ethanol from the region stems from the increased demand for biofuels in Organisation for Economic Co-operation and Development (OECD) countries and the comparative advantages of SADC members.

An alternative crop that is being considered in some future scenarios is sweet sorghum, which is a sorghum variety that has higher relative sugar content than grain sorghum, making it suitable for ethanol production as well as a source of fibre. It has a much shorter growing period than cane – about four months – and has much lower water requirements and better drought resistance properties. It does not have good properties for crystalline sugar production and consequently is not yet grown for commercial uses. It is grown from seeds rather than plantings, making it a more flexible alternative compared to sugarcane and more suited to small-scale farming.

Rising oil prices and falling prices for sugar exports make ethanol production more commercially attractive than sugar production in SADC countries, and will stimulate a shift from exporting sugar to producing ethanol for domestic use and/or export. Since typical ignition-spark engines are optimised for petrol, the substitution of ethanol results in a lower output, generally between 65 percent and 80 percent. At or above the minimum efficient scale, and in the absence of import tariffs, bio-ethanol from SADC countries appears to be competitive with petrol when oil prices rise above US$45-55 per barrel. With current import tariffs in the EU and the US, the competitive price is US$60-70 per barrel.

Market scenarios and strategies

The potential to expand cane production in the SADC region depends upon alternative land-uses, vegetative cycles, soil properties, and climate conditions as well as the potential effect of such expansion on the availability of water and other key resource inputs. Given these considerations, the potential for expansion is quite limited in Mauritius, South Africa, and Zimbabwe – which are the three countries that currently account for two-thirds of the SADC's sugarcane production. Environmental issues such as salinisation are key limiting factories in other countries, such as Swaziland. Other countries such as Angola and the Democratic Republic of Congo that have suitable land and climatic conditions seem unlikely to expand in the near-term due to political instability. Madagascar has some expansion potential, although concern over deforestation may limit some options. The countries that appear to have the greatest potential for expansion are Malawi, Mozambique, and Zambia.

Table 1: Land-use summary for the Southern African Development Community (SADC) region and Brazil, China, India and the United States

Country/Region	Total land area	Forest area		Agricultural area (a)		Cultivated area (b)	
UNITS:	Million ha	Million ha	share of total land area	Million ha	share of total land area	Million ha	share of total land area
Total SADC	**964.1**	**368.3**	**38%**	**433.2**	**45%**	**53.4**	**5.5%**
Brazil	845.9	543.9	64%	263.6	31%	66.6	7.9%
China	932.7	163.5	18%	554.9	59%	154.9	16.6%
India	297.3	64.1	22%	180.8	61%	169.7	57.1%
United States	915.9	226.0	25%	409.3	45%	175.5	19.2%

ha = hectares   Source: FAOSTAT 2005 (United Nations Food and Agriculture Organization)

Note: (a) Agricultural areas include temporary and permanent pastures, permanent crops, and temporary crops. The figures do not provide any indication of the suitability or availability of the land for particular purposes.

Note: (b) Cultivated areas includes permanent crops and temporary crops

Table 2: Bio-ethanol production potential from sugarcane and sweet sorghum (million litres)

YEAR	2005	2010	2015	2020	2025	Average Annual Increase
Scenarios for ethanol production in SADC	939	6443	13787	23650	36996	20.16%
SADC petrol demand - projections (energy basis)	203	2475	4315	6155	8195	20.30%
assumed % ethanol:	***1%***	***10%***	***15%***	***20%***	***25%***	
Remaining allocation for export market	**736**	**3968**	**9472**	**17495**	**28801**	**20.12%**
Relative to demand in other regions (volume basis)						
China	1%	4%	9%	15%	21%	
Japan	1%	7%	16%	29%	48%	
United States	0%	1%	2%	3%	4%	
EU15	0%	2%	6%	10%	16%	

Sources: own calculations and demand projections from IEA 2005 (International Energy Agency)

Several market issues will impact the future direction of the sugar industry in southern Africa and its potential for becoming a major producer of renewable energy. The changes in the sugar industry through reforms in EU sugar policies as well as World Trade Organization trade reforms will most likely result in some consolidation of the industry; the lower sugar prices resulting from the removal of preferential markets will cause shifts to the regions with better conditions and higher agricultural productivity. At the same time, rising oil prices and energy security issues are providing incentives for expanded bioenergy production. Market scenarios therefore depend on three key factors: (1) future demand for sugar; (2) future demand for biofuels; and (3) future demand for alternative sources of electric power.

