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Environmental and Energy Products

THE BENEFITS OF LIBERALISING TRADE

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Foreword

In the latter half of the 1990s, the OECD's Joint Working Party on Trade and Environment (JWPTE) carried out a series of analytical studies, based on the OECD/Eurostat manual that had recently been drawn up to support statistical surveys on national environment industries. A seminal volume published in 2001, *Environmental Goods and Services: The Benefits of Further Trade Liberalisation*, assembled these studies and included, in an annex, an illustrative list of "environmental goods", with their Harmonized System codes. This list has since become a reference point for analytical studies, as well as a key point of departure for input into the ensuing WTO negotiations. Indeed, WTO ministers at the 2001 Doha Ministerial Conference mandated negotiations on "the reduction or, as appropriate, elimination of tariff and non-tariff barriers to environmental goods and services". However, since the relevant paragraph 31(iii) of the Doha Ministerial Declaration stops short of defining "environmental goods" or "environmental services", the scope of the Doha mandate has been left to negotiators, who have therefore turned to work undertaken by international organisations, including the OECD, for supporting analysis.

Over the last five years, the JWPTE continued its work in this area and produced two volumes, of which this is the second. The previous volume, published in 2005, *Trade that Benefits the Environment and Development: Opening Markets for Environmental Goods and Services* addressed some of the more generic issues that confront negotiators: issues of scope and definition of environmental goods, the mechanics of liberalisation at both the national and multinational levels, and the important synergies between trade in environmental services and trade in environmental goods. This volume explores in greater depth three categories of "environmental goods": environmentally preferable products, renewable energy and energy-efficient electrical appliances. Its three chapters consider the scope and definition of each product category, examine tariff and non-tariff barriers to trade, and explain the environmental effects of liberalising such goods. Most of the studies produced for the JWPTE and included in these two volumes have been shared with WTO members in information sessions, symposiums and the special (negotiating) sessions of the WTO Committee on Trade and Environment (CTE-SS).

It is hoped that the analytical work recently completed in the OECD's JWPTE will continue to serve as input in addressing the challenges presented by initiatives involving environmental goods and services in the WTO.

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Chapter 3 was initially drafted by Scott Vaughan, an external consultant to the Trade Directorate, who was at the time with the Carnegie Endowment for International Peace. It was substantially developed by Ronald Steenblik (at the time with the Trade Policy Linkages Division), and Paul Waide (International Energy Agency), with input from colleagues in the OECD Environment Directorate's Global and Structural Policies Division and the International Energy Agency's Energy and Environment Division. Rod Janssen (HELIO International) and Alan Meier provided helpful comments and additional information on an early version, and Monika Tothova (OECD Trade Directorate) provided statistical assistance on tariffs.

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Acronyms and Abbreviations

AIT	Asian Institute of Technology
ANSI	American National Standards Institute (www.ansi.org)
APEC	Asia-Pacific Economic Co-operation (www.apecsec.org.sg)
ARI	Air-conditioning and Refrigerating Institute (www.ari.org)
ASEAN	Association of Southeast Asian Nations
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers (www.ashrae.org
CACM	Central American Common Market
CAFTA-DR	Central American-Dominican Republic Free Trade Agreement
CEEC	Central and Eastern European Countries
CEFTA	Central European Free Trade Agreement
CEN	European Committee for Standardization (www.cenorm.be)
CENELEC	European Committee for Electrotechnical Standardization (www.cenelec.org)
CFL	compact fluorescent lamp
COMESA	Common Market of Eastern and Southern Africa
CRE	Centre for Renewable Energy (Nepal)
CTE	Committee on Trade and Environment
CTS	Council on Trade in Services
EAC	East African Co-operation
ECMT	European Conference of Ministers of Transport
EER	energy-efficiency ratio
EG&S	environmental goods and services
EPPs	environmentally preferable products
ESIS	Energy Standards Information System
EU	European Union
FDI	foreign direct investment
FSC	Forest Stewardship Council
GDP	gross domestic product
GEF	Global Environment Facility
GHG	greenhouse gas
GHP	geothermal heat pump
GNP	gross national product
HS	Harmonized Commodity Description and Coding System

IEA	International Energy Agency (www.iea.org)
IEC	International Electrotechnical Commission (www.iec.ch)
IESNA	Illuminating Engineering Society of North America (www.iesna.org)
IFC	International Finance Corporation
ISO	International Organization for Standardization (www.iso.org)
ITC	International Trade Centre (www.intracen.org)
JIS	Japan Industrial Standards Association (www.jsa.or.jp)
JWPTE	Joint Working Party on Trade and Environment
kWh	kilowatt-hour
LDC	least-developed country
LED	light-emitting diode
LPG	liquefied petroleum gas
MEA	multilateral environmental agreement
MEPS	minimum energy-performance standards
MERCOSUR	Southern Common Market
MFN	most-favoured nation
NAEWG	North American Energy Working Group
NAFTA	North American Free Trade Agreement
NGO	non-governmental organisation
NTB	non-tariff barrier
PPM	processes and production methods
PPP	purchasing power parity
PPP	public-private partnership
PV	photovoltaic
PVMTI	Photovoltaic Market Transformation Initiative
Quad	United States, European Union, Japan and Canada
RTA	regional trade agreement
SAPTA	South Asian Preferential Trade Arrangement
SERC	state electricity regulatory commissions (India)
SMEs	small and medium-sized enterprises
TBT	technical barrier to trade, or the WTO Agreement on Technical Barriers to Trade
TENESA	Total Energie Southern Africa
TEPS	target energy-performance standard
UN DESA	United Nations Department of Economic and Social Affairs
UNCED	United Nations Conference on Environment and Development
UNCTAD	United Nations Conference on Trade and Development

UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
WCO	World Customs Organization
WLED	White-light-emitting diode
WRI	World Resource Institute
WTO	World Trade Organization (www.wto.org)

Executive Summary

Liberalising trade in environmentally preferable products

Chapter 1 examines the potential benefits of liberalising international trade in certain goods designated as “environmentally preferable products” (EPPs) in the context of the Doha Development Round of multilateral trade negotiations and the Johannesburg Plan of Implementation. EPPs are defined as “products that cause significantly less ‘environmental harm’ at some stage of their ‘life cycle’ than alternative products that serve the same purpose.” (UNCTAD, 2004)

Because environmental goods can potentially come from any of the commodity chapters of the Harmonized Commodity Description and Coding System (the “HS”), but encompass none of them, discussions of possible environmental goods rely on positive lists to identify products of interest. Chapter 1 builds on the list of EPPs from UNCTAD (1995) and suggests a wide range of possible qualifying products. It divides the illustrative additions into seven broad categories: environmentally preferable (EP) transport, energy, pollution control, life-cycle extension, EP alternatives, and waste and scrap. Each category includes several sub-categories, including complements, parts and infrastructure, where applicable. The illustrative list presented in the Annex covers almost every chapter of the HS dealing with non-agricultural products.

Three groups of products were chosen for case studies: sisal (from the original UNCTAD list), bicycles (a form of environmentally preferable transport), and cooking appliances (pollution control, specifically air-quality improvement). Each case study points out trade, environmental and developmental benefits and stresses the need to supplement trade liberalisation with appropriate domestic policies.

Sisal and other textile fibres of the genus *Agave* are the coarsest “hard” fibres of many varieties grown in tropical and subtropical conditions. The largest sisal producers are Brazil, Tanzania, Kenya and Madagascar. Many countries apply higher tariffs on processed sisal products than on the raw material. The global market for sisal (and its major product, agricultural twine) has contracted in the wake of the development of synthetic substitutes. However, new applications exploit the fact that sisal is a faster renewable alternative to wood-derived fibre and stress its promising use in the recycled paper industry as a reinforcing fibre in paper with a high recycled wood-fibre content.

The environmental and developmental benefits of bicycles as a flexible, affordable and non-motorised form of transport have long been recognised, although their full potential has yet to be realised. China is the largest exporter of assembled bicycles and delivery tricycles. Production of bicycle parts is less geographically concentrated, and a number of developing countries are producers. Countries tend to levy higher tariffs on assembled units than on individual parts.

In many developing countries food is cooked on open fires fuelled by low-grade solid fuels (wood, dung and crop residues). This results in high levels of indoor smoke pollution. One way to reduce indoor pollution is to improve the cooking devices so that they use fuel more efficiently. Stoves are, however, generally subject to high levels of tariffs. Moreover, co-operation in research and development is needed in order to develop a basic, fuel-efficient stove that ensures proper ventilation.

Liberalising trade in renewable energy and associated technologies

Over the past several years, the importance of eliminating barriers to trade in renewable forms of energy and the technologies used to exploit them has been stressed in various quarters as part of a broader strategy to reduce dependence on more polluting and less secure energy sources. An opportunity to achieve this goal at the multilateral level took the form of a negotiating mandate given to members of the World Trade Organization (WTO) by the Ministerial Declaration adopted at the meeting of WTO ministers in Doha, Qatar, in November 2001. In the absence of an official definition of an "environmental good", WTO members have taken the approach of putting forward positive lists of goods for possible inclusion in a final list to be agreed to eventually by all. Several WTO members have already included certain technologies relating to renewable energy — such as solar photovoltaic cells and wind turbines — in the lists they have submitted to the negotiating groups. They were essentially included because they produce less or no air pollution or CO_2 emissions during use.

Chapter 2 examine the implications of liberalising trade in renewable energy in general and several representative fuels and technologies in particular. In considering selected energy sources and technologies for trade liberalisation, it is useful to be aware of how high the remaining barriers are and how the benefits of reducing those barriers would be distributed.

The chapter builds on a positive list of renewable energy and associated technologies of interest to both developed and developing countries, and analyses the benefits (and costs) of liberalisation for selected countries and products. These are: charcoal, solar photovoltaic (PV) systems and their complements; wind turbines and wind pumps; biodiesel; solar thermal and geothermal energy-related products.

Charcoal is an inferior good, used predominantly by people living on very low incomes. Solar PV systems are particularly suited for supplying off-grid power to households and communities pulling themselves out of poverty. Wind pumps and turbines are one of the fastest-growing segments of the global market for grid-connected power plants. There is also interest in developing countries in the potential for producing and using biodiesel, solar-thermal water heaters and geothermal plants. The resources on which these forms of energy are based are distributed widely across the world, and the technologies involved are generally less sophisticated than for other renewable-energies.

Production of biodiesel (a methyl or ethyl ester resembling petroleum-derived diesel fuel) has been increasing rapidly in recent years and is set to continue expanding at a rapid rate through the end of this decade as planned capacity comes on stream. Much of the new capacity is being built in OECD countries, but several developing countries — Brazil, China, India and Malaysia in particular —are poised to join the ranks of major producers. In many cases the choice of feedstock, particularly oils from the tropical plants that are available, means that developing countries can produce biodiesel at lower cost than elsewhere. Liberalising tariffs on biodiesel would lower prices and encourage a faster rate of substitution of this relatively clean-burning fuel for petroleum diesel. However, for trade in biodiesel to reach its full potential, complementary changes in domestic policies will need to be put in place to safeguard the environment. In some countries, consumer subsidies for petroleum diesel would have to be eliminated.

Solar thermal water heaters have been around for decades, and there are now perhaps hundreds of small and medium-sized producers of these devices in the world, including in developing-countries. As water heating is the leading or second-most important energy requirement if households in most of the countries of the world, any change in policy that reduces the cost of these devices will benefit the environment by substituting clean energy derived from the sun for other, less benign energy sources. Barriers to trade in solar thermal water heaters are highest among developing countries, including those with the climate conditions that favour their use the most.

The potential for developing geothermal resources is substantial, although limited to particular areas of the world. Some developing countries, such as the Philippines, have pursued the development of their geothermal energy resources rapidly. Lowering tariffs on the components of goods necessary to exploit geothermal energy would help a number of other countries to reach their full potential and thereby reduce their dependence on more polluting fossil fuels.

Because some renewable-energy technologies and their components are not separately identified at the harmonised, 6-digit level in the HS, identifying current patterns of trade for particular goods is not straightforward. Based on information that can be obtained on trade in renewable energy and associated technologies, however, it can be said with a high degree of confidence that most trade in renewables still takes place among OECD countries. Trade in charcoal is the main exception. Nonetheless, both consumption and production of renewables is increasing outside the OECD area, and notably in developing countries. Consumption is driven by the attractiveness of several types of systems for providing electric power based on renewable energy to households in rural areas. These form the majority of the 1.6 billion people living in developing countries who lack access to electricity. Many renewable-energy projects are underwritten in part (sometimes in large part) by development assistance agencies, non-governmental organisations or multilateral lending agencies. Purchases of technologies for generating electricity from renewable energy on a large scale, notably geothermal power plants and large wind turbines, are also rising in several developing countries, aided by new information identifying areas of high resource potential.

Eliminating tariffs on renewable energy and associated technologies — which are 15% or higher on an *ad valorem* basis in many developing countries — would reduce the tax that consumers in some countries pay on these goods. This would benefit those living in rural areas of developing countries where many renewable-energy technologies are making, and are likely to continue to make, an especially great contribution. To the extent that reducing import tariffs also reduces the costs of grid-connected technologies, these technologies would also become a more affordable option in the portfolio of energy options available to electric utilities.

To be sure, manufacturers located in OECD countries would benefit from increased trade in renewable-energy technologies and components. But so would the growing number of companies based in developing countries that have emerged in recent years.

These companies range in size from small-scale merchants of PV-based systems to local affiliates of the large wind-turbine manufacturers. Already, Brazil, China, India and South Africa are emerging as centres for sales of renewable-energy technologies in their respective regions. Other countries could also become producers of these technologies, either through development of independent companies, or in alliance with established companies.

The elimination of tariffs would also help to level the playing field between some aid-financed goods and goods imported through normal market transactions. Goods associated with aid projects, for example, tend to receive waivers of import duties. Such waivers help customers in the short run but undermine the emergence of a commercially viable local industry. Other reforms may be needed in the area of non-tariff barriers, but these are not examined in this report.

To achieve the maximum benefits of trade liberalisation in renewable-energy technologies, additional reforms may be required in domestic policies, especially those affecting the electricity sector, and rural electrification in particular. Studies of experience with renewable energy suggest that several factors are important: *i)* creating a stable investment climate for investors in energy projects; *ii)* allowing competition among different electric power options; *iii)* making the high cost of extending electricity transmission lines into rural areas more transparent, and reducing or ending cross-subsidies for their construction; and *iv)* developing innovative ways to finance small-scale projects. Environmental policies are also crucial, especially in the markets for competing grid-connected technologies. Basically, the more stringent a country's limits on emissions of pollutants, the better chance renewable energy has to compete with dirtier fuels.

Can energy-efficient electrical appliances be considered environmental goods?

Public policies in a large number of OECD and non-OECD countries seek to steer producers and consumers towards goods that are relatively more energy-efficient. Can such goods therefore be considered environmentally preferable, or even "environmental goods" in the sense implied in the World Trade Organization (WTO) mandate to negotiators (paragraph 31(iii) of the Doha Ministerial declaration) to liberalise trade in environmental goods?

Chapter 3 explores possible ways of creating preferential tariff margins for relatively energy-efficient goods and reflects upon the practical and economic issues that trade negotiators would need to consider before employing such a blunt, yet powerful, trade-policy instrument. It finds that the feasibility of distinguishing goods for the purpose of selective tariff liberalisation depends on the nature of the technology and the degree of difference in testing procedures and regulations among countries.

While some relatively energy-efficient appliances employ technologies that are readily distinguishable from those used in their less efficient counterparts, most achieve their high performance levels through combinations of features that are difficult to characterise succinctly in the types of product descriptions normally used for customs purposes. This suggests that, were relatively energy-efficient goods to be defined as "environmental" for the purposes of a market-access negotiation, it might be necessary and desirable to distinguish them according to a single criterion: their energy performance in use.

The chapter focuses on household and office electrical appliances, which are produced and consumed in large and increasing numbers both in industrialised and, increasingly, in developing countries. Currently, countries' technical regulations and standards relating to energy performance vary widely. Some 51 countries currently regulate a minimum energy performance standard (MEPS) for one or more classes of electrical appliances and an additional 26 countries are in the process of developing MEPS. Most are developed or rapidly industrialising countries, although a fast-growing number of less developed countries are establishing similar regulations. Among countries that have established MEPS, there are major differences in the classification and description of products for which energy performance is regulated. Countries also specify standards differently and at different levels, and test procedures to measure energy performance are often not substantially the same as those set out in internationally established test standards.

The situation is similar for energy labels. Some 57 countries have implemented labels for one or more class of household appliance and some 28 more are developing them. A much larger percentage of the world's population lives in countries that have developed or are developing appliance energy standards and labels; however, a large number of mostly smaller or less developed countries have not yet instigated standards and labelling programmes. Furthermore, the number of product types covered by standards and labels varies considerably from country to country and many have currently only developed requirements for a small number of products.

Some products, such as compact fluorescent lamps and LCD computer monitors, could theoretically be differentiated easily on the sole basis of visually verifiable physical characteristics. For most products visual inspection is inadequate because their relative energy performance can only be established by testing. Among these are some products whose energy test procedures, product categorisation, efficiency metrics and required efficiency thresholds are similar enough to make it feasible to devise a common set of requirements for determining entitlement to a liberalised tariff. There are also products for which many aspects of the test procedure, product categorisation and efficiency metrics are similar, or could be expressed in a comparable manner, but for which the efficiency thresholds currently applied differ markedly from one market to another. Such differences in efficiency requirements often reflect differences in the price of energy and the way the product is used that determine the efficiency level at which the product is most cost-effective for the consumer. In this case a harmonised efficiency requirement for entitlement to a reduced tariff may be inappropriate. However, agreement on a common approach to devising economy-specific efficiency thresholds for liberalised tariffs for this category of goods might be a way forward. The same approach could be adopted for goods for which there are large differences in test procedures, categories, metrics and efficiency thresholds.

The study therefore notes the need for work to either standardise or harmonise product descriptions and energy-performance metrics or to develop algorithms that would allow simple conversion from one set of requirements to another and avoid the need for retesting. For products exhibiting large regional variations in design features, use patterns, testing procedures and energy-performance standards, differentiating more from less efficient models at the multilateral level would be less feasible, at least over the short or medium term. In support of that longer-term goal, however, work towards harmonising test procedures for measuring the energy performance of household and office electrical appliances would in itself help to lower non-tariff barriers affecting energy-efficient goods and thereby help to achieve one of the goals of the Doha Development Agenda.

At present, international co-operation on energy-efficiency programmes and labels is progressing on several fronts, especially within regional bodies, such as the Asia-Pacific Economic Co-operation (APEC) Energy Working Group, the North American Energy Working Group (NAEWG) and the European Economic Association (EEA).

The question is whether enough progress has been made for WTO members to consider using energy performance as a basis for defining certain goods as "environmental" for the purpose of improving market access. Trade negotiations incur high transaction costs: any multilateral decision to work towards reducing non-tariff and tariff barriers on relatively energy-efficient goods would presumably have to be justified by an expectation that the net benefits of liberalising trade in the goods would be sufficiently large. This chapter therefore attempts to scope the potential magnitude of such benefits and points to mechanisms that could be implemented to realise them. Nonetheless, while relatively high energy performance may be necessary to distinguish an energy-using good as environmentally preferable, in some cases it may not be sufficient. The chapter does not attempt to analyse these additional product environmental characteristics, but simply notes that they exist and are often alluded to in eco-labelling requirements.

References

UNCTAD (2004), "UNCTAD's Work on Environmental Goods and Services: Briefing Note", Document No. TN/TE/INF/7, WTO, Geneva.

UNCTAD (1995), "Environmentally Preferable Products (EPPs) as a Trade Opportunity for Developing Countries", UNCTAD/COM/70, Geneva.

Chapter 1

Liberalising Trade in Environmentally Preferable Products[1]

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This chapter addresses the issue of environmentally preferable products (EPPs) in the context of the Doha Development Round and the Johannesburg Plan of Implementation. It reviews available definitions; describes existing compilations of products and identifies broad categories of EPPs; and offers case studies on three groups of products addressing benefits (and costs) of liberalisation for selected countries and products. Three groups of products, including their parts and complements, were identified for case studies owing to their potential trade, environmental and developmental benefits: sisal and other fibres of the genus Agave, bicycles and solid-fuel cooking stoves.

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1. The mention or discussion of any particular product should not be regarded as necessarily implying an endorsement of that product by either the OECD or the Joint Working Party on Trade and Environment (JWPTE).

Introduction

The notion of "environmentally sound technologies" appears to have preceded that of "environmentally preferable goods" by several years. In 1992 the United Nations Conference on Environment and Development (UNCED) defined *environmentally sound technologies* as "those which protect the environment, are less polluting, use all resources in a more sustainable manner, recycle more of their wastes and products, and handle residual wastes in a more acceptable manner than the technologies for which they were substitutes".[2]

The term *environmentally preferable products* was first defined at the international level by UNCTAD in 1995 as "products which cause significantly less environmental harm at some stage of their life cycle (production, processing, consumption, [or] waste disposal)[3] than alternative products that serve the same purpose, or products the production and sales of which contribute significantly to the preservation of the environment". UNCTAD also sometimes uses a shorter definition, namely "products that cause significantly less 'environmental harm' at some stage of their 'life cycle' than alternative products that serve the same purpose". (WTO, 2004)

Many (mostly developed) countries have adopted an assortment of terms and definitions to designate goods with environmentally superior characteristics. "Environmentally preferable" is common, but so is "environmentally friendly" and "green", especially in the context of government procurement. For example, in the United States, Section 201 of the Executive Order 13101 of September 1998 directs executive agencies to identify and purchase environmentally preferable products, *i.e.* products or services that "have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose. This comparison may consider raw materials, acquisition, production, manufacturing, packaging, distribution, reuse, operation, maintenance, or disposal of the product or service."[4]

The EU uses the term "*green* public procurement" in reference to procedures that address environmental elements contracting authorities may take into account when procuring goods or services, such as energy-efficient computers and buildings, office furniture made from sustainably grown timber, recyclable paper, electric cars and electricity derived from renewable energy sources.[5] The Australian State of Queensland uses "environmentally *friendly* procurement" for goods or practices that conserve resources, save energy, minimise waste, protect human health, protect public amenity (in respect of noise, dust, odour and light pollution) and maintain environmental quality and safety.[6]

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2. Agenda 21, the Rio Declaration on Environment and Development, and the Statement of Principles for the Sustainable Management of Forests were adopted by more than 178 governments at the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil, 3-14 June 1992. See: www.un.org/esa/sustdev/documents/agenda21/english/agenda21chapter34.htm.

3. For details on life cycle assessment, see UNCTAD (1995).

4. www.ofee.gov/eo/13101.htm.

5. http://europa.eu.int/comm/environment/gpp/background.htm.

6. www.qgm.qld.gov.au/bpguides/envir/4frien.html.

Given the nature of environmental goods, the lack of agreed definitions, and reliance on positive lists identifying goods in trade negotiations, considerable uncertainty exists among governments and analysts on whether the 2001 Doha Ministerial mandate on EGS [Paragraph 31(iii)] covers, or could be interpreted to include, EPPs.

A definition from the joint OECD/Eurostat publication, *Environmental Goods & Services Industry: Manual for Data Collection and Analysis,* declares that the "environmental goods and services industry consists of 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 eco-systems. This includes cleaner technologies, products and services that reduce environmental risk and minimise pollution and resource use." (OECD/Eurostat, 1999) In addition to accommodating traditional environmental remedies ("measure or correct"), it also accommodates environmentally preferable products ("prevent, limit or minimise"). The definitions of UNCTAD and others noted above complement the definition of environmental goods and services (EG&S) by extending the coverage to the entire life cycle of a product, including production, processing, consumption and disposal.

Illustrative lists of environmental goods

Earlier lists

The negotiations on liberalising trade in environmental goods and services have similarities with previous multilateral sectoral initiatives. However, environmental goods and services are not easy to define. This group of products cuts through a number of chapters of the Harmonized Commodity Description and Coding System (HS)[7] and often covers multiple-use goods. Moreover, few of the possible candidates for EPPs can qualify as such in all circumstances.[8] Therefore, to facilitate trade negotiations, positive lists of products have to be compiled, often including ex-outs.[9] For a variety of reasons, efforts to compose lists of candidates for environmental goods by various institutions and countries' submissions to the WTO have so far largely focused on environmental remedies or goods that can be readily identified as a discrete (end use) category, such as renewable energy technologies.

In its 1995 analysis, UNCTAD grouped EPPs into several broad categories, including "products which are more environmentally friendly than petroleum-based competitors" [*i.e.* biomass fuels, jute and kenaf], "products which are produced in an environment-friendly way" [*i.e.* tropically grown products and tropical timber from sustainably

7. The Harmonized Commodity Description and Coding System, generally referred to as the "Harmonized System" or "HS", is a multipurpose international nomenclature developed by the World Customs Organization. It comprises about 5 000 commodity groups, each identified by a 6-digit code, arranged in a legal and logical structure. The system is used by more than 190 countries and economies as a basis for their customs tariffs and for the collection of international trade statistics (WCO, 2005).

8. For example, boats provide environmentally preferable transport. However, improperly operated boats can pollute.

9. In the language of trade negotiations "ex outs" are goods which are not separately identified at the 6-digit level of the HS and have to be identified in national tariff schedules at the 8- or 10-digit level.

managed forests], and "products which contribute to the preservation of the environment [*i.e.* some non-timber forest products]".[10]

The submission of the European communities to the WTO (TN/TE/W/47) identified EPPs as "goods that have a high environmental performance or low environmental impact" identified "on the basis of objective parameters" such as composition (*e.g.* the renewable character of components) or environmental performance (*e.g.* energy consumption, efficiency, recyclability or biodegradability, low or zero pollution) and provided examples of such products.[11] At the time of writing, several other countries were compiling lists for submission to the WTO.

Illustrative list of environmentally preferable products

When searching for products beyond the UNCTAD list for discussion in the case studies, a broad interpretation of the UNCTAD definition was used. That is, a product can be classified as environmentally preferable on the basis of : *i)* the function the product performs by design or function (for example, baking soda or soap); *ii)* its own environmental impact using life cycle analysis (for example, bicycles as a form of transport); or *iii)* the environmental impact of other goods which the product could improve (for example, assuming that a longer life cycle is related to lower environmental impact, small repair tools can extend the useful life of some products).

However, the categories are not absolute and may overlap: products considered EPPs based on the function the good may perform can be made "more environmentally preferable" by lowering its environmental impact. Products with positive effects on the environmental impact of other goods can themselves have less environmental impact. And longer life does not necessarily imply lower environmental impact, as in the case of inefficient appliances.

Lacking a clear definition of EPPs, partially owing to cultural and societal differences, several examples of broad groups emerged from the search for qualifying products in each category discussed above. Categories were extended to include infrastructure and complements (see Annexes 1.A1 and 1.A2). The following are examples of product categories characterised as EPPs based on different criteria:

- Environmentally preferable (EP) transport:
  - EP transport core (both people and cargo): bicycles, boats, locomotives, cross-country skis, rollerblades. This category includes public transport, water transport, and self-propelled transport.
  - EP transport infrastructure: rails, sleepers, ski bindings, ski shoes.
  - EP transport complements: bike helmets, trailers.
  - EP transport parts and associated tools: chains, tyres.

10. Products identified on the UNCTAD list are referenced in Annex 1.A2 as "U".

11. Products identified in the EC submission, if not already on the UNCTAD list, are referenced in Annex 1.A2 as "EC".

- Energy:
  - Relatively energy-efficient technologies:[12] centrifugal dryers, fluorescent lamps.
  - Goods powered by renewable energy: solar heaters, solar food dryers.
  - Passive energy-efficient goods: insulation boards, double-glazed windows, thermal flasks.
  - Parts of passive energy-efficient goods: glass for windows.
  - Manual tools.
- Pollution control:
  - Air quality improvement: efficient cooking stoves and other cooking appliances.
  - Air quality improvement complements: fuel for stoves, linings.
  - Cleaning and hygiene supplies.
  - Pollution control miscellaneous: passive pollution protection (masks, air filters).
- EP alternatives (generic):
  - Sustainable agriculture and fisheries (inputs): dolomite.
  - EP alternatives made of renewable materials (“lower environmental impact”): soy ink, soy candles.
    - EP alternatives to disposable products.
    - EP alternatives that are biodegradable:13 baking soda in cleaning.14
    - EP alternatives miscellaneous: kenaf paper, waste reduction, soap refills in pouches, supplies for air drying laundry.
- The environmental impact of other goods that a product could improve:
  - Life cycle extension: mattress covers, repair tools. (See Annex 1.A2 for a comparison of life-cycle extension and utilisation of waste and scrap.).
  - A combination of the product’s own environmental impact *and* the environmental impact of other goods that it could improve:
  - Waste and scrap: waste and scrap: encourages re-use and proper disposal. For the purposes of this list, “waste and scrap” are defined as lines in the HS that

12. “Relatively energy-efficient” goods are understood as goods used to improve energy efficiency and those that are efficient in their use of energy relative to existing goods that deliver an equivalent service (*i.e.* lumens of light).

13. Biodegradability: “To be truly biodegradable, a substance or material should break down into carbon dioxide (a nutrient for plants), water, and naturally occurring minerals that do not cause harm to the ecosystem (salt or baking soda, for example, are already in their natural mineral state and do not need to biodegrade).” See www.worldwise.com/biodegradable.html.

14. Vinegar (HS 2209.00) is also a biodegradable cleaning alternative. It is not listed here as it is classified as an agricultural product in the HS.

have a potential to be re-used, further worked or somehow utilised, but such uses are not clear from the HS subheading description.

– Utilisation of waste and scrap: defines a category of products obtained from waste and scrap, such as reconstructed stones and recycled paper.

– By-product utilisation: a category of products produced from by-products and by-products themselves, if suitable for further processing, such as wood tar, wood naphtha and other by-products of wood carbonisation used to impregnate ships' cables.[15]

The illustrative list of EPPs that satisfy a broadly interpreted UNCTAD definition using the criteria discussed above, covering almost all chapters of the HS, and containing goods of interest of both developed and developing countries, can be found in Annex 1.A2. The examples were drawn up in an effort to complement the original APEC and OECD lists (see OCDE, 2006 add to refs the first volume), which focused primarily on environmental remedies, taking the UNCTAD list as a starting point. Products from the UNCTAD list and the EC submission are not classified or assigned to a category and are listed without explanation. Technical and explanatory notes accompany the illustrative list (see Annexes 1.A1 and 1.A2).

Case studies

Three groups of products were chosen for case studies: sisal, bicycles, and cooking appliances. Sisal was chosen from the original UNCTAD list, bicycles and cooking appliances were identified as examples of EPPs that facilitate EP transport and air-quality improvement.

The benefits of liberalising trade in EPPs are likely to be even greater if their parts, infrastructure and complements are also liberalised. Therefore, the case studies do not focus solely on specific products (represented by a single line in the HS) but also take into account groups of products clustered around categories of goods. Unless otherwise indicated, the trade data is from 2003, the latest year for which a full data set for all countries was available at the time of writing. Each case study describes the product, its benefits and trade situation, and discusses possible complementary measures. Non-tariff barriers and conformity assessment procedures are not considered.

A common observation for all of the case studies points to the "water" in the bound tariffs. A sub-set of WTO members apply only nuisance tariffs (on a most-favoured nation [MFN] basis), while maintaining bound levels[16] at 50% or higher.[17]

Sisal and other fibres of the genus Agave

Sisal and other textile fibres of the genus *Agave* are the coarsest vegetable "hard" fibre of many varieties grown in tropical and subtropical conditions; they are coarser than jute and other textile bast fibres. The most important in commercial terms are *Agave*

15. Many by-products already have commercial value. For example, propane (C3H8) is a by-product of natural-gas processing, and commands an even higher price per cubic meter.

16. A bound tariff is a legal commitment that the country will not apply a tariff higher than that rate.

17. Countries agree to lower their bound tariff rates, not necessarily their applied rates. Thus, once the current round of multilateral trade negotiations is finished and tariff cuts are negotiated, countries may still be able to apply their currently applied tariffs.

sisalana (and its hybrids) and *Agave fourcroydes* (better known as henequen).[18] *Agave sisalana* yields hard, flexible fibres, which are suitable for making rope and twine, cord matting, padding and upholstery. Related fibres are Haiti hemp (*Agave foetida*), and istle or ixtle (Tampico or Mexican hemp). These fibres, extracted from *Agave funkiana* or *Agave lechugilla*, are used mainly in brush making, but they are occasionally used for textiles. The category also includes maguey and cantala, obtained from *Agave cantala* (Philippines or Indonesia), or *Agave tequilana* (Mexico) and pita (*Agave americana*) (WCO, 2005).

Sisal, the most widespread of these fibres, originated in Mexico, and was introduced to Tanganyika (now mainland Tanzania) at the end of the 19th century. Following its success in that country, the crop was introduced in 1903 to Kenya (UNIDO, n.d.). Brazil saw its first commercial planting of sisal in the late 1930s. Sisal accounts for two-thirds of world production of hard fibres, and about three-quarters of sisal is used for agricultural twine (UNIDO, n.d.). Box 1.1 summarises the agronomic and production characteristics of sisal.

Box 1.1. Sisal

The sisal plant has a 7-10 year life span (longer in Mexico, where growth is slower) and is usually cut first after two or three years and then at 6-12 month intervals. A typical plant produces 200-250 commercially usable leaves in its lifetime (hybrid varieties produce up to 400-450), and each leaf contains an average of around 1 000 fibres. The fibre element, which accounts for only about 4% of the plant by weight, is extracted by a process known as decortication.

In eastern Africa, where sisal is grown on estates, the leaves are in the main transported to a central decortication plant, after which the fibre is dried, brushed and baled for export or for use in domestic mills. In Brazil it is mainly grown by smallholders and the fibre is extracted by teams using portable raspadors.

East African sisal, once washed and decorticated, is considered to be superior in quality to Brazilian sisal (although the latter is more than adequate for the manufacture of agricultural twines and general cordage and is used domestically in the production of kraft paper). In normal times, it commands a significant price premium on the world market.

Source: www.wigglesworthfibres.com/products/sisal/history.html.

The area planted to sisal peaked in the late 1960s, when it exceeded 1 million hectares worldwide, and has since stabilised at around 350 000 hectares. Production[19] has been even at around 300 000 tonnes a year, having fallen from more than 800 000 tonnes in the 1960s and 1970s (Figure 1.1). The largest sisal producers are Brazil (191 000 tonnes in 2004), Tanzania (23 500 tonnes), Kenya (20 000 tonnes), Madagascar (17 500 tonnes), Mexico (16 635 tonnes), and China (16 000 tonnes). Small quantities are also harvested in Cuba, Haiti, Venezuela, Morocco, South Africa, Ethiopia, Mozambique, Angola, Dominican Republic, Indonesia, Central African Republic, Jamaica, Guinea, Malawi, and

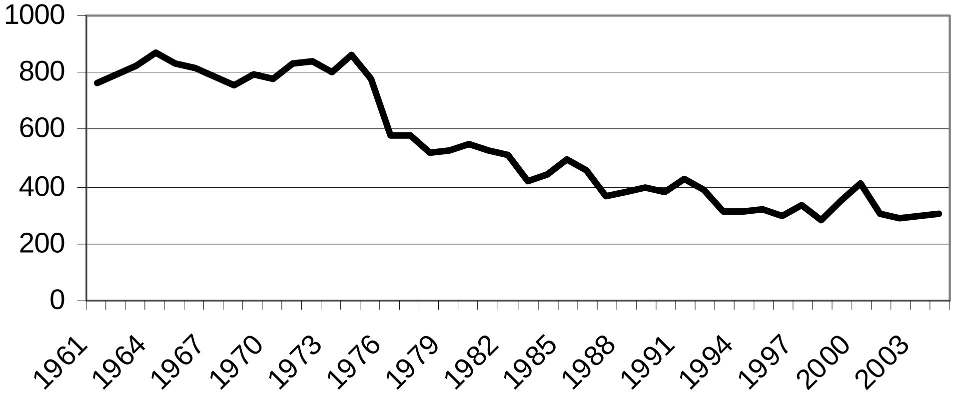
18. See www.wigglesworthfibres.com/products/sisal/history.html. In Mexico, henequen production (largely in the Yucatan peninsular) has fallen from a peak of about 160 000 tonnes in the 1960s to about 15 000 tonnes today, all of which is used locally.