It is useful to compare the total bio-ethanol that could be produced from sugarcane and sweet sorghum with other international markets, including the EU, the US, China and India. The EU biofuels directive aims to increase the share of biofuels to 5.75 percent by 2010 and as much as 20 percent by 2020. The high cost of bio-ethanol production in Europe means that an import strategy would probably be cost-effective in meeting this goal. Table 2 gives the potential production from sugarcane and sweet sorghum in comparison with international markets, and future regional projections.

The potential bio-ethanol available is fairly significant in terms of the EU market, more than enough to meet the EU targets. The land required for the expansion turns out to be a rather small amount of the total agricultural land available, due to the high productivity of both sugarcane and sweet sorghum. In global market terms, the ethanol production is less significant, due mainly to the tremendous consumption in the US and the expected increases in consumption in China and elsewhere.

Implementation and investment

The countries of southern Africa can benefit from the experiences of Mauritius, India, and Brazil with respect to electricity and ethanol from sugarcane. In addition to scaling up production, implementation strategies can be based on South-South technology transfer platforms to the benefit of global development of bioenergy resources. Sugarcane and other crops with high energy potential offer a potential comparative advantage to southern Africa in the industrial development of bioenergy. However, significant investment will be needed to upgrade facilities in order to harness the cane resource and stimulate industrial development.

The establishment of a new estate and sugar factory processing 2 million tonnes of cane per year would cost US$200-300 million; the capital costs for an ethanol distillery are in the range of US$50-80 million; the costs of a cogeneration plant are about US$1000-1200 per installed kilowatt (kW) or about US$70-84 million for a 70 megawatt (MW) plant. Further costs for transport infrastructure and storage would also be incurred. It will be difficult to attract such investment to the region, where poor infrastructure and high interest rates often pose formidable barriers. However, additional investment could be leveraged through carbon finance, i.e. to leverage other investments using the market value of expected GHG emission reductions in existing carbon markets.

The only established export market is currently for raw or refined sugar, which is still governed by preferential agreements. Export markets for bio-ethanol are small and generally aimed only at the potable ethanol market or the industrial market rather than the fuel ethanol market.[2] Large-scale export to the US or the EU faces trade barriers in the form of agricultural tariffs and/or domestic producer credits. Import tariffs and non-tariff barriers to trade present a much more significant barrier than transport and distribution costs, due in part to the low cost of shipment by sea. In Brazil, efforts are underway to reduce transport costs even further by building a pipeline, or adapting oil pipelines where feasible. Reduction in tariffs and other trade barriers along with the loss of preferential sugar markets will create incentives for South-to-North exports of bio-ethanol; production costs of ethanol from sugarcane are lower than is the case in temperate regions where feedstocks such as corn and wheat are used, and furthermore the GHG mitigation benefits are several times higher.

Conclusions

Programs and policies for the development of cane and sweet sorghum as bioenergy resources for the SADC region should start by learning from the successful undertakings that have been realised elsewhere, particularly the Brazilian fuel ethanol experience, the Mauritius efforts in cogeneration, and Indian programs in various co-products. Above all, it would depend on availability of markets and the political commitment of the countries to sustainable energy for development. Common decisions and targets could be formulated at the level of the SADC.

The exploitable bioenergy potential of the sub-Saharan African region is significant. Economic integration in southern Africa through the SADC makes the southern African region particularly appealing for bioenergy expansion, given the efforts at lowering trade barriers and the harmonisation of standards and regulations in the SADC. One area of bioenergy development that offers some opportunities both for domestic markets and international export markets is bio-ethanol. The region has a fairly strong industrial base in the sugar industry. Expansion of sugar production is unlikely to be rewarding, given decisions in recent years to reduce the preferential sugar market access to African, Caribbean, and Pacific countries. The land requirements are modest, even when a major export program is considered. The high productivity of sugarcane and sweet sorghum also results in significant environmental advantages in addition to the overall economic and industrial development benefits.

Opportunities for Biofuel in Select Asian Economies: Emerging Policy Challenges

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Introduction

Biofuels have been used for many years throughout the world. However, biofuels have long been perceived as less competitive on a large scale compared to their fossil fuel counterparts, and expensive and inconsistent in quality and supply. Now, increasing crude oil prices, growing awareness of the adverse environmental impacts of fossil fuels, and strengthened international commitments to the Kyoto Protocol are motivating a growing number of countries to implement 'agro-energy' policies.

This has prompted a much more substantive focus on biofuels across the globe. About 70 percent of global ethanol production comes from Brazil and the US (followed by China), and ethanol has become part of these countries' national strategies for economic and agricultural development. In the case of Brazil, it is also being considered as a prime policy prescription for rural development. Both the US and the EU have launched major policy and production initiatives on biofuels.

Several countries are funding programs to identify less expensive and more effective raw materials and production techniques. The application of new technologies is helping make biofuels more cost-effective, consistent in quality, and available for large-scale commercial supply. Technological advances are moving producers beyond first-generation biofuels, based on food crops, to more sustainable options that utilise cellulose waste and biomass while minimising the impact on food security and forest cover.

In this paper, we first look at the experiences of India, Thailand, China and Malaysia in developing green enterprises for rural development through sustainable biofuel production. We then examine the technological challenges faced in developing alternative sources for biofuel, and finally set out some policy recommendations.

Biofuels in Asia

In Asia, the production of biofuels is at the intersection of agriculture (as the predominant economic sector) and energy (as national economies are affected by increasing oil import bills). As a result, several governments in Asia have launched programs to promote production of biofuel crops as a way to cut costly fuel imports. It may be worth analysing whether the production of ethanol and biodiesel will be more expensive than oil imports given the costs of importing the technological expertise required to upgrade biofuel production.

India

India has set up a National Biofuel Development Board (NBDB), headed by the prime minister. The NBDB, which has yet to become operational, would fix a minimum support price for the conversion of non-edible vegetable oil seeds into biodiesel and for other biofuels such as ethanol. India has recently announced a policy of five percent blending of ethanol with gasoline. Oil marketing companies would require 500,000 kilolitres of ethanol for implementing this national program. According to estimates from the Wasteland Development Board, around 107 million hectares of land is available for reclamation, which could be used for growing energy crops such as wood, leafy biomass, etc.

In January 2003, five percent ethanol blending in petrol was made mandatory in nine states. Unlike in Brazil, sugarcane juice is not directly used for ethanol production in India. Instead, ethanol in India is made from molasses, which is estimated to yield 2 million kilolitres of alcohol per year. Of this, about 0.8 million kilolitres of ethanol can be spared for blending in petrol. If all the 0.8 million kilolitres of ethanol is made available, it could replace around nine percent of current petrol requirements.

A few state governments have promoted biofuel more actively than the federal government. While taking the lead on development plans, states have identified a clear role for the private sector. Chattisgarh, for example, has established a Biofuel Development Authority with clear guidelines for private sector participation. Other leading states are Andhra Pradesh and Tamil Nadu.

Thailand

In Thailand, the government has constituted a National Biofuel Committee (NBC) to lay out a roadmap for production. The NBC is supported by the Ministries of Finance, Agriculture, Energy, Industry and Science and Technology, as well as universities. The statutory requirement is to mix gasoline with ten percent ethanol. The government has provided tax breaks for the sugar industry to produce ethanol, aiming to achieve an ethanol production capacity of 4.11 million litres/day by the end of 2006 and a biodiesel output of 8.5 million litres/day by 2012. Thailand, the world's top cassava producer, already converts some of the vegetable into fuel ethanol. The national goal for the consumption of biofuel is 1600 million tonnes of oil equivalent (Mtoe) by 2011, totalling 3 and 8.5 million litres per day of ethanol and biodiesel, respectively.