19. Data on production are from FAOSTAT. According to the documentation on *Agave sisalana,* sisal fibre is obtained from the leaves of the plant. It also is used as an ornamental plant. Trade data cover fibres that are raw, prepared for spinning, and tow and waste, including yarn waste and garnetted stock.

Thailand (declining order of production volume). In total, least-developed countries (LDCs) harvested 48 855 tonnes from 77 830 hectares in 2004. Trends in production by the four leading producers are illustrated in Figure 1.2.

Figure 1.1. World sisal production, 1961-2004

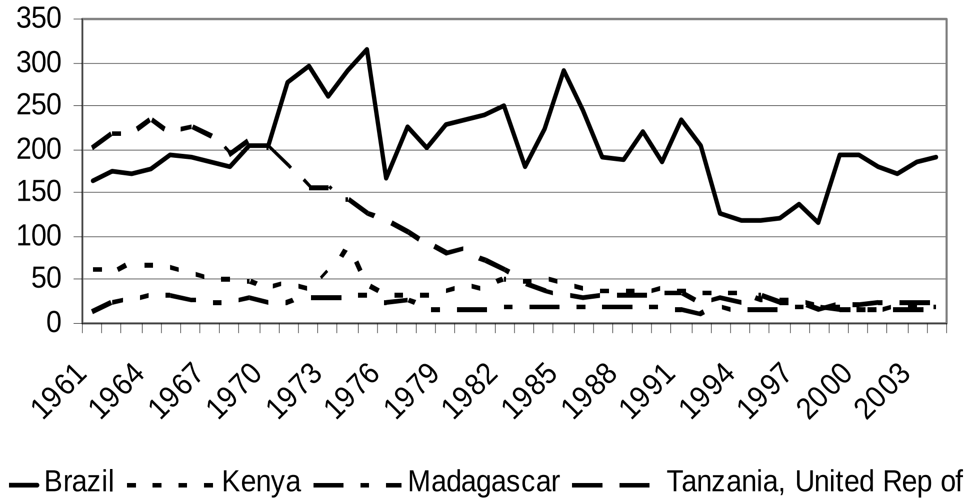
Thousands of metric tons



Source: FAOSTAT Data, 2004.

Figure 1.2. Sisal production in selected countries, 1961-2004

Thousands of metric tons



Source: FAOSTAT Data, 2004.

Trade

Table 1.1 lists HS codes of products relevant to sisal.

Table 1.1. HS codes relevant to sisal and other fibres of the genus *Agave*

HS	Description
46	Manufactures of straw, of esparto or of other plaiting materials; basketware and wickerwork (ex-out: made of sisal)
4706.9x	Other pulps derived from other fibrous cellulosic material
5304.10	Sisal and other textile fibres of the genus *Agave*, raw
5304.90	Sisal and other textile fibres of the genus *Agave*, processed but not spun; tow and waste of these fibres (including yarn waste and garnetted stock).
5308.90ex	Other yarn of other vegetable textile fibres; paper yarn
5311.00	Woven fabrics of other vegetable textile fibres; woven fabrics of paper yarn
5607.21	Twine, cordage, ropes and cables, whether or not plaited or braided and whether or not impregnated, coated, covered or sheathed with rubber or plastics; Of sisal or other textile fibres of the genus Agave; Binder or Baler twine
5607.29	Twine, cordage, ropes and cables, whether or not plaited or braided and whether or not impregnated, coated, covered or sheathed with rubber or plastics; Of sisal or other textile fibres of the genus Agave; Other
5702.99	Carpets and other textile floor coverings, woven, not tufted or flocked, whether or not made up; Of other textile materials
9209.99 ex*	Parts and accessories of musical instruments (ex-out: strings made of sisal for percussion instruments)

** not an EPP per se since it is not an alternative. It is listed to illustrate uses of sisal.*

Source: OECD, based on the 2002 edition of the Harmonized System.

Annex Table 1.A3.1 summarises the leading exporters and the countries with the highest applied and bound tariffs on raw sisal and selected products of interest.[20] Highlighted are major exporters as well as the share of the LDCs. Sisal production represents the majority in the *Agave* genre and tends to be exported raw. The leading exporters of raw sisal are Brazil (supplying 43% of exports), Kenya (26%), Tanzania (13%), Madagascar (3%) and India (2%). Other countries supply less than 1%. In 2003 the OECD countries and China were the main importers of raw sisal. The OECD countries imported 45% of Brazilian exports, 39% of Kenyan exports, 51% of Madagascan exports and 72% of Tanzanian exports. China, the biggest rope producer, imported 38% of Brazilian exports, 27% of Kenyan exports, and 22% of Madagascan exports.

Several countries apply tariffs exceeding 20% on both raw sisal and products. However, a significantly larger number of countries apply higher tariffs on processed products than on the raw material. Such tariff escalation may be one of the reasons why the largest raw sisal exporters choose to export raw material rather than add value at source. Brazil is a notable exception, with the majority of its binder (or baler) twine directed to the US market.

20. Not all products are listed since many of them are ex-outs, for which data are not available.

South–South trade

Sisal is a plant that grows well in many developing countries. Given its environmental attributes and alternative uses, if there were suitable policies in place, part of the demand lost with the advent of synthetic fibres could be recovered. Trade liberalisation would contribute, especially if it brought tariffs on raw and manufactured products into parity, as this would encourage adding value at source. Increased demand for the raw product, generated by alternative uses, and adding value at source would increase employment opportunities in several LDCs.

Many traditional and alternative uses of sisal are relatively labour-intensive. Because of their geographical proximity to producers of raw sisal, some neighbouring developing countries could become involved in processing the fibre and manufacturing.

Traditional and alternative uses

Traditional uses of sisal and other textile fibres include agricultural twine ("binder" and "baler" twine), rope and cordage. The global market for sisal (and its major product, agricultural twine) has contracted since the development of synthetic substitutes for natural fibre, particularly the use of polypropylene for baler twine and other cordage (FAO, 2000). Nevertheless, with increasing interest in natural, renewable and biodegradable products, there is a potential for sisal trade to grow once traditional uses are re-discovered and new uses are explored.

New (or reinvented) applications would exploit the fact that sisal is a faster renewable alternative to wood-derived fibre. It can also be used as a strengthening agent (replacing asbestos and glass fibre) in wire-rope cores, speciality pulps and plaster. Decorative and insulation uses include carpets, wall coverings and macramé, mattresses, bags and handicrafts. Other uses are in padding, buffing cloths, filters, geotextiles used in civil and environmental engineering, as a component of automobiles. Waste from sisal production can be used as livestock feed, as a soil amendment, and to produce biogas. Research on alternative uses is taking place at the international level, led by the FAO (FAO, 2000). With the increasing popularity of recycling, a promising use of sisal is emerging in the recycled paper industry as a reinforcing fibre in paper with a high recycled wood-fibre content (Hurter, 2000).

Complementary policies

Technical research is needed to improve varieties, introduce new hybrids and new production techniques, especially in eastern Africa and Madagascar. Production there has stagnated, old varieties are still being planted (FAO, 2000), and most of the product is exported in its raw state.[21]

Bicycles[22]

The environmental benefits of bicycles as flexible, affordable and non-motorised transport have long been recognised, but their full potential has yet to be realised.

21. UNIDO (n.d.) reports co-operation between Brazil and the Tanzania Sisal Board.

22. Since many studies are available (see the references), this case study briefly summarises the benefits of bicycles, and focuses on trade liberalisation. It emphasises the need for broad and systematic trade liberalisation of bicycles, including parts and complements. The World Bank has conducted extensive research on the health and mobility benefits of non-motorised transport.

Although bicycles are not expressly mentioned in the Johannesburg Plan of Implementation, they are ideal technologies for assisting in poverty reduction, sustainable development and changing patterns of consumption. OECD countries are increasingly supporting local cycling initiatives and bringing bicycling to full parity with other modes of transport. For example, in 1998 US President Clinton signed the Transportation Equity Act, thereby setting the stage for further integration of bicycles into transport planning (Brown and Larsen, 2002).[23] In Europe, from 1998 to 2001, the European Conference of Ministers of Transport (ECMT), jointly with the OECD, conducted a project, Implementing Sustainable Urban Travel Policies, which encouraged countries to adopt a comprehensive national cycling policy and to raise awareness and "de-marginalise" cycling as a sustainable mode of transport (ECMT, 2004). The Netherlands, Denmark and the United Kingdom are in the vanguard in implementing national cycling plans.

While developed countries are rediscovering bicycles mostly for their environmental merits, NGOs and many developing-country governments see bicycles as a means of improving welfare. However, as developing countries define their national transport strategies and planning cities, it is appropriate to consider the bicycle from the beginning, to ensure suitable urban planning and bicycle infrastructure, such as available, properly positioned and smoothly accessible bike lanes, secure facilities for parking, and smooth connection to public transport. China, still the most prominent cycling country, now faces this issue. Its economic boom and increased purchasing power, combined with a desire by many to own a motorised vehicle, has led the government to invest massively in motorways, possibly marginalising bicycle riders.

The environmental benefits of bicycles include, but are not limited to, reducing congestion[24], avoiding air pollution and CO_2 emissions, and conserving fuels. A bicycle places fewer demands on space than a motorised vehicle, in terms of both operation and parking. Among the developmental benefits are: empowerment of vulnerable groups, increased income-generating opportunities, accessibility, low capital investment and low maintenance costs. Health-care and social workers and their patients also benefit: for example, bikes are helping HIV/AIDS educators in Ghana reach 50% more people than they would if they travelled by foot (Brown and Larsen, 2002).

Adult bicycle use can be divided into utility and recreational cycling. Utility cycling consists, for example, of commuting, commercial transport of cargo and persons, delivery and messenger services, bicycle ambulances and bicycle policing. While the personal and societal benefits of recreational cycling in the form of physical activity and environmentally benign recreation are important, especially as more and more countries — some developing countries included — are fighting obesity epidemics, the focus here is on utility cycling. No distinction is made in the analysis among different kinds of bicycles, which are commonly grouped into mountain bikes, racing bikes and touring (or city) bikes.[25] This reflects the fact that, the HS has only one 6-digit subheading for bicycles and delivery tricycles; it does not differentiate according to types of bicycle or final use.

In addition to employment in production, benefits generated by the bicycle include employment in related services. Bicycle repair is relatively low technology, involves only a moderate amount of investment, and the staff does not require extensive training. The

23. A fact sheet on bicycle transport is available at www.fhwa.dot.gov/tea21/factsheets/b-ped.htm.

24. In extreme cases, with a lack of urban planning, congestion of different sort could occur.

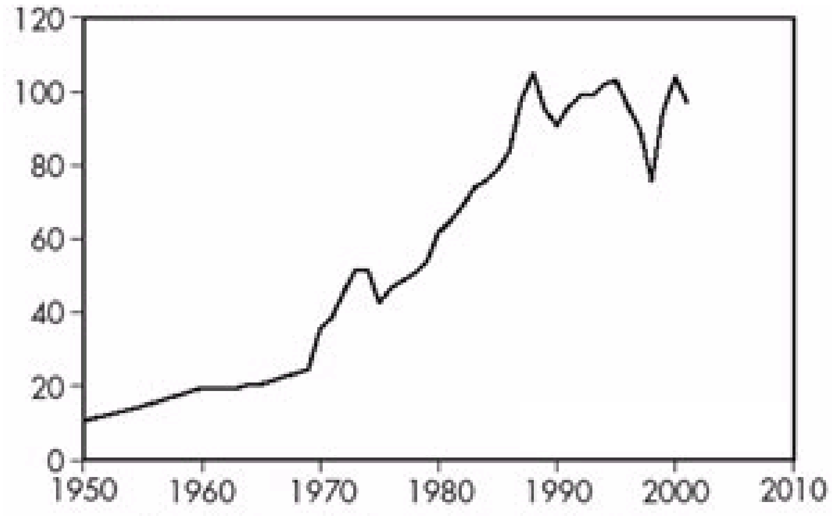
25. A detailed taxonomy of bicycles is presented in UNCTAD (1985).

bike cab and rickshaw business provides employment in several developing countries. However, some countries and cities (*i.e.* Burundi and Dhaka, Bangladesh), are starting to ban bicycle-based services on safety grounds.

The Earth Policy Institute, drawing on data compiled in 2002 by the World Watch Institute, reports there were 97 million bicycles produced worldwide in 2001.[26] The World Watch Institute cites excess inventory as the reason for decreasing production in recent years (Figure 1.3).

Figure 1.3. World bicycle production, 1950-2001

Millions



Source: www.worldwatch.org/features/vsow/2003/06/18/.

Core, parts and complementary products

Trade liberalisation of bicycles, if accompanied by liberalisation of spare parts and complements (Table 1.2), such as safety gear, would deliver greater benefits than liberalisation of trade in bicycles alone. An important complement is a trailer, which can extend a bicycle's functions. For example, trailers are used in bicycle ambulances.[27] At the 6-digit level, bicycles are grouped with non-motorised delivery tricycles. Many tools needed to assemble a bicycle are multiple-use and not bicycle-specific, and hence not listed. Because of their multiple-use characteristics, and for the sake of simplicity, goods related to certain technical steps in the production process, such as painting, are also ignored. Many of the bicycle complements are multiple-use as well, and are marked as such. Since bicycle infrastructure, although important for the safe operation of bicycles, is not specific to that mode of transport (unlike rails for trains and trams), no goods associated with infrastructure are listed.

26. The last year for which information on production was readily available.

27. www.itdg.org/?id=bicycle_ambulances.

Table 1.2. HS codes for bicycles, parts and components

HS code	Description
EP transport core	
8712.00	Bicycles and other cycles (including delivery tricycles), not motorised
EP transport parts and tools	
4011.50	New pneumatic tyres, of rubber of a kind used on bicycles
4013.20	Inner tubes, of rubber of a kind used on bicycles
7315.11ex	Roller chain (ex-out: bicycle chain)
7515.19ex	Parts of roller chains
8204.1x	Non-adjustable hand-operated spanners and wrenches * multiple use*
8306.10ex	Bells, gongs and the like (ex-out: bicycle bells)
8414.20	Hand- or foot-operated air pumps *multiple use*
8414.90	Parts of hand- or foot-operated air pumps *multiple use*
8512.10	Lighting or visual signalling of a kind used on bicycles
8512.90	Parts of lighting
8714.91	Frames and forks, and parts thereof
8714.92	Wheel rims and spokes
8714.93	Hubs, other than coaster braking hubs and hub brakes, and free-wheel sprocket-wheels
8714.94	Brakes, including coaster braking hubs and hub brakes, and parts thereof
8714.95	Saddles
8714.96	Pedals and crank gear, and parts thereof
8714.99	Other
EP Transport complements	
6506.10ex	Safety headgear (ex-out: bicycle helmets)
8301.10	Padlocks *multiple use*
8301.60	Parts of padlocks *multiple use*
8301.70	Keys presented separately *multiple use*
8716.40ex	Other trailers and semi-trailers (ex-out: bicycle trailers)
8716.90	Parts of Other trailers and semi-trailers (ex-out: parts of bicycle trailers)
9029.20ex	Speed indicators and tachometers, stroboscopes (ex-out: speed indicators for bicycles)
9029.90	Parts and accessories *multiple use*

Note: Environmentally preferable transport devices also include two- and three-wheel scooters, classified as an ex-out under HS 9501.00, “Wheeled toys designed to be ridden by children (i.e. tricycles, scooters, pedal cars); dolls' carriages).”

Source: Based on the 2002 edition of the Harmonized System.

Trade

The international trade statistics used for this study focus on a sample of goods irrespective of quality differences; because they are available only at the 6-digit level of aggregation, it is not possible to collect comparable trade data on ex-outs. Data on export values, bound and applied tariffs for HS 8712.00 and 8714.9x are presented in Annex Table 1.A3.2.

The total value of bicycle exports (HS 8712.00, including delivery tricycles) exceeded USD 2.8 billion in 2003, the latest year for which a full set of data is available. The total value of exports of parts (HS 8714.91 to 8714.99) topped USD 3.2 billion, surpassing the value of assembled units. China is the leading exporter of assembled bicycles and delivery tricycles, accounting for 51% of total exports, followed by OECD countries (42%). Within the OECD countries, the Netherlands supplies 18% of total OECD exports, Italy 15%, and Belgium 10%. China is also a leading supplier of bicycle parts, although its share is generally smaller than its share of the assembled bicycle market. Among the countries contributing at least 1% of the world's supply of bicycle parts, measured in value terms (hence likely to contain re-exports), are India, Thailand, Malaysia, Bulgaria, Singapore, Brazil and Romania, in addition to the OECD countries. The share of the LDCs in this trade is minuscule for both categories.

Several additional observations stand out:

- There are notable differences in the numbers of tariff lines used by countries. Applied MFN tariffs vary widely among and within WTO members' economies, observers and non-members, in some cases exceeding 50%.
- Trade in parts exceeds trade in assembled units. The HS is organised such that a complete bicycle can be assembled from parts from HS 8714.91 through 8714.99. Some countries apply higher tariffs on assembled units than on parts and import more parts than assembled bikes in value terms.
- Production of bicycle parts is diversified among many countries, likely because production of parts is less capital-intensive than assembly of complete units. Many developing countries are able to compete globally by developing a strong brand image for their products.

South–South trade

In order to explore the opportunities for developing countries in this market, the direction of Indian exports of bicycle parts and components was analysed (Table 1.3). While India exports less than China, it is still a major player. Most of its trade has been with other developing countries.[28]

Bicycles and bicycle parts are often produced under a copyright brand name for export to countries with relatively well-established biking infrastructure. However, conditions in many developing countries require bicycles that can safely transport people and heavy cargo over unpaved roads. While some bicycles on the market (*i.e.* mountain bicycles) are well suited for off-road conditions, they often contain luxury features, tend to be sold in niche markets at a premium and require access to sophisticated repair shops. Any one of these characteristics can make them prohibitively expensive for a large segment of a country's population. This suggests there may be opportunities for South–South co-operation in research and development of a simple, affordable bicycle, one that well fits the needs of developing countries. In addition, there are both learning curves and economies of scale in the production of individual parts; this may encourage concentrated production of individual parts and trade, and possibly the assembly of units in the

28. For comparison, during India's 1981/82 fiscal year, Nigeria, the Islamic Republic of Iran, and Iraq were the final destinations for 75% of India's total bicycle exports. Other export markets for bicycles included Uganda, Sri Lanka, Hong Kong (China), Ghana and Egypt. Exports of bicycle components were directed towards a larger number of countries and were slightly less geographically concentrated (UNCTAD, 1985).

importing country. Such an arrangement could deliver employment benefits and lower transport costs.

Table 1.3. Top Indian export destinations, bicycle parts, 2003

HS subheading	Total Indian exports (thousands $)	% of world exports	Comments
8712.00	43 277	1.53	
8714.91	9 431	1.95	
8714.92	24 003	11.06	Nigeria 12.5%; OECD countries 11.5%; Tanzania 7.9%; Malawi 7.4%; Burkina Faso 7%; Egypt, Syrian Arab Rep. 6.8%; Uganda 6%
8714.93	40 357	20.52	OECD countries 21.6%; Nigeria 9.2%; Brazil 8.9%; Tanzania 6.1%
8714.94	7 984	2.57	
8714.95	4 667	3.61	
8714.96	8 161	3.24	
8714.99	47 011	2.77	

Source: COMTRADE.

Refurbishing initiatives and other bicycle support programmes

Although a new bicycle, especially a basic model, can be a relatively inexpensive form of transport, its cost may be still out of reach for people living in poverty. Refurbished bicycles, by comparison, can cost considerably less than new ones and are often donated by charities in developed countries. Statistics on trade in refurbished bicycles are not available, however, and they are likely to escape production statistics if not refurbished by a bicycle manufacturer.

While projects that refurbish bicycles for local users are common in OECD countries,[29] several initiatives to ship refurbished bicycles to developing countries have emerged recently. An example is the Bicycle Refurbishing Initiative (Velo Mondial[30]), which plans to collect bicycles in the Netherlands, Ireland, England and the United States and refurbish them in South Africa after training local personnel. These projects will extend the life of the products and provide local employment. If bicycles are refurbished in developing countries, using imported parts, it is crucial that trade in these parts be liberalised as well.[31]

Complementary policies

While trade liberalisation is a crucial step, full implementation of environmentally preferable transport policies might require rectification of domestic policies as well.

29. For example, the “Share-a-bike program”, set up by a Michigan volunteer group, repairs bicycles and gives them away to needy citizens in East Lansing. See www.bikes.msu.edu/.

30. See www.velomondial.net/. For an opposing view on foreign refurbishing initiatives, see www.afriwheels.org/afri/bestbike.html.

31. Some refurbishing projects refurbish bicycles, often to be donated to developing countries, in a developed country by otherwise marginalised groups. A refurbished bicycle belongs to the same HS subheading as a new one.

Encouragement of bicycling requires a multisectoral approach: a proper marriage of trade, environment, development and urban-planning policies. For example, in Kenya a luxury tax on bicycles was levied at the rate of 80% until 1986 and was gradually reduced and finally eliminated in 2002 (UN DESA, 2004). Supporting policies sometimes encourage bicycle use indirectly by discouraging use of other means of transport. Bicycles, because of their light weight, put less wear and tear on roads than motorised vehicles, and this translates into lower road maintenance and repair costs. In Nagoya, Japan, employer contributions for commuting by bicycle were doubled in 2000, while allowances for automobile commuters were halved.[32]

While bicycles have great potential as a transport mode in cities in both developing and developed countries, prevalent social attitudes can significantly limit their use. Biking policies, infrastructure and biking culture are closely related. Some countries perceive bicycles and other forms of non-motorised transport as having less status than a car, and most city infrastructure is planned around cars.[33] In many developing countries, despite the benefits they could receive from access to better transport, women are often discouraged from using bicycles by a perception that is it inappropriate for them to use bicycles on public streets (Bamberger *et al.*, 2001).

Cooking appliances

Stoves and other cooking appliances are basic necessities. Around 95% of staple foods, a great part of the diet of poor people, must be cooked before they can be eaten (Warwick and Doig, 2004). In much of the developing world, food is cooked on open fires fuelled by low-grade solid fuels (wood, dung and crop residues). Indoor smoke from burning these fuels is a major contributor to respiratory disease, including pneumonia, which is the leading cause of mortality in developing nations and kills four to five million children worldwide every year (Kammen, 1995). Warwick and Doig (2004) report that indoor air pollution from the burning of solid fuels kills over 1.6 million people, predominantly women and children, each year, a death toll higher than that caused by malaria. In addition, the burden of collecting wood, mostly by women and children, takes children away from school to assist in domestic chores. The chief environmental impacts relate to inefficient charcoal production and unsustainable harvesting of fuelwood (UNDP, 2000), and consist mainly of air pollution, deforestation and desertification. Reducing problems caused by inefficient cooking appliances is one of the Millennium Development Goals.

The developmental, environmental and health literature presents alarming facts (Warwick and Doig, 2004). An estimated 2.4 billion people burned traditional biomass for cooking and heating in 2002. Of these, approximately 800 million depend solely on crop residues and dung. When coal is included, a total of 3 billion people cook with solid fuel. Over half of all people cooking with biomass live in India and China. The highest proportions of the population cooking with biomass are found in Sub-Saharan Africa, and are over 90% in many countries. On current trends, an extra 200 million people worldwide will rely only on traditional biomass for cooking and heating by 2030, according to the International Energy Agency (IEA, 2004). The increase is partly due to increasing population, but households in some countries — for example in Central Asia and some formerly centrally planned economies (Tajikistan and the Kyrgyz Republic) —

32. Additional success stories at www.earth-policy.org/Updates/Update13_data.htm.

33. However, cars are more private and perceived as safer in high-crime areas.

are also reverting back to solid fuels in response to inadequate domestic policies and collapsing natural gas infrastructure, especially in rural areas.

The problem is not confined to rural areas: the urban poor frequently spend a significant fraction of their income on the purchase of charcoal (considered an urban fuel) and wood (Kammen, 1995), and the increased concentration worsens the outdoor air pollution. If current trends in fuel use in Sub-Saharan Africa continue, cooking fires will pump 6.7 billion tonnes of carbon into the atmosphere as greenhouse gases over the next 45 years (Bailis *et al*., 2005).[34]

The health effects of indoor smoke pollution tend to appear relatively slowly compared with other health hazards, such as malaria or infectious diseases. However, they deteriorate quality of life for those affected, mostly already vulnerable groups. Table 1.4 summarises the pollutants generated from burning one kilogram of wood in an environment without proper ventilation, and compares the concentrations with typical standards set to protect health in developed countries.

Table 1.4. Pollutants generated from burning one kilogram of wood

Pollutant	Typical concentrations *	Typical standards set to protect health	Number of times in excess of guidelines
Carbon monoxide (ppm**)	129	8.6	15
Particles (µg/m³)	3 300	100	33
Benzene (µg/m³)	800	2	400
1-3 Butadiene (µg/m³)	150	3	50
Formaldehyde (µg/m³)	700	100	7

* From burning 1 kg of wood in a traditional stove in a 40 m^3 kitchen with 15 air changes per hour.

** Parts per million.

Source: UNDP (2000) in *Warwick and Doig* (2004).

The health consequences of indoor smoke pollution are primarily reflected in problems of the respiratory system, from respiratory infections to asthma, tuberculosis and lung cancer. Secondary problems, such as eye cataract, low birth weight and infant mortality, are also attributed to chronic exposure to wood-smoke pollutants. The most affected by indoor smoke pollution are women and children: children aged under five account for 56% of total deaths attributed to indoor air pollution (Warwick and Doig, 2004). In Sub-Saharan Africa, the number of premature deaths among women and young children exposed to wood smoke from stoves could, on current trends, reach nearly 10 million by 2030, from about 400 000 in 2000 (Bailis *et al*., 2005).

Indoor smoke pollution depends on the type of fuel used, construction of the cooking stove, and ventilation of the cooking space. Solutions to the problem range from the simple to the sophisticated, from reducing smoke by avoiding it to reducing the need for fire. Table 1.5 summarises potential interventions for reducing exposure to indoor air

34. The estimate assumes a BAU (business as usual) scenario, defined such that the proportion of people in rural and urban areas using each fuel remains unchanged from the baseline year. However, differential rates of population growth and urbanisation in different countries in the region result in regional changes in household fuel choice during the period of analysis. No changes occur in wood-fuel harvesting practices or in charcoal production techniques, in which 20% of trees removed for charcoal and 80% of those removed for wood regenerate (Bailis *et al.*, 2005).

pollution. Short-term tactics include, for example, "passive" control in the form of improved ventilation, and "manual" improvements of the stoves (installing chimneys, hoods, etc).[35] Long-term strategies include development and adaptation of more efficient stoves, delivery of alternative fuels, and building infrastructure to deliver fuels.

Table 1.5. Potential interventions for the reduction of exposure to indoor air pollution

Source of smoke	Living environment	User
Improve the cooking devices Chimney-less improved biomass stoves Improved stoves with chimneys **Change the fuel used to one of the following:** Briquettes and pellets Charcoal Kerosene LPG Biogas Producer gas Solar energy Other low-smoke fuels Electricity **Reduce the need for fire** Insulate houses Install solar water heaters	**Improve ventilation** Dust all hoods and fireplaces Increase the number of windows and ventilation holes **Kitchen design and placement of stove** Create a shelter for cooking (move stove to a better ventilated area) Place the stove at waist height	**Reduce exposure through operation of source** Dry the fuel first Use pot lids Maintain the stoves better Operate them more efficiently **Avoid exposure** Keep children away from the smoke

Source: Adapted from Ballard-Tremeer *et al*. (2000) in Warwick and Doig (2004).

Most research attention is given to alternative cooking fuels. A switch from burning wood to burning petroleum-based fuels such as kerosene would reduce indoor air pollution by at least 90%, and prevent as many as 3.7 million deaths a year from respiratory illness, depending the speed of the transition (Bailis *et al*., 2005). Household fuels are ranked on an energy ladder, a scale that rates the quality of household fuels. On the lower end of the ladder are traditional biomass fuels such as dried animal dung, scavenged twigs and grass, crop residues, wood and charcoal. Next are coal, kerosene, bottled and piped gas, biogas (from animal dung) and electricity (Smith *et al.*, 2000 in Warwick and Doig, 2004). As the welfare of poor people improves, they tend to switch to fuels higher on the energy ladder.

Some cleaner fuels cost less per unit than wood. However, infrastructure is necessary to ensure reliable delivery. Some research suggests that similar health and environmental benefits, at least in terms of lower pollution, would be achieved by encouraging a shift from burning wood to burning charcoal (Bailis *et al*., 2005), an approach objected to by some environmentalists owing to current production processes for charcoal (OECD, 2005).

35. Moving cooking outdoors, seemingly a simple solution for removing indoor smoke pollution, is not technically and culturally feasible in some regions and would not resolve any of the environmental problems of outdoor air pollution.

Core, parts and complementary products

One of the remedies for reducing indoor smoke pollution is to improve cooking devices so that they use fuel more efficiently. Table 1.6 lists HS subheadings related to improved cooking appliances. Basic headings are from Chapters 73 (incorporating a range of fuels) and 69. Multiple-use products which could be used in passive (*i.e.* improved ventilation) and active (more efficient cooking stoves, alternative fuels, infrastructure development) indoor smoke pollution control are not listed.

Table 1.6. Products related to improved cooking appliances

HS code	Description
2710.19ex	Other petroleum oils and oils obtained from bituminous materials, other than crude… (ex-out: kerosene for cooking stoves)
6914.10ex	Other ceramic articles of porcelain or china (ex-out: linings for wood burning stoves of porcelain or china, stoves of porcelain and china)
6914.90ex	Other ceramic articles (ex-out: linings for wood burning stoves of ceramics other than porcelain or china, ceramic stoves other than of porcelain and china)
7321.11	Cooking appliances and plate warmers – non-electric domestic stoves and ranges for gas fuel or both gas and other fuels [includes solar stoves]
7321.12	Cooking appliances and plate warmers – non-electric domestic stoves and ranges for liquid fuel [includes vegetable oil stoves, kerosene stoves]
7321.13	Cooking appliances and plate warmers – non-electric domestic stoves and ranges for solid fuels
7321.90ex	Parts of 7321 (ex-out: as applicable)
8516.60ex	Other ovens; cookers, cooking plates, boiling rings, grillers and roasters (ex-out: domestic electric stoves)
8516.90ex	Parts of 8516.90 (ex-out: as applicable)

Source: Based on the 2002 edition of the Harmonized System.

Trade

Total trade in non-electric cooking appliances and plate warmers (cooking appliances for short) that use different types of fuels are presented in Annex Table 1.A3.3. Trade statistics do not provide a comprehensive view of improved cooking appliances because of non-specificity at the 6-digit level. However, several observations can be made:

- By far the greatest number of traded stoves use gas. The export value of trade in cooking appliances using gas or both gas and other fuels is eight times greater than the export value of trade in cooking appliances using solid fuels, and 24 times the value of cooking appliances using liquid fuels.
- Cooking appliances are generally subject to high tariff levels regardless of the type of fuel they use, although some countries vary the tariff on stoves according to the type of fuel used. Such treatment could indicate a preference for a specific type of fuel (gas, solid, or liquid).
- There are notable differences in the numbers of tariff lines used by countries. Applied tariffs vary widely among and within the WTO members, observers and non-members, in some cases exceeding 50%.

- Trade in parts is small compared with trade in cooking appliances using gas. Countries tend to levy lower tariffs on parts than on complete units.
- The share of LDCs in both categories is miniscule.

South–South trade

The long-term goal of many countries and development agencies has been to replace inefficient stoves that burn solid fuel with more efficient models using gas or liquid fuels. This is often not feasible because of high costs and high demands on infrastructure. Cooking appliances, especially those beyond a simple fireplace or a self-made device, tend to require a large monetary outlay for a household. In addition, to achieve high rates of adoption, stove designs have to be field-tested and accepted by users.[36]

Owing to the lack or unreliability of infrastructure for delivering less polluting fuels, solid fuels are likely to remain the main energy source in many developing countries. Although local conditions and cooking cultures differ across countries, resulting in differences in desirable stove designs, the problem of indoor smoke pollution is the same. However, trade in cooking appliances using solid fuels is relatively small, indicating a possible gap in the market that developing countries could fill. Co-operation in research and development, drawing upon existing knowledge on liners, combustion temperatures and ventilation, is needed to develop a basic fuel-efficient stove frame with proper ventilation.[37]

The largest potential for involvement of developing countries seems to be in the production and trade in parts that could be assembled in their destination countries to fit local conditions and cooking practices. There are economies of scale in the production of parts to be exploited. In addition, final adjustments in the consuming country would provide employment opportunities for local artisans.

Complementary policies

Liberalisation of trade in stoves and related parts is a necessary but not sufficient condition to deal with the indoor smoke pollution problem caused by burning raw biomass. To maximise benefits, any reduction in tariffs would need to be complemented by research and development to develop appliances fitting local conditions, domestic policy incentives (for example, changes in taxes on appliances and alternative fuels), availability of micro-credit schemes, incentives for adoption, and education and extension programmes. Although alternative fuels may be preferable in some circumstances, encouraging the adoption of new cooking appliances without having set up a proper infrastructure to deliver the fuels is likely to be a wasteful exercise. Some innovations for cooking appliances could be extended to water heaters and other domestic appliances.

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36. For example, in Kenya the first improved stoves began to appear in the early 1980s and were designed by aid groups such as UNICEF and CARE Kenya. Seeking to improve the efficiency of the common metal stove, these groups only carried out brief field tests and the stoves received a mixed response from users (Kamman, 1995). The results in India were also mixed, owing to high breakdown rates and poor stove design. Success stories include the *plancha* in Guatemala, LPG in Ghana, the Mirte *injera* (flat bread) stove in Ethiopia and smoke hoods in Kenya (Bess and Mazzoni, 2001), biogas in Nepal, rocket stoves and Ecostoves in Central America, various stove programmes in China, and fuel-efficient stoves in Sri Lanka.

37. For a treatment of the transfer of environmentally sound technologies, see Tébar Less and McMillan (2005).

Health benefits from using improved cooking appliances go beyond the immediate effects of indoor smoke reduction. Improved health conditions have far-reaching developmental benefits, such as facilitating work outside home, freeing children from the chore of wood collection (increasing the likelihood they will remain in school), and opening small businesses. Kammen (1995) shows that one effect of the ceramic *Jiko* stove on household finances was savings typically of around 1 300 pounds (almost 600 kg) of fuel a year, freeing up about USD 65 per household — up to a fifth of the annual income of urban dwellers. In India, installing improved *chula* stoves halved cooking time and fuel requirements.[38]

Concluding remarks

The case studies examine two manufactured products (bicycles and stoves) and one commodity (sisal) and extend the analysis to parts and complements. They suggest opportunities for further removal of tariffs as well as South-South co-operation. Nevertheless, trade liberalisation may not be sufficient on its own to achieve environmental and developmental goals, and may require additional or complementary reforms at the domestic level. The chapter also proposes an illustrative list of EPPs that may interest both developed and developing countries. The list includes products from almost every chapter of the HS.

38. www.shellfoundation.org/flag_programmes/breath_news/02.htm.

Annex 1.A1

Codes for Explaining Environmental Benefits in the Illustrative List of Environmentally Preferable Products in Annex 1.A2

Category	Code
Environmentally preferable (EP) transport	
EP transport core (for the conveyance of people or cargo)	TCR
EP transport infrastructure	TIN
EP transport complements	TCM
EP transport parts and associated tools	TPAT
Energy	
Relatively energy efficient technologies	REEF
Goods powered by renewable energy	GPRE
Manual tools	MT
Passive energy-efficient goods	PEFG
Parts of passive energy-efficient goods	PGP
Pollution control	
Air quality improvement	AQI
Air quality improvement complements	AQIC
Cleaning and hygiene supplies	CSS
Pollution control miscellaneous	PCM
Life-cycle extension	LCE
EP alternatives (generic)	
Sustainable agriculture and fisheries (inputs)	SAF
EP alternatives made of renewable materials	AMRM
EP alternatives to disposable products	ADP
EP alternatives that are biodegradable	AB
EP alternatives miscellaneous	AM
Waste and scrap	
Waste and scrap: encourages proper disposal	WAS
Utilization of waste and scrap: for material recovery	UWS
By-product utilization	BU

Annex 1.A2

Illustrative List of Environmentally Preferable Products

Explanatory and technical notes

In coding the table in this annex, only environmental benefits were identified. Codes are shown in Annex 1.A1. Not all products are environmentally preferable in all circumstances: for example, diatomatious earth, an input in organic agriculture, can be mixed with nitro-glycerine to make dynamite.[39] Compared with earlier lists of environmental goods and services, this illustrative list may appear to contain some rather unsophisticated products. However, if one considers environmental performance in use, many consumer goods can also qualify as EPPs.

Almost every manufactured good in the HS can be made more environmentally preferable by using recycled or renewable materials (*i.e.* filling upholstered furniture with renewable natural materials), changing the packaging (*i.e.* designing furniture to be packed flat for shipping), etc. These alternatives are not included on the illustrative list since in most cases the changes do not alter their HS classification. Since not every good can qualify as an EPP in all circumstances, the illustrative list should be read in connection with the explanatory and technical notes.

Explanatory notes

Categorisation: Goods may belong to more than one category at the same time.

Waste and scrap: When traded, waste and scrap has an intrinsic value, and the importing party provides a payment for the good, there is a reasonable indication it will be somehow utilised. However, when waste and scrap are destined to be disposed of in the target country, a payment is provided by the exporter, and the disposal is considered to be a service: the receiving country is exporting an environmental service (solid or hazardous waste management). It must be stressed that nothing in this chapter should be read as contradicting the Basel Convention and its decisions which, by applying "environmentally sound management" to hazardous waste, aims to minimise the generation of hazardous wastes in terms of quantity and hazardousness, to dispose of them as close to the source of generation as possible, and to reduce the movement of hazardous waste.[40]

Life-cycle extension vs. utilisation of waste and scrap: Utilisation of waste and scrap or materials recovered from waste and scrap is in a sense life-cycle extension. For the purposes of this list, life-cycle extension incorporates goods that have not been disposed of. Utilisation of waste and scrap involves products recovered or recoverable from waste

39. On the other hand, even dynamite, in controlled explosions, saves energy in mining.

40, www.basel.int/pub/basics.html.

and scrap, such as metals, organic waste used as a fertiliser, or recycled paper for further use. Products listed in the life-cycle extension category, such as floor and window coverings, also serve as insulation, both against temperature extremes and noise (almost all thermal insulation is also sound insulation).

Parts: Parts and replacements could also belong to the life-extension category. This use, rather trivial, is not mentioned, and parts are listed under their primary use (*e.g.* bicycle tyres and associated tools).

Upstream and downstream movements in a chain: All categories identified include relevant parts if they pertain to a specific use and are fairly explicit. For example, nails and screws, although they are essential, are not included owing to their multiple uses. Immediate parts and necessary complements are included, however; luxury or non-mandatory complements which are not essential for using the product were omitted. For example, ski boots and ski fastenings are essentials for cross-country skiing, ski outfits are (probably) not.

Agricultural products: Although the UNCTAD list and the EC submission contain examples of agricultural products (HS Chapters 1–24), they were omitted from the illustrative list of EPP examples listed in this paper.

Overlaps: Some products (*e.g.* brooms) occurred on the OECD list of environmental goods and services. Some renewable energy technologies could appear on the list of EPPs as well, since by some definitions renewables are environmentally preferable alternatives to other forms of energy.

Technical notes regarding filing into the HS:

- Products are often identified as ex-outs of a 6-digit HS subheading.
- An HS heading (4-digit) normally contains more than one subheading (6-digit), and, when so listed, all subheadings are considered EPP candidates. For example, HS 4406 (Railway or tramway sleepers [cross-ties) of wood) contains subheadings 4406.10 (Not impregnated) and 4406.90 (Other). In the list only HS 4406 is listed.
- “x” instead of the sixth digit is used when products differ on the sixth digit, but the entire category can be considered an EPP candidate. For example, HS 6306.31 are Sails of synthetic material, HS 6306.39 are Sails of other textile materials. The list gives HS 6306.3x (Sails).

For consideration as possible qualifying products (not filed in the illustrative list): plant-based pesticides; composting toilets; rainwater harvesting; plant oil sold directly as fuel (Chapter 15); fuel cell based power systems; hydrogen cars; devices to minimise summertime solar overheating while maximising daylight and winter time solar gains such as: daylight collection and guidance devices, daylight optimisation blinds and photosensitive glazing; building heat recovery systems such as certain types of heat exchanger; building thermal energy storage systems including phase change materials purposely designed for this task; [electronic?] building energy management systems.

Other notes:

- Note 1: Insulated or energy-controlling glazing (double or triple-glazing, argon-filled double glazing, glazing with infrared reflecting coatings, special types of solar control glazing, etc.)

- "Ref" column: indicates the origin of the good: "U" from the UNTAD list; "EC" from the EC submission to the WTO (TN/TE/W/47); "H" in house.

HS	Description	Ex-out	R	Cat	Rationale, if applicable
2512.00	Siliceous fossil meals (for example, kieselguhr, tripolite and diatomite), whether or not calcined, other or not calcined)	diatomous earth	H	SAF	Diatomite used in organic agriculture.
25.13	Pumice; emery; natural corundum, natural garnet and other natural abrasives, whether or not heat-treated		U		
2517.10	Pebbles, gravel, broken or crushed stone, of a kind commonly used for concrete aggregates, for road metalling or for railway ballast, shingle and flint, whether or not heat treated	gravel for railroads	H	TIN	Complement: used in railroad construction.
2518.10	Dolomite, not calcined or sintered	dolomite dust	H	SAF	Rock dust is a soil amendment.
2525.30	Mica waste		H	UWS	Used in joint compound, paint, roofing, oil well drilling additives, and rubber products, making mica paper and as a filler and reinforcer in plastics.
2618.00	Granulated slag (slag sand) from the manufacture of iron or steel		H	UWS	Obtained, for example, by pouring liquid dross into water as it leaves the blast furnace; can be used to make cement.
2619.00	Slag, dross (other than granulated slag), scalings and other waste from the manufacture or iron or steel		H	UWS	Might include sufficient iron to permit recovery of the metal. Otherwise used in the manufacture of cement, for ballast and in road construction.
26.20	Ash and residues (other than from the manufacture of iron and steel), containing arsenic, metals or their compounds		H	UWS	Can be used for the extraction of arsenic or metals or as basis for the manufacture of their chemical compounds.
26.21	Other slag and ash, including seaweed ash (kelp); ash and residues from the incineration of municipal waste		H	UWS	Used as fertilizers, material for cement manufacture, supplement to cement in concrete and mine backfill, as a mineral filler in plastics and paints, as a lightweight aggregate in block manufacture, and in civil structures, for extracting iodine or in the glass industry.
2710.19	Other [petroleum oils and oils obtained from bituminous materials, other than crude…]	kerosene for cooking stoves	H	AQIC	If kerosene stoves to be included as a way to reduce pollution from solid fuels.
2710.9x	Waste oils		H	WAC	Encourages proper disposal.
2836.30	Sodium hydrogencarbonate (sodium bicarbonate)		H	CSS AB	Baking soda – cleaning.
3006.80	Waste pharmaceuticals		H	WAC	Pharmaceutical products which are unfit for their original intended purpose. Encourages proper disposal of waste pharmaceuticals.
3101.00	Animal or vegetable fertilizers, whether or not mixed together or chemically treated; fertilizers produced by the mixing or chemical treatment of animal or vegetable products	includes compost	U		
3103.20	Basic slag		H	UWS	A by-product of iron and steel manufacturing, see WCO notes.
3105.10	[Fertilisers] In tablets or similar forms or in packages of a gross weight not exceeding 10 kg	fertilisers included in this list	H	UWS	
32.01	Tanning extracts of vegetable origin; tannins and their salts, ethers, esters and other derivatives		H	AB AMRM	Biodegradable tanning extracts, renewable source.
3203.00	Colouring matter of vegetable or animal origin …		H	AB AMRM UWS	

HS	Description	Ex-out	R	Cat	Rationale, if applicable
32.15	Printing ink, writing or drawing ink and other inks, whether or not concentrated or solid	soy ink	H	AMRM	Soy ink is more easily degradable [despite popular beliefs, it is not 100 % degradable] than conventional ink and is renewable.
34.01	Soap; organic surface-active products and preparations for use as soap		U		
3401.19	Soap; organic surface-active products and preparations for use as soap: Other: natural soaps made from vegetable oil		U		
3401.30	Organic surface-active products …. Put up for retail sale, …..	refills (concentrated in pouches, consumer adds water)	H	AM	Waste reduction. In addition, pouch can be made biodegradable.
34.02	Organic surface-active agents (other than soap); surface-active preparations, washing preparations and cleaning preparations, whether or not containing soap, other than those of heading 3401		U		
3402.20	Preparations put up for retail sale	refills (concentrated in pouches, consumer adds water)	H	AM	Waste reduction. In addition, pouch can be made biodegradable.
34.04	Artificial waxes and prepared waxes		H	LCE	Extend life cycle of protected items, resulting in slower replacement and resource preservation.
34.05	Polishes and creams, for footwear, furniture, floors, coachwork, glass or metal…		H	LCE	Extend life cycle of protected items, resulting in slower replacement and resource preservation.
3406.00	Candles, tapers and the like	soy, palm oil candles; recycled candles	H	AMRM AM	Soy candles - cleaner and longer burning. Renewable source
3505.20	Glues		H	LCE	Facilitate repairs and extend life cycle of items.
3606.10	Liquid or liquefied-gas fuels in containers of a kind used for filling or refilling cigarette or similar lighters and of a capacity not exceeding 300 cm^2		H	AM	For refillable lighters.
3803.00	Tall oil, whether or not refined		H	BU	By-product of wood pulp manufacturing, variety of uses - in soaps, road-surfacing, plasticizer.
3804.00	Residual lyes from the manufacture of wood pulp, whether or not concentrated, desuraged or chemically treated, including lignin sulphonates, but excluding tall oil of heading 3808		H	BU	By-product of wood pulp manufacturing, variety of uses – binder for compressed blocks of fuel, glue preparation, etc.
3807.00	Wood tar; wood tar oils; wood creosote; wood naphtha; vegetable pitch; brewers' pitch and similar preparations based on rosin, resin acids or on vegetable pitch		H	BU	By-product of wood carbonization. Variety of uses – impregnation of ships' cables, medicine, etc.
3825.41	Waste organic solvents halogenated [Residual products of the chemical or allied industries, not elsewhere specified or included; municipal waste; sewage sludge; other wastes]		H	UWS	Can be used for recovery of the solvents.
3825.49	Waste organic solvents other [Residual products of the chemical or allied industries, not elsewhere specified or included; municipal waste; sewage sludge; other wastes]		H	UWS	Can be used for recovery of the solvents.
3825.50	Wastes of metal pickling liquors, hydraulic fuels, brake fluids and anti-freeze fluids [Residual products of the chemical or allied industries, not elsewhere specified or included; municipal waste; sewage sludge; other wastes]		H	UWS	Generally used for recovery of primary products.

HS	Description	Ex-out	R	Cat	Rationale, if applicable
3825.90	Other [Residual products of the chemical or allied industries, not elsewhere specified or included; municipal waste; sewage sludge; other wastes]	residues from the manufacture of antibiotics	H	UWS	Suitable for use for the preparation of compound animal feeds.
3825.90	Other [Residual products of the chemical or allied industries, not elsewhere specified or included; municipal waste; sewage sludge; other wastes]	spent oxide	H	UWS	From gas purification, used as a source of sulphur and cyanides, as fertilizer and insecticide.
39.12	Cellulose and its chemical derivatives, not elsewhere specified or included, in primary forms		U		
3913.90	Natural polymers: Other: Chemical derivatives of natural rubber		U		
39.15	Waste, parings and scrap, of plastics		H	UWS	Includes PET for recycling.
39.18	Floor coverings of plastics, whether or not self-adhesive, in rolls or in the form of tiles; wall or ceiling coverings of plastics		H	LCE	Protected floors last longer, also insulation.
39.21	Other plates, sheets, film, foil and strip, of plastics	insulation panels	H	PEEG	
3926.30	Fittings for furniture, coachwork or the like		H	LCE	Protected furniture lasts longer.
3926.90	Other articles of plastics	clothes pins	H	AM	Facilitate air drying of laundry (energy saving)
3926.90	Other articles of plastics	refillable printer cartridges [to be refilled with soy ink]	H	LCE UWS	
40.01	Natural rubber, balata, gutta-percha, guayule, chicle, and similar natural gums, in primary forms or in plates, sheets		U		
4003.00	Reclaimed rubber in primary forms or in plates, sheets or strip		H	UWS	Obtained from used rubber articles, esp. tyres, from waste scrap, etc. by various chemical or mechanical means.
4004.00	Waste, parings and scrap of rubber (other then hard rubber) and powders and granulates obtained there from		H	UWS	Can be used as a filler or for moulding rubber articles not requiring great strength.
40.10	Conveyor or transmission belts or belting, of vulcanised rubber	conveyor belts	H	TIN	
4011.50	Of a kind used on bicycles [new pneumatic tyres, of rubber]		H	TPAT	Complementing bicycles.
40.12	Retreated or used pneumatic tyres of rubber; solid or cushion type, tyre treads and tyre flaps, of rubber		H	LCE UWS	Retreating extends life cycle of tyres.
4013.20	Of a kind used on bicycles [inner tubes, of rubber]		H	TPAT	Complementing bicycles.
4016.91	Floor coverings and mats [of vulcanised rubber other than hard rubber]		H	LCE	Protected floors last longer, also insulation.
4017.00	Hard rubber in all forms, incl. waste and scrap; articles of hard rubber	waste and scrap	H	UWS	
41.15	Composition leather with a basis of leather or leather fibre, in slabs, sheets or strip, whether or not in rolls; parings and other waste of leather or of composition leather, not suitable for the manufacture of leather articles; leather dust, powder and flour		H	UWS	
42.03	Articles of apparel and clothing accessories, of leather or of composition leather	articles of composition leather	H	UWS	

HS	Description	Ex-out	R	Cat	Rationale, if applicable
4204.00	Articles of leather or of composition leather, of a kind used in machinery or mechanical appliances or for other technical uses	articles of composition leather	H	UWS	
4205.00	Other articles of leather or of composition leather	articles of composition leather	H	UWS	
44	Wood and articles of wood; wood charcoal		H	AMRM AB	
4401.30	Sawdust and wood waste and scrap, whether or not agglomerated in logs, briquettes, pellets or similar forms		H	UWS	
44.06	Railway or tramway sleepers (cross-ties) of wood		H	TIN	Complementing rail transport.
44.10	Particle board and similar board of wood or other ligneous materials, whether or not agglomerated with resins or other organic binding substances		H	UWS	Can be made using waste and scrap.
44.11	Fibreboard of wood or other ligneous materials, whether or not bonded with resins or other organic substances		H	UWS	Can be made using waste and scrap.
44.12	Plywood, veneered panels and similar laminated wood		H	UWS	Can be made using waste and scrap.
44.15	Packing cases, boxes, crates, drums and similar packings, of wood; cable drums of wood; pallets, box pallets and other load boards, of wood; pallet collars of wood		H	ADP AMRM	Reusable packaging made of renewable material.
4416.00	Casks, barrels, vats, tubs and other coopers' products and parts of thereof, of wood, including staves		H	ADP AMRM	Reusable and made of renewable material.
4417.00	Tools, tool bodies, tool handles, broom or brush bodies and handles, of wood; boot or shoe lasts and trees, of wood	hand tools, broom handles, snow shovels	H	LCE MT	Tools, if properly used, help with small repairs to extend life cycle of repaired products.
4418.10	Windows, French-windows and their frames	See Note 1, ¶66	H	PGP	
4421.90	Other articles of wood	clothes pins	H	AM	Facilitate air drying of laundry (energy saving).
4421.90	Other articles of wood	wood mulch	H	AB AM	Biodegradable, water savings from mulching.
45	Cork and articles of cork		H	AMRM AB	Renewable, reusable, biodegradable.
45.01	Natural cork, raw or simply prepared; waste cork; crushed granulated or ground cork		H	AMRM AB	Renewable, biodegradable, also some scrap utilization.
4502.00	Natural cork, debacked or roughly squared, ….		H	AMRM AB	
45.03	Articles of natural cork		H	AMRM AB	
45.04	Agglomerated cork (with or without a binding substance) and articles of agglomerated cork	includes insulation sheets of cork	U		
46	Manufactures of straw, of esparto or of other plaiting materials; basketware and wickerwork		U		
47.06	Pulps of fibres derived from recovered (waste and scrap) paper or paperboard or from other fibrous cellulosic material		H	UWS	Includes pulp from kenaf, sisal and other fibrous materials.
47.07	Recovered (waste and scrap) paper or paperboard		H	UWS	To be used for pulping, occasionally for packing.
48	Paper and paperboard; articles of paper pulp, of paper or of paperboard	made of recycled paper	H	UWS	
48.14	Wallpaper and similar wall coverings; window transparencies of paper		H	LCE	Protected walls last longer, better insulation, biodegradable window transparencies.

HS	Description	Ex-out	R	Cat	Rationale, if applicable
4815.00	Floor coverings on a base of paper or of paperboard, whether or not cut to size		H	LCE	Protected floors last longer, also insulation.
48.19	Cartons, boxes, cases, bags and other packing containers, of paper, paperboard, cellulose wadding or webs of cellulose fibres; …		H	ADP AB	Reusable, biodegradable.
4823.90	Other paper, paperboard, cellulose wadding and webs of cellulose fibres, cut to size or shape; other articles of paper pulp, paper, paperboard, cellulose wadding or webs of cellulose fibres	cup sleeves, paper insulation	H	PEEG	
4823.90	Other paper, paperboard, cellulose wadding and webs of cellulose fibres, cut to size or shape; other articles of paper pulp, paper, paperboard, cellulose wadding or webs of cellulose fibres	paper dog poop scoopers	H	CSS AB	Biodegradable.
4823.90	Other paper, paperboard, cellulose wadding and webs of cellulose fibres, cut to size or shape; other articles of paper pulp, paper, paperboard, cellulose wadding or webs of cellulose fibres	paper mulch	H	AB AM	Biodegradable, water savings from mulching.
50.03	Silk waste (incl. cocoons unsuitable for reeling, yarn waste and garnetted stock)		H	UWS	
5005.00	Yarn spun from silk waste, not put up for retain sale		H	UWS	
5006.00	Silk yarn and yarn spun from silk waste, put up for retail sale; silk-worn gut	yarn spun from silk waste	H	UWS	
50.07	Woven fabrics of silk or of silk waste	woven fabric of silk waste	H	UWS	
51	Wool, fine or coarse animal hair; horsehair yarn and woven fabric		H	AMRM AB	Utilizing by-product (horsehair).
51.03	Waste of wool or of fine or coarse animal hair, incl. yarn waste but excluding garnetted stock		H	UWS	
5104.00	Garnetted stock of wool or of fine or coarse animal hair	garnetted = reworked, reclaimed	H	UWS	Obtained by garnetting rags of knitted, woven, etc., material or by garnetting the waste yarns obtained during the spinning, weaving, knitting, etc operations. Used for fabrics manufacturing or padding or stuffing purposes.
52	Cotton		H	AMRM AB	
52.02	Cotton waste (incl. yarn waste and garnetted stock)		H	UWS	May be used for spinning or other purposes.
52.04	Cotton sewing thread, whether or not put up for retail sale		H	LCE	Can extend life cycle of clothes and other textiles, repairs.
53	Other vegetable textile fibres; paper yarn and woven fabrics of paper yarn			AMRM AB	The entire chapter, with the exception of true hemp (53.02) is already on the UNCTAD list. Many headings also include waste and scrap.
53.01	Flax, raw or processed but not spun; flax tow and waste		U		
53.03	Jute and other textile bast fibers (excluding flax, true hemp and ramie), raw or processed but not spun; tow and waste of these fibres (including yarn waste and garnetted stock)	includes kenaf	U		
53.04	Sisal and other textile fibres of the genus Agave, raw or processed but not spun; tow and waste of these fibres (including yarn waste and garnetted stock)		U		

HS	Description	Ex-out	R	Cat	Rationale, if applicable
53.05	Coconut, abaca (Manila hemp or Musa garnetted Nee), ramie and other vegetable textile fibres, not elsewhere specified or included, raw or processed but not spun; tow, noils and waste of these fibres (including yarn waste and garnetted stock)		U		
53.06	Flax yarn		U		
53.07	Yarn of jute or other textile bast fibres		U		
53.08	Yarn of other vegetable textile fibres; paper yarn		U		
53.09	Woven fabric of flax		U		
53.10	Woven fabrics of jute or of other textile bast fibres		U		
53.11	Woven fabrics of other vegetable textile fibres; woven fabrics of paper yarn		U		
54.01	Sewing thread of man-made filaments, whether or not put up for retail sale		H	LCE	Can extend life cycle of clothes and other textiles, repairs.
55.05	Waste (incl noils, yarn waste and garnetted stock) of man-made fibres		H	UWS	
5604.90	Other [Rubber thread and cord, textile covered; textile yarn, and strip and the like of heading 54.04 or 54.05, impregnated, coated or sheathed with rubber or plastics	clothes line for drying	H	AM	Facilitate air drying of laundry (energy saving).
5607.10	Twine, cordage, ropes and cables of jute or other textile bast fibres		U		
5607.2x	Twine, cordage, ropes and cables of sisal or other textile fibres of the genus Agave		U		
56.08	Knotted netting of twine, cordage or rope; made up fishing nets and other made up nets, of textile materials		U		
57	Carpets and other textile floor coverings		H	LCE	Protected floors last longer, also insulation.
5811.00	Quilted textile products in the piece, composed of one or more layers of textile materials assembled with padding by stitching or otherwise, other than embroidery of heading 58.10	with scrap material as a quilt fill	H	UWS	
59.01	Textile fabrics coated with gum or amylaceous substances, of a kind used for the outer covers of books or the like		H	LCE	Extends life cycle of books.
59.04	Linoleum, whether or not cut to shape; floor coverings consisting of coating or covering applied on a textile backing, whether or not cut to shape		H	LCE	protected floors last longer, insulation
5905.00	Textile wall coverings		H	LCE	Protects walls; can serve as insulation.
5908.00	Textile wicks, woven, plaited or knitted, for lamps, stoves, lighters, candles or the like, …		H	AM	Complements soy candles, also used in some stoves.
5910.00	Transmission or conveyor belts or belting, of textile material, whether or not impregnated, coated, covered or laminated with plastics…		H	TIN	
63.02	Bed linen, table linen, toilet linen and kitchen linen		H	LCE	Among other uses: EP alternative to disposable products (towels and table cloths), extend life cycle of products they cover (bed linens, table cloths).
6305.10	Sacks and bags, of a kind used for the packaging of goods of jute or of other textile bast fibers		U		Subheading singled out by UNCTAD.

HS	Description	Ex-out	R	Cat	Rationale, if applicable
63.03	Curtains (incl. drapes) and interior blinds; curtain or bed valances		H	PEEG	Provide some thermal insulation.
63.05	Sacks and bags, of a kind used for the packing of goods		H	ADP	Reusable packaging.
6306.1x	Tarpaulins		H	CSS ADP	Protect cargo - thus limit pollution, also reusable.
6306.2x	Tents		H	AM	Disaster management: for example, temporary shelters after natural disasters.
6306.3x	Sails		H	TIN	Complements EP transport.
6306.4x	Pneumatic mattresses		H	AM	Disaster management: for example, temporary shelters after natural disasters.
6307.10	Floor-cloths, dish-cloths, dusters and similar cleaning products [Other made up articles, including dress patterns]		H	CSS	
6307.10	Floor-cloths, dish-cloths, dusters and similar cleaning products [Other made up articles, including dress patterns]	electrostatic dust cloths, other treated dust cloths	H	CSS	Washable, ease cleaning. Include … cloths whether or not impregnated with a cleaning preparation, but excl 34.01 or 34.05
6307.20	Life-jackets and life-belts [Other made up articles, including dress patterns]		H	TCM	Complements EP transport (on water).
6307.90	Other [Other made up articles, including dress patterns]	domestic laundry or shoe bags, …	H	CSS	Also life cycle extension.
6307.90	Other [Other made up articles, including dress patterns]	garment bags (other than 42.02 - suitcases)	H	LCE	
6307.90	Other [Other made up articles, including dress patterns]	flat protective sheets	H	LCE	
6307.90	Other [Other made up articles, including dress patterns]	textile coffee filters, icing bags, etc.	H	LCE	
6307.90	Other [Other made up articles, including dress patterns]	shoe polishing pads	H	LCE	
6307.90	Other [Other made up articles, including dress patterns]	tea cosy covers	H	PEEG	
6307.90	Other [Other made up articles, including dress patterns]	fans and hand screens (those with frames of precious metal classified separately)	H	AM	
6307.90	Other [Other made up articles, including dress patterns]	packing cloths	H	LCE	
6307.90	Other [Other made up articles, including dress patterns]	textile face masks of a kind worn by surgeons	H	PCM	Cross-cutting with public health.
6307.90	Other [Other made up articles, including dress patterns]	face masks for protection against dust, odours	H	PCM	Passive pollution control.
6307.90	Other [Other made up articles, including dress patterns]	draught excluders	H	PEEG	
6309.00	Worn clothing and other worn articles		H	LCE	
63.10	Used or new rags, scrap twine, cordage, rope and cables and worn out articles of twine, cordage, rope or cables, of textile materials		H	LCE	
6402.12	Ski-boots, cross-country ski footwear and snowboards boots [Other footwear with outer soles and uppers of rubber or plastics]	cross country	H	TIN	Complements EP transport.

HS	Description	Ex-out	R	Cat	Rationale, if applicable
6403.12	Ski-boots, cross-country ski footwear and snowboards boots [footwear with outer soles of rubber, plastics, leather or composition leather and uppers of leather]	cross country	H	TIN	Complements EP transport.
6404.11	Sports footwear; tennis shoes, basketball shoes, gym shoes, training shoes and the like [ftwear with outer soles of rubber, plastics, leather or composition leather and uppers of textile materials]		H	TIN	Sports footwear encourages walking.
6506.10	Safety headgear	bike, ski, fire-fighter helmets, …	H	TCM	Complements EP transport.
66.01	Umbrella and sun umbrellas		H	TCM	Complements EP transport, protect walker in an inclement weather.
6602.00	Walking sticks, seat sticks, whips, riding-crops and the like	walking sticks	H	TCM	Complements EP transport, walking stick eases walking.
66.03	Parts, trimmings, and accessories of articles of heading 66.01 or 66.02		H	TCM	
67.01	Skins and other parts of birds with their feathers or down, parts of feathers, down and articles thereof		U		
68.06	Slag wool, rock wool and similar mineral woods, exfoliated vermiculite, expanded clays, foamed slag and similar expanded mineral materials; mixtures and articles of heat-insulating, sound-insulating or sound-absorbing mineral materials, other than those of heading 68.11 or 68.12 or of Chapter 69	thermal insulation	H	PEEG	
6807.90	Other articles of asphalt or of similar material	insulating boards of asphalt, of a kind used for roofing or siding	H	PEEG	
6808.00	Panels, boards, tiles, blocks and similar articles of vegetable fibre, of straw or of shavings, chips, particles, sawdust or other waste, ….	thermal insulation	H	PEEG	Also possible utilization of waste and scrap.
6809.90	Other articles of plaster or of compositions based on it	thermal insulation	H	PEEG	
68.14	Worked mica and articles of mica, including agglomerated or reconstituted mica, …	reconstituted mica	H	UWS	Includes reconstructed mica.
6901.00	Bricks, blocks, tiles and other ceramic goods of siliceous fossil meals or of similar siliceous earths	thermal insulation	H	PEEG	
6914.10	Other ceramic articles of porcelain or china	linings for wood burning stoves of porcelain or china, stoves of porcelain and china	H	AQIC	
6914.90	Other ceramic articles	linings for wood burning stoves of ceramics other than porcelain or china, ceramic stoves other than of porcelain and china	H	AQI AQIC	
7001.00	Cullet {broken or refuse glass} and other waste and scrap of glass; glass in the mass	scrap	H	WAS	Further workable.

HS	Description	Ex-out	R	Cat	Rationale, if applicable
70.03	Cast glass and rolled glass, in sheets or profiles, whether or not having an absorbent, reflecting or non-reflecting layer, but not otherwise worked	window glass, see Note 1, ¶66	H	PGP	
70.04	Drawn glass and blown glass, in sheets, whether or not having an absorbent, reflecting or non-reflecting layer, but not otherwise worked	window glass, see Note 1, ¶66	H	PGP	
70.05	Float glass and surface ground or polished glass, in sheets, whether or not having an absorbent, reflecting or non-reflecting layer, but not otherwise worked	window glass, see Note 1, ¶66	H	PGP	
70.06	Glass of heading 70.03, 70.04, or 70.05, bent, edge-worked, engraved, drilled, enamelled or otherwise worked, but not framed or fitted with other material	window glass, see Note 1, ¶66	H	PGP	
7008.00	Multiple-walled insulating units of glass		H	PGP	
7012.00	Glass inners for vacuum flasks or for other vacuum vessels		H	PGP	Considerably extend life cycle of vacuum flasks.
7016.90	Articles of pressed or moulded glass , multicellular or foam glass in blocks, panels, plates, shells or similar forms	thermal insulation	H	PEEG	
7019.3x	Thin sheets (voiles), webs, mats, mattresses, boards and similar non-woven products	thermal insulation	H	PEEG	
7019.40	Woven fabrics of rovings	thermal insulation	H	PEEG	
7019.5x	Other woven fabrics	thermal insulation	H	PEEG	
7019.90	Other	thermal insulation	H	PEEG	
71.04	Synthetic or reconstr. precious or semiprecious stones	reconstructed stones	H	UWS	
71.05	Dust and powder of natural or synthetic precious or semiprecious stones		H		
71.12	Waste and scrap of precious metal or of metal clad with precious metal; other waste and scrap containing precious metal or precious metal compounds, of a kind used principally for the recovery of precious metal		H	WAS	
72.04	Ferrous waste and scrap; remelting scrap ingots of iron or steel		H	WAS	Can be used for the recovery of metal by re-melting or for the manufacture of chemicals.
73.02	Railway or tramway track construction material of iron or steel, the following: rails, check-rails and rack rails, switch blades, crossing frogs, etc.…		H	TIN	complements EP transport
7308.30	Doors, windows and their frames and thresholds for doors	See Note 1, ¶66	H	PEEG	
7315.11	Roller chain	bicycle chain	H	TPAT	Complements bicycles.
7315.90	Parts	parts of bicycle chains	H	TPAT	Complements bicycles.
73.19	Sewing needles, knitting needles, bodkins, crochet hooks, embroidery stilettos and similar articles, for use in the hand, of iron or steel; safety pins and other pins of iron and steel, not elsewhere specified or included		H	LCE	Facilitate repairs.
7321.11	For gas fuel or both gas and other fuels [Cooking appliances and plate warmers - non-electric domestic stoves and ranges]	includes solar stoves	H	AQI	
7321.12	For liquid fuel [Cooking appliances and plate warmers - non-electric domestic stoves and ranges]	vegetable-oil stoves, kerosene stoves, ..	H	AQI	

HS	Description	Ex-out	R	Cat	Rationale, if applicable
7321.13	For solid fuel [Cooking appliances and plate warmers - non-electric domestic stoves and ranges]		H	AQI	
7321.90	Parts of 73.21		H	AQI	
7323.93	Of stainless steel [Other: Table , kitchen or other household articles and parts …, of iron and steel]	solar food dehydrator	H	GPRE	
7323.9x	Other table and kitchen or household appliances and parts thereof, of iron or steel; …	pressure cookers of iron or steel	H	REEF	Shortens cooking time, energy saving.
7323.9x	Other table and kitchen or household appliances and parts thereof, of iron or steel; …	pot lids	H	REEF	Shortens cooking time, energy saving.
7404.00	Copper waste and scrap		H	UWS	Used in further recovery and production.
7503.00	Nickel waste and scrap		H	UWS	Used in further recovery and production.
7508.90	Other articles of nickel {incl. windows}	See Note 1, ¶66	H	PEEG	
7602.00	Aluminium waste and scrap		H	UWS	Used in further recovery and production.
7615.19	Other table, kitchen or other household articles and parts thereof, of aluminium	pressure cookers of aluminium	H	REEF	Shortens cooking time, energy saving.
7615.19	Other table, kitchen or other household articles and parts thereof, of aluminium	pot lids	H	REEF	Shortens cooking time, energy saving.
7802.00	Lead waste and scrap		H	UWS	Used in further recovery and production.
7902.00	Zinc waste and scrap		H	UWS	Used in further recovery and production.
7907.00	Other articles of zinc {incl. windows}	See Note 1, ¶66	H	PEEG	
8002.00	Tin waste and scrap		H	UWS	Used in further recovery and production.
8101.97	Waste and scrap [tungsten]		H	UWS	Used in further recovery and production.
8102.97	Waste and scrap [molybdenum]		H	UWS	Used in further recovery and production.
8103.30	Waste and scrap [tantalum]		H	UWS	Used in further recovery and production.
8104.20	Waste and scrap [magnesium]		H	UWS	Used in further recovery and production.
8105.30	Waste and scrap [cobalt]		H	UWS	Used in further recovery and production.
8106.00	Bismuth and articles thereof, inc waste and scrap	waste and scrap	H	UWS	Used in further recovery and production.
8107.30	Waste and scrap [cadmium]		H	UWS	Used in further recovery and production.
8108.30	Waste and scrap [titanium]		H	UWS	Used in further recovery and production.
8109.30	Waste and scrap [zirconium]		H	UWS	Used in further recovery and production.
8110.20	Waste and scrap [antimony]		H	UWS	Used in further recovery and production.
8110.00	Manganese …, incl. waste and scrap	waste and scrap	H	UWS	Used in further recovery and production.
8112.13	Waste and scrap [beryllium]		H	UWS	Used in further recovery and production.
8112.22	Waste and scrap [chromium]		H	UWS	Used in further recovery and production.
8112.30	Germanium [includes waste and scrap]	waste and scrap	H	UWS	Used in further recovery and production.
8112.40	Vanadium [includes waste and scrap]	waste and scrap	H	UWS	Used in further recovery and production.
8112.52	Waste and scrap [thallium]		H	UWS	Used in further recovery and production.
8112.92	Unwrought; waste and scrap; powders [other]		H	UWS	Used in further recovery and production.
8113.00	Cerments (note: A composite material consisting of a combination of ceramic and metallic materials) and articles thereof, including waste and scrap	waste and scrap	H	UWS	Used in further recovery and production.

HS	Description	Ex-out	R	Cat	Rationale, if applicable
82.01	Hand tools, the following: spades, shovels, mattocks, picks, hoes, forks and rakes; axes, bill hooks and similar hewing tools, secateurs and pruners of any kind; scythes, sickles, hay knives, hedge shears, timber wedges and other tools of a kind used in agriculture, horticulture or forestry	includes snow shovels of metal, pooper scooper	H	LCE MT	To conduct small repairs, prevent further deterioration, and prolong life cycle.
8202.10	Hand saws		H	MT	Hand tools – mechanic.
8202.39	Other, including parts		H	MT	Hand tools – mechanic.
8203.30	Metal cutting shears and similar tools		H	MT	Hand tools – mechanic.
8203.40	Pipe-cutters, bolt croppers, perforating punches and similar tools		H	MT	Hand tools – mechanic.
8204.1x	Hand-operated wrenches	wrenches for bicycles	H	TPAT	Complements bicycles.
8205.10	Drilling, threading or tapping tools [Hand tools]		H	MT	Hand tools – mechanic.
8205.20	Hammers and sledge hammers [Hand tools]		H	MT	Hand tools – mechanic.
8205.30	Planes, chisels, gouges and similar cutting tools for working wood [Hand tools]		H	MT	Hand tools – mechanic.
8205.40	Screwdrivers [Hand tools]		H	MT	Hand tools – mechanic.
8205.51	Household tools [Other hand tools (including glaziers' diamonds)]		H	MT	Hand tools – mechanic.
8205.59	Other [Other hand tools (including glaziers' diamonds)]		H	MT	Hand tools – mechanic.
8206.00	Tools of two or more of the headings 82.02 to 82.05, put up in sets for retail sale		H	MT	Hand tools – mechanic.
8210.00	Hand-operated mechanical appliances, weighting 10 kg or less, used in the preparation, conditioning or serving of food or drink		H	MT	Mechanic, such as coffee or spice mills, bread slicers, fruit slicers, etc.
8301.10	Padlocks	bicycle locks	H	TCM	Complements bicycles.
8301.60	Parts	parts of bicycle locks	H	TCM	Complements bicycles.
8301.70	Keys presented separately	parts of bicycle locks	H	TCM	Complements bicycles.
8306.10	Bells, gongs, and the like	bells for bicycles	H	TPAT	Complements bicycles.
	many products from Ch 84 already on the A+O list				
8414.20	Hand- or foot-operated air pumps	bicycle pumps	H	TPAT	Complements bicycles.
8414.51	Table, floor, wall, window, ceiling or roof fans, with a self-contained electric motor is an output not exceeding 125 W		H	REEF	
8414.5x	Fans	with a variable or rated-speed drive system	H	REEF	
8414.90	Parts [Air or vacuum pumps…]	as relevant	H	TPAT REEF	
84.15	Air-conditioning machines, …	water cooled	H	REEF	
84.15	Air-conditioning machines, …	with a variable or rated-speed drive system	H	REEF	
8418.10	Combined refrigerator-freezers, fitted with separate external doors	with a variable or rated-speed drive system	H	REEF	Also using vacuum insulation panels.
8418.2x	Refrigerators, household type	with a variable or rated-speed drive system	H	REEF	Also using vacuum insulation panels.