China

As the supply-demand gap of energy availability widens in China, the Chinese government is engaged in identifying new supply sources. The economy, which is growing at nine percent a year, has an energy demand growing at 15 percent annually, and oil imports growing at 30 percent annually. China is now the world's second-largest consumer of energy and accounts for 12 percent of the global energy demand. Coal continues to be the main source of energy (at 65 percent).

The Chinese government is promoting ethanol and financing nuclear, hydroelectric and solar power, aiming to increase renewable energy sources from seven percent currently to 15 percent by 2020. This also includes efforts to produce coal-to-liquid (CTL) technology. China is now in a position to export ethanol and is expected to export approximately 500,000 tonnes in 2006, mainly to the United States.

The government has plans to promote biofuels, targeting replacement of five percent of its total gasoline consumption with nearly 5 million tonnes of ethanol in the next five years. Tax incentives would exempt ethanol producers from consumption and value-added taxes. China is set to increase its ethanol production to four million tonnes by 2010 from a recorded output of 920, 000 tonnes in 2005.[1] In the 11th Five Year Plan (2006-2011), China has proposed to set aside US$101.1 billion by 2020 to meet 15 percent of its transportation energy needs through the use of biofuels, which corresponds to 12 million tonnes.[2]

The Chinese government subsidises production at four biofuel plants with a combined annual capacity of 1.02 million tonnes, or about 0.5 percent of projected corn and wheat output this year.

Malaysia

Malaysia has emerged as an important catalyst in the adoption of biofuels in Asia. The government instituted a five percent mandatory blending policy in October 2006, and has proposed to set up a RM 500 million (US$136.7 million) fund to develop palm oil-based biodiesel production. It also envisages a major role in supplying feedstock to processing units in neighbouring countries, such as in the Archer Daniels Midland US$29 million biodiesel facility in Singapore for which a raw materials agreement was signed with a Malaysian firm.

In order to maintain a balance between the various end-uses of palm oil, licenses for biodiesel production have been issued to only a few companies. The government has launched a scheme to establish biofuel parks in different parts of Malaysia, promoting biofuel research and refinery plants in geographical proximity.

Technological challenges

The scope of biotechnology-based products has greatly expanded, raising many issues. At the institutional level, these issues include the development of synergistic mechanisms for multi-state/multi-institutional collaboration and the building strong regional and national support. At the policy level, the issues range from the role of genomics in the emerging bioenergy and bioproduct economy, to the involvement of private institutions and economic development activities. In the context of developing countries, where the agro-economy is largely struggling with productivity stagnation in key crops, the bioproduct-based agro-revolution offers a new development paradigm for these economies.

The wide adoption of bioenergy and other bioproducts may provide a boost to the economic growth of rural economies. Given consumer resistance to food and feed from genetically modified (GM) technology, biofuel development may be an appropriate application of this technology to facilitate agriculture and industry convergence based on biomass. A GM-based industry would help create good quality jobs near rural communities and close to the raw material itself. This would also help reduce dependence on imported fuel and decrease emissions of greenhouse gases. However, entrepreneurs entering in these areas would need support for the initial investments.

Second-generation biofuels

Second-generation biofuels would involve cellulosic biomass, the fibrous, woody, and generally inedible portions of plant matter. Given the current level of technology, this process is likely to happen only gradually. In the United States, it is expected that the cost of production of this type of biofuel would be US$1.07/ gallon of ethanol by 2012, offering the potential to displace up to 30 percent of the nation's current gasoline use by 2030.[3]

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in Hyderabad, India, has launched a major research project to identify possible options for feedstocks so that the cost of ethanol production may be reduced without affecting food security. ICRISAT has identified a little-known dryland crop called sweet sorghum, a variety of sorghum which stores large quantities of energy as sugar in its stalks while also producing reasonable grain yields.[4] ICRISAT proposes to build on efforts made by India's National Research Centre for Sorghum (NRCS), which has developed excellent open-pollinated varieties and some hybrids of sweet sorghum. Many of these hybrids are also less photoperiod-sensitive so they can be grown year-round, smoothing out supply variations for the ethanol production facilities.[5]

Policy recommendations

The demand for biofuel is set to expand in the Asia-Pacific region, as more governments implement mandatory standards for blending biofuel and gasoline. There is a need to launch Asia-specific fora to help developing economies to assess their biofuel potential and to facilitate resource mobilisation. These fora can also promote cross-national experience-sharing and help overcome non-tariff measures on exports of biofuel-related products. These gatherings could also be used to identify innovative financing mechanisms, such as loan guarantees, and Clean Development Mechanism (CDM) projects under the Kyoto Protocol.

Asian developing countries are spending astronomical amounts on the import of fossil fuels; biofuel offers a strong alternative. However, caution is warranted because the combination of population growth and increased demand for both biofuels and food will put extraordinary pressure on land. Significant price increases for agricultural products may have a negative impact on the net food-importing developing countries. Adoption and production of biofuels on a large scale may also have an impact on biodiversity, as is being discussed with respect to rainforest deforestation in Brazil and Borneo.[6] Addressing the negative aspects of biofuel production may require new strategies for technology development. Private industry and governments must work out matters related to intellectual property rights. Institutions such as ICRISAT may be asked by national governments to share their experiences and the results of their technology development efforts. Attention to the social and economic impacts of unique agricultural systems for biofuel production must also be addressed.

At the regional and sub-regional levels, the quality of products available for planting purposes must be assured, as some people try to pass off uncertified seeds as `hybrids' at higher prices in many rural areas in India. Finally, a more pragmatic view of biotechnology research and development expenditures can identify opportunities for many stakeholders to share the cost of advanced technology development. This may eventually prove to be an important investment for the Asian region.

The Brazilian Experience with Sugarcane Ethanol

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Trade, energy, environmental protection and sustainable development are issues that are closely related. The concept of sustainable development, as defined by the 1987 Brundtland Commission, calls for the preservation of natural resources for the generations to come. This requires us to address the depletion of fossil fuel reserves and the rising atmospheric levels of greenhouse gases. Brazil has found that biofuels, particularly sugar-based ethanol, offer affordable alternatives to oil and gas that also provide environmental benefits.

Biofuels are a tradable form of renewable energy used mainly for transportation. They can be produced locally in most parts of the world (especially developing countries with high external debts due to oil product imports) and conveniently stored and transported. They avoid net emissions of carbon dioxide and tackle efficiently the problem of climate change by replacing gasoline and diesel, the main fuels used in transport today. In this way they can contribute to the achievement of the Kyoto Protocol goals.

The Doha Ministerial Declaration reflects the determination that negotiations on trade liberalisation in environmental goods and services (EGS) should enhance the mutual supportiveness of trade and environment. While developed countries expect greater access to emerging environmental markets for their export-oriented industries, developing countries look for their sustainable development in economic, social and environmental terms. Achieving this set of goals requires an easier access to environmentally sound technologies and expertise, strengthened capacity and an improved market for their environmentally preferable products and services.

EGS are a central issue that cannot be dissociated from the challenges of the United Nations Millennium Development Declaration and Millennium Development Goals, the 2002 Johannesburg World Summit on Sustainable Development (WSSD), and the United Nations Framework Convention on Climate Change (UNFCCC). Discussions at WSSD made clear that policies for renewable energy are essential to achieve global sustainable development and that free international trade is a necessary tool for such a goal. Environmental protection, job creation, alleviation of the external debts of developing countries and security of energy supply are some of the key issues that make renewable energy very appealing as a real contribution toward meeting the sustainable development challenge.