HS	Description	Ex-out	R	Cat	Rationale, if applicable
8418.30	Freezers of the chest type, not exceeding 800 l capacity	with a variable or rated-speed drive system	H	REEF	Also using vacuum insulation panels.
8418.40	Freezers of the upright type, not exceeding 900 l capacity	with a variable or rated-speed drive system	H	REEF	Also using vacuum insulation panels.
8418.50	Other refrigerating or freezing chests, cabinets, display counters, show-cases and similar refrigerating or freezing furniture	with a variable or rated-speed drive system	H	REEF	Also using vacuum insulation panels.
8418.61	Other refrigerating or freezing equipment, heat pumps	water cooled	H	REEF	
8418.61	Other refrigerating or freezing equipment, heat pumps	with a variable or rated-speed drive system	H	REEF	Also using vacuum insulation panels.
8418.99	Parts	as relevant	H	REEF	
8419.19	Other [Instantaneous or storage water heaters, non-electric]	solar water heaters	H	GPRE	Not necessarily more efficient in a narrow engineering sense.
8419.90	Parts	solar water heaters, parts	H	GPRE	
8421.12	Clothes-dryers [Centrifuges, including centrifugal dryers]		H	REEF	The big advantages of centrifugal dryers are speed and energy efficiency because most of the water is rapidly flung off rather than having to be evaporated.
8421.21	For filtering or purifying water [Filtering or purifying machinery and apparatus for liquids]	domestic water filters	H	CSS AM	Also saves packaging of bottled water.
8421.91	Parts of Centrifuges, including centrifugal dryers		H		
8424.81	Agricultural or horticultural sprinkles		H	SAF	Water savings.
8424.90	Parts	as relevant	H		
8431.41	Buckets, shovels, grabs and grips [parts of machinery of heading 84.30]	parts of snow-ploughs and snow blowers	H	CSS MT	
8451.2x	Drying machines	using a heat pump	H	REEF	
8462.99	Machine tools (including presses) for working metal…	can crushers	H	CSS	Also waste reduction.
8470.10	Electronic calculators capable of operation without an external source of electric power and pocket sized data recording, reproducing and displaying machines with calculating functions	solar calculators	H	GPRE	
8471.60	Input or output units, whether or not containing storage units in the same housing	LCD monitors	H	REEF	
	many products from Ch 85 already on the A+O list				
8504.40	Static converters	battery chargers	H	REEF	
85.07	Electric accumulators, incl. separators thereof, whether or not rectangular (incl. square)	rechargeable cells (batteries)	H	REEF	Rechargeable cells and batteries are NOT part of 85.06 (primary cells and primary batteries).
8512.10	Lighting or visual signalling equipment of a kind used on bicycles		H	TPAT	Complements bicycles.
8512.90	Parts of 8512.10				
85.13	Portable electric lamps designed to function by their own source of energy (*i.e.* dry batteries, accumulators, magnetos), other than lighting equipment of hdng 85.12	solar lamps	H	GPRE	
8516.10	Electric instantaneous or storage water heaters and immersion heaters	using a heat pump	H	REEF	Typically two to three times as efficient as their electric counterparts using resistance heaters.

HS	Description	Ex-out	R	Cat	Rationale, if applicable
8516.2x	Electric space heating apparatus and electric soil heating apparatus	using a heat pump	H	REEF	Typically two to three times as efficient as their electric counterparts using resistance heaters.
8539.39	Other [Discharge lamps, other than ultra-violet lamps]	fluorescent tubes	H	REEF	Longer life cycle.
8541.40	Photosensitive semiconductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light emitting diodes	solar cells	H	GPRE	
8516.33	Hand-drying apparatus		H	CSS	Reduces amount of waste.
8548.10	Waste and scrap of primary cells, primary batteries and electric accumulators; spent primary cells, spent primary batteries and spent electric accumulators		H	WAS	
86	Railway or tramway locomotives, rolling-stock and parts thereof; railway or tramway track fixtures and fittings, …		H	TCR	
86.01	Rail locomotives powered from an external source of electricity or by electric accumulators		H	TCR	
86.02	Other rail locomotives; locomotive tenders		H	TCR	
86.03	Self-propelled railway or tramway coaches, vans and trucks, other than those of heading 86.04		H	TCR	
86.04	Railway or tramway maintenance or service vehicles….		H	TCR	
86.05	Railway or tramway passenger coaches….		H	TCR	
86.06	Railway or tramway goods vans and wagons…		H	TCR	
86.07	Parts of railway or tramway locomotives or rolling stocks		H	TCR	
8608.00	Railway or tramway track fixtures…..		H	TCR	
8609.00	Containers (including containers for the transport of fluids) specially designed and equipped for carriage by one or more modes of transport)		H	TCM	Reusable, facilitates transport by rail.
87.02	Motor vehicles for the transport of ten or more persons, including the driver		H	TCR	
87.03	Motor cars and other motor vehicles principally designed with for the transport of persons (other than those of heading 87.02), …	hybrid engine vehicles, fuel efficient cars	H	AQI	
8703.10	Vehicles specially designed for travelling on snow; golf cars and similar vehicles	golf cars	H	TCR	Rechargeable.
8705.90	Other [special purpose vehicles, *i.e.* mobile workshops, mobile radiological units]	includes snow ploughs with build-in equipment	H	TCR	Includes snow blowers, street sweepers, mobile clinics, field kitchens, mobile libraries, …
8706.00	Chassis fitted with engines, for the motor vehicles of headings 87.01 to 87.05	as relevant	H	TPAT	Complement public transport, fire protection, etc.
87.07	Bodies (including cabs), for the motor vehicles of headings 87.01 to 87.07		H	TPAT	Complement public transport
87.08	Parts and accessories of the motor vehicles of headings 87.01 to 87.05		H	TPAT	Complement public transport
87.09	Works trucks, self-propelled, not fitted with lifting or handling equipment, of the type used in factories, warehouses, dock areas or airports for short distance transport of goods; tractors of the type used on railway station platforms; parts of the foregoing vehicles		H	TCR	Also, some can be electrical.
8712.00	Bicycles and other cycles (incl. delivery tricycles), not motorised		H	TCR	

HS	Description	Ex-out	R	Cat	Rationale, if applicable
87.13	Carriages for disabled persons, whether or not motorised or otherwise mechanically propelled		H	TCR	
8714.9x	Parts and accessories of vehicles of headings 87.11 to 87.13	parts of bicycles	H	TPAT	Complement public transport, fire protection, etc.
8715.00	Baby carriages and parts of thereof		H	TCM	
8716.40	Other trailers and semitrailers	for bicycles	H	TCM	By attaching a trailer, one has to make fewer trips.
8716.90	Parts [Other trailers and semitrailers]	for bicycles	H	TCM	
8801.90	Other [Balloons and dirigibles; gliders, hang gliders and other non-powered aircraft]	dirigibles	H	TCR	Meteorology, environment changes.
88.03	Parts of goods of heading 8801		H	TPAT	Complement EP transport.
8804.00	Parachutes (including dirigible parachutes and paragliders) and rotochutes; parts of thereof and accessories thereto	Paraglides	H	TCR	Paraglides are foot launched, and may allow ascending trajectories. Unlike glides, paraglides are carried on foot.
89.01	Cruise ships, excursion boats, ferry boats, cargo ships, barges and similar vessels for the transport of persons or goods	all but cruise ships and excursion boats	H	TCR	EP mode of transport.
89.03	Yachts and other vessels for pleasure or sports; rowing boats and canoes		H	TCR	EP mode of transport.
8904.00	Tugs and pusher crafts		H	TCR	EP mode of transport, support to other vessels.
89.05	Light-vessels, fire-floats, dredgers, floating cranes and other vessels the navigability of which is subsidiary to their main function; floating docks; floating or submersible drilling or production platforms		H	TCR	EP mode of transport.
8906.90	Other - other vessels other than rowing boats,*i.e.* lifeboats		H	TCR	Complement EP mode of transport.
89.07	Other floating structures (for example, rafts, tanks, cofferdams, landing-stages, buyons and beacons)		H	TCR	Complement EP mode of transport.
	many products from Ch 90 already on the A+O list				
9029.10	Revolution counters, production counters, taximeters, mileometers, pedometers and the like	pedometers	H	TPAT	Pedometers encourage walking and other activities, an EP mode of transport.
9029.20	Speed indicators and tachometer; stroboscopes	related to bicycles	H	TPAT	
9029.90	Parts and accessories of revolution counters, production counters, pedometers, speed indicators, …	relevant headings mentioned in this list	H	TPAT	Pedometers encourage walking and other activities, an EP mode of transport.
91.01-91.05	Watches ... Which device which drives the movement "runs on" changes in temperature or atmospheric pressure	solar watch	H	GPRE	Alternative source of energy.
91.08	Watch movements, complete and assembled	solar-powered	H	GPRE	as above
91.09	Clock movements, complete and assembled	solar-powered	H	GPRE	as above
91.10	Complete watch or clock movements	solar-powered	H	GPRE	as above
9401.50	Seats of cane, osier, bamboo or similar materials		H	AMRM	Made of quickly renewable materials.
9403.80	Furniture of other materials, including cane, osier, bamboo or similar materials		H	AMRM	Made of quickly renewable materials.
9404.90	Other [mattress supports; articles of bedding etc, incl. mattress covers (protectors, pads)]	mattress pads	H	LCE	Mattress pad protects mattress, and extends its life cycle.
9405.50	Non-electrical lamps and lighting fittings [candelabra, candlesticks]	candelabra	H	AM	Complement soy candles.
9406.00	Prefabricated buildings		H	AM	EP alternative to on-site building, better control of pollution, likely more efficient, less messy.

HS	Description	Ex-out	R	Cat	Rationale, if applicable
9501.00	Wheeled toys designed to be ridden by children (*i.e.* tricycles, scooters, pedal cars); dolls' carriages (DOES NOT INCLUDE BIKES)		H	TCR	According to notes, two and three wheels scooters ridden by adults belong here too, which makes them a EP transport device for all age groups.
9506.11	Skis	for cross-country skiing	H	TCR	Alternative transport.
9506.12	Ski-fastenings (ski-bindings)	for cross-country skis	H	TIN	Alternative transport and accessories.
9506.19	Other [other snow ski equipment]	for cross-country skis	H	TCR	Alternative transport and accessories.
9506.70	Ice skates and roller skates, including skating boots with skates attached		H	TCR	
9506.99	Other [Articles and equipment for general physical exercise…}	snowshoes and parts and accessories thereof	H	TCR	
9603.10	Brooms and brushes, consisting of twigs or other vegetable materials bound together, with or without handles		H	CSS	Also can utilize by-products, waste and scrap.
9604.00	Hand sieves and hand riddles		H	MT	Mechanic way to separate solid substances according to particle size (WCO notes).
96.08	Ball point pens; felt tipped pens and markers; fountain pens, stylograph pens and other pens; duplicating stylos; propelling or sliding pencils; pen-holders, pencil holders and similar holders; parts (incl. caps and clips) of the foregoing articles, other than those of heading 96.09	If filled with soy ink	H	LCE	
96.09	Pencils (other than 96.08), crayons, pencil leads, drawing charcoals, writing or drawing chalks and tailors chalks	chalk	H	AM	Chalk - EP alternative to inky markers.
9610.00ex	Slates or boards, with writing or drawing surfaces, whether or not framed	chalk board	H	AM	An EP alternative to a board to be used with markers (although both under same heading).
9613.20	Pocket lighters, gas fuelled, refillable		H	LCE	Reusable, re-gas-able.
9613.90	Parts		H	LCE	Complement refillable lighters.
96.16	Scent sprays and similar toilet sprays, and mounts and heads thereof; powder-puffs and pads for the application of cosmetics or toilet preparations	refillable perfume flacons and bottles	H	LCE	More EP than individual perfume bottles (that is not to say for single use), reusable.
9617.00	Vacuum flasks and other vacuum vessels, complete with cases; parts thereof other then glass inners		H	PEEG	Reusable, energy-saving, models with the space between the casting and glass inners can use recyclables, like cork, glass fibre, felt. Outer sleeve adds additional isolation.
9703.00	Original sculptures and statuary, in any material	if made of scrap materials	H	UWS	

Annex 1.A3

Total World Trade in Selected EPPS and Highest Tariffs Applied

For all tables in this annex:

Tariff rates listed as min-max range.

OECD trade values include intra-EU trade and possibly re-exports.

Ethiopia excludes Eritrea.

Bound rate column legend:

NA: a country is either a WTO Observer or non-member.

"–": no tariff was bound on the particular line.

Source: Comtrade (trade values), TRAINS (applied and bound tariff rates).

Table 1.A3.1. Total world trade in sisal and products and highest tariffs applied

Product [HS Code]	Leading exporters, 2003	Export value (USD 000)	Importers with the highest level of duty (data year)	Applied tariff, in % (number of tariff lines)	Bound rate, in % (number of tariff lines)
Sisal and other textile fibres [5304]	***World***	***51 471***	Bahamas, The (2002)	35 (2)	NA
	Brazil	22 017	Djibouti (2002)	33 (2)	40 (2)
	Kenya	13 614	India (2004)	30 (4)	40 (2)
	Tanzania	6 678	Maldives (2003)	25 (2)	30 (2)
	OECD countries	*5 892*	Sudan (2002)	25 (2)	NA
	– of which Belgium	1 987	Bangladesh (2004)	22.5 (2)	–
	– of which Korea	121	Bhutan (2004)	20 (2)	NA
	– of which Mexico	12	Kenya (2004)	20 (2)	–
	Madagascar	1 688			
	India	1 063	Congo, Dem. Rep. (2003)	5 (2)	100 (2)
			Kuwait (2002)	4 (2)	100 (2)
	LDC	8 349	Mozambique (2003)	2.5 (2)	100 (2)
			Rwanda (2003)	5 (2)	100 (2)
			Solomon Islands (1995)	0 (2)	80 (2)
			Barbados (2003)	5 (2)	70 (2)
			St. Kitts & Nevis (2003)	0 (2)	70 (2)
			Angola (2002)	2 (2)	60 (2)
			Lesotho (2001)	0 (2)	60 (2)
			Tunisia (2004)	0 (2)	60 (2)
			Antigua & Barbuda (2003)	5 (2)	50 (2)
			Belize (2003)	5 (2)	50 (2)
			Dominica (2003)	0 (2)	50 (2)
			Grenada (2003)	5 (2)	50 (2)
			Guinea-Bissau (2004)	5 (2)	50 (2)
			Guyana (2003)	5 (2)	50 (2)
			Jamaica (2003)	0 (2)	50 (2)
			Niger (2004)	5 (2)	50 (2)
			St. Lucia (2003)	0 (2)	50 (2)
			St. Vincent & the Grenadines (2003)	5 (2)	50 (2)
			Trinidad & Tobago (2003)	0 (2)	50 (2)

Product [HS Code]	Leading exporters, 2003	Export value (USD 000)	Importers with the highest level of duty (data year)	Applied tariff, in % (number of tariff lines)	Bound rate, in % (number of tariff lines)
Sisal and other textile fibres of the genus *Agave*, raw [5304.10]	***World***	***46 005***	Bahamas, The (2002)	35 (1)	NA
	Brazil	21 991	Djibouti (2002)	33 (1)	40 (1)
	Kenya	11 339	India (2004)	30 (3)	40 (1)
	Tanzania	6 572	Maldives (2003)	25 (1)	30 (1)
	OECD countries	*3 220*	Sudan (2002)	25 (1)	NA
	– of which Belgium	1 389	Bangladesh (2004)	22.5 (1)	–
	– of which Mexico	7	Bhutan (2004)	20 (1)	NA
	– of which Turkey	1	Kenya (2004)	20 (1)	–
	Madagascar	1 662			
	India	754	Congo, Dem. Rep. (2003)	5 (1)	100 (1)
	South Africa	288	Kuwait (2002)	4 (1)	100 (1)
	Morocco	153	Mozambique (2003)	2.5 (1)	100 (1)
	China	20	Rwanda (2003)	5 (1)	100 (1)
			Solomon Islands (1995)	0 (1)	80 (1)
	LDC	8 234	Barbados (2003)	5 (1)	70 (1)
			St. Kitts & Nevis (2003)	0 (1)	70 (1)
			Angola (2002)	2 (1)	60 (1)
			Lesotho (2001)	0 (1)	60 (1)
			Tunisia (2004)	0 (1)	60 (1)
			Antigua & Barbuda (2003)	5 (1)	50 (1)
			Belize (2003)	5 (1)	50 (1)
			Dominica (2003)	0 (1)	50 (1)
			Grenada (2003)	5 (1)	50 (1)
			Guinea-Bissau (2004)	5 (1)	50 (1)
			Guyana (2003)	5 (1)	50 (1)
			Jamaica (2003)	0 (1)	50 (1)
			Niger (2004)	5 (1)	50 (1)
			St. Lucia (2003)	0 (1)	50 (1)
			St. Vincent & the Grenadines (2003)	5 (1)	50 (1)
			Trinidad & Tobago (2003)	0 (1)	50 (1)
Sisal and other textile fibres of the genus *Agave* other {processed but not spun; tow and waste of these fibres including yarn waste and garnetted stock} [5304.90]	***World***	***5 466***	Bahamas, The (2002)	35 (1)	NA
	OECD countries	*2 673*	Djibouti (2002)	33 (1)	40 (1)
	– of which Korea	121	India (2004)	30 (1)	40 (1)
	– of which Mexico	5	Maldives (2003)	25 (1)	30 (1)
	Kenya	2 274	Sudan (2002)	25 (1)	NA
	India	310	Bangladesh (2004)	22.5 (1)	–
	Tanzania	106	Bhutan (2004)	20 (1)	NA
			Kenya (2004)	20 (1)	–
	LDC	115			
			Congo, Dem. Rep. (2003)	5 (1)	100 (1)
			Kuwait (2002)	4 (1)	100 (1)
			Mozambique (2003)	2.5 (1)	100 (1)
			Rwanda (2003)	5 (1)	100 (1)
			Solomon Islands (1995)	0 (1)	80 (1)
			Barbados (2003)	5 (1)	70 (1)
			St. Kitts & Nevis (2003)	0 (1)	70 (1)
			Angola (2002)	2 (1)	60 (1)
			Lesotho (2001)	0 (1)	60 (1)
			Tunisia (2004)	0 (1)	60 (1)
			Antigua & Barbuda (2003)	5 (1)	50 (1)
			Belize (2003)	5 (1)	50 (1)
			Dominica (2003)	0 (1)	50 (1)
			Grenada (2003)	5 (1)	50 (1)

Product [HS Code]	Leading exporters, 2003	Export value (USD 000)	Importers with the highest level of duty (data year)	Applied tariff, in % (number of tariff lines)	Bound rate, in % (number of tariff lines)
			Guinea-Bissau (2004)	5 (1)	50 (1)
			Guyana (2003)	5 (1)	50 (1)
			Jamaica (2003)	0 (1)	50 (1)
			Niger (2004)	5 (1)	50 (1)
			St. Lucia (2003)	0 (1)	50 (1)
			St. Vincent & the Grenadines (2003)	5 (1)	50 (1)
			Trinidad & Tobago (2003)	0 (1)	50 (1)
Yarn of other vegetable textile fibres; paper yarn, other [5308.90]	***World***	***110 579***	Burundi (2002)	40 (1)	–
	China	78 786	Bahamas, The (2002)	35 (1)	NA
	OECDcCountries	*21 528*	Djibouti (2002)	33 (1)	33 (1)
	– of which Korea	581	Morocco (2003)	32.5 (21)	40 (6)
	– of which Mexico	27	Egypt, Arab Rep. (2002)	15 – 30 (3)	15 (3)
	– of which Turkey	3	Algeria (2003)	15 – 30 (4)	NA
	Brazil	8 499	India (2004)	30 (2)	40 (2)
	India	874	Nigeria (2002)	25 (1)	–
	Tanzania	198	Maldives (2003)	25 (1)	30 (2)
	Hong Kong, China	166	Sudan (2002)	25 (1)	NA
	Kenya	166	Bangladesh (2004)	22.5 (1)	–
			Bhutan (2004)	20 (1)	NA
	LDC	212	Ethiopia[3] (2002)	20 (1)	NA
			Kenya (2004)	20 (1)	–
			Solomon Islands (1995)	20 (1)	80 (1)
			Vietnam (2004)	20 (1)	NA
			Congo, Dem. Rep. (2003)	10 (1)	100 (2)
			Kuwait (2002)	4 (1)	100 (1)
			Mozambique (2003)	7.5 (1)	100 (2)
			Rwanda (2003)	5 (2)	100 (1)
			Solomon Islands (1995)	20 (1)	80 (1)
			Barbados (2003)	5 (1)	70 (1)
			St. Kitts & Nevis (2003)	0 (1)	70 (1)
			Angola (2002)	2 (1)	60 (1)
			Lesotho (2001)	0 (1)	60 (1)
			Tunisia (2004)	15 (4)	60 (2)
			Antigua & Barbuda (2003)	5 (1)	50 (1)
			Belize (2003)	5 (1)	50 (1)
			Dominica (2003)	5 (1)	50 (1)
			Grenada (2003)	5 (1)	50 (1)
			Guinea-Bissau (2004)	10 (2)	50 (2)
			Guyana (2003)	5 (1)	50 (1)
			Jamaica (2003)	0 (1)	50 (1)
			Niger (2004)	10 (2)	50 (2)
			St. Lucia (2003)	0 (1)	50 (1)
			St. Vincent & the Grenadines (2003)	5 (1)	50 (1)
			Trinidad & Tobago (2003)	0 (1)	50 (1)

Product [HS Code]	Leading exporters, 2003	Export value (USD 000)	Importers with the highest level of duty (data year)	Applied tariff, in % (number of tariff lines)	Bound rate, in % (number of tariff lines)
Woven fabric of other vegetable textile fibres or paper yarn [5311.00]	**World**	**157 684**	Solomon Islands (1995)	230 (1)	80 (1)
	China	96 668	Burundi (2002)	40 (1)	20 (1)
	OECD countries	*56 970*	Ethiopia[3] (2002)	20 – 40 (3)	NA
	– of which Korea	7 661	Morocco (2003)	40 (20)	40 (3)
	– of which Mexico	1 008	Vietnam (2004)	40 (1)	NA
	– of which Turkey	156	Nigeria (2002)	35 (1)	–
	Hong Kong, China	1 743	Djibouti (2002)	33 (1)	40 (1)
	Sri Lanka	1 259	Bangladesh (2004)	30 (2)	–
	Thailand	284	Bhutan (2004)	30 (1)	NA
	India	180	Egypt, Arab Rep. (2002)	30 (2)	30 (2)
	Singapore	156	India (2004)	30 (10)	40 (1)
			Syrian Arab Rep. (2002)	15 – 30 (5)	NA
			Kenya (2004)	25 (3)	–
			Maldives (2003)	25 (2)	30 (1)
			Mozambique (2003)	25 (1)	100 (1)
			Pakistan (2004)	25 (1)	25 (1)
			Romania (2001)	25 (2)	35 (2)
			Sudan (2002)	25 (1)	NA
			Congo, Dem. Rep. (2003)	10 (1)	100 (3)
			Kuwait (2002)	4 (1)	100 (1)
			Mozambique (2003)	25 (1)	100 (1)
			Solomon Islands (1995)	230 (1)	80 (1)
			Barbados (2003)	5 (1)	70 (1)
			St. Kitts & Nevis (2003)	5 (1)	70 (1)
			Angola (2002)	20 (1)	60 (1)
			Lesotho (2001)	0 (1)	60 (1)
			Tunisia (2004)	15 (8)	60 (5)
			Antigua & Barbuda (2003)	5 (1)	50 (1)
			Belize (2003)	5 (1)	50 (1)
			Dominica (2003)	5 (1)	50 (1)
			Grenada (2003)	5 (1)	50 (1)
			Guinea-Bissau (2004)	20 (1)	50 (1)
			Guyana (2003)	5 (1)	50 (1)
			Jamaica (2003)	0 (1)	50 (1)
			Niger (2004)	20 (1)	50 (1)
			St. Lucia (2003)	5 (1)	50 (1)
			St. Vincent & the Grenadines (2003)	5 (1)	50 (1)
			Trinidad & Tobago (2003)	0 (1)	50 (1)
Binder or baler twine [5607.21]	**World**	**47 336**	Morocco (2003)	50 (1)	40 (1)
	Brazil	24 470	Syrian Arab Rep. (2002)	15 – 50 (2)	NA
	OECD Countries	*16 179*	Tunisia (2004)	43 (1)	–
	– of which Korea	273	Mauritius (2002)	40 (1)	–
	– of which Mexico	238	Zimbabwe (2002)	40 (1)	–
	– of which Turkey	4	Bahamas, The (2002)	35 (1)	NA
	Nepal	2 657	Cambodia (2003)	35 (1)	–
	Tanzania	988	Djibouti (2002)	33 (1)	40 (1)
	Kenya	764	Algeria (2003)	30 (1)	NA
	Madagascar	547	Egypt, Arab Rep. (2002)	30 (1)	30 (1)
			Jordan (2003)	30 (1)	20 (1)
	LDC	4 258	Nigeria (2002)	30 (1)	–
			Vietnam (2004)	30 (1)	NA
			Sri Lanka (2004)	27.5 (1)	25 (1)
			Israel (1993)	27.4 (1)	15 (1)

Product [HS Code]	Leading exporters, 2003	Export value (USD 000)	Importers with the highest level of duty (data year)	Applied tariff, in % (number of tariff lines)	Bound rate, in % (number of tariff lines)
			Kenya (2004)	25 (1)	–
			Maldives (2003)	25 (1)	30 (1)
			Pakistan (2004)	25 (1)	25 (1)
			Romania (2001)	25 (1)	35 (1)
			Sudan (2002)	25 (1)	NA
			Zambia (2003)	25 (1)	–
			Congo, Dem. Rep. (2003)	20 (1)	100 (1)
			Kuwait (2002)	4 (1)	100 (1)
			Mozambique (2003)	7.5 (1)	100 (1)
			Rwanda (2003)	5 (1)	100 (1)
			Solomon Islands (1995)	10 (1)	80 (1)
			Barbados (2003)	15 (1)	70 (1)
			St. Kitts & Nevis (2003)	5 (1)	70 (1)
			Trinidad & Tobago (2003)	15 (1)	70 (1)
			Angola (2002)	10 (1)	60 (1)
			Lesotho (2001)	20 (1)	60 (1)
			Tunisia (2004)	43 (1)	60 (1)
			Papua New Guinea (2004)	0 (1)	55 (1)
			Antigua & Barbuda (2003)	15 (1)	50 (1)
			Belize (2003)	15 (1)	50 (1)
			Dominica (2003)	15 (1)	50 (1)
			Grenada (2003)	15 (1)	50 (1)
			Guinea-Bissau (2004)	10 (1)	50 (1)
			Guyana (2003)	15 (1)	50 (1)
			Jamaica (2003)	15 (1)	50 (1)
			Niger (2004)	10 (1)	50 (1)
			St. Lucia (2003)	15 (1)	50 (1)
			St. Vincent & the Grenadines (2003)	15 (1)	50 (1)
Other	**World**	**36 909**	Morocco (2003)	50 (1)	40 (1)
[5607.29]	*OECD countries*	*24 940*	Syrian Arab Rep. (2002)	15 – 50 (2)	NA
	– of which Korea	941	Tunisia (2004)	43 (4)	60 (2)
	– of which Mexico	3 675	Mauritius (2002)	40 (1)	–
	– of which Turkey	82	Zimbabwe (2002)	40 (1)	–
	Tunisia	2 984	Bahamas, The (2002)	15 – 35 (2)	NA
	China	2 802	Cambodia (2003)	35 (1)	–
	Brazil	1 942	Djibouti (2002)	33 (1)	40 (1)
	India	1 579	Algeria (2003)	30 (2)	NA
	Tanzania	900	Egypt, Arab Rep. (2002)	30 (1)	30 (1)
			Nigeria (2002)	30 (1)	–
	LDC	922	Vietnam (2004)	30 (1)	NA
			Israel (1993)	27.4 (1)	15 (1)
			Kenya (2004)	25 (1)	–
			Maldives (2003)	25 (1)	30 (1)
			Pakistan (2004)	25 (1)	25 (1)
			Romania (2001)	25 (2)	35 (2)
			Sudan (2002)	25 (1)	NA
			Zambia (2003)	25 (1)	–
			Congo, Dem. Rep. (2003)	20 (1)	100 (1)
			Kuwait (2002)	4 (1)	100 (1)
			Mozambique (2003)	7.5 (1)	100 (1)
			Rwanda (2003)	5 (1)	100 (1)
			Solomon Islands (1995)	10 (1)	80 (1)

Product [HS Code]	Leading exporters, 2003	Export value (USD 000)	Importers with the highest level of duty (data year)	Applied tariff, in % (number of tariff lines)	Bound rate, in % (number of tariff lines)
			Barbados (2003)	5 – 15 (2)	70 (2)
			St. Kitts & Nevis (2003)	5 (2)	70 (3)
			Trinidad & Tobago (2003)	5 – 15 (2)	70 (2)
			Angola (2002)	10 (1)	60 (1)
			Lesotho (2001)	20 (1)	60 (1)
			Tunisia (2004)	43 (4)	60 (2)
			Papua New Guinea (2004)	0 (1)	55 (1)
			Antigua & Barbuda (2003)	5 – 15 (2)	50 (3)
			Belize (2003)	5 – 15 (2)	50 (3)
			Dominica (2003)	5 – 15 (2)	50 (2)
			Grenada (2003)	5 – 15 (2)	50 (2)
			Guinea-Bissau (2004)	10 (1)	50 (1)
			Guyana (2003)	5 – 15 (2)	50 (2)
			Jamaica (2003)	0 – 15 (2)	50 (2)
			Niger (2004)	10 (1)	50 (1)
			St. Lucia (2003)	5 – 15 (2)	50 (2)
			St. Vincent & Grenadines (2003)	5 – 15 (2)	50 (3)
Of other textile materials [5702.99]	**World**	**143 630**	Solomon Islands (1995)	250 (1)	80 (1)
	OECD countries	*75 369*	Mauritius (2002)	80 (1)	–
	– of which Turkey	2 142	Syrian Arab Rep. (2002)	30 – 75 (4)	NA
	Iran, Islamic Rep.	37 775	Nigeria (2002)	65 (1)	–
	China	12 560	Iran, Islamic Rep. (2004)	50 (1)	NA
	India	9 200	Morocco (2003)	50 (2)	40 (1)
	Romania	3 266	Seychelles (2001)	50 (2)	NA
			Turkmenistan (2002)	50 (1)	NA
	LDC	0.06	Sudan (2002)	45 (1)	NA
			Tunisia (2004)	43 (2)	–
			Burundi (2002)	40 (1)	20 (1)
			Egypt, Arab Rep. (2002)	40 (1)	60 (1)
			Ethiopia (2002)	40 (1)	NA
			Romania (2001)	40 (1)	40 (1)
			Vietnam (2004)	40 (1)	NA
			Zimbabwe (2002)	40 (1)	–
			Bahamas, The (2002)	35 (1)	NA
			Cambodia (2003)	35 (1)	–
			Djibouti (2002)	33 (1)	40 (1)
			Congo, Dem. Rep. (2003)	20 (1)	100 (1)
			Kuwait (2002)	4 (1)	100 (1)
			Mozambique (2003)	25 (1)	100 (1)
			Solomon Islands (1995)	250 (1)	80 (1)
			Barbados (2003)	20 (1)	70 (1)
			St. Kitts & Nevis (2003)	25 (1)	70 (1)
			Angola (2002)	20 (1)	60 (1)
			Egypt, Arab Rep. (2002)	40 (1)	60 (1)
			Lesotho (2001)	30 (1)	60 (1)
			Antigua & Barbuda (2003)	20 (1)	50 (1)
			Belize (2003)	20 (1)	50 (1)
			Dominica (2003)	20 (1)	50 (1)
			Grenada (2003)	20 (1)	50 (1)
			Guinea-Bissau (2004)	20 (1)	50 (1)
			Guyana (2003)	20 (1)	50 (1)
			Jamaica (2003)	20 (1)	50 (1)

Product [HS Code]	Leading exporters, 2003	Export value (USD 000)	Importers with the highest level of duty (data year)	Applied tariff, in % (number of tariff lines)	Bound rate, in % (number of tariff lines)
			Niger (2004)	20 (1)	50 (1)
			Philippines (2003)	10 (1)	50 (1)
			St. Lucia (2003)	20 (1)	50 (1)
			St. Vincent & Grenadines (2003)	20 (1)	50 (1)
			Trinidad & Tobago (2003)	20 (1)	50 (1)

Table 1.A3.2. Total world trade in bicycles and parts and highest tariffs applied

Product [HS Code]	Leading exporters, 2003	Export value (USD 000)	Importers with the highest level of duty (data year)	Applied tariff, in % (number of tariff lines)	Bound rate, in % (number of tariff lines)
Bicycles and other cycles (including delivery tricycles), not motorised [8712.00]	***World***	***2 827 135***	Vietnam (2004)	5 – 80 (4)	NA
	OECD countries	*1 195 425*	Iran, Islamic Rep. (2004)	70 (1)	NA
	– of which Korea	984	Morocco (2003)	25 – 50 (4)	40 (2)
	– of which Mexico	3 562	Tunisia (2004)	43 (4)	–
	– of which Turkey	14 449	Thailand (2003)	40 (3)	–
	China	1 441 491	Egypt, Arab Rep. (2002)	20 – 40 (2)	60 (1)
	India	43 277	Burundi (2002)	40 (1)	–
	Lithuania	37 375	Romania (2001)	35 (3)	35 (3)
			Bahamas, The (2002)	35 (1)	NA
	LDCs	11 638	Djibouti (2004)	33 (1)	40 (1)
			Mexico (2004)	23 – 30 (5)	35 (5)
			Algeria (2003)	30 (3)	NA
			India (2004)	30 (2)	–
			Cuba (2004)	10 – 30 (2)	–
			Syrian Arab Rep. (2002)	30 (1)	NA
			Pakistan (2004)	30 (1)	–
			Jordan (2003)	30 (1)	20 (1)
			Gabon (2002)	30 (1)	15 (1)
			Equatorial Guinea (2002)	30 (1)	NA
			Congo, Rep. (2002)	30 (1)	–
			Chad (2002)	30 (1)	–
			Central African Rep. (2002)	30 (1)	25 (1)
			Cameroon (2002)	30 (1)	–
			Bangladesh (2004)	30 (1)	–
			Angola (2002)	5 (1)	100 (2)
			Antigua & Barbuda (2003)	5 – 20 (2)	100 (1)
			Barbados (2003)	5 – 20 (2)	100 (1)
			Belize (2003)	0 – 5 (2)	100 (1)
			Congo, Dem. Rep. (2003)	20 (1)	80 (1)
			Costa Rica (2004)	15 (1)	70 (2)
			Dominica (2003)	5 – 10 (2)	70 (2)
			Egypt, Arab Rep. (2002)	20 – 40 (2)	60 (1)
			Grenada (2003)	5 – 20 (2)	60 (1)
			Trinidad & Tobago (2003)	2.5 – 20 (2)	30 – 60 (2)
			Guyana (2003)	5 – 20 (2)	50 (2)
			Jamaica (2003)	0 – 20 (2)	50 (2)
			Kuwait (2002)	4 (1)	50 (2)
			Lesotho (2001)	0 – 15 (2)	50 (2)
			Mozambique (2003)	5 – 25 (3)	50 (2)
			Niger (2004)	20 (1)	5 – 50 (2)
			Rwanda (2003)	5 (1)	50 (3)
			Solomon Islands (1995)	10 (1)	50 (2)
			St. Kitts & Nevis (2003)	5 – 25 (2)	50 (2)
			St. Lucia (2003)	0 – 25 (2)	50 (2)
			St. Vincent & the Grenadines (2003)	5 – 20 (2)	45 (3)