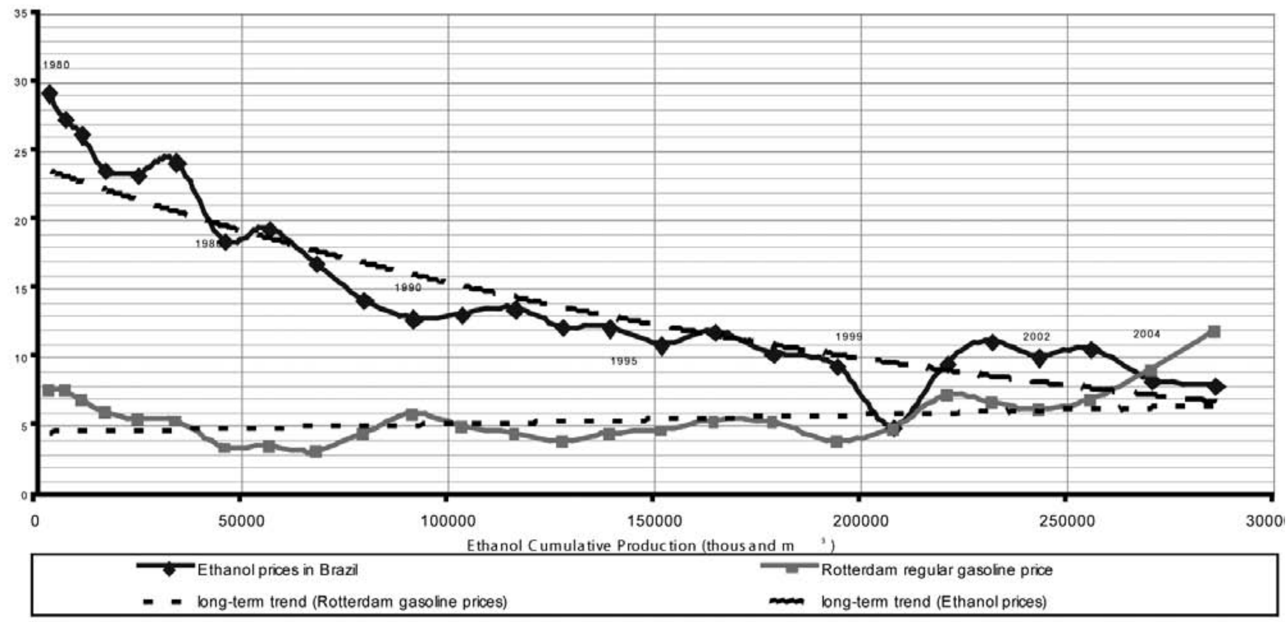
The Brazilian Energy Initiative and Brazilian Alcohol Program

A very common argument against renewable energy sources is their lack of economic competitiveness, mainly compared with fossil fuels. Addressing this argument is precisely the objective of the Brazilian Energy Initiative (BEI), which proposed a minimum global target of 10 percent of energy from renewable sources, with the possibility of trading renewable energy certificates among countries. The initiative aims at pushing governments to introduce renewables, even if they cost more at present. A mandatory target for renewable energy acts on the demand side of large markets in developed countries, dropping costs through the 'learning curve effect'.

One of the most important examples of learning curves is provided by the Brazilian Alcohol Program (PROALCOOL). This program was established in 1975 for the purpose of reducing oil imports by producing ethanol from sugarcane and achieved positive environmental, economic and social results. It has become the most important biomass energy program in the world.

In the 1975-2002 period, Brazilian production of ethanol increased from 0.6 to 12.6 million cubic metres, due to productivity of sugarcane crops. In Brazil, ethanol is used in cars as an octane enhancer and oxygenated additive to gasoline (blended in a proportion of 20 to 26 percent anhydrated ethanol in a mixture called "gasohol") in dedicated

Figure 1: Price paid to alcohol producers vs. Rotterdam gasoline prices.



Note: Prices were converted into US Dollar (US$) per gigajoule (GJ) of each fuel, assuming the low heating value of each one.

Source: Goldemberg et al, 2003.

hydrated ethanol engines or in flexible fuel vehicles. Since February 1999, prices have not been controlled by the government and hydrated ethanol is sold at 60 to 70 percent of the price of gasohol at the pump station, due to significant reductions in production costs. These results show the long-term economic competitiveness of ethanol fuel when compared to gasoline (as seen in Figure 1).

Locally produced, inexpensive fuels

The Brazilian experience in biofuels production shows that it is possible to produce such fuels in a sustainable way and at a low cost. If we consider the steady decrease of production costs — as happened in the case of Brazilian ethanol — biofuels from developing countries could be commercialised in developed countries, contributing to the reduction of carbon emissions with low economic impacts.

All the energy needs of sugarcane ethanol plants are supplied with renewable bagasse, a by-product of sugarcane crushing, which is burned in boilers. This is the main reason why the energy balance of sugarcane ethanol is highly positive (8:1 to 10:1), when compared with other crops. This positive energy balance is also one of the reasons for the low cost of this biofuel.

Applying the Brazilian lessons

Sugarcane ethanol has proven to be economically competitive. The Brazilian experience can be repeated in other developing countries, enabling them to enhance their energy security with locally produced fuels and to export biofuels to developed countries. Better environmental awareness in importing countries could, through trade and the search for innovative solutions, lead to greater internalisation of environmental externalities in exporting countries. Gains in competitiveness could offset increases in costs for adaptation to the new standards.

The land-use implications of biofuel production are of concern. We have found that Brazilian sugarcane crops have not created pressure on the Amazon, nor other native forests, thanks to strict environmental legislation and enforcement. Amazon deforestation is indeed a problem to be addressed but the main driver comes from soy crops, not from sugarcane. As agricultural land becomes more profitable due to high returns for biofuel sales, strong management regimes must guard against deforestation. Competition regarding the use of land for biofuels as opposed to what is required for food production must also be avoided.

Ethanol is now receiving a great deal of attention because of its substantial potential for replacing fossil fuels and reducing greenhouse gas emissions. However, great care must be taken to ensure that biofuel production is managed to minimise its potential negative environmental impacts, including but not limited to greenhouse gas emissions. Lifecycle assessments should be conducted in the agricultural phase, as well as in the refining process and other aspects of industrial applications. Rigorous assessment should guide policy and practice for each type of fuel. Brazil has found that with proper management, biofuels can play an important role in providing affordable energy while protecting the environment.

REFERENCES:

Goldemberg, J.; Coelho, S.T.; Nastari, P.M.; Lucon, O. (2003). *Ethanol learning curve - the Brazilian experience*. Biomass and Bioenergy, Vol 26/3 pp 301-304.

OECD (2006) Identifying Complementary Measures to Ensure the Maximum Realisation of Benefits from the Liberalisation of EG&S: Case study of Brazil. Organisation for Economic Co-operation and Development. Report COM/ENV/TD(2003)116/FINAL

UNCTAD (2005) Biofuels – Advantages and Trade Barriers. United Nations Conference on Trade and Development. Report UNCTAD/DITC/TED/2005/1

ENDNOTES:

Transition to a Sustainable Energy Future: Global Trade Rules and Energy Policies

1 World Energy Outlook (2005).
2 This includes Canadian non-conventional reserves. Excluding Canada, this estimate of OPEC share rises to 84 percent. Original source: Oil and Gas Journal.
3 Gibbs, M. (2003), Energy Services, Energy Policies and the Doha Agenda in Energy and Environmental Services: negotiating objectives and development priorities, UNCTAD, 2003.
4 Some of these practices included dual-pricing practices and resulting subsidies; export restrictions and export taxes; discriminatory procurement, etc. Note by the Secretariat, Summary of statements and proposals made concerning negotiations on natural resource-based products, MTN.GNG/NG3/8, November 13, 1987, para. 5.
5 Gibbs, op. cit.
6 SCM Agreement, Annex II Guidelines on Consumption of Inputs in the Production Process, footnote 61 to the SCM Agreement.
7 See Appleton, A. (2005), The Agreement on Technical Barriers to Trade, in The World Trade Organization: Legal, Economic and Political Analysis, Vol. I.