Product [HS Code]	Leading exporters, 2003	Export value (USD 000)	Importers with the highest level of duty (data year)	Applied tariff, in % (number of tariff lines)	Bound rate, in % (number of tariff lines)
Frames & forks, and parts thereof [8714.91]	***World***	***483 290***	Iran, Islamic Rep. (2004)	10 – 70 (3)	NA
	OECD countries	*224 472*	Morocco (2003)	50 (3)	40 (1)
	– of which Korea	1 034	Vietnam (2004)	50 (5)	NA
	– of which Mexico	175	Tunisia (2004)	43 (3)	–
	– of which Turkey	162	Thailand (2003)	40 (2)	–
	China	263 889	Bahamas, The (2002)	35 (1)	NA
	India	9 431	Pakistan (2004)	35 (1)	–
	Thailand	5 425	Djibouti (2002)	33 (1)	40 (1)
			Algeria (2003)	30 (1)	NA
	LDCs	538	Bangladesh (2004)	30 (2)	–
			Egypt, Arab Rep. (2002)	20 – 30 (2)	30 (1)
			India (2004)	30 (1)	–
			Jordan (2003)	30 (1)	20 (1)
			Nigeria (2002)	30 (1)	–
			Romania (2001)	30 (3)	35 (3)
			Syrian Arab Rep. (2002)	30 (1)	NA
			Kuwait (2002)	4 (1)	100 (1)
			Mozambique (2003)	7.5 (1)	100 (1)
			Rwanda (2003)	5 (1)	100 (1)
			Solomon Islands (1995)	10 (1)	80 (1)
			Barbados (2003)	5 (1)	70 (1)
			St. Kitts & Nevis (2003)	5 (1)	70 (1)
			Malawi (2001)	5 (1)	65 (1)
			Angola (2002)	5 (1)	60 (1)
			Lesotho (2001)	5 (1)	60 (1)
			Antigua & Barbuda (2003)	5 (1)	50 (1)
			Belize (2003)	5 (1)	50 (1)
			Dominica (2003)	5 (1)	50 (1)
			Grenada (2003)	5 (1)	50 (1)
			Guatemala (2004)	5 – 10 (2)	50 (2)
			Guyana (2003)	5 (1)	50 (1)
			Jamaica (2004)	0 (1)	50 (1)
			Niger (2004)	5 – 20 (2)	50 (1)
			St. Lucia (2003)	0 (1)	50 (1)
			St. Vincent & the Grenadines (2003)	5 (1)	50 (1)
			Trinidad & Tobago (2003)	5 (1)	50 (1)
Wheel rims and spokes [8714.92]	***World***	***217 011***	Morocco (2003)	50 (4)	40 (1)
	OECD countries	*121 313*	Vietnam (2004)	50 (2)	NA
	– of which Korea	113	Tunisia (2004)	43 (2)	–
	– of which Mexico	612	Iran, Islamic Rep. (2004)	40 (1)	NA
	– of which Turkey	146	Thailand (2003)	40 (2)	–
	China	34 547	Bahamas, The (2002)	35 (1)	NA
	India	24 003	Pakistan (2004)	35 (1)	–
	Thailand	23 076	Djibouti (2002)	33 (1)	40 (1)
	Malaysia	7 049	Algeria (2003)	30 (1)	NA
	Bulgaria	3 546	Bangladesh (2004)	30 (2)	–
			Egypt, Arab Rep. (2002)	20 – 30 (2)	30 (1)
	LDCs	504	India (2004)	30 (1)	–
			Jordan (2003)	30 (1)	30 (1)
			Malaysia (2003)	0 – 30 (4)	30 (4)
			Nigeria (2002)	30 (1)	–
			Romania (2001)	30 (2)	35 (2)

Product [HS Code]	Leading exporters, 2003	Export value (USD 000)	Importers with the highest level of duty (data year)	Applied tariff, in % (number of tariff lines)	Bound rate, in % (number of tariff lines)
			Syrian Arab Rep. (2002)	30 (1)	NA
			Kuwait (2002)	4 (1)	100 (1)
			Mozambique (2003)	7.5 (1)	100 (1)
			Rwanda (2003)	5 (1)	100 (1)
			Solomon Islands (1995)	10 (1)	80 (1)
			Barbados (2003)	5 (1)	70 (1)
			St. Kitts & Nevis (2003)	5 (1)	70 (1)
			Malawi (2001)	5 (1)	65 (1)
			Angola (2002)	5 (1)	60 (1)
			Lesotho (2001)	0 (1)	60 (1)
			Antigua & Barbuda (2003)	5 (1)	50 (1)
			Belize (2003)	5 (1)	50 (1)
			Dominica (2003)	5 (1)	50 (1)
			Grenada (2003)	5 (1)	50 (1)
			Guatemala (2004)	0 – 10 (2)	50 (2)
			Guyana (2003)	5 (1)	50 (1)
			Jamaica (2004)	0 (1)	50 (1)
			Niger (2004)	5 – 20 (2)	50 (1)
			St. Lucia (2003)	0 (1)	50 (1)
			St. Vincent & the Grenadines (2003)	5 (1)	50 (1)
			Trinidad & Tobago (2003)	5 (1)	50 (1)
Hubs, other than coaster braking; Hubs and hub brakes, and free-wheel sprocket-wheels [8714.93]	***World***	***196 635***	Morocco (2003)	50 (3)	40 (1)
	OECD countries	*76 914*	Vietnam (2004)	50 (2)	NA
	– of which Korea	366	Thailand (2003)	40 (2)	–
	– of which Mexico	46	Bahamas, The (2002)	35 (1)	NA
	– of which Turkey	9	Pakistan (2004)	35 (1)	–
	China	46 598	Djibouti (2002)	33 (1)	40 (1)
	India	40 357	Algeria (2003)	30 (1)	NA
	Singapore	25 153	Bangladesh (2004)	22.5 – 30 (2)	–
	Thailand	3 641	India (2004)	30 (3)	–
	Malaysia	2 159	Jordan (2003)	30 (1)	20 (1)
			Romania (2001)	30 (2)	35 (2)
	LDCs	543	Syrian Arab Rep. (2002)	30 (1)	NA
			Kuwait (2002)	4 (1)	100 (1)
			Mozambique (2003)	7.5 (1)	100 (1)
			Rwanda (2003)	5 (1)	100 (1)
			Solomon Islands (1995)	10 (1)	80 (1)
			Barbados (2003)	5 (1)	70 (1)
			St. Kitts & Nevis (2003)	5 (1)	70 (1)
			Malawi (2001)	5 (1)	65 (1)
			Angola (2002)	5 (1)	60 (1)
			Lesotho (2001)	0 (1)	60 (1)
			Antigua & Barbuda (2003)	5 (1)	50 (1)
			Belize (2003)	5 (1)	50 (1)
			Dominica (2003)	5 (1)	50 (1)
			Grenada (2003)	5 (1)	50 (1)
			Guyana (2003)	5 (1)	50 (1)
			Jamaica (2003)	0 (1)	50 (1)
			Niger (2004)	5 – 10 (2)	50 (1)
			St. Lucia (2003)	0 (1)	50 (1)
			St. Vincent & the Grenadines (2003)	5 (1)	50 (1)
			Trinidad & Tobago (2003)	5 (1)	50 (1)

Product [HS Code]	Leading exporters, 2003	Export value (USD 000)	Importers with the highest level of duty (data year)	Applied tariff, in % (number of tariff lines)	Bound rate, in % (number of tariff lines)
Brakes, including coaster braking hubs, hub brakes, and parts thereof [8714.94]	***World***	***310 974***	Morocco (2003)	50 (3)	40 (1)
	OECD ountries	*239 217*	Vietnam (2004)	50 (2)	NA
	– of which Korea	692	Thailand (2003)	40 (2)	–
	– of which Mexico	19	Bahamas, The (2002)	35 (1)	NA
	– of which Turkey	89	Pakistan (2004)	35 (1)	–
	China	45 549	Djibouti (2002)	33 (1)	40 (1)
	Thailand	10 959	Algeria (2003)	30 (1)	NA
	India	7 984	Bangladesh (2004)	15 – 30 (2)	–
			India (2004)	30 (1)	–
	LDCs	37	Jordan (2003)	30 (1)	30 (1)
			Romania (2001)	30 (3)	35 (3)
			Syrian Arab Rep. (2002)	30 (1)	NA
			Kuwait (2002)	4 (1)	100 (1)
			Mozambique (2003)	7.5 (1)	100 (1)
			Rwanda (2003)	5 (1)	100 (1)
			Solomon Islands (1995)	10 (1)	80 (1)
			Barbados (2003)	5 (1)	70 (1)
			St. Kitts & Nevis (2003)	5 (1)	70 (1)
			Malawi (2001)	5 (1)	65 (1)
			Angola (2002)	5 (1)	60 (1)
			Lesotho (2001)	0 (1)	60 (1)
			Antigua & Barbuda (2003)	missing (1)	50 (1)
			Belize (2003)	5 (1)	50 (1)
			Dominica (2003)	5 (1)	50 (1)
			Grenada (2003)	5 (1)	50 (1)
			Guyana (2003)	5 (1)	50 (1)
			Jamaica (2003)	0 (1)	50 (1)
			Niger (2004)	5 – 10 (2)	50 (1)
			St. Lucia (2003)	0 (1)	50 (1)
			St. Vincent & the Grenadines (2003)	5 (1)	50 (1)
			Trinidad & Tobago (2003)	5 (1)	50 (1)
Saddles [8714.95]	***World***	***129 362***	Maldives (2003)	15 – 100 (2)	–
	OECD countries	*92 711*	Iran, Islamic Rep. (2004)	57 (1)	NA
	– of which Mexico	0.4	Morocco (2003)	50 (3)	40 (1)
	– of which Turkey	5	Vietnam (2004)	50 (2)	NA
	China	27 153	Tunisia (2004)	43 (1)	–
	India	4 667	Thailand (2003)	40 (2)	–
	Brazil	1 501	Bahamas, The (2002)	35 (1)	NA
			Pakistan (2004)	35 (1)	–
	LDCs	30	Djibouti (2002)	33 (1)	40 (1)
			Algeria (2003)	30 (1)	NA
			Bangladesh (2004)	15 – 30 (2)	–
			India (2004)	30 (2)	–
			Jordan (2003)	30 (1)	30 (1)
			Nigeria (2002)	30 (1)	–
			Romania (2001)	30 (1)	35 (1)
			Syrian Arab Rep. (2002)	30 (1)	NA
			Kuwait (2002)	4 (1)	100 (1)
			Mozambique (2003)	7.5 (1)	100 (1)
			Rwanda (2003)	5 (1)	100 (1)
			Solomon Islands (1995)	10 (1)	80 (1)
			Barbados (2003)	5 (1)	70 (1)

Product [HS Code]	Leading exporters, 2003	Export value (USD 000)	Importers with the highest level of duty (data year)	Applied tariff, in % (number of tariff lines)	Bound rate, in % (number of tariff lines)
			St. Kitts & Nevis (2003)	5 (1)	70 (1)
			Malawi (2001)	5 (1)	65 (1)
			Angola (2002)	5 (1)	60 (1)
			Lesotho (2001)	0 (1)	60 (1)
			Antigua & Barbuda (2003)	5 (1)	50 (1)
			Belize (2003)	5 (1)	50 (1)
			Dominica (2003)	5 (1)	50 (1)
			Grenada (2003)	5 (1)	50 (1)
			Guyana (2003)	5 (1)	50 (1)
			Jamaica (2003)	0 (1)	50 (1)
			Niger (2004)	5 – 10 (2)	50 (1)
			St. Lucia (2003)	0 (1)	50 (1)
			St. Vincent & the Grenadines (2003)	5 (1)	50 (1)
			Trinidad & Tobago (2003)	5 (1)	50 (1)
Pedals & crank gear, and parts thereof [8714.96]	***World***	***251 365***	Maldives (2003)	15 – 100 (2)	–
	OECD countries	*187 966*	Morocco (2003)	50 (7)	40 (1)
	– of which Korea	50	Vietnam (2004)	50 (3)	NA
	– of which Mexico	3	Iran, Islamic Rep. (2004)	10 – 40 (3)	NA
	– of which Turkey	155	Thailand (2003)	40 (2)	–
	China	45 599	Bahamas, The (2002)	35 (1)	NA
	India	8 161	Pakistan (2004)	35 (1)	–
	Singapore	7 609	Djibouti (2002)	33 (1)	40 (1)
			Algeria (2003)	30 (1)	NA
	LDCs	244	Bangladesh (2004)	15 – 30 (2)	–
			India (2004)	30 (1)	–
			Jordan (2003)	30 (1)	20 (1)
			Nigeria (2002)	30 (1)	–
			Romania (2001)	30 (3)	35 (3)
			Syrian Arab Rep. (2002)	30 (1)	NA
			Kuwait (2002)	4 (1)	100 (1)
			Mozambique (2003)	7.5 (1)	100 (1)
			Rwanda (2003)	5 (1)	100 (1)
			Solomon Islands (1995)	10 (1)	80 (1)
			Barbados (2003)	5 (1)	70 (1)
			St. Kitts & Nevis (2003)	5 (1)	70 (1)
			Malawi (2001)	5 (1)	65 (1)
			Angola (2002)	5 (1)	60 (1)
			Lesotho (2001)	0 (1)	60 (1)
			Antigua & Barbuda (2003)	5 (1)	50 (1)
			Belize (2003)	5 (1)	50 (1)
			Dominica (2003)	5 (1)	50 (1)
			Grenada (2003)	5 (1)	50 (1)
			Guyana (2003)	5 (1)	50 (1)
			Jamaica (2003)	0 (1)	50 (1)
			Niger (2004)	5 – 10 (2)	50 (1)
			St. Lucia (2003)	0 (1)	50 (1)
			St. Vincent & the Grenadines (2003)	5 (1)	50 (1)
			Trinidad & Tobago (2003)	5 (1)	50 (1)

Product [HS Code]	Leading exporters, 2003	Export value (USD 000)	Importers with the highest level of duty (data year)	Applied tariff, in % (number of tariff lines)	Bound rate, in % (number of tariff lines)
Other	***World***	***1 697 982***	Maldives (2003)	15 – 100 (3)	–
[8714.99]	*OECD ountries*	*1 041 812*	Morocco (2003)	50 (12)	40 (1)
	– of which Korea	4 602	Vietnam (2004)	50 (5)	NA
	– of which Mexico	3 433	Tunisia (2004)	27 – 43 (5)	–
	– of which Turkey	10 229	Thailand (2003)	40 (2)	–
	China	231 330	Bahamas, The (2002)	35 (1)	NA
	Singapore	191 222	Pakistan (2004)	35 (1)	–
	Malaysia	117 131	Djibouti (2002)	33 (1)	40 (1)
	India	47 011	Algeria (2003)	30 (2)	NA
	Thailand	40 069	Bangladesh (2004)	30 (2)	–
	Romania	18 861	India (2004)	30 (3)	–
			Jordan (2003)	30 (1)	20 (1)
	LDCs	1 313	Malaysia (2003)	0 – 30 (15)	30 (13)
			Romania (2001)	30 (4)	35 (4)
			Syrian Arab Rep. (2002)	30 (1)	NA
			Kuwait (2002)	4 (1)	100 (1)
			Mozambique (2003)	7.5 (1)	100 (1)
			Rwanda (2003)	5 (1)	100 (1)
			Solomon Islands (1995)	10 (1)	80 (1)
			Barbados (2003)	5 (1)	70 (1)
			St. Kitts & Nevis (2003)	missing (1)	70 (1)
			Malawi (2001)	5 (1)	65 (1)
			Angola (2002)	5 (1)	60 (1)
			Egypt, Arab Rep. (2002)	20 – 30 (2)	30 – 60 (2)
			Lesotho (2001)	0 (1)	60 (1)
			Antigua & Barbuda (2003)	5 (1)	50 (1)
			Belize (2003)	5 (1)	50 (1)
			Central African Rep. (2002)	20 (1)	50 (1)
			Dominica (2003)	5 (1)	50 (1)
			Grenada (2003)	Missing (1)	50 (1)
			Guatemala (2004)	0 – 10 (3)	30 – 50 (3)
			Guyana (2003)	5 (1)	50 (1)
			Jamaica (2003)	0 (1)	50 (1)
			Niger (2004)	5 – 20 (2)	5 – 50 (2)
			St. Lucia (2003)	0 (1)	50 (1)
			St. Vincent & the Grenadines (2003)	5 (1)	50 (1)
			Trinidad & Tobago (2003)	5 (1)	50 (1)

Table 1.A3.3. Total world trade in stoves and parts and highest tariffs applied

Product [HS code]	Leading exporters 2003	Export value (USD 000)	Importers with the highest level of duty (data year)	Applied tariff, in % (number of tariff lines)	Bound rate, in % (number of tariff lines)
Cooking appliances and plate warmers for gas or both gas and other fuels [7321.11]	***World***	***1 941 742***	Syrian Arab Rep. (2002)	100 (1)	NA
	OECD countries	*1 479 157*	Zimbabwe (2002)	40 – 65 (2)	–
	– of which Korea	15 305	Iran, Islamic Rep. (2004)	50 (1)	NA
	– of which Mexico	290 194	Morocco (2003)	50 (9)	40 (9)
	– of which Turkey	107 976	Tunisia (2004)	43 (5)	–
	China	220 112	Burundi (2002)	40 (1)	–
	Brazil	69 534	Egypt, Arab Rep. (2002)	40 (1)	60 (1)
	Belarus	67 563	Nigeria (2002)	40 (1)	–
	Romania	23 489	Solomon Islands (1995)	35 (1)	80 (1)
	Costa Rica	12 644	Kenya (2004)	35(1)	–
	Slovenia	11 749	Grenada (2003)	20 – 35 (4)	50 (4)
	Ecuador	11 746	St. Vincent & the Grenadines (2003)	20 – 35 (4)	50 (4)
	Malaysia	10 463	Djibouti (2004)	33 (1)	40 (1)
	LDCs	14	Kuwait (2002)	4 (1)	100 (1)
			Rwanda (2003)	15 (2)	100 (1)
			Mozambique (2003)	25 (1)	100 (1)
			Congo, Dem. Rep. (2003)	20 (1)	100 (1)
			Barbados (2003)	20 (4)	70 – 85 (4)
			Solomon Islands (1995)	35 (1)	80 (1)
			St. Kitts & Nevis (2003)	25 (4)	70 (4)
			Trinidad & Tobago (2003)	20 – 25 (4)	50 – 70 (6)
			Angola (2002)	5 (1)	60 (1)
			Egypt, Arab Rep. (2002)	40 (1)	60 (1)
			Lesotho (2001)	15 (1)	60 (1)
			Papua New Guinea (2004)	0 (1)	55 (1)
			Antigua & Barbuda (2003)	missing (1)	50 (4)
			Belize (2003)	0 – 20 (4)	50 (4)
			Central African Rep. (2002)	30 (1)	50 (1)
			Dominica (2003)	20 (4)	50 (4)
			Grenada (2003)	20 – 35 (4)	50 (4)
			Guyana (2003)	20 (4)	50 (4)
			Jamaica (2003)	20 (4)	50 (4)
			St. Lucia (2003)	20 – 30 (4)	50 (4)
			St. Vincent & the Grenadines (2003)	20 – 35 (4)	50 (4)
			Guinea Bissau (2004)	20 (2)	50 (1)
			Niger (2004)	20 (2)	50 (1)
Cooking appliances and plate warmers for liquid fuel [7321.12]	***World***	***80 942***	Syrian Arab Rep. (2002)	100 (1)	NA
	China	43 477	Iran, Islamic Rep. (2004)	50 (1)	NA
	OECD countries	*29 687*	Morocco (2003)	50 (3)	40 (1)
	– of which Korea	238	Tunisia (2004)	43 (3)	–
	– of which Mexico	5	Burundi (2002)	40 (1)	–
	– of which Turkey	14	Egypt, Arab Rep. (2002)	40 (1)	60 (1)
	Iran, Islamic Rep.	3 524	Nigeria (2002)	40 (1)	–
	Singapore	1 525	Zimbabwe (2002)	15 – 40 (2)	15 (1)
			Solomon Islands (1995)	35 (1)	80 (1)
	LDCs	21	Grenada (2003)	20 – 35 (4)	50 (4)
			St. Vincent & the Grenadines (2003)	20 – 35 (4)	50 (4)
			Djibouti (2004)	33 (1)	40 (1)
			Kuwait (2002)	4 (1)	100 (1)
			Rwanda (2003)	15 (1)	100 (1)

Product [HS code]	Leading exporters 2003	Export value (USD 000)	Importers with the highest level of duty (data year)	Applied tariff, in % (number of tariff lines)	Bound rate, in % (number of tariff lines)
			Mozambique (2003)	25 (1)	100 (1)
			Congo, Dem. Rep. (2003)	20 (1)	100 (1)
			Solomon Islands (1995)	35 (1)	80 (1)
			Barbados (2003)	20 (4)	70 (4)
			St. Kitts & Nevis (2003)	25 (4)	70 (4)
			Angola (2002)	5 (1)	60 (1)
			Egypt, Arab Rep. (2002)	40 (1)	60 (1)
			Lesotho (2001)	15 (1)	60 (1)
			Papua New Guinea (2004)	0 (1)	55 (1)
			Antigua & Barbuda (2003)	missing (1)	50 (4)
			Belize (2003)	0 – 20 (4)	50 (4)
			Central African Rep. (2002)	30 (1)	50 (1)
			Dominica (2003)	20 (4)	50 (4)
			Grenada (2003)	20 – 35 (4)	50 (4)
			Guyana (2003)	20 (4)	50 (4)
			Jamaica (2003)	20 (4)	50 (4)
			St. Lucia (2003)	20 – 30 (4)	50 (4)
			Malawi (2001)	25 (1)	50 (1)
			Trinidad & Tobago (2003)	20 – 25 (4)	50 (4)
			St. Vincent & the Grenadines (2003)	20 – 35 (4)	50 (4)
			Bangladesh (2004)	30 (1)	50 (1)
			Guinea Bissau (2004)	20 (2)	50 (1)
			Niger (2004)	20 (2)	50 (1)
Cooking	***World***	***231 211***	Syrian Arab Rep. (2002)	100 (1)	NA
appliances	China	128 166	Iran, Islamic Rep. (2004)	50 (1)	NA
and plate	*OECD countries*	*93 718*	Morocco (2003)	50 (2)	40 (1)
warmers	– of which Korea	91	Burundi (2002)	40 (1)	–
for solid	– of which Mexico	16	Egypt, Arab Rep. (2002)	40 (1)	60 (1)
fuel	– of which Turkey	956	Nigeria (2002)	40 (1)	–
[7321.13]	Macedonia, FYR	2 298	Zimbabwe (2002)	15 – 40 (2)	–
	Croatia	1 629	Tunisia (2004)	36 (3)	–
	Brazil	1 235	Grenada (2003)	20 – 35 (4)	50 (4)
			Kenya (2004)	15 – 30 (2)	–
	LDCs	80	Solomon Islands (1995)	35 (1)	80 (1)
			St. Vincent & the Grenadines (2003)	20 – 35 (4)	50 (4)
			Djibouti (2004)	33 (1)	40 (1)
			Kuwait (2002)	4 (1)	100 (1)
			Rwanda (2003)	15 (2)	100 (1)
			Mozambique (2003)	25 (1)	100 (1)
			Congo, Dem. Rep. (2003)	20 (1)	100 (1)
			Solomon Islands (1995)	35 (1)	80 (1)
			Barbados (2003)	20 (4)	70 (4)
			St. Kitts & Nevis (2003)	25 (4)	70 (4)
			Angola (2002)	5 (1)	60 (1)
			Egypt, Arab Rep. (2002)	40 (1)	60 (1)
			Lesotho (2001)	15 (1)	60 (1)
			Antigua & Barbuda (2003)	missing (1)	50 (4)
			Belize (2003)	0 – 20 (4)	50 (4)
			Central African Rep. (2002)	30 (1)	50 (1)
			Dominica (2003)	20 (4)	50 (4)
			Grenada (2003)	20 – 35 (4)	50 (4)
			Guyana (2003)	20 (4)	50 (4)

Product [HS code]	Leading exporters 2003	Export value (USD 000)	Importers with the highest level of duty (data year)	Applied tariff, in % (number of tariff lines)	Bound rate, in % (number of tariff lines)
			Jamaica (2003)	20 (4)	50 (4)
			St. Lucia (2003)	20 – 30 (4)	50 (4)
			Trinidad & Tobago (2003)	20 – 25 (4)	50 (4)
			St. Vincent & the Grenadines (2003)	20 – 35 (4)	50 (4)
			Guinea Bissau (2004)	20 (1)	50 (1)
			Niger (2004)	20 (1)	50 (1)
Parts	***World***	***630 237***	Syrian Arab Rep. (2002)	30 – 100 (2)	NA
[7321.90]	*OECD countries*	*478 231*	Morocco (2003)	25 – 50 (4)	40 (4)
	– of which Korea	5 028	Tunisia (2004)	20 – 43 (4)	–
	– of which Mexico	22 003	Burundi (2002)	40 (1)	–
	– of which Turkey	6 430	Egypt, Arab Rep. (2002)	40 (1)	60 (1)
	China	116 870	Nigeria (2002)	40 (1)	–
	Brazil	11 325	Kenya (2004)	35 (1)	–
	Croatia	6 949	Solomon Islands (1995)	35 (1)	80 (1)
	Thailand	3 753	Djibouti (2004)	33 (1)	40 (1)
	Romania	1 771	Algeria (2003)	30 (1)	NA
	South Africa	1 439	India (2004)	30 (1)	–
	Slovenia	1 225	Jordan (2003)	0 – 30 (3)	10 – 30 (3)
			Malaysia (2003)	5 – 30 (4)	30 (3)
	LDCs	0	Mexico (2004)	13 – 30 (8)	35 (8)
			Vietnam (2004)	30 (1)	NA
			Kuwait (2002)	4 (1)	100 (1)
			Rwanda (2003)	15 (3)	100 (1)
			Mozambique (2003)	7.5 (1)	100 (1)
			Congo, Dem. Rep. (2003)	10 (1)	100 (1)
			Solomon Islands (1995)	35 (1)	80 (1)
			Barbados (2003)	5 (1)	70 (1)
			St. Kitts & Nevis (2003)	5 (1)	70 (1)
			Angola (2002)	2 (1)	60 (1)
			Egypt, Arab Rep. (2002)	40 (1)	60 (1)
			Lesotho (2001)	15 (1)	60 (1)
			Antigua & Barbuda (2003)	missing (1)	50 (1)
			Belize (2003)	0 (1)	50 (1)
			Central African Rep. (2002)	20 (1)	50 (1)
			Dominica (2003)	5 (1)	50 (1)
			Grenada (2003)	5 (1)	50 (1)
			Guyana (2003)	5 (1)	50 (1)
			Jamaica (2003)	0 (1)	50 (1)
			St. Lucia (2003)	5 (1)	50 (1)
			Trinidad & Tobago (2003)	2.5 (1)	50 (1)
			St. Vincent & the Grenadines (2003)	5 (1)	50 (1)
			Guinea Bissau (2004)	10 (1)	50 (1)
			Niger (2004)	10 (1)	50 (1)

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Chapter 2

Liberalising Trade in Renewable-Energy Products and Associated Goods

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Various studies and events over the past several years have stressed the importance of eliminating barriers to trade in renewable forms of energy and the technologies used to exploit them, as part of a broader strategy to reduce dependence on more-polluting and less secure energy sources. This chapter examines the implications of liberalising trade in renewable energy, focusing on several representative fuels and technologies: charcoal, solar photovoltaic systems and their complements, wind turbines and wind pumps, biodiesel, solar-thermal water heaters and geothermal energy systems. Eliminating tariffs on renewable energy and associated goods — which are 15% or higher on an ad valorem basis in many developing countries — would reduce a burden on consumers of energy, particularly people living in rural areas of developing countries, where many renewable-energy technologies are making, and are likely to make, their greatest contribution. Manufacturers in OECD countries would benefit from increased trade in renewable-energy technologies and components, as would a growing number of companies in developing countries. For biodiesel, developing countries have the potential to become major suppliers to OECD countries. The elimination of tariffs would also help to level the playing field between aid-financed goods, which often benefit from tariff waivers, and goods imported through normal market transactions, which often do not. To realize the maximum benefits of trade liberalisation in renewable-energy technologies, however, further reforms may be needed in importing countries' domestic policies, especially those affecting the electricity sector and rural electrification in particular, the pricing of liquid fuels, competition in the electricity sector, and protection of the environment.

This chapter is based on OECD Trade and Environment Working Papers Nos. 2005-07 and 2006-01

Introduction

Various countries have proposed including renewable-energy technologies among goods for consideration in a list, or lists, of environmental goods, as part of the Doha ¶ 31(iii) negotiations. Both the Asia-Pacific Economic Cooperation (APEC) and the OECD lists referred to several renewable-energy technologies, as have Canada, the European Commission, Japan, Korea, New Zealand, Switzerland and the United States, in their lists, and Qatar in the context of hybrid energy systems that combine renewable energy sources with natural gas.[1] Some analysts have even suggested that renewables should be regarded as a special category of environmentally preferable products (EPPs), inasmuch as they are seen to be preferable to energy derived from fossil fuels.

When considering whether to liberalise trade in an environmental good, it is helpful to know how high the remaining barriers are and how the costs and benefits of reducing those barriers would be distributed. This chapter attempts to explore these issues by: *i)* identifying a positive list of renewable energy and associated technologies of interest to both developed and developing countries; *ii)* among those, identifying goods of special interest to developing countries; and *iii)* exploring the effects of liberalisation for selected countries and products.

The environmental, economic and development cases for renewables

The International Energy Agency (IEA, 2004a) defines renewable energy as "energy that is derived from natural processes that are replenished constantly. In its various forms, it derives directly or indirectly from the sun, or from heat generated deep within the earth. Included in the definition is energy generated from solar, wind, biomass, geothermal, hydropower and ocean resources, and biofuels and hydrogen derived from renewable resources." Renewable energy normally does not include energy derived from fossil fuels, waste products from fossil sources, or waste products from inorganic sources.

The idea of tapping into the enormous amount of energy that arrives freely from the sun, or passes by in the winds, or bubbles up from the depths of the Earth, has attracted scientists and engineers for centuries. The economic development of many economies and regions began with such efforts, notably through the exploitation of wind power (the Netherlands in the 18th century) and hydroelectric power (Austria, Norway, Switzerland and others in the 20th century). When in the 1970s alarm was raised over future supplies of energy, policy makers also began to envisage that renewable energy (and in some countries nuclear power) would eventually replace fossil fuels as cheap supplies of the latter ran out. Fear of energy shortages waned in the 1980s but was succeeded by a new argument for renewable energy: the need to develop low-carbon alternatives to the coal, oil and natural gas on which the world currently depends.

With world demand for energy again growing apace, driven more and more by economic expansion in newly industrialising countries, international interest in facilitating the spread of renewable energy technologies across the globe has never been higher (see Annex 3.A2). The IEA's latest *World Energy Outlook* (IEA, 2004b), in its "Reference Scenario", projects that, in the absence of new government policies or accelerated deployment of new technology, world primary energy demand will rise by

1. A complete listing, as of November 2005, can be obtained in document TN/TE/W/63, available, as are other WTO official documents, from http://docsonline.wto.org/gen_search.asp?searchmode=simple.

almost 60% between 2004 and 2030. Some 85% of that increase would be in the form of carbon-emitting fossil fuels. Two-thirds of the new demand is expected to come from the developing world, especially China and India.

The environmental case for renewable energy is slightly different for biomass fuels and geothermal energy than for technologies that transform falling water, wind or sunlight into useful heat, mechanical power or electricity. Biofuels may emit some pollutants when combusted, but they generally burn cleaner than corresponding fuels used in similar applications. (The exception is biomass burned in open hearths.) Moreover, their net contribution to CO_2 emissions is much lower or zero. The environmental case for other renewable energy technologies stresses the lack or absence of air-pollutant emissions during their normal operation. Table 2.1 shows that, when monetised, the external costs — *i.e.* the costs imposed, but not borne, by producers or consumers of a good or service — associated with solar photovoltaic plants and wind turbines are very low compared with those associated with electricity production from fossil fuels.

Table 2.1. Range of generating costs and external costs for different electricity generating technologies as of the late 1990s[1]

Euro cents per kWh

Type of power plant	Generating costs	External costs
Coal or lignite	3.2-5.0	1.8-15.0
Fuel oil	4.9-5.2	2.9-10.9
Natural gas	2.6-3.5	0.5-3.5
Nuclear energy	3.4-5.9	0.24-0.7
Biomass	3.4-4.3	0.24-5.2
Solar photovoltaic	51.2-85.3	0.14-0.33
Wind turbine	6.7-7.2	0.05-0.26

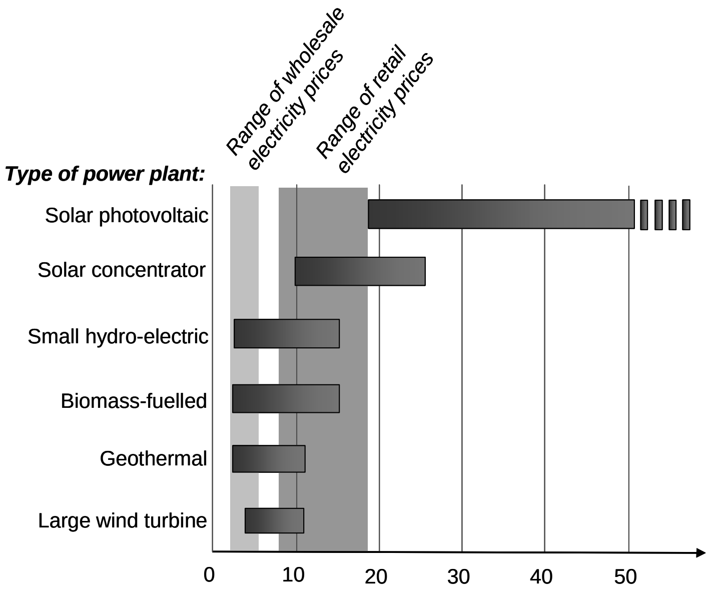
1. Caution should be used when interpreting this table. Environmental externalities associated with various energy technologies are highly dependent on the severity and nature of site-specific environmental effects (e.g. air pollution). It is also difficult to estimate externality values for greenhouse gas emissions with any degree of accuracy.

Source: Nuclear Energy Agency, *Nuclear Electricity Generation: What Are the External Costs?,* OECD, Paris, 2003, p. 37, based on data in European Commission DGXII, *ExternE, Externalities of Energy*, Vol. 10, National Implementation, EC, Brussels, 1999.

Often not counted in estimates of external costs associated with different electricity-generating technologies are those relating to high-voltage transmission lines. The corridors created for these lines can create new points of access to forested areas and contribute to ecosystem fragmentation (Kaufman, 1999). A particular advantage of small-scale electricity systems based on renewable energy for areas of countries not currently connected to electricity grids is that they avoid the need for power transmission lines and reduce the amount of fuel transported to remote areas. These attributes can be particularly important for preserving protected forests and other vulnerable ecosystems.

The economic case for renewables is strongest when such environmental externalities are taken into account, or when potential customers are dispersed and do not already have access to an electricity grid. Over the past two decades, the cost of generating electricity from renewable energy has dropped dramatically. The price of photovoltaic cells, for example, has dropped by approximately 20% with every doubling of their cumulative production (Luther, 2004). Depending on the quality of the resource (geothermal heat, wind velocity and consistency, insolation), the cost of generating electricity from renewable energy can be competitive with the price of electricity paid by final consumers (favouring dispersed, small-scale units) or by electric utilities for bulk power (Figure 2.1). Costs of most of the newer technologies are expected to continue to fall as new materials are discovered and economies of scale are exploited.

Figure 2.1. Cost competitiveness of selected renewable power technologies as of the early 2000s



Source: Adapted from NET Ltd. Switzerland, in *Renewables for Power Generation: Status and Prospects*, 2003 edition, International Energy Agency, OECD, Paris, p. 20.

The developmental case for renewables derives from the health benefits enabled by switching to cleaner fuels, and from the activities made possible by bringing electricity to households and small, rural businesses that previously lacked access to it. Currently, around 1.6 billion people in the world have no access to electricity and, in the absence of new policies, 1.4 billion will still lack it in 2030 (IEA, 2004b). Numerous socio-economic impact studies have demonstrated the enormous difference that electrification can make to economic development. One, carried out in the Philippines, found that, controlling for all other factors, electrification of rural households resulted on average in 1.82 additional years of education (because better lighting allows for more study time), 33 extra hours a month of leisure time, and USD 36 more income each month from additional business hours (in households with a business).[2] Reducing the usage of kerosene lanterns and paraffin candles for lighting also alleviates a fire hazard and, in the case of kerosene, lessens the risk of accidental poisoning (Kaufman, 1999).

2. A. Domdom, V. Abiad, D. Barnes and H. Peskin, “Benefit estimates of rural electrification in the Philippines”, presentation to the Joint Donors’ Meetings for Trust Funded Energy Programs at the World Bank (Washington, D.C., 7-8 May 2001) www.worldbank.org/html/fpd/esmap/pdfs/phil_elec.pdf.

International trade and tariffs

Trade in technologies used in harnessing renewable energy is clearly of environmental significance. It is also believed to be growing at a fast pace. Because the Harmonized Commodity Coding and Classification System (HS) does not have separate 6-digit codes for all the technologies used to harness renewable energy, however, statistics on world trade in renewables are imprecise.[3]

Trade in renewables falls into two categories: trade in renewable energy products (such as liquid and solid fuels made from biomass), and trade in goods used in harnessing renewable energy, such as arrays of photoelectric cells, wind-driven water pumps, and hydraulic turbines and water wheels. Table 2.A1.1 lists some of the main HS (2002) sub-headings and codes under which renewables are classified for the purposes of import duties and statistics.[4] A few HS codes are specific, such as for fuel wood (HS 4401.10), wood charcoal (HS 4401.10), hydraulic turbines (HS 84.10) and wind-powered generating sets (HS 4401.10). Others are less specific. The code for photosensitive semiconductor devices (HS 8541.40), for example, covers not only photovoltaic cells but also light-emitting diodes (LEDs) and photo-sensitive transistors. None of these limitations was addressed in the latest revision of the HS, scheduled to go into effect by 2007.[5]

A number of other goods are not so readily identified in the HS as “renewable-energy technologies” but are nonetheless essential to systems built around them (Table 2.A1.2). Most of these, such as other engines and motors (HS 84.12) and mechanical stokers (HS 8416.30), have multiple applications. But a few, particularly those that either run off direct current (DC) electricity, or are used to regulate it or convert it to alternating current (AC), could easily be distinguished in national tariff schedules at the 8- or 10-digit level.

Because of the limitations of the HS, it is not possible to give a global estimate of the value of trade in renewable energy and related technologies. Judging from Table 2.A1.3, it could well be in the neighbourhood of USD 4 billion a year. OECD countries clearly dominate exports of high-technology renewable-energy technologies, but in renewable-energy fuels, and in such relatively low-tech devices as solar water heaters, developing countries and countries in transition are major players, both as users and exporters. This finding is in keeping with an earlier analysis by UNCTAD (2003); their calculations estimate that, whereas developing countries are net importers of environmental goods that are capital goods, exports and imports in 2002 were roughly in balance for renewable energy products.

Table 2.A1.3 points to large differences in the volume of world trade in renewables, and the share of non-OECD countries in that trade. In the cases of fuel wood and wood charcoal, more than 40% of exports originate from outside OECD countries. Another market in which there is considerable developing-country participation is solar water heaters, which are covered by HS 8419.19.

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3. The International Energy Agency has pointed to potential problems caused by the lack of stand-alone customs codes for integrated plants, like geothermal electric power plants.

4. Because ethanol is considered an agricultural product for the purpose of the WTO negotiations, it is not covered in this chapter.

5. Besides these codes are those for components that go into renewable-energy plant, such as electrical wiring and steel for support structures, which are not unique to renewable energy.

World trade in small hydraulic turbines (less than 10 MW output) — the kind used in so-called “micro” and “mini” hydroelectric plants, such as run-of-river plants — is, by comparison, tiny at less than USD 30 million in each of the two categories (HS 8410.11 and 8410.12) in 2003. Trade in hydraulic turbines of greater than 10 MW capacity (HS 8410.13) is larger, but still small (USD 47 million). In all three categories, OECD countries account for the bulk of export sales. The market for hydraulic turbines is heavily influenced by government procurement, which may account for the relatively small share of imports in total global sales. Export sales of parts for hydraulic turbines, by contrast, are four times those of turbines, at USD 436 million in 2003. Some 80% of exports are from OECD countries.

Currently, international trade in wind-powered electric generating sets (HS 8502.31) is highly concentrated, with European companies accounting for more than 70% of global exports (EWEA, 2004). However, several developing and transition countries are starting to emerge as important suppliers of components. Much less is known about world trade in photovoltaic (solar) cells, whether assembled into modules or panels or not (HS 8541.40 ex), since statistics as the 6-digit HS level include other photosensitive semiconductor devices, and light-emitting diodes (LEDs), which for the moment have bigger markets. Developing-country manufacturers of photovoltaic cells and modules include Brazil, China, India, the Philippines and Saudi Arabia.

Regarding import tariffs, preliminary analysis suggests that applied tariffs on wood and charcoal exceeding 25% are fairly common among developing countries, even those that use a lot of wood or charcoal for domestic cooking. Tariffs on hydraulic turbines, parts for hydraulic turbines, wind-powered generating sets and solar cells exceed 15% in tenor fewer countries in each case. Most striking are the tariffs on solar water heaters, which surpass 25% in a number of countries, including those with a sunny climate or dispersed rural populations which would seem to be appropriate candidates for deployment of the technology.

Assessing the effects of liberalising trade in renewable energy and related technologies

This section examines the markets for, and the potential effects of, liberalising trade in a selection of representative products. The products selected — charcoal, solar photovoltaic cells and modules, wind turbines and pumps, biodiesel, solar thermal and geothermal energy — are among the fastest-growing segments of the renewable-energy market, and several of the energy sources. For each product, an attempt is made to analyse the potential environmental and developmental effects of liberalisation, as well as economic and trade-related benefits that can be easily identified. Special attention is given to assessing developmental benefits for the most vulnerable populations. Each sub-section then identifies possible complementary changes in trade-related or environmental policies that would help ensure the maximum realisation of trade, environmental, and development benefits.

Wood charcoal

The fuel and related technology

Charcoal is a black, porous material, containing 85% to 98% carbon, derived from wood or woody biomass. Although its first uses predate history, its controlled production can be traced back at least 3 500 years. As the FAO wrote in 1987, and it remains true, "[t]hroughout the world wood is turned into charcoal by a surprising variety of systems". Traditional charcoal-making involves heating biomass in an earthen mound to drive off moisture and some of the wood's volatile matter. It is inexpensive, but yields are poor, typically 10% on a mass-balance basis, and large amounts of ground-level air pollution are released in the process. Improved traditional methods use small-scale steel or brick kilns, which provide more consistent results and are less labour-intensive than the traditional method. Yields can be as high as 20% but are more typically around 15% (Stassen, 2002).

Industrial methods seek to control variables such as temperature, oxygen supply and pressure precisely. Various technologies are used, involving batch-wise operated brick or metal kilns or continuously operated retorts. The highest efficiencies in commercial use (1 kg of charcoal from 3-4 kg of wood) are obtained by heating pre-dried wood in a ceramic brick-lined carbonisation furnace at peak temperatures of around 900°C. The tars and gases produced as the wood heats up are separately combusted and the flue gas is then used to heat the carbonisation furnace and to pre-dry the wood (Stassen, 2002). An alternative process, developed at the University of Hawaii in the mid-1990s, obtains high yields (45%, or a thermal efficiency of about 68%) and fast reaction times (hours rather than days) by operating the reactor at elevated pressures in a stagnant gaseous environment (Antal *et al.*, 1996).

Charcoal burns cleaner than wood and dried biomass, produces higher temperatures, and is cheaper to transport and store. For these reasons, interest in charcoal as a fuel is reviving. A recent study, led by researchers at the University of California, Berkeley, and the Harvard School of Public Health (Bailis *et al.*, 2005), suggests that if the large number of households in developing countries that cook and heat their homes with raw biomass were to switch to charcoal, as many as 3 million premature deaths from respiratory illness due to indoor pollution would be averted, depending on how quickly the transition is made.

Charcoal can also be substituted for coal, a fossil fuel, in industrial and electric power-plant applications. Its energy density, approximately 30 000 kilojoules per kilogramme, is around that of bituminous coal, and its ash and sulphur content is typically equivalent or lower (Arcate, 1998). Because it can be ground to a fine powder, it can be used in many existing boilers designed for pulverised coal. (By contrast, co-firing biomass in pulverised-coal boilers requires investing in a separate biomass feed system.) That attribute creates the potential for quickly and rapidly increasing the share of biomass — the production of which on a life-cycle basis contributes much less to net emissions of CO_2 than coal — in the production of electricity. Charcoal can also be used in cement kilns, but it is generally more expensive than the low-grade fuels, such as petroleum coke, currently preferred by the industry.

Production and trade

Charcoal is produced the world over, often in association with commercial logging, but outside the OECD region and Russia much of its production occurs on a small scale, typically involving no more than covering a stack of burning wood with dirt and leaving it to smoulder for a week. Statistics on global charcoal production are therefore very uncertain. According to various sources (*e.g.* World Energy Council, 2001; Karekezi *et al.*, 2004), the leading charcoal-producing countries are China, India, Brazil and the countries of tropical Africa (particularly Sudan, Kenya and Côte d'Ivoire). Whereas charcoal consumption is expected to grow moderately in Latin America and East Asia, on recent trends it could grow by 4% or 5% a year in South Asia and Africa, leading to more than a doubling of its use in these regions over the next 15 years (Table 2.2).

Table 2.2. Estimated and projected charcoal consumption in several world regions

Millions of tonnes of oil equivalent

Region	1995	2005[1]	2020[2]	Annual growth rate
Latin America	6.4	6.8	7.2	0.4%
East Asia	5.6	7.0	9.2	1.9%
South Asia	3.5	6.0	11.1	4.2%
Africa	6.8	13.5	30.8	5.6%

1. Interpolation between the 1995 estimates and projections for 2010.

2. Projected.

Source: Karekezi *et al*. (2004) based on International Energy Agency, *World Energy Outlook*, 1998, OECD, Paris.

Only a small proportion of charcoal production is traded internationally. About 40% of charcoal exports, valued at USD 250 million, originates in OECD countries. Four of the leading exporters of wood charcoal in 2003 were developing countries: China, Argentina, South Africa and Malaysia. Most charcoal entering world trade is used as a fuel or as an input to the production of steel, copper, zinc and certain precious metals. Some is further processed into activated charcoal, a highly porous material used in filtering out impurities from liquids and gases.

Most OECD countries apply a zero tariff on wood charcoal. By contrast, applied import tariffs on wood charcoal exceed 20% in many African countries and reach 100% in Libya and the Seychelles. Although trade in charcoal has never comprised a large share of total production and consumption, it is striking that some of the highest tariffs are found in precisely the region that is the most dependent on charcoal as a fuel. In 2000, nearly 470 million tonnes of wood were consumed in homes in Sub-Saharan Africa in the form of firewood or charcoal, the highest per capita rate of consumption of any world region.

Potential implications of liberalising trade in wood charcoal

The trade and environmental effects of liberalising trade in wood and charcoal would depend on a wide number of variables. Most countries have the potential to produce charcoal, and many could be net exporters. For the supply of charcoal to be sustainable, however, close attention has to be paid to the management of the feedstock resource. Some charcoal is already made from waste material generated by the forest industry and from agriculture, such as nut shells and husks, and sugar-cane leaves. Additional charcoal could be produced from biomass obtained from the pruning of trees in towns and cities, and from other "clean" wood.[6] However, any substantial increase in charcoal production

6. Arcate (1998) defines clean wood as stumps, branches over 10 centimetres in diameter, and untreated and unpainted pallets and construction lumber that is free of metal, concrete and other non-woody material.

would have to come from harvesting fast-growing trees or other suitable energy crops, including shrubs and switchgrass.

Increasing the efficiency of charcoal production would also help to minimise pressures on forest resources and enable realising economies of scale. Modern, high-yield systems can produce three times as much charcoal from a given amount of feedstock as traditional charcoal-making kilns, with far lower emissions. The FAO reports that improved charcoal-making facilities are now being built not only in OECD countries but also in countries like China, Ghana and South Africa (Stassen, 2002). A factory for producing charcoal from municipal waste wood is under construction in Singapore.

Any development in the trade that resulted in greater volumes of charcoal becoming available at a lower cost would mean tremendous benefits for consumers, particularly in developing countries. More households could switch from using raw biomass, and thereby substantially reduce their exposure to air pollutants. If that charcoal were used in improved cooking stoves, the energy-efficiency of cooking would increase dramatically, further reducing the time required for preparing meals and therefore exposure to pollutants (see Chapter 1).

Benefits derived from using charcoal for generating steam heat, particularly in electric power plants, would likely be realised over the longer term, and would depend critically on the relative prices of charcoal and coal, and on policies constraining emissions of greenhouse gases. Currently, most of the world’s coal-fired industrial and power plants are found in OECD countries and in China, India, Indonesia, Russia and South Africa. Many, if not most, of these installations are centred around coal fields, from which coal can be procured at costs ranging from around USD 30 to USD 50 a tonne (IEA, 2005a. By comparison, imported charcoal, even if free of import duties, currently costs USD 100 a tonne, or more.[7] However, where coal-fired plants have been built near ports, and are dependent on imported fuel, charcoal — either domestically sourced or imported — could become an economically viable fuel supplement for some plants.

Complementary policies

As mentioned above, any change in policy that would encourage greater production and use of charcoal is often greeted with nervousness among the environmental community. With reason: besides the prospect of denuded forests, scenarios that envisage large shifts to charcoal and no improvements in harvesting and production suggest that associated greenhouse gas emissions could reach 15 billion tonnes of carbon by 2050 (Bailis *et al.*, 2005). But with the correct incentives at each stage, from biomass production through end use, negative consequences need not be inevitable. As expressed by Girard (2002, p. 31):

> The sustainable production and use of charcoal through proper management and planning of supply sources, together with rational trade and marketing infrastructures and efficient use, can also have a significant positive impact by helping to conserve resources, reducing migration from rural or forested areas and improving people’s incomes. However, the necessary interventions for long-term solutions are not easy to implement, especially for poor tropical countries that lack the necessary financial resources, institutional capacity and skilled personnel.

The alternative in the short to medium term is not necessarily to increase the availability of kerosene or liquefied petroleum gas (LPG) to households. A study in

7. This is an indicative price.

Dar-es-Salaam, Tanzania, found that charcoal used in energy-efficient stoves was the cheapest fuel per unit of energy delivered (Foster, 2000). With free-market prices for kerosene now more than 60% higher than in the late 1990s, the relative cost of charcoal cooking is likely to look even more attractive. Nonetheless, over the last two decades many governments, concerned about the potential threat of charcoal to forest resources and encouraged by multilateral lending agencies (*e.g.* van der Plas, 1995), have tried to encourage LPG and kerosene use, in some cases by subsidising these fuels or furnishing households with new equipment (Girard, 2002). In Africa these programmes have not been as successful as originally hoped, in part because, as Matly (2000) observes, people who move to cities do not always readily adopt urban habits. Moreover, fuel-substitution programmes and policies to stamp out charcoal production have at times backfired, creating unemployment in forest areas. This unemployment in turn increased the rate of rural-urban migration, thereby accentuating the demand for fuelwood and especially for charcoal (Girard, 2002).

Box 2.1. Producing charcoal from a sustainably managed forest

Currently there are less than a handful of enterprises in the world that sell hardwood charcoal from forests certified to FSC (Forest Stewardship Council) standards. One of them is Noram de Mexico, S.A., which produces natural charcoal from 100% scrub oak hardwood. Its source for raw materials, the pine-oak forests of the Sierra Madre, are home to black bear, puma, Mexican wolf, the thick-billed parrot, the eared trogon and the imperial woodpecker, and are internationally recognised as areas of high endemism and biodiversity.

About half of Noram’s raw materials, such as oak branches gathered from nearby pine-oak forests, are purchased from local indigenous communities (*ejidos*). Noram supports these communities by providing training in such practices as pruning, fire prevention and the protection of reforested areas and biodiversity corridors. It is also increasing the benefits *ejidos* receive from their sustainable forestry practices by promoting forest conservation projects in co-ordination with the Consejo Civil Mexicano de Silvicultura Sostenible. Locally, Noram's charcoal is sold through leading Mexican supermarket chains; Mexicans are estimated to consume 200 000 tonnes of charcoal annually — as much as consumed by the entire EU. The company has been exporting charcoal to Europe since 1996 and recently began selling its product to customers in the United States.

In 2000 Noram won first prize at the World Resource Institute’s (WRI’s) New Ventures Investor Forum, an annual WRI gathering which attracts hundreds of venture capitalists, investment bankers and entrepreneurs from across Latin America. Part of Noram’s equity is held by two venture capital firms, Environmental Enterprises, a Washington-based firm established with support from major US foundations, and EcoEnterprises Fund, a firm recently launched in San Jose, Costa Rica, by The Nature Conservancy and the Multilateral Investment Fund of the Inter-American Development Bank. These firms have also provided long-term loans to Noram. In addition, the Andean Development Corporation (Corporación Andina de Fomento), a Latin American regional development bank, has provided the company with a seven-year, USD 400 000 working capital loan from its Human Development Fund (Fondo de Desarollo Humano).

Sources: Abstracted from www.ecoenterprisesfund.com/Portfolio/deal%20sheets/noram.htm, www.new-ventures.org/opportunities.investors.noramnv.html and www.new-ventures.org/aboutus.successes.norampressrelease.html.

Lowering barriers to trade in charcoal could help create more stable markets, which in turn would help encourage investment in newer and more efficient charcoal-making technologies. Obtaining a net positive outcome from liberalising trade in charcoal would depend on the extent to which:

- The management of forests and other lands on which plant species suitable to charcoal production are grown was strengthened, particularly in developing countries, so that over-harvesting was avoided. Forest-management certification schemes already play a small role in this regard (Box 2.1).
- Programmes to help the spread of improved charcoal-making techniques, including training for operators, were stepped up.
- Studies were undertaken to identify potential bottlenecks in the distribution chain.
- Information was provided to households in developing countries on the time they could save, and the improvement in their health they would see, from using charcoal in efficient cooking stoves.

Solar photovoltaic cells, modules and systems

The technology

Energy from the sun can be harnessed in several ways to produce electricity. Solar photovoltaic (PV) cells work by converting the energy from photons from sunlight into direct-current electricity. Solar PV cells are simple devices to use, but because they are currently made with semiconducting materials, either in thin wafers (cells) of pure crystalline silicon, or in thin strips of amorphous silicon, their manufacturing is complex and relatively costly. Individual PV cells are fragile and produce a maximum output of only 2 Watts, so they are normally soldered together in series, usually of 36 or 72 cells, and then hermetically sealed in an encapsulated assembly. These assemblies, called modules, sandwich the cells between a rigid, transparent top surface (usually of glass) and an insulating backface. A typical weather-resistant module (also sometimes called a solar panel) can provide between 20 and 30 years of safe, reliable service.

There are only a few centralised, on-grid solar PV installations in the world, and most are heavily supported, through direct subsidies and regulated prices. The largest solar-electric plant in the world is the 10-MW Bavaria Solarpark, comprised of 57 600 photovoltaic panels. Most applications of solar PV cells are much smaller in scale, supplying electric power for a device such as a water pump, or to a home or a village.

Solar water-pumping systems are particularly well suited to rural areas. They usually consist of two to four PV modules; a variable-voltage, direct-current electric pump; and associated piping and storage tanks. Apart from pumps, other common dedicated, single-use applications of PV systems include supplying electric current for rural telecommunications systems, navigation beacons, and isolated data monitoring and recording systems, and providing cathodic protection for pipelines.

Grid-connected distributed PV systems are intended to supplement electric power supplied by mains and, in some cases, to feed electricity back to the grid. These kinds of installations exist mainly in OECD countries, especially Germany and Japan. Most of the off-grid, domestic applications of solar energy are in rural areas, increasingly of developing countries, where some 400 000 are already in operation. A basic household solar module will typically comprise a roof-mounted 15-watt to 150-watt solar array, a 20 to 100 ampere-hour solar (lead-acid) battery, a charge controller (for optimising the charging and discharging of the battery), several low voltage and low-wattage lamps (Box 2.2), and accessories such as connecting cables, mounting brackets and fasteners. A larger system will also include an inverter to convert 12-volt direct current into standard 110- or 220-volt alternating current, for operating radios or other household appliances.

Box 2.2. Reducing costs with light-emitting diodes

In order to reduce the required number of solar cells, most household solar PV systems are designed to use low-wattage electric lamps for lighting. Traditionally that has meant fluorescent lamps, which need less than one-third the energy per lumen of incandescent filament lamps (*i.e.* the classic light bulb). White-light-emitting diodes (WLEDs)[1] require even less energy per lumen than fluorescent lamps (and only 5% of incandescent lamps), but they are expensive and so far have been used primarily in specialty applications. Nepal's Centre for Renewable Energy (CRE), however, has shown that when hooked up to small solar-based power sources, WLEDs can be cost-effective.

With financial support provided by the Swedish International Development Co-operation Agency (Sida), under the framework of the "Renewable Energy Technologies in Asia — A Regional Research and Dissemination Programme" project, the CRE has developed a lighting system based on a single solar PV cell (around 2-3 Watt-peak) and two WLED-based lamps. Each lamp is made up of three tiny WLEDs, which together consume only 0.3 Watt of electrical power but produce sufficient focused light (275 lux[2] at a distance of 30 cm from the source) to replace a traditional kerosene lamp. An economic analysis conducted by the CRE found that the cost of the system is roughly equal to what a typical rural household spends on kerosene (for two lamps burning around 4-5 hours daily) and dry-cell batteries (to operate a radio and torch light) over a period of slightly more than two years. Annual operating costs, mainly associated with the replacement of rechargeable batteries once every two years, are minimal: about NPR 300 (USD 4). A survey of 43 users revealed a high degree of customer satisfaction with the system.

1. WLEDs are classified under the same HS sub-heading (8541.40) as solar cells.

2. Lux is the metric unit for measuring the illuminance of a surface; one lux is equal to one lumen per square metre.

Sources: Sharma *et al.* (2005); Kumar *et al.* (2005); and Light Up the World Foundation www.lutw.org/illum_benefits.html.

Production and trade in PV cells and modules

According to industry sources,[8] global production of solar PV cells was around 1200 MW in 2004, an increase of almost 60% over the previous year. Over the past 15 years, growth has averaged around 25% a year. Solarbuzz.com predicts that industry annual turnover will grow from USD 6.5 billion in 2004 to USD 18.5 billion by 2010.

Manufacturing of solar PV cells is dominated by five companies: Sharp Electronics Corporation, Kyocera Solar, BP Solar, Shell Solar Industries and Sanyo Electric Company. Sharp, Kyocera and Sanyo produce mainly in Japan; Shell's PV-cell manufacturing facilities are in Germany and the United States; and BP Solar has plants in Australia, India, Spain and the United States. Although Japan still accounts for half the world's solar-cell production and exports, followed by the United States and the EU, production is increasing rapidly in the rest of the world, more than doubling in 2004 to 171 MW. A private company in Saudi Arabia, Al-Afandi Solar Wafers and Cells (part of the much larger Al-Afandi conglomerate), has recently begun manufacturing multi-crystalline solar cells for clients in Germany at its factory in Jeddah.[9]

The manufacturing of solar modules is more geographically distributed. Some companies, like Total Energie Southern Africa (TENESA) are local affiliates of solar majors.[10] Others are joint ventures between one of the solar majors and a local energy or

8. Photon International (www.photon-magazine.com/) reports production of 1256 MW, and Solarbuzz (www.solarbuzz.com/) reports 1146 MW, in 2004.

9. www.photon-magazine.com/news/news_2004-10_%20af%20sn%20Cell%20Factory%20in%20Saudi%20Arabia.htm.

10. www.total-energie.fr/Filiales/Tenesa/.

electronics company. One of the first was Tata BP Solar, set up in India as a joint venture between Tata Power and BP Solar in 1989. It is now India's leading supplier of solar-energy technologies, and its 38-MW solar module manufacturing facility in Bangalore is one of the largest of its kind in the world. More than half of its total sales derive from exports, mainly to Europe and North America. Manufacturers have also established subsidiaries in developing countries for marketing cells, modules and systems. In most cases, these subsidiaries are staffed by local sales agents and engineers.

Elsewhere, there are growing numbers of independent suppliers and installers of solar PV systems, especially for off-grid use. Energy Source Guides (http://energy.sourceguides.com) lists around 35 manufacturers of solar PV cells or modules, and 115 suppliers of solar electric power systems, in India. One of them, Ammini Solar, based around Trivandrum, has expanded from a three-person firm in 1993 to become the country's largest producer of solar lighting systems. Kenya has at least nine small and medium-sized companies marketing PV systems for household or communal use.[11] These systems are based largely on imported components, and are assembled and serviced locally. According to the Solar Electric Light Fund, since the mid-1980s over 20 000 household solar PV systems have been installed in Kenya by independent businesses operating on a strictly cash basis.[12]

In Asia, a Regional Research and Dissemination Programme, supported by the Swedish International Development Co-operation Agency and co-ordinated by the Asian Institute of Technology (AIT), has been sponsoring adaptive research on PV-system components under the Renewable Energy Technologies in Asia programme. Locally designed components were first tested in laboratories and then installed in the field. Today, charge controllers, ballasts for fluorescent lamps, converters and inverters are being manufactured in Bangladesh, Cambodia and Vietnam (Box 2.3). Benefits include improvements in after-sales service and in the availability of spare parts (Kumar *et al.*, 2005).

Potential implications of liberalising trade in PV cells

Liberalisation of trade in solar-photovoltaic technologies and related components would benefit several groups of countries. Consumers everywhere would benefit from lower costs of solar-generated electricity, which requires no fuel or fuel-related infrastructure, and is emission-free. As PV cells account for more than half of the cost of an installed residential solar-electricity system, reducing tariffs on these would have a significant effect on overall costs. Most-favoured nation (MFN) tariffs are currently 20% in several countries with a high solar-energy potential: Cambodia, the Solomon Islands, Djibouti, Libya, Maldives, Vanuatu and Ethiopia. They are 15% in India, Nepal, Nigeria, Oman, Rwanda, Seychelles, the Syrian Arab Republic and Yemen. Eliminating import duties entirely would cut the cost of purchasing PV systems by 7-10%. Eliminating import duties on related components of solar electricity systems, such as storage batteries, charge controllers, compact fluorescent lamps, and inverters, would further reduce costs, making solar-PV systems even more affordable (Box 2.4).

11. See http://energy.sourceguides.com/businesses/byGeo/byC/Kenya/Kenya.shtml and www.solarbuzz.com/CompanyListings/Kenya.htm.

12. www.self.org/shs_role.asp.

Box 2.3. Developing solar PV components in Bangladesh, Cambodia and Vietnam

Under the RETs in Asia programme, demonstration systems were built to increase awareness of solar PV technology, and local people were trained in the operation, maintenance and management of these systems, with the aim of improving after-sales service. Results from the programme were disseminated through workshops and seminars, and are summarised below.

Bangladesh: As of June 2005, about 100 000 solar lamps (using locally designed and manufactured ballasts), 30 000 charge controllers and 6 000 DC-to-AC converters had been developed and were being used in the field. Costs of production are up to 50% below the price of imported components, resulting in overall savings of 10% on the total cost of a solar household system.

Cambodia: The programme resulted in the development of a type of charge controller, 40 of which have been installed in street lights on a rural bridge (as part of a demonstration project funded by the government). In their first 18 months of operation, no major problems were reported.

Vietnam: Four different prototypes were developed, of which three (charge controller, ballast for fluorescent lamp and inverter) have been commercialised. The programme also developed a direct current (DC) energy-saving lamp.

Source: Kumar *et al.* (2005).

Box 2.4. Promoting solar photovoltaic systems in the Sudan

"Sudan's main energy source is biomass, mostly in traditional uses. Electricity constitutes only 2% of the country's energy consumption. The national electricity grid reaches a half million households, less than 10% of the population; major and minor local grids serve another 5%. Consequently, the majority of Sudanese take care of their energy needs themselves. In addition to biomass, liquefied petroleum gas and charcoal are sources of household energy. Wealthier households often invest in diesel generators.

…

"Today, the Sudanese government is actively supporting PV policies. The [GEF's] solar PV project has contributed to enhanced awareness of the social and economic potential of PV power and has boosted activities by the National Energy Committee of the National Assembly to enact a Solar Energy Act. In the annual 2004 national development budget, the parliament passed a resolution exempting PV-system components from import duties and the value added tax. The government has further decided to invest in a joint venture with China for a module assembly line. It is expected that the combined effects of tax reduction and local assembly will reduce PV costs by 30–40%."

Source: Abridged from GEF (2004), pp. 4-5, www.gefweb.org/Outreach/outreach-PUblications/Renew_Energy_inserts.pdf.

The initial beneficiaries of increased sales of PV cells and modules would include the major manufacturers listed above. However, with new manufacturing and assembly plants being built close to final markets, exports from several developing countries could be boosted as well. At the moment, the beneficiaries might include Brazil, China, India, the Philippines, Saudi Arabia and South Africa. Greater local demand would also benefit companies and their employees in the numerous developing countries that specialise in the assembly and installation of solar-PV systems for rural areas. Liberalising trade in PV-system components, such as charge controllers and DC-powered electric lamps and home appliances,[13] would spread the benefits even further, as many of these devices are manufactured primarily in developing countries.

Eliminating tariffs on PV cells and modules would also enable suppliers to better rationalise their supply chains. Currently, several suppliers have set up warehouses for stockpiling PV modules in strategic locations (*e.g.* southern Africa and south-east Asia) in countries applying low or zero tariffs on these products. This enables them to meet local orders more quickly and to re-export modules to other countries as needed. In other regions, PV modules are subject to tariffs applied both by the country to which they are initially shipped and then by the countries to which they are re-exported (usually as part of a PV-system). These extra charges ultimately increase the cost of PV-produced electricity. The alternative is to wait for a specific order and to ship to the final customer directly, and at much higher cost.

The environmental effects of liberalising trade in PV technology would depend on the degree to which solar PV systems replaced other means of producing electricity that would have been used in its place. Solar PV-cell modules normally produce no waste products while in operation. However, the manufacture of the cells does require energy and materials, and it may emit pollutants. Also, the disposal of cells at the end of the module's life may have an environmental impact. Still, most life-cycle studies[14] (World Energy Council, 2004) suggest that lifetime emissions of CO_2 are comparable with those from other renewable-energy technologies — *i.e.* less than 100 grams per kilowatt-hour — and far less than those from fossil-fuel electricity plants, which can be 10 to 20 times higher.

Complementary policies

The world market for PV modules and systems is currently heavily influenced by government policies. In developed countries, consumption of PV systems for homes and larger installations is often subsidised in the interest of diversifying energy sources and stimulating the market so that the industry may continue to move along the experience curve, finding new ways to reduce production costs.

A large share of exports of solar PV systems from developed to developing countries are associated with aid projects, some of which are tied — *i.e.* provided on the condition that the recipient country use the funds to buy goods or services from the donor country — or involve donations in kind or directed credit (Box 2.5). Equipment imported for small projects funded by charities and other non-governmental organisations often must pay whatever import duties apply, and equipment imported by local commercial enterprises must always pay them. Yet solar modules and related components associated with large projects, especially if they are part of a tied-aid project, often benefit from tariff waivers. Tied aid distorts competition in favour of the exporter whose products are given preference. To the extent that those same exporters benefit from tariff waivers and their competitors do not, the distortion is increased. If there are no tariffs to waive in the first place, the degree of distortion will be less.

13. DC-powered electric lamps are also used in bicycle headlights and motorised vehicles. And DC-powered refrigerators are used in camping vans. But the main market is in connection in homes powered by PV-systems.

14. Taking into account all processes: energy extraction, plant construction, fuel transportation and refining, and plant operation and maintenance.

Box 2.5. OECD approaches to supporting the dissemination of solar PV systems

Virtually all OECD countries support research and development on renewable energy sources and the technologies to produce or exploit them. Many of these policies are aimed at increasing the share of renewable energy in grid-based electricity generation, but OECD countries have also encouraged the dissemination of renewable-energy technologies for distributed uses, such as supplying electricity for remote farmsteads or villages, buoys and similar isolated devices, and individual homes.

Many OECD countries, as well as sub-national governments, provide partial grants, tax credits or rebates to households and community organisations that install small-scale PV power systems. The practice by electric utilities of buying back surplus electricity generated by residential PV systems at the retail price of electricity has also helped stimulate demand. A few countries have established programmes specifically aimed at getting homeowners to install solar thermal water heaters or solar photovoltaic modules on rooftops. Germany's "100 000 Roofs Programme", by the time it ended in July 2003, had stimulated the installation of 55 000 solar PV rooftop units with a total capacity of 261 MW. A similar programme in Japan, also established in 1994, led to the installation of 162 525 residential PV systems by 2003.

An important feature of several of the programmes is that the incentives for the purchase of PV systems declined over time. Japan's programme, for example, initially covered 50% of the costs of installing PV modules on roofs. As the cost of solar cells fell, however, the subsidy rate was reduced to one-third and then to about 10% of the cost. Despite the reduced subsidy, the number of new units installed each year continues to rise.

Other government policies have also influenced consumer demand for residential PV systems, and for electricity based on renewable energy in general, through the regulation of air pollutant emissions and ambient air quality. All OECD countries have progressively tightened rules on emissions of air pollutants over the last 30 years, and some have also started to institute limits on total emissions of carbon dioxide, a product of combustion. Such regulations raise the cost or otherwise constrain the building of new fossil-fuelled power stations, making zero-emission electricity generating sources, like solar PV systems and wind turbines, more financially viable.

Sources: IEA (2004c); International Energy Agency, "Global Renewable Energy Policies and Measures Database": http://renewables.iea.org; New Energy Foundation, www.nef.or.jp/.

Of those aid-related projects that are not tied, most involving bilateral or multilateral aid also benefit from tariff waivers.[15] The market distortions caused by these projects are less than for tied-aid projects, especially if the components of the systems are purchased through competitive bidding. However, if they are too large-scale and too long-lasting, they risk creating expectations of further donor giveaways and driving away domestic firms that might otherwise develop a robust renewables market on their own.[16] For that reason, multilateral agencies, such as the International Finance Corporation (IFC), more and more direct their efforts towards accelerating the commercialisation and financial

15. In China during the 1980s and 1990s, for example, applications to reduce or exempt customs duty on renewable-energy technologies and related components imported with international assistance were commonplace, so that the actual duties paid on these goods were very low (NREL, 2004). More generally, the development agencies of some OECD countries include in their assistance agreements special provisions to ensure an exemption from customs duties or other taxes in the recipient country. As of 2003, for example, the United States had 77 bilateral framework agreements with countries receiving bilateral assistance through USAID. All of these agreements stipulate that goods (i.e. "supplies, materials, equipment, or other property") imported or introduced for use in assistance projects shall be free from any tariffs, customs duties, import taxes and other taxes or similar charges; more than half also prohibit taxation of goods purchased in the country (GAO, 2004).

16. For a general critique of tariff and tax waivers on foreign financed products see Chambas (2005).

viability of PV-based energy services in developing countries, rather than simply exporting turn-key projects (Box 2.6).