Climate Change Benefits from Environmental Goods and Services

1 UNCTAD (1995), Environmentally Preferable Products (EPPs) As a Trade Opportunity for Developing Countries. UNCTAD/COM/70, December.
2 OECD/Eurostat (1999), The Environmental Goods and Services Industry, Manual for data collection and Analysis.

Asia and Pacific: Policies for a Sustainable Energy Transition

1 The paper builds on a research note involving as other authors Akira Ogihara, Peter King and Hideyuki Mori from the Institute for Global Environmental Strategies.
2 See http://www.iges.or.jp/APEIS/RISPO/inventory/db/index.html for the case study database.

Biofuels and Trade: Peril and Promise for Policy-makers

1 World Bank (2005), Potential for Biofuels for Transport in Developing Countries, ESMAP Knowledge Exchange Series, Number 4, February 2006.
2 OECD Trade Policy Series (1999), Environmental and Energy Products: The Benefits of Liberalizing Trade.
3 Ted Turner (2005), Speech to WTO Public Forum, 25 September 2006, Geneva, Switzerland.
4 ICTSD (2006), Transition to a Sustainable Energy Future: The WTO Rules and Agreements and their Relevance to the Energy Sector.
5 We are grateful to Dale Andrew, OECD, for this insight.
6 UNCTAD (2006, forthcoming).

Trade and Sustainable Development Implications of the Emerging Biofuels Market

1 This article is an abridged version of the UNCTAD study: The Emerging Biofuels Market: Regulatory, Trade and Development Implications, UNCTAD/DITC/TED/2006/4, New York and Geneva.
2 Oxford Analytica, North America/Brazil: Ethanol in fuel market, 20 July 2006.
3 Nastari P.M., I de Carvalho Macedo and A. Szwarc, Observation on the draft document entitled "Potential for Biofuels for Transport in Developing Countries", The World Bank Air Quality Thematic Group, July 2005 at 22, found at: http://www.unica.com.br/i_pages/files/ibm.pdf, visited on 23 March 2006.

Certification as a Tool for Sustainable Bioenergy

1 This paper draws from a Background Paper written by Jane Earley and Sergio Trindade for the "International Conference on Sustainability Criteria for Bioenergy" organised by the United Nations Foundation and the German NGO Forum Environment & Development, Bonn, Germany, 12-13 October 2006 (unpublished).

Bio-ethanol from Sugarcane and Sweet Sorghum in Southern Africa: Agro-Industrial Development

1 This article is based on the work program of the Cane Resources Network for Southern Africa (CARENSA). All references are taken from the CARENSA work program and can be found on the website (www.carensa.net).
2 The potable market includes those buyers who provide ethanol to producers of spirits and alcoholic beverages. The industrial market includes applications in chemical, pharmaceutical, and other industries. Both the potable and industrial markets require higher quality or purity and therefore command a price premium.

Opportunities for Biofuel in Select Asian Economies: Emerging Policy Challenges

1 Sydney Morning Herald (2006), China set to boost Ethanol Output, August 14.
2 Financial Express October 4th 2006.
3 USDE (2006), Breaking the Biological Barriers to Cellulosic Ethanol: A Research Roadmap Resulting from the Biomass to Biofuels Workshop December 7-9, 2005, Rockville, Maryland, United States Department of Energy.
4 Dar, W.D. (2006), Biofuel Crops: Power to the Poor, International Crops Research Institute for Semi Arid Tropics (ICRISAT) Hyderabad.
5 ibid.
6 ICTSD (2006), Ted Turner Promotes Biofuels at WTO Forum; Urges Governments to 'Fight One More Round' For Doha, *Bridges Weekly Trade News Digest* Volume 10 Number 31 27th November, ICTSD, Geneva.