Box 2.6. The IFC/GEF Photovoltaic Market Transformation Initiative

The Photovoltaic Market Transformation Initiative (PVMTI) is a strategic joint initiative of the International Finance Corporation (IFC) and the Global Environment Facility (GEF) aimed at accelerating the penetration of PV technology "as a renewable and emission-free source of electric power in developing countries, especially for off-grid applications". In operation since 1998, the GEF has approved USD 30 million for the project, of which USD 25 million has been used for concessional investments in PV market-development projects in India, Kenya, and Morocco. (The remaining USD 5 million is reserved for implementation costs.) The investment period will run through 2005, and all programme activity and recovery of funds is due to be completed by June 2008.

The PVMTI's main impact is expected to be in facilitating the success of companies intended to serve as good examples of viable PV businesses — with financial structures and business approaches that work — thus forming the basis for the long-term sustainability and replicability of the projects. Entrepreneurs receive assistance in drawing up business plans, following which they can apply for concessional financing. The initiative can provide debt, equity or loan guarantees to project sponsors, which are likely to be companies that target the sale or leasing, distribution, installation, and service of PV equipment. The IFC may also choose to co-invest with PVMTI in selected commercially viable projects. The PVMTI estimates that the total project investment stimulated by the initiative will be in the neighbourhood of USD 90-120 million.

Sources: Based on www.ifc.org/ifcext/enviro.nsf/Content/Photovoltaic and www.ifc.org/ifcext/enviro.nsf/e11ffa331b366c54ca2569210006982f/24b7345f65a9f88c85256dc200104943?OpenDocument.

Complementary policy changes within countries can also have a tremendous influence on the benefits to be gained from liberalising trade in photovoltaic cells and modules and associated components. As various studies have shown, the market for electricity-generating technologies based on renewable energy is influenced by a wide range of factors related to the way that electricity and competing fuels are priced, and the openness of electricity markets. As the bulk of solar-PV systems installed in developing countries are likely to be for off-grid use, the most important policies in the short term are probably those regulating services connected with the installation and servicing of equipment. But as the number and income of users increase, more and more owners of such installations may become interested in selling some of the electricity they produce back to the electricity grid. In those situations, it may become necessary to reform electricity markets so as to allow the private supply of electric power.

One other reform is also crucial: making the high cost of extending electricity transmission lines into rural areas more transparent. Noting that "most (if not all) of rural electrification programs around the world have been funded through implicit cross-subsidies (often from industrial to residential consumers and from urban to rural consumers)", Cabraal and Fitzgerald (2002, p. 3) point out:

> Because electricity is so desirable to the public, power-sector operations and rural lines extension are often highly politicized. Where politicians interfere with the orderly planning and running of programs by, for instance, directing that favored constituents constituents are connected first, or by preventing constituents from being disconnected for not paying their bills, rural electrification efforts can quickly become inefficient and a burden on the public budget or on power-sector finances.

Making the costs of extending grid lines to rural areas more transparent, and halting the practice of cross-subsidising their construction and maintenance, would reveal lower-cost ways of meeting the same objectives. Chile was an early pioneer in this regard, establishing a decentralised scheme (the "minimum subsidy vehicle") which awarded funds to the rural electrification projects that required the smallest payment per unit of social value (Jadresic, 2000). In many cases, the lowest-cost option was to install a stand-alone power supply (such as solar PV systems, small wind turbines or small hydroelectric stations) to homes, or to set up micro-scale grids, rather than to extend a transmission line.

Finally, in order to minimise problems associated with the disposal of solar PV system components at the end of their useful lives, mechanisms for collecting and recycling PV cells and storage batteries need to be in place. Lead-acid solar batteries are of particular concern, because of the toxicity and persistence of lead in the environment. The recovery of lead from such batteries is not difficult, however, and merchants able to recycle 12-volt car and lorry batteries already exist in most countries. Electric lighting facilitated by solar-electric systems may also reduce the consumption of disposable flashlight batteries (which often contain heavy metals), recycling options for which are much less prevalent than for larger batteries in developing countries.[17]

Wind turbines and pumps

The technology

A wind turbine is a machine that converts the kinetic energy in wind into mechanical rotation, which in turn drives an electrical generator. Wind turbines are made in a multitude of shapes and sizes, from small devices producing a few hundred watts of power to massive towers, the largest of which are rated at 5 000 000 Watts (5 MW). Most commercial wind turbines, especially large ones, are horizontal-axis machines. The share of the market supplied by wind turbines that transfer mechanical rotation along a vertical axis is tiny. Large wind turbines are sometimes built in isolation, but in OECD countries most are installed in groups (wind farms) of ten or more, sometimes even hundreds.

A wind pump captures wind energy in much the same way as a wind turbine, but is a much simpler device, using mechanical rotation to lift or pump water. Wind pumps can draw water from wells as deep as 200 metres. Wind-powered pumps have been in use for over 2 000 years, and the technology is mature. While producing the transmission and drive train for a high-quality wind pump requires machine tools, the rotors and lattice towers can be produced in small-scale workshops.[18]

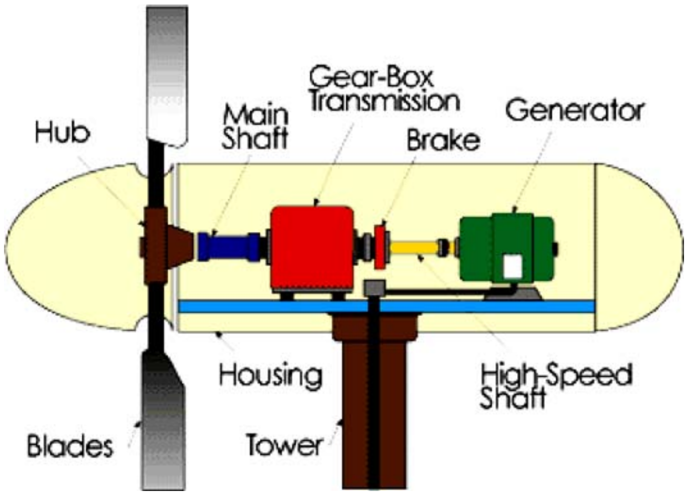
Figure 2.2 shows the main working elements of a wind turbine. The two or three blades (foreshortened in the figure) that, together with the hub, make up the rotor, are the most expensive part of the machine. The turbine blades, the largest of which can reach more than 50 metres in length and weigh 15 tonnes or more, are often made of composite materials (*e.g.* graphite fibre in epoxy) or fibreglass, and require precision manufacturing techniques. The gearbox transforms the relatively slow rotation of the blades (30 to 60 rotations per minute — rpm), into the speed required by the generator to produce electricity (1 200 to 1 500 rpm). Because gearboxes are costly and heavy, engineers are exploring direct-drive generators that would operate at lower rotational speeds without a

17. www.self.org/shs_envir.asp.

18. http://igadrhep.energyprojects.net/Links/Profiles/WindPumps/WindPumps.htm.

gearbox. Until such generators are developed, most wind turbines use standard induction generators that produce 50- or 60-cycle AC electricity.

Figure 2.2. Partial side view of a wind turbine



Source: Iowa Energy Center, *Wind Energy Manual*, Ames, Iowa, 2005, p. 7, www.energy.iastate.edu/renewable/wind/wem/wem-07_systems.html.

Production and trade in wind turbines and wind pumps

Energy Source Guides (http://energy.sourceguides.com/) lists some 1 355 wind-energy “businesses” in the world, covering manufacturers, retail sales businesses, wholesale suppliers, system design, system installation, architectural services, non-profit organisations, trade associations, and other types of businesses. The production of large, utility-scale turbines (>50 kWe), however, is dominated by just a handful of companies. According to the Danish company BTM Consult, the four largest manufacturers accounted for 79% of global sales in 2004, as measured by rated generating capacity. The Danish company Vestas Wind Systems A/S maintained its historical lead, capturing 34% of the world market. Gamesa Eolica, of Spain, rose to second position, at 18%, followed by Germany’s Enercon GmbH (16%) and the United States’ General Electric (11%). The largest locally owned company based outside the OECD area, Suzlon (India), supplied just under 4% of the market.

As a large wind turbine is normally assembled in place from its different elements, “production” of a wind turbine means the manufacturing of blades, hubs, gear boxes, towers and other components. These manufacturing activities are distributed not only within OECD countries but also across several developing countries. For example, Vestas, the most vertically integrated producer, has established factories not only throughout Europe, but also recently started manufacturing blades for MW-class turbines in Australia, and has decided in principle to establish local production facilities in China and North America (Vestas, 2005). Recently, Vestas RRB India Ltd., which is 49% owned by Vestas Wind System A/S, began manufacturing windmill controllers at a facility near Chennai, and had plans to open a blade-manufacturing plant at the same site by the end of 2005. With these investments, some 75% of the value added of the wind turbines the company sells in India’s fast-growing market will be generated within the country (*The Hindu Business Line*, 2005).

Enercon GmbH, besides manufacturing in Germany, Sweden and Turkey, has invested in facilities in Brazil and India. Wobben Windpower Ceará Ltda., a subsidiary of Enercon, currently operates two plants in the Brazilian states of Sao Paulo and Ceara, where it produces 0.6-MW, 1.0-MW and 1.6-MW turbines for customers in South America, and components for export to Europe and elsewhere. Enercon India Limited is a 56:44 joint venture with an Indian company that manufactures complete wind turbines for the local market and exports blades to Europe.

Small wind turbines — generally those rated at 50 kW or less — are often manufactured in one place and shipped as a kit for assembly. It is not known precisely how many companies are involved in their production, but barriers to entry are presumably lower than for large turbines. The World Wind Energy Association has so far identified over 35 manufacturers of small wind turbines, including several in southern Africa, China and India. Koenemann and Lehmann (2005) estimate that there are over 100 manufacturers world-wide, of which about 30 in China alone. The number of commercial manufacturers of wind pumps appears to be smaller than that of small wind turbines, but many are located in developing countries.[19] One company, based in Nicaragua, is producing a rope wind pump that costs much less than a traditional "Aeromotor" wind pump, and is simpler to erect and maintain; more than 100 systems have been installed in Nicaragua and the technology is now spreading to other countries in Latin America (de Jongh and Rijs, 1999).[20]

On a country basis, Denmark is by far the dominant exporter of complete wind electric generating sets (as they are called in the statistics), accounting for 95% of world trade in 2003, in total worth USD 1.1 billion. The next largest exporter was Brazil (with exports worth USD 2 million), followed by India (USD 0.7 million). Trade in components of large wind turbines, especially blades, towers and generators, probably exceeds that in complete wind turbines,[21] but the available statistics are insufficiently detailed to distinguish trade in these items from trade in other products classified under the same HS subheadings. Because of the nature of investment in the industry, much of the international trade that takes place in the components of large wind turbines is internal to the major multinational wind-turbine companies.

Potential implications of liberalising trade in wind turbines and wind pumps

As with solar-PV systems, the beneficiaries of liberalising trade in wind turbines and wind pumps would first and foremost be consumers of electricity, especially those currently living in countries where tariffs on these machines are high (*e.g.* 15% or greater). Judging from Table 2.A1.5, these would include Brunei, Cambodia, India, Maldives, Mexico, Nepal, Nigeria, Romania, Tanzania, Thailand and Yemen. While some aid-supported, utility-scale wind turbines may already be entering these countries duty-free, it is likely that many imports of smaller-scale wind turbines are currently subject to import tariffs.

19. The Intergovernmental Authority on Development (http://igadrhep.energyprojects.net/) lists seven manufacturers and suppliers of wind pumps in Africa.

20. See also www.gamos.demon.co.uk/just%20gamos%20homepage/henkfnl2.htm.

21. The net turnover of the Vestas Group alone was EUR 1.6 billion (USD 1.9 billion) in 2003. As 85% of Vestas' sales of wind turbines are for export, and its global market share in 2003 was 32%, this suggests that a much larger proportion of sales of wind turbines takes place in the form of components.

On the production side, a large number of companies based in OECD countries would benefit from any extra sales generated by trade liberalisation of wind turbines and their components. So, too, would people working for local subsidiaries and joint ventures of these companies in countries like Brazil, China and India. Many other developing countries could become involved in manufacturing wind turbines as their own regional markets grow. Many of the components of wind turbines are bulky to ship, and this works to the advantage of local production.

The environmental effects of liberalising trade in wind-turbine technology would depend in part on the degree to which wind turbines replace other means of producing electricity. Wind turbines emit no emissions while operating, except for some noise. Other disruption to the environment may be associated with the construction of the concrete bases into which larger turbines are set, and the construction and use of access roads. The concrete requirement, at roughly 0.3 cubic metres per kilowatt, is not insignificant: 700 MW of wind turbines (the capacity of a single, new coal-fired power plant) would use 210 000 cubic meters — enough to cover 10 international soccer pitches to a depth of 3 metres. Life-cycle studies (World Energy Council, 2004) suggest that emissions of CO_2 and air pollutants per kilowatt-hour generated are slightly less than from solar photovoltaic systems (on a full life-cycle basis), and much lower than from fossil-fuel electricity plants.

Complementary policies

For off-grid applications of wind power, many of the policy considerations discussed above for solar PV systems apply. But given that, in value terms, the bulk of wind turbine capacity produced in the world is for generating high-voltage electricity for central power grids, policies relating to the electricity sector as a whole have a critical influence on the extent to which economic opportunities for wind-generated electricity can be fully exploited.

Reforms of electricity sectors often include one or more of the following: vertical unbundling (separating the ownership of generation, transmission and distribution); horizontal unbundling (breaking up private or public monopoly control over service categories or geographic areas); and market pricing of bulk-power sales (Cabraal and Fitzgerald, 2002). Such reforms, as well as more targeted policies (Box 2.7), have proved instrumental in creating a more favourable investment climate for companies specialising in the production of power from new energy sources and technologies, including wind power. Restructuring, and the introduction of greater competition into the electricity market, has also tended to increase public involvement in energy choices, often to the benefit of cleaner and less obtrusive electricity supply solutions (G8 Renewable Energy Task Force, 2001a). And, by fundamentally altering the roles of key stakeholders, the financial support provided by states to particular technologies may become more transparent, facilitating the elimination of programmes that no longer serve the public interest.

Box 2.7. Targeted policies to promote on-grid electric power based on renewable energy

OECD countries have used various policies to promote the expansion of wind power (and other on-grid sources of electricity produced from renewable energy). Grants for research and development, tax concessions and other investment incentives were important in the early years of the industry. Nowadays, the policies that provide the greatest stimuli are those that affect the market for renewable-based electricity itself. The two main policies of this sort are "feed-in" electricity tariffs and quota schemes.

Germany has been the greatest exponent of feed-in tariffs. Its Electricity Feed-in Law was introduced in 1991 and has since been modified twice. The Law has two components. First, operators of electricity distribution networks must provide renewable-energy generators with access to their grids and charge them only actual connection costs. Second, the grid owners have to pay the renewable-energy generators a price for their electricity that is set at a level higher than the market price for electricity generated from non-renewable energy sources, such as coal. Thanks to the security afforded investors by the feed-in law, Germany has more wind capacity than any other country: 16 600 MW as of the end of 2004.

Quota schemes normally involve an obligation for electricity distribution companies to obtain a specified percentage of the electricity that they sell to customers from renewable-energy sources. In 2002, for example, the United Kingdom set itself a target to generate 3% of its electricity from renewable sources in 2002, 10% by 2010 and 15% by 2015. Suppliers can meet this obligation by contracting to buy electricity from renewable-energy generators (receiving "green certificates" in return) or by paying a "buy-out" price to a central fund. The proceeds of the buy-out fund are distributed to the suppliers that have obtained the requisite number of green certificates. Compared with feed-in tariffs, quota schemes are more cost-effective.

Some developing countries are adopting similar policies. India's Electricity Act 2003, for example, has several provisions intended to accelerate the emergence of private electricity production from non-conventional power sources. These include obligations on the state electricity regulatory commissions (SERCs) to allow access to their electricity grids, and to obtain a specified percentage of the total electricity consumption in their areas from cogeneration plants or renewable sources of energy. As of mid-2005, 17 Indian states had announced policies to allow grid access and establishing buy-back policies for electricity sold by private-sector generators.

Source: Based on "Renewable Energy for India", www.reeep.org/index.cfm?articleid=1193.

Countries liberalising trade in wind turbines will also naturally be concerned about increasing the share of related value-adding activities. Vocational training in the maintenance and operation of wind turbines is one investment that is likely to pay off. Forcing the situation through trade-related investment measures, such as local-content obligations on sales (Box 2.8), is not only economically a second-best approach, but is also inconsistent with the WTO Agreement on Trade-Related Investment Measures. Commenting on China's local-content regime, one observer (Lewis, 2005) concludes that, "[r]ather than a fixed percentage localisation requirement, project evaluators should design criteria that more flexibly award creative methods for combining advanced international technology with local materials and integrating locally-manufactured components, and particularly methods that include collaborative innovation and development between foreign and Chinese companies".

Box 2.8. China's local-content requirement for wind turbine concessions

In 2003, China instituted a policy of granting 25-year concessions to suppliers of wind power through competitive bids. Initially the government's guidelines stipulated that proposed projectsshould be 100 MW in size, and use turbines over 600 kW in capacity, with a minimum 50% domestic content for concession-related projects. Effective mid-2005, a 70% minimum domestic content requirement became applicable for *all* new wind projects in China, unless a written agreement had been signed previously. This requirement was accompanied by a change in the Chinese tariffs intended to favour domestic production of wind turbines. Import duties are 3% for individual parts, 8% for assembled components, and 17% for entire pre-assembled turbines. Winning bidders of concessions benefit from fast-tracking of approvals to develop the selected project site, guaranteed grid interconnection, financial support for grid extension and access roads, and preferential loans and tax treatment.

The first five projects were awarded after two rounds of bidding in 2003 and 2004, resulting in over 550 MW of new wind turbine capacity. A third round of concession bidding took place in 2005. One of the concessions, from the Chinese company Jiangsu Unipower Wind Power Co. Ltd. (for 50, 2.0-MW wind turbines for the Pudong Wind Power Concession project), was awarded to the Danish company, Vestas. To meet the local-content requirement, Vestas is building a blade factory in China. In addition, in February 2005, the company opened a Strategic Purchasing Office in Shanghai to source the purchase of both raw materials and components from Chinese suppliers.

Sources: Lewis (2005); "Growing support for wind in China", *VestasGlobal*, April 2005, pp. 14-16, www.vestas.com/pdf/publikationer/VestasGlobal/no3/UK_VestasGlobal0305.pdf; Eric Martinot, "Renewable energy in China", www.martinot.info/china.htm (page updated 13 November 2005).

Biodiesel

The fuel and related goods

Biodiesel is defined by the World Customs Organization (WCO) as "a mixture of mono-alkyl esters of long-chain [C16-18] fatty acids derived from vegetable oils or animal fats, which is a domestic renewable fuel for diesel engines and which meets the specifications of ASTM D 6751".[22] The fuel can be used in standard compression-ignition (*i.e.* diesel) engines with little or no modification. It is biodegradable, non-toxic, and essentially free of sulphur, aromatic hydrocarbons (such as carcinogenic benzene), and produces far less particulate matter during combustion than diesel refined from petroleum.

Biodiesel can be made from almost any naturally occurring oil or fat. Most of the world's production of biodiesel currently derives from plant oils, chiefly canola (rapeseed) and soy. Other oleaginous crops used as biodiesel feedstock include castor seed, coconut, jojoba, oil palm (*Elaeis guineensis*), physic nut (*Jatropha curcus L.*), and sunflower seed — many of which are grown predominantly in developing countries. Biodiesel can also be produced from waste cooking oils, fish oil,[23] and tallow[24] (animal

22. ASTM stands for the American Society for Testing and Materials. ASTM D6751 refers to the ASTM's "Standard Specification for Biodiesel Fuel (B100) Blend Stock for Distillate Fuels".

23. Terrence Sing, "Biotech industry goes fishing to find new auto fuel", *Pacific Business News*, 9 April 2004, www.bizjournals.com/pacific/stories/2004/04/12/focus3.html.

24. Two of Australia's plants are designed to process tallow (www.arfuels.com.au), as are several of the plants currently operating in Canada, and a 100 000 tonne per year plant is scheduled to start up in Brazil in June 2006.

fat). There have even been suggestions that waste fat obtained from liposuction,[25] some 100 tonnes of which are produced in the United States alone each year, also could be used as a feedstock for biodiesel.[26]

Transforming oils and fats into biodiesel involves a relatively simple chemical process, using well-established technologies.[27] Plant oils and animal fats consist mainly of triglycerides, the fatty acid esters of glycerine. Unprocessed, they are extremely viscous and tend to leave resins which are undesirable in a fuel tank.

The most commonly used process for refining plant oils, base-catalysed transesterification, involves stripping the glycerine from the fatty acids with a catalyst such as sodium or potassium hydroxide, and replacing it with an anhydrous alcohol, usually methanol. The resulting raw product is then centrifuged and washed with water to cleanse it of impurities. This yields methyl or ethyl ester (biodiesel), as well as a smaller amount of glycerol (HS 2905.45), a valuable by-product used in making soaps, cosmetics and numerous other products.

Biodiesel can be produced in very small quantities with simple equipment for handling, storing and mixing the feedstock, reagent, catalyst and end-products. Several companies now manufacture modular biodiesel refineries that can be transported and installed rapidly. A UK company, D1 Oils Plc, for example, has developed a modular, stand-alone skid-mounted continuous transesterification unit (the “D1 20”), capable of producing a nominal 8 000 tonnes a year of biodiesel from a wide range of vegetable oil feedstock. The unit, which measures 3.3 meters wide, 10 meters long and 4 meters high and weighs just under 15 tonnes, can be shipped anywhere in the world that is accessible by road, rail or sea.[28] Biofuels S.A. (www.biofuels-sa.com) a company based in Argentina, sells even smaller units. Such refineries could be classified under HS 8479.20 (Machinery for the extraction or preparation of animal or fixed vegetable fats or oils). Another piece of essential equipment is a crusher, which would be an ex-out of HS 8479.82 (Mixing, kneading, crushing, grinding, screening, sifting, homogenising, emulsifying or stirring machines).

Production and trade

Currently, OECD countries account for most of the world’s consumption of biodiesel, and about 85% of its production. Demand throughout the world has been driven largely by tax incentives, regulations on the quality or share of biofuels in transport fuel, and government procurement policies. Exemption from or refund of the excise tax on diesel, which effectively doubles the retail price of petroleum diesel in many OECD countries, is the most common consumption incentive.

25. “A usually cosmetic surgical procedure in which excess fatty tissue is removed from a specific area of the body, such as the thighs or abdomen, by means of suction. Also called *suction lipectomy*.” *The American Heritage® Dictionary of the English Language*, Fourth Edition, 2000.

26. Brett Schaeffer, “The accidental conservationist, *In These Times*, 3 December 2003 www.inthesetimes.com/site/main/article/the_accidental_conservationist/.

27. Two other methods, both generally more expensive, can be used: *i)* direct, acid-catalysed esterification of the oil with methanol; and *ii)* conversion of the oil first to fatty acids, and then to alkyl esters using acid catalysts.

28. “D1 20 Modular Biodiesel Refinery”, www.d1plc.com/energy/d1_20_way.php.

Target shares for biofuels generally, or biodiesel in particular, have been established in many countries. In May 2003 the European Union issued a Directive (2003/30/CE) setting targets for the share of biofuels (which include ethanol in addition to biodiesel) in total transport fuel. The aim was that by end 2005 biofuels should have accounted for a share of at least 2% and a share of 5.75% by the end of 2010. In Brazil, a 2% mixture (abbreviated as B2) will be compulsory starting in 2008; the intention is then to increase the percentage gradually to 5% (B5) in 2013. Malaysia has mandated the sale and universal use of a B5 blend of biodiesel beginning in 2008, and Thailand has fixed a 3% target share for biodiesel by 2011. In February 2004, the Philippines ordered all government vehicles to use a 1% biodiesel blend in their diesel vehicles. On a smaller scale, numerous municipalities around the world have mandated minimum shares of biodiesel in their bus fleets.

Construction of plants for transforming oils and fats into biodiesel has received considerable support from governments. These have included grants and interest-free loans, and in some countries subsidies for the purchase of raw materials (ABI, 2005; Biofuels Taskforce, 2005). In addition, many OECD countries apply lower excise taxes on biodiesel than on petroleum diesel, or pay an incentive for each litre of biodiesel placed on the market. Reasons given by governments for these subsidies include maintaining domestic agricultural production and employment, reducing CO_2 emissions and reducing dependence on imported petroleum fuels. The cost-effectiveness of current subsidies to biofuels in meeting these objectives is beyond the scope of this chapter.[29]

European countries currently lead the world in the production of biodiesel, approaching 3 million tonnes a year, but recent heavy investments in Australia, Brazil, India, Malaysia and the United States mean that these countries are poised to become major producers as well (Table 2.3). Indonesia, one of the world's leading producers of palm oil (almost 35% of global production), could also emerge as a major producer of biodiesel.

Although biodiesel is as easy to transport as petroleum-derived diesel fuel, international trade in biodiesel is still small. There has been considerable intra-European trade, as suppliers seek out markets with the greatest differential between the after-tax price of petroleum diesel and the tax-exempt price of biodiesel. Japan has also imported small quantities of coconut methyl ester from the Philippines. A rapid increase in traded volumes is foreseen, however, driven by increasing demand for transport fuels in developing countries, concerns about transport-related pollution and policies in OECD countries to actively promote the use of biofuels (IEA, 2005b; Loppacher and Kerr, 2005).

29. Various studies have compared the cost-effectiveness of biofuel policies with other means of reducing transport demand for petroleum fuels and reducing greenhouse gas emissions from transport. See, for example, EUCAR, CONCAWE and JRC (2005), Kampman and Boon (2005) and Transportation Research Board (2005).

Table 2.3. Rough estimates of world production of biodiesel, 2002-07

Thousand tonnes

Country	2002	2003	2004	2005 estimated	2006 projected	200 projected	2008 projected
Canada	1	3	3	43	76	83	100
Mexico	—	—	—	—	—	—	—
United States	50	67	83	250	336	499	741
North America	**51**	**70**	**86**	**292**	**412**	**582**	**824**
Austria	25	32	57				
Czech Rep.			60				
Denmark	10	41	70				
France	366	357	348				
Germany	450	715	1 035				
Italy	210	273	320				
Slovakia			15				
Spain	0	6	13				
Sweden	1	1	1				
United Kingdom	3	9	9				
OECD Europe			**1 930**				
Europe total	**1 073**	**1 544**	**1 935**	**2 200**	**3 000**	**4 000**	**5 200**
Australia	27	27	29	36	187	268	350
Japan	2	2	3	3	3	7	10
Other	—	—	—	—	—	—	—
OECD Asia-Pacific	**29**	**29**	**31**	**39**	**190**	**275**	**360**
Brazil	neg.	neg.	6	176	238	300	700
China	neg.	20	45	64	150	337	450
India	neg.	neg.	neg.	neg.	8	50	300
Malaysia	—	—	—	—	135	135	180
Philippines	—	—	29	29	58	58	100
Thailand	neg.	neg.	neg.	79	100	100	150
Other	**neg.**	**20**	**80**	**348**	**689**	**980**	**1 880**
Total world	**1 153**	**1 663**	**2 133**	**2 880**	**4 250**	**5 800**	**8 000**

Sources: OECD based in part on: North America: National Biodiesel Board (*www.nbb.com*); Europe: European Biodiesel Board (*www.ebb-eu.org/stats.php*);

Fediol, Europe's vegetable oil federation, recently suggested that Asian palm oil could supply up to 20% of the EU's biodiesel requirements by 2010.[30] Recently, the Malaysian Palm Oil Board announced that it would enter into 50:50 joint partnerships with other investors to establish three biodiesel plants, each with an annual capacity of

30. "Asian palm oil for euro diesel", 6 May 2005, www.greencarcongress.com.

60 000 tonnes (205 million litres in total). The plants are expected to be completed by the end of 2006, and most of their output will be exported to Europe.[31]

Over the longer term, a number of countries in Africa and Asia have considerable potential for benefiting from biodiesel production and trade based on jatropha, a large, fast-growing, drought-resistant perennial shrub, the seeds of which yield up to 2 700 kg of raw oil per hectare. Projects to demonstrate the possibilities of producing biodiesel from jatropha have been started or are being planned in at least ten developing countries (Burkina Faso, China, Ghana, India, Lesotho, Madagascar, Malawi, South Africa, Swaziland and Zambia). This plant is particularly suitable for growing on land too poor and arid to support food crops, and is also nitrogen-fixing.[32] Early experiments in India using simple technologies have already yielded biodiesel that meets the EU norm for biodiesel quality.

Statistics on trade and tariffs are hampered by biodiesel's current classification in the Harmonized System. A recent decision by the WCO's Harmonized System Committee (35th Session, March 2005) confirmed that biodiesel should be classified under HS 3824.90, which refers to chemical products and preparations of the chemical or allied industries (including those consisting of mixtures of natural products), not elsewhere specified or included. That decision helped to standardise the classification of biodiesel across countries, but did not deal with the problem of lack of specificity: biodiesel shares the same subheading with numerous other unrelated chemical products. For example, the 2005 edition of the Harmonized Tariff Schedule of the United States lists 25 chemical mixtures at the 10-digit level under HS 3824.90, ranging from cultured crystals to "electroplating chemical and electroless plating solutions and other materials for printed circuit boards, plastics and metal finishings".

Current applied tariffs are lower for biodiesel than for some other renewable-energy products. Only 13 countries levy *ad valorem* tariffs higher than 10%. India tops the list, at 30%, followed by the Maldives (25%) and Ghana (20%). Almost 40 countries have bound their tariffs at *ad valorem* rates of 20% or more, however. Some countries, like Australia, also apply specific rate (*i.e.* per volume) tariffs on imports.

Current applied tariffs on both oil-extraction machinery (HS 8479.20) and crushing machinery (HS 8479.82) are 7% or less in OECD countries but are 15% or higher in ten developing countries. Bound tariffs are much higher, exceeding 15% in over 50 countries, including several OECD countries. Mozambique and Rwanda have bound their tariffs for this type of equipment at 100%, even though they currently apply tariffs of 5% or zero.

Implications for the environment

Many studies have been undertaken on the net environmental impacts of substituting biofuels for fossil fuels, including biodiesel. Those effects can be divided into impacts on air pollutants and greenhouse gas (GHG) emissions, on waste streams, and on resources used in the cultivation of biofuels.

Impacts on air pollutant emissions have perhaps been the most thoroughly studied of the potential environmental effects of substituting biodiesel for other fuels. Even so,

31. "Malaysia investing in three palm-oil biodiesel plants", 29 September 2005, www.greencarcongress.com.

32. For example, by some estimates, India has 50 to 130 million hectares of agriculturally marginal and degraded lands (www.ecoworld.org/Home/Articles2.cfm?TID=353).

results differ from one test to another and appear to be affected by a number of variables, depending on the quality of the fuels compared, the engine used for testing and ambient conditions (see, *e.g.* National Traffic Safety and Environment Laboratory, 2004), Table 2.4, which is provided for illustrative purposes, shows the changes in life-cycle emissions of air pollutants using 100% biodiesel instead of low-sulphur petroleum diesel (various grades), normalised for differences in fuel efficiency. The emissions shown are those that result mainly from transport, storage and incomplete combustion of biodiesel. While the percentage reductions differ somewhat depending on the types of biodiesel and grades of petroleum diesel that are compared, two general conclusions can be drawn: emissions of carbon monoxide, volatile organic carbon and particulate matter are reduced when biodiesel is used, but emissions of nitrogen oxides are increased (by up to 30% when comparing biodiesel from rapeseed with extra-low-sulphur petroleum diesel). Since biodiesel (from whatever source) contains only trace amounts of sulphur, emissions of sulphur dioxide (SO_2) are also substantially reduced. Because of biodiesel's lower sulphur content, and its other superior qualities, such as greater lubricity, engines that use it have a longer operating life.

Table 2.4. Percentage change in full life-cycle air pollutant emissions (as g/km) for 100% biodiesel compared with low-, ultra-low- and extra-low-sulphur petroleum diesel[1]

Diesel type against which comparison is made, pollutant	Biodiesel from rapeseed	Biodiesel from tallow	Biodiesel from waste cooking oil	Low-sulphur petroleum diesel (LSD)	Ultra low-sulphur petroleum diesel (ULSD)	Extra low-sulphur petroleum diesel (XLSD)
Compared with LSD						
Carbon monoxide (CO)	-27	-37	-47	—	-	-2
Nitrogen oxides (NOx)	+6	+5	-5	—	-9	+18
Volatile organic carbon (VOC)	-32	-35	-50	—	-8	+13
Particulate matter (PM)	-32	-33	-39	—	-20	+24
Compared with ULSD						
Carbon monoxide (CO)	-27	-37	-47	+	—	-1
Nitrogen oxides (NOx)	+17	+15	+4	+10	—	+10
Volatile organic carbon (VOC)	-26	-29	-45	+9	—	-5
Particulate matter (PM)	-15	-16	-23	+25	—	-5
Compared with XLSD						
Carbon monoxide (CO)	-26	-36	-46	+2	+1	—
Nitrogen oxides (NOx)	+30	+28	+16	+22	+11	—
Volatile organic carbon (VOC)	-22	-26	-42	+15	+5	—
Particulate matter (PM)	-11	-12	-20	+31	+5	—

1. Based on measurements from a non-articulated lorry ("rigid truck").

Source: Biofuels Taskforce (2005), p. 83, based on T. Beer, D. Olaru, M. Van der Schoot, T. Grant, B. Keating, S. Hatfield Dodds, C. Smith, M. Azzi, P. Potterton, D. Mitchell, Q. Reynolds, J. Winternitz, S. Kierce, A. Dickson, C. Short, T. Levantis and E. Heyhoe, "Appropriateness of a 350 million litre biofuels target", CSIRO, ABARE, and BTRE Report to the Australian Government. Department of Industry Tourism and Resources, Canberra, December 2003.

Life-cycle reductions in carbon-dioxide (CO_2) emissions depend on the source of the feedstock, production pathways and assumptions regarding alternative uses of the land from which the feedstock was produced, especially if it had previously been forested. A recent IEA study (2005b, Table 3.6) reports "well-to-wheel" reductions in greenhouse gases of between 44% and 63% per kilometre, compared with petroleum diesel, based on studies involving rapeseed methyl ester and soy methyl ester. The European Commission's more recent "Wells to Wheels" study (EUCAR, CONCAWE and JRC, 2005), concludes that the fossil energy and greenhouse gas (GHG) savings from conventionally produced biofuels such as biodiesel "are critically dependent on manufacturing processes and the fate of by-products". The GHG balance is particularly uncertain because of nitrous oxide (NOx) emissions associated with growing oil-bearing plants, which are largely dependent on the nitrogen fertiliser application rate. Nitrogen-fixing plants, including legumes like soy, and non-leguminous plants, like jatropha and jojoba, are less problematic in this respect.

From a waste-management standpoint, production of biodiesel from used cooking oil or low-grade tallow is environmentally beneficial as it provides a cleaner means of disposing of these products than is typically used. The world consumes each year billions of litres of oil and lard for frying foods, and much of the used oil is discarded into sewage systems, where it adds to the cost of treating effluent or pollutes waterways.[33] Efficiently collecting this oil from households would be difficult and costly, but waste cooking oil generated by restaurants in cities is already commonly collected and re-used of in a large number of cities around the world, especially in the OECD area.

It may be assumed that the environmental effects of trade liberalisation in the short to medium term would not be high. For one, in the medium term, demand for biodiesel over the next decade is likely to be driven by government policy, especially tax policies and laws regulating the minimum shares of liquid biofuels in total transport requirements. If global (pre-tax) prices of petroleum diesel remain high or increase, and relatively cheaper biodiesel from developing countries is able to compete with biodiesel produced in developed countries, total biodiesel consumption might exceed the targets set by the EU and other countries, with benefits for air pollutant and carbon-dioxide emissions.

The effects on land requirements of modest increases in trade would depend on which oils are used as feedstock. Some new clearing of previously forested land might occur, but the global pattern of oilseed production might change, with more tropical plant oils used for fuel than for food. For every hectare of rapeseed displaced, a slightly smaller area would need to be planted to castor beans, two-thirds of a hectare to jatropha, or 0.2 hectares to palm oil. Currently, castor bean and jatropha plantations are being started mainly in semi-arid areas on degraded land. Both plants adapt well to semi-arid climates, and a few millimetres of rain each year are all that are necessary for reasonable yields.

Environmental impacts associated with seaborne transport of biodiesel are also likely to be moderate. For any shipment, there is always the risk of an accident that leads to the spilling of large volumes of cargo. Compared with a spill of petroleum diesel, however, there would be less damage, both because biodiesel is less toxic to living organisms and because it degrades twice as quickly in the environment (Zhang *et al.*, 1998; Zhou *et al.*, 2003). In this respect, it is noteworthy that French regulations on the transport of hazardous materials classify biodiesel as a food (von Wedel, 1999). Nevertheless, a large spill would harm seabirds and other animals if the biodiesel drifted close to shore, as would a spill of pure vegetable oil. Additional CO_2 would be produced during seaborne transport — on the order of 1% to 2% of the CO_2 embodied in the fuel — but that could

33. Although vegetable oils and animal fats biodegrade in water, the biological process uses up oxygen that would otherwise remain available to aquatic organisms.

very easily be compensated by lower life-cycle CO_2 emissions than those of the domestic biodiesel with which the traded fuel will compete. Additional emissions of sulphur dioxide (SO_2) will be generated also, but most of these occur at sea and are precipitated out before they reach land.

Over the longer term, the potential for the replacement of petroleum diesel by biodiesel is enormous. Current world vegetable oil production is around 100 million tonnes annually, while the demand for diesel is expected to rise to over 1 500 million tonnes by 2020. While additional volumes of recovered cooking oil, tallow and fish oil could be converted into biodiesel, large-scale production of biodiesel would require cultivation of a significant amount of land for feedstock, and some new land not previously cultivated would have to be converted to agriculture, possibly releasing to the atmosphere carbon that had been locked up in the soil.

The total area required would be a function of both the total demand not satisfied by tallow and recycled oil and the oil yield per hectare. Yields vary significantly by crop (Table 2.5), but also depend on crop variety, climate, natural fertility of the soil, and inputs such as pesticides and fertilisers. The yields will also evolve over time as a result of advances in technology. Based on typical yields today, the amount of oil that can be harvested from a hectare of rapeseed is seven times what can be squeezed out of a hectare of maize, and the oil yield of hectare of palm oil is five times that of the same area planted to rapeseed. Accordingly, to satisfy a billion litre annual increase in consumption of biodiesel (ignoring any extra consumption of biodiesel needed for crop production), approximately 2 150 square kilometres would have to be planted to oil palm, or 10 700 square kilometres to rapeseed, or 74 200 square kilometres to maize (roughly the area of Panama). To displace all the diesel fuel consumed in the world in 2000 with plant-derived biodiesel would require areas 1 000 times greater. Even if the fuel were derived entirely from oil palm, 2.15 million square kilometres would be required, roughly the surface area of Saudi Arabia. Consumption of diesel in 2020 is expected to be at least 50% greater than in 2000.

The environmental impact of diverting land to the production of oil feedstock for transformation into biodiesel depends on more than yields, however. Some oil-bearing plants, like maize and rapeseed, require large amounts of water and chemical inputs. In many countries, water used in growing crops for the production of biofuels is heavily subsidised, being mined from aquifers, or both. Other crops, like jojoba and jatropha, require relatively few inputs, and can even halt erosion and improve the quality of the soil in the long term. Cultivation and harvesting practices also matter. All else equal (slope, rainfall conditions, soil type), it is harder to control soil erosion during the planting, cultivation and harvesting of annual field crops than it is from perennial crops harvested from shrubs or trees. Effects on biodiversity due to changes in or loss of habitats will vary considerably and will be greater the more dramatic the change, *e.g.* from mixed, low-intensity agriculture to intensively farmed monocrops, or from tropical rainforest to managed plantations. However, it is also important to recognise that this is not only an issue for new production of crops for biofuels. To the extent that current government support policies maintain agricultural land in production, and that land would likely revert to less-intensive forest agriculture if the support were withdrawn, there is an opportunity cost associated with continuing these policies in that the resulting level of biodiversity would be less than it might otherwise be.

Table 2.5. Average oil yields, land requirements and major producers of oleaginous plants

Crop	Litres of feedstock plant oil/ hectare	Km² per 10⁹ litres of mineral diesel displaced	Leading producing countries of crop in 2004
Maize (corn)	172	74 252	United States, China, EU, Brazil, Mexico
Cotton seed	325		China, India, United States, Pakistan, Uzbekistan, Brazil
Hemp	363	35 183	Canada
Soybean	446	28 635	United States, Brazil, Argentina, China, India, Paraguay
Linseed (flax)	478	26 718	Canada, China, United States, EU
Sesame	696	18 350	India, China, Sudan
Safflower	779	16 395	India, Mexico, Ethiopia, Australia
Tung oil tree	940	13 587	
Sunflowers	952	13 415	Russian Federation, Ukraine, Argentina, EU, India
Peanut	1 059	12 060	China, India, Nigeria, Myanmar (Burma), United States
Opium poppy	1 163	10 981	Afghanistan, Turkey
Rapeseed	1 190	10 732	EU, China, Canada, India, Australia
Olive	1 212	10 537	EU, Syria, Turkey, Tunisia, Morocco
Castor bean	1 413	9 038	Brazil
Jojoba	1 818	7 025	United States, Mexico, Argentina, Israel
Jatropha	1 892	6 750	Cultivated in almost all tropical and subtropical countries
Macadamia nut	2 246	5 686	Australia
Brazil nut	2 392	5 339	Brazil
Avocado	2 638	4 841	Mexico, United States, South Africa, Chile, Spain, Israel
Coconut	2 689	4 749	Philippines, Indonesia, India, Vietnam, Mexico
Oil palm	5 950	2 146	Malaysia, Indonesia, Nigeria, Thailand, Colombia

Sources: **Oil yields:** "Journey to Forever" web site (http://journeytoforever.org/biodiesel_yield.html#ascend); **producers of major oil crops:** US Foreign Agricultural Services (www.fas.usda.gov/psd/); **producers of minor crops:** various sources.

One of the major concerns expressed about production of feedstock plant oil based on oil-seed palm is that large-scale expansion could take place at the expense of tropical forests or permanent grasslands. A number of reports have recently been released (*e.g.* Brown and Jacobson, 2005) and various Web portals are calling attention to the impacts of creating oil-palm plantations on newly cleared rainforest or peat-swamp forests (*e.g.* www.rainforestweb.org/Rainforest_Destruction/Agribusiness/Palm_Oil/ and www.wrm.org.uy/plantations/palm.html). However, even critics of oil-palm cultivation acknowledge that:

> As with any other crop, the problem is not the palm itself but the industrial model in which it is being implemented. There are numerous examples — particularly in Africa — to show that this palm can be grown and harvested in an environmentally-friendly manner and that it can serve to fulfill the needs of the local populations in a sustainable and equitable manner.

Companies operating palm-oil plantations are clearly aware of these environmental concerns, and some have endeavoured to improve their performance (Box 2.9). However, some observers of the expansion of the industry in developing countries (*e.g.* Hunt *et al.*, 2006, p. 70) contend that responsible environmental behaviour in the production of biofuels cannot be presumed and that some system of certifying conformity with certain environmental standards, such as net GHG savings, is needed. A voluntary certification system might address some of these concerns with relatively minimal trade effects, though even voluntary schemes can have unintended consequences for market access (OECD, 2005).

Box 2.9. One Brazilian palm-oil producer's approach to production and the environment

Agropalma, a Brazilian-owned company, is investing in the production of biodiesel through partnerships with small farmers, mainly in the Amazon region. In one of its programmes, in the state of Pará, around 150 families cultivate oil palms. The project is supported by the government of the state of Pará, the Brazilian Agricultural Research Corporation (Embrapa) and the Bank of the Amazon (BASA).

The basic production model is as follows. Each family receives 12 hectares. Agropalma supplies the saplings and the initial infrastructure and teaches techniques for cultivating the palm. The company endeavours to use biological methods for controlling plant pests and diseases, reducing as much as possible the application of chemical agents. Once the trees bear fruit the company purchases the whole crop at prices based on foreign market prices. Because the palm tree takes 36 months to produce its first fruit, the BASA loans farmers a minimum monthly salary of around USD 130 so that they can live on the farm and purchase the necessary inputs for the crop. The farmers must pay back the total value of the loan (after a grace period of seven years) plus interest, set at 4% a year.

Agropalma's total land holdings cover 82 000 hectares, of which 50 000 are kept as environmental preservation areas; the original vegetation is maintained and hunting and fishing are prohibited in order to keep the ecosystem unchanged. When planting new palms, priority is given to degraded areas. Riparian forests, which protect water courses, have been preserved in their entirety. Future plantations, whether by Agropalma or by third parties, will be restricted to areas already considered degraded.

All waste resulting from the production of palm fruits is used, as is the waste produced during the extraction of palm oil and palm kernel oil. Empty bunches are used as organic fertiliser in areas where certified organic oil production takes place. Fibres resulting from fruit pressing are used as fuel in steam-generating boilers, which drive electric turbine-generators; part of the residual vapour is also used for sterilisation and process heat for the oil extraction process. The effluent is used as ferti-irrigation of the palm plantation near the industrial area. No effluent reaches rivers or creeks.

Source : Cláudia Abreu, "Biodiesel, the social fuel", *Arab-Brazil News Agency*, 1 November 2005 (www.anba.com.br/ingles/especial.php?id=250) and Agropalma's Web site www.agropalma.com.br/en/default.aspx?PortalID=14&TabId=9.

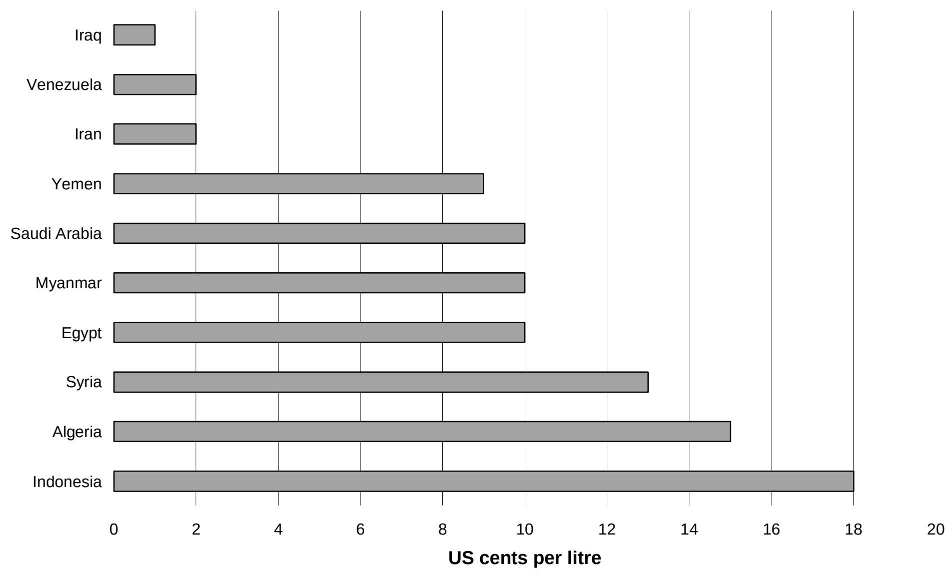
The European Commission's Biomass Action Plan (CEC, 2005) goes further and specifically calls for a requirement by which "through a system of certificates, only biofuels whose cultivation complies with minimum sustainability standards will count towards the targets" set for the market share of biofuels in total EU transport fuels. It adds, "The system of certificates would need to apply in a non-discriminatory way to domestically produced biofuels and imports." While such a scheme would not be directly linked to trade, it could certainly have an impact on imports, as non-certified suppliers would have a harder time finding buyers for their biodiesel. A number of issues on certification to sustainability standards would need to find positive resolution with a view to facilitating trade. Who would set the standards, and on which internationally agreed criteria would they be based? What body would accredit the certifiers, and on what criteria? Would firms or professionals accredited to carry out certification or inspection services in one country be accredited to perform those same services in another?

Complementary policies

Liberalisation of tariffs on biodiesel would help make the fuel more cost-competitive with petroleum diesel, particularly in countries in which the domestic retail prices of petroleum diesel are in line with world market prices or higher because of excise taxes. However, at least 40 countries in the world still regulate the domestic retail price of diesel fuel, in some cases at prices far below the free-market price. According to Metschies (2005), as of November 2004 these countries included several sizeable economies, such as Egypt, Indonesia, Iran, and Venezuela. Figure 2.3 shows the ten most populous countries in which retail prices for diesel were below the price for crude oil on the world market (USD 0.27 per litre at the time).

Reforming retail fuel prices is politically difficult, as countries that have done so can attest. For example, Metschies (2005) documents the experience of Yemen, which has doubled its diesel prices since November 2004. The case for aligning domestic prices with world prices is strong, nevertheless, quite independent from the effects of low prices on competing renewable fuels. Ensuring that the prices of petroleum substitutes for diesel fuel do not create a barrier to trade in their renewable substitutes is one more argument for domestic price reform.

Figure 2.3. Retail prices for petroleum diesel as of November 2004 in selected countries



Source: Metschies (2005), p. 63.

Solar thermal water heaters

The resource and related goods

Another market in which there is considerable developing-country participation is ***solar water heaters***, which are covered by HS 8419.19. Using the sun to heat, or pre-heat, water is most cost-effective in areas that receive high levels of insolation — namely, between about 35 south latitude and 35 north latitude — but, depending on climate conditions and the cost of alternatives, it can also compete with or supplement other ways of heating water at latitudes outside this zone.

A typical household solar water-heating system consists of one or more collectors, a well-insulated storage tank and, depending on the system, an electric pump. The technologies of the distinguishing component, the collector, vary from the simple to the sophisticated. A *flatplate* collector, the most common type, runs plastic or copper tubing through an insulated, weather-proofed box. *Evacuated-tube* collectors are made up of rows of parallel, transparent glass tubes. *Concentrating* collectors for residential or commercial applications are usually parabolic troughs that use mirrored surfaces to concentrate the sun's energy onto an absorber tube (called a receiver) containing a heat-transfer fluid.

The potential for growth in solar water heating is large, especially in countries that receive ample year-round sunlight. Israel requires all new homes and apartments to use solar water heating, and over 90% of homes in Cyprus have solar water heaters.[34]

Production and trade

There are hundreds of manufacturers of solar thermal water heaters. Within the OECD region, manufacturing takes place in almost every member country, including Mexico and Turkey. Elsewhere, at least 32 countries are engaged in the manufacturing of solar water heaters: Argentina, Armenia, Barbados, Brazil, Bulgaria, Chile, China, Croatia, Cuba, Cyprus, Dominica, Egypt, Hong Kong (China), India, Indonesia, Iran, Israel, Jordan, Lithuania, Macedonia, Malaysia, Morocco, Nepal, Pakistan, Philippines, Russia, Saudi Arabia, Singapore, South Africa, Sri Lanka, Thailand, and the United Arab Emirates.

In OECD countries solar water heaters tend to be used in conjunction with back-up electric or gas water heaters. In other regions, however, solar water heaters are often the sole source of hot water and are connected to insulated storage tanks.

Surprisingly, tariffs on solar water heaters exceed 20% in over 40 WTO member economies, including many whose sunny climates or dispersed rural populations would seem to favour deployment of the technology. Bound rates exceed 20% in over 50 WTO members, including several OECD countries.

Implications for the environment

The main environmental result of an increase in the use of solar water heaters is displacement of fuel that would otherwise be consumed directly to heat the water or to run an electric power plant. That energy is not insignificant. In north-temperate, high-income countries, water heating is typically the second-most important end-use activity, after space heating or cooling. In Canada, for example, water heating accounts for around

34. www.ucsusa.org/clean_energy/renewable_energy_basics/how-solar-energy-works.html.

20% of total household energy consumption (Natural Resources Canada, 2005). Less energy is consumed per capita for water heating in middle-income countries, but the share of household energy consumption related to heating water can be considerably greater, and is usually the leading energy end-use. Among the poorest households, especially rural households in developing countries, heated water is often produced with wood-fired water heaters (Box 2.10) or over open fires.

Other environmental impacts of solar water heaters are minor. Water heaters are typically installed on the roofs of buildings, incremental land requirements are therefore low: the main impacts are aesthetic.

Box 2.10. Shifting from conventional to solar water heaters in India

Each year, an additional 15 000 wood-fired water heaters are installed in the Anand District of the Indian state of Gujarat alone. Between four and six other districts in Gujarat have similar use levels of wood-fired water heaters. Households usually have 40-litre wood-fired systems, which cost approximately USD 75 each and provide hot water for about five people. Larger households may have a 100-litre capacity system, which costs about USD 130. Women must collect or purchase the firewood, and burning the wood produces significant indoor air pollution. If 6 kg of firewood are used each day, fuel costs would be USD 4 per month. Solar water heaters, on the other hand, have higher capital costs, and generally have a higher capacity, with a minimum of about 100 litres per day. The smallest solar system costs about USD 375. However, fuel wood costs are saved, and indoor pollution is reduced.

In 2002, funded in part with a grant from the Global Energy Facility’s Small Grants Programme, the Sardar Patel Renewable Energy Research Institute (SPRERI) undertook a survey of more than 55 industrial manufacturers of wood-fired water heaters. The survey collected information about the pattern of use, cost, sales and service of these heaters. An interactive meeting between SPRERI and manufacturers helped introduce solar water heaters to the manufacturers. In addition, SPRERI identified key users of water heaters and their needs and monitored thermal efficiency and pollution data related to the use of wood-fired water heaters. Two solar-powered systems were obtained from NRG Technologies and Steel Hacks Industries, and SPRERI conducted experiments to assess how these water heaters would meet users’ needs. A meeting with users helped in the development of an appropriate incentive scheme to promote the use of solar water heaters. As a result, 12 manufacturers now supply solar water heaters, and 50 solar water heaters have been installed. Users contribute about 75% of the cost of the equipment.

Each household previously used 5-7 kg of firewood every day for water heating. Using solar water heaters, households save this amount of firewood, thus reducing carbon dioxide emissions. During approximately two months of the year, solar energy is not sufficient to heat water. During these periods, electricity or LPG [liquefied propane gas] is used to heat water.

Source: http://sgp.undp.org/download/SGP_India2.pdf.

Complementary policies

Penetration of solar thermal water heaters into some markets is hampered by subsidised prices for electricity or natural gas, the main energy sources used for water-heating appliances. Bringing prices into line with costs of delivery is politically difficult, particularly if customers have grown accustomed to subsidised prices over many decades. But reform is important to avoid investments in housing stock and related infrastructure that respond to distorted signals about long-term resource availability.

Geothermal energy

The energy source and related technology

Geothermal energy refers to energy obtained from the subsurface of the earth. There are many ways in which this energy is obtained and transformed into useful heat or electricity. People have exploited warm or hot springs since prehistoric times, mainly for bathing, cooking or washing clothes. Today, geothermally heated water is tapped for many heating and process-heat uses and forms the basis of district heating systems in several towns or cities in China, France, Hungary, Iceland, Italy, Japan, Poland, Romania, Russia, Sweden, Turkey and the United States. The use of geothermal energy for the production of electricity dates from 1904, when the first plant went into operation in Larderello, Italy. A number of commercial-scale plants are now operating around the world, producing electricity from natural underground sources of steam. Plants tapping into so-called “hot dry rocks” are still largely at the development and demonstration stages.

Another geothermal application, involving heat pumps, takes advantage of the thermal mass of the upper three metres of the earth. The ground at this depth maintains a nearly constant temperature (between 10° and 16°C in temperate climates, for example), so that in winter its temperature is warmer than the air above it, and in the summer it is cooler. Geothermal heat pumps take advantage of this temperature difference to heat and cool buildings. In contrast with high-temperature geothermal resources, which are relatively scarce, the resource represented by warm, shallow ground is globally widespread.

The value of any high-temperature geothermal steam resource depends on its temperature, pressure, depth from the surface, and distance from potential users. Within the OECD region, high-temperature geothermal energy is being exploited in Canada, Iceland, Italy, Japan, Mexico, New Zealand and the United States. Outside the OECD region, areas of known economically exploitable resources can be found in almost 50 countries: the Andean volcanic belt (Argentina, Bolivia, Chile, Columbia, Ecuador, Peru, and Venezuela); the Central American volcanic belt (including parts of Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama); the Lesser Antilles islands in the eastern Caribbean; the eastern and southern Mediterranean region (*e.g.* Algeria, Israel, Jordan, and Tunisia); the East Africa Rift System (particularly Djibouti, Ethiopia, Kenya, Malawi, Tanzania, Uganda, and Zambia); the Himalayan geothermal belt (which is over 150 km wide and extends 3 000 km through parts of China’s Yunnan Province, India, Myanmar, Thailand, and Tibet); Indonesia; the Philippines; eastern China; the Kamchatka Peninsula of Russia.

The example of the Philippines illustrates how one developing country has benefited from tapping into its geothermal resources. Philippine geothermal fields are large and have been developed at a rapid rate. The main areas of development have been on the island of Luzon, north of Manila, and on the south-east island of Leyte. The Philippines’ first geothermal electric plant was built in 1979; as of the end of 2004 the country’s geothermal electricity-generating capacity stood at just under 2 000 MWe. Among the incentives provided to developers of geothermal sites is an exemption on duties and "compensating tax" on imported machinery, equipment, spare parts and materials used in geothermal operations.[35] Geothermal heat in the Philippines is also used directly for processing fish, producing salt and drying coconuts and fruit.

Production and trade

Assessing trade in, and tariffs on, goods related to geothermal energy is difficult. The main components of a geothermal power plant, besides its electric generator, are: the steam turbine, heat exchangers, condensers, pumps and the piping and valves that connect them. Almost all of this equipment, apart from the steam turbine, have multiple uses and are not unique to geothermal plants. Steam turbines typically used in geothermal power applications differ from those used in other applications, however. In particular, they are designed to operate at lower pressures and temperatures than steam turbines used in conventional steam-generating power plants. But they are not separately identified in the HS, and therefore fall, along with other turbines not used for marine propulsion, under either HS 8406.81 or HS 8406.82, depending on whether their rated output exceeds, or is equal to or less than, 40 MW.

Most countries apply the same tariffs on steam turbines whether they are rated at 40 MW or less or at greater than 40 MW. Eleven countries apply tariffs of 15% or more; many more have bound their tariffs at much higher rates.

Goods associated with the direct use of geothermal energy in the form of warm or hot groundwater are not specific to these applications and are generally the same as for extracting groundwater generally. Some pre-treatment of the water may be required, however, if it contains high concentrations of dissolved salts.

A geothermal heat pump (GHP) system consists essentially of three elements: a ground heat exchanger, a heat pump unit, and an air- or water-delivery system (ducts or radiators). The heat exchanger is basically a system of pipes buried in the shallow ground near the building. A fluid (usually water or a mixture of water and a chemical additive to keep the water from freezing) circulates through the pipes, absorbing from, or transferring heat to, the ground. If sold as an entire unit for heating only, these are classified under HS 84.18 (Other refrigerating or freezing equipment; heat pumps) as either HS 8418.61 (Compression type units whose condensers are heat exchangers) or HS 8418.69 (Other). If they incorporate a refrigerating unit and a valve for reversal of the cooling-heating cycle (reversible heat pumps), they are classified under HS 8415.81. However, these categories are not specific to earth-to-water or earth-to-air heat pumps, and probably are dominated by trade in air-to-water and air-to-air heat pumps.

Applied tariffs on reversible heat pumps are low in most OECD countries but exceed 20% in around 60 WTO members.

Implications for the environment

The environmental benefits of liberalising trade in goods used for the exploitation of geothermal resources depend on the degree to which the geothermal energy thereby put to use substitutes for other means of producing heat or electricity. Geothermal steam plants emit some pollutants (and noise), but at much lower levels than plants run on fossil fuels. According to the Renewable Energy Policy Project[36] (citing Bloomfield *et al.*, 2003),

35. www.doe.gov.ph/geothermal/default.htm.

36. www.crest.org/geothermal/geothermal_brief_environmental_impacts.html.

average CO_2 emissions per kilowatt-hour emitted by geothermal power plants in the United States are about 85% lower than from natural-gas-fired plants. Disruptions to the environment may be associated with the construction of the plant sites, the construction and use of access roads, and local land subsidence.

Complementary policies

As for other electric power systems based on renewable energy, policy changes within countries can have a tremendous influence on the benefits to be gained from liberalising trade in geothermal plants and associated components. The market for renewable-energy-based electricity-generating technologies is influenced by a wide range of factors related to the way that electricity and competing fuels are priced, and the openness of electricity markets. As the bulk of geothermal systems installed in developing countries are likely to be for on-grid use, the most important policies in the short term are probably those regulating services connected with the installation and servicing of the equipment. Policies that reserve domestic fossil fuels for domestic power production (*e.g.* through price regulation or restrictions on exports) also can distort the relative economic competitiveness of geothermal power plants.

Concluding remarks

This analysis has undertaken a largely qualitative examination of trade in renewable energy and in the technologies used to exploit it. The results at this stage should be regarded as indicative, as statistics on trade in renewable energy technologies, and particularly their components, are incomplete. What the statistics do show is that while OECD countries still account for the bulk of world trade in renewable-energy technologies, especially the most technically advanced parts of those technologies, new investments in manufacturing are taking place in developing countries, and several companies have started to emerge as regional or even global suppliers. There are now also many small and medium-sized companies around the world — in both developed and developing countries — whose business is to market and service systems based on renewable energy scaled to the needs of households or small communities.

Beyond the export interest developing countries may have in renewables, the environmental and developmental benefits that could be derived from reducing tariffs on them may be even more important. These include making forms of energy that are cleaner than the fuels and technologies currently in use more affordable, thus helping to accelerate the pace of rural electrification.

For the benefits of reducing tariffs to be realised, however, additional reforms at the domestic level may be required. In the area of energy policy, creating a more favourable investment climate for companies specialising in the production of power from new energy sources and technologies, and fostering competition in the market for electricity, are both crucial. And, to enable off-grid power sources to fill their proper niches, governments should strive for transparency on the costs of extending grid lines to rural areas, and halt the practice of cross-subsidising the construction and maintenance of such grids.

In terms of the environmental effects of adopting a more liberal trading regime for a particular good or set of goods, these will ultimately be specific to each country and influenced by broader policies. To avoid unsustainable exploitation of energy derived from biomass, for example, governments may need to strengthen their regimes for managing and protecting those resources. Because many systems based on renewable energy involve electronic components and storage batteries, new systems for collecting and disposing of or recycling parts and materials may be required. Educational and training programmes may be needed as well, to explain the benefits of particular fuels and technologies and to demonstrate their proper use and disposal.

Analysis of the effects of liberalising trade in renewable-energy products and associated goods could be refined through additional research in several areas. For one, this report covers only one fuel and two representative technologies. It would be usefully to have more information on the comparative life-cycle performance and costs of renewable energy and associated technologies and more examples of improvements brought about by the installation of renewable-energy-based systems in developing countries. With regard to trade, further research may reveal additional investments being undertaken in the production of goods related to renewable energy in developing countries.

Annex 2.A1

Table 2.A1.1. Primary renewable energy products and technologies for harnessing renewable energy

HS heading or code	Product description [renewables component]
22.07	**Undenatured ethyl alcohol of an alcoholic strength by volume of 80% volume or higher; ethyl alcohol and other spirits, denatured, of any strength.**[1]
38.24	**Products, preparations and residual products of the chemical or allied industries, incl. those consisting of mixtures of natural products, n.e.s . (excl. binders for foundry moulds and cores; naphthenic acids, their water-insoluble salts and their esters; non-agglomerated metal carbides mixed together or with metallic binders; prepared additives for cements, mortars and concretes; non-refractory mortars and concretes; sorbitol).**
3824.90 (ex)	– Other. [Biodiesel and waste fats and oil suitable as a fuel.]
44.01	**Fuel wood, in logs, in billets, in twigs, in faggots or in similar wood in chips or particles; sawdust and wood waste and scrap, whether or not agglomerated pellets or similar forms.**
4401.10	– Fuel wood, in logs, in billets, in twigs, in faggots or in similar forms.
4401.30 (ex)	– Sawdust and wood waste and scrap, whether or not agglomerated in logs, briquettes, pellets or similar forms [Artificial logs made from pressed sawdust; wood waste suitable as a fuel.]
4402.00	Wood charcoal (including shell or nut charcoal), whether or not agglomerated. [Wood, shell or nut charcoal used for fuel.]
84.10	**Hydraulic turbines, water wheels, and regulators therefor.**
8410.11	– Of a power not exceeding 1 000kW.
8410.12	– Of a power exceeding 1,000 kW but not exceeding 10 000 kW.
8410.13	– Of a power exceeding 10 000 kW.
8410.90	– Parts, including regulators.
84.12	**Other engines and motors.**
8412.80 (ex)	– Other [Steam engines; windmills without pumps.]
8412.90 (ex)	– Parts [Parts for steam engines and windmills.]
84.13	**Pumps for liquids, whether or not fitted with a measuring device; liquid elevators.**
8413.81 (ex)	– Other pumps; liquid elevators — Pumps —— [Windmill pumps]
84.19	**Machinery, plant or laboratory equipment, whether or not heated (excluding furnaces, ovens and other equipment of heading 85.14), for the treatment of materials by a process involving a change of temperature such as heating, cooking, roasting, distilling, rectifying, sterilising, pasteurising, steaming, drying, evaporating, vaporising, condensing or cooling, other than machinery or plant of a kind used for domestic purposes; instantaneous or storage water heaters, non-electric.**
8419.19 (ex)	– Instantaneous or storage water heaters, non-electric — other [solar water heaters]
85.02	**Electric generating sets and rotary converters.**
8502.31	– Other generating sets — Wind powered
8502.39 (ex)	– Other generating sets — Other [a generating set combining an electric generator and either a hydraulic turbine or a Sterling engine]
85.41	**Diodes, transistors and similar semiconductor devices; semiconductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light emitting diodes; mounted piezo-electric crystals.**
8541.40 (ex)	– Photosensitive semiconductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light emitting diodes [Photovoltaic cells and modules.]

1. Ethyl alcohol, only some of which is classified under HS 22.07 and is used for fuel, is covered by the Agreement on Agriculture. It is included in this list only for completeness.

Source: OECD, based on the 2002 edition of the Harmonized System.

Table 2.A1.2. Common components of renewable-energy based systems

HS heading or code	Product description [renewables component]
84.02	**Steam or other vapour generating boilers (other than central hot water boilers capable also of producing low pressure steam); super-heated water boilers.**
8402.11	– Water-tube boilers with a steam production exceeding 45 tonnes per hour.
8402.12	– Water-tube boilers with a steam production not exceeding 45 tonnes per hour.
8402.19	– Other vapour-generating boilers, including hybrid boilers.
84.13	**Pumps for liquids, whether or not fitted with a measuring device; liquid elevators.**
8413.50 (ex)	– Other reciprocating positive displacement pumps [DC-powered water pumps]
8413.70 (ex)	– Other centrifugal pumps [DC-powered submersible water pumps]
84.16	**Furnace burners for liquid fuel, for pulverised solid fuel or gas; mechanical stokers, including their mechanical grates, mechanical ash dischargers and similar appliances.**
8416.30	– Mechanical stokers, including their mechanical grates, mechanical ash dischargers and similar appliances [Mechanical stokers and related appliances used for burning biomass.]
8416.90	– Parts [Parts for mechanical stokers and related appliances used for burning biomass.]
85.01	**Electric motors and generators (excluding generating sets).**
8501.31	– Other DC motors; DC generators — Of an output not exceeding 750 W
8501.61	– AC generators (alternators) — Of an output not exceeding 75kVA
85.04	**Electrical transformers, static converters (for example, rectifiers) and inductors.**
8504.40 (ex)	– Static converters [Inverters (for converting DC power to AC power)]
85.07	**Electric accumulators, including separators therefor, or not rectangular (including square).**
8507.20 (ex)	– Other lead-acid accumulators [solar batteries]
85.37	**Boards, panels, consoles, desks, cabinets and other bases, with two or more apparatus of heading 85.35 or 85.36, for electric control or the distribution of electricity, including those incorporating instruments or apparatus of Chapter 90, and numerical control apparatus, other than switching apparatus of heading 85.17.**
8537.10 (ex)	– For a voltage not exceeding 1 000 V [Charge controllers (for storage batteries)]
85.41	**Diodes, transistors and similar semiconductor devices; semiconductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light emitting diodes; mounted piezo-electric crystals.**
8541.40 (ex)	– Photosensitive semiconductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light emitting diodes [white-light emitting diodes.]
90.26	**Instruments and apparatus for measuring or checking the flow, level, pressure or other variables of liquids or gases (for example, flow meters, level gauges, manometers, heat meters), excluding instruments and apparatus of heading 90.14, 90.15, 90.28 or 90.32.**
9026.80 (ex)	Other instruments or apparatus [Anemometers]

Source: OECD, based on the 2002 edition of the Harmonized System.

Table 2.A1.3. World exports of, and maximum tariffs applied to, renewable fuels and renewable-energy technologies

Product HS code	Product description	Value of world exports in 2003 for all goods under same HS subheading (USD millions)[2]	Estimated value of renewables component (USD millions)[3]	Share of exports from non-OECD countries (%)	Maximum applied *ad valorem* tariff[4]
2207.10	Undenatured ethyl alcohol, ≥ 80% strength (for fuel)[1]	960	480	45	300%
2207.20	Denatured ethyl alcohol and other spirits, any strength (for fuel)[1]	222	110	19	125%
3824.90	Biodiesel	19 118[5]	175	52	30%
4401.30	Sawdust and wood waste and scrap	439	145	18	100%[6]
4402.00	Wood, shell or nut charcoal	250	250	56	100%[6]
8410.11	Hydraulic turbines, < 1 MW	28	28	16	33%
8410.12	Hydraulic turbines, ≥ 1 MW but < 10 MW	27	27	16	33%
8410.13	Hydraulic turbines, > 10 MW	47	47	15	25%
8410.90	Parts for hydraulic turbines	436	436	19	25%
8412.80	Windmills	277	10	10	35%
8413.81	Windmill pumps	2 164	100	14	43%
8416.30	Mechanical stokers, etc. for biomass	57	25	13	35%
8419.19	Solar water heaters	777	200	5	50%
8501.31	Other DC motors; DC generators, output < 750 W	2 801	14	12	35%
8501.61	AC generators or alternators, output < 75 kVA	347	3	16	35%
8502.31	Wind-powered electric generating sets	1 128	1 128	< ½	35%
8541.40	Solar cells and modules	8 119	900	19	35%
	Total	20 422	~ 4 000	21	NA

1. Ethanol (HS 2207.10 ex and HS 2207.20 ex) is covered by the Agreement on Agriculture and is included here only for completeness.

2. Including exports from individual EU Member States to other EU member states.

3. For description of the renewables component, see Table 2.A1.1.

4. Applied by WTO members or observers. Neither specific-rate tariffs nor their ad valorem equivalent are included in this column.

5. Some biodiesel may have also been traded under HS 1516.20 in 2003.

6. These tariffs rates are applied by certain observers to the WTO; among WTO members, the highest applied tariffs are in *the* order of 35%.

Source: OECD compilation based on data from COMTRADE (trade values), TRAINS (applied tariff rates), and WTO (bound tariff rates).

Table 2.A1.4. HS sub-headings for biodiesel and goods associated with the harnessing of solar-thermal and geothermal energy

HS heading or sub-heading	Product description [renewables component]
38.24	Products, preparations and residual products of the chemical or allied industries, incl. those consisting of mixtures of natural products, n.e.s . (excl. binders for foundry moulds and cores; naphthenic acids, their water-insoluble salts and their esters; non-agglomerated metal carbides mixed together or with metallic binders; prepared additives for cements, mortars and concretes; non-refractory mortars and concretes; sorbitol).
3824.90 (ex)	– Other. [Biodiesel and waste fats and oil suitable as a fuel.]
84.06	Steam turbines and other vapour turbines.
8406.81 (ex)	– Other turbines, of an output exceeding 40 MW [Low-temperature and low-pressure steam turbines for use in a geothermal power plant.]
8406.82 (ex)	– Other turbines, of an output not exceeding 40 MW [Low-temperature and low-pressure steam turbines for use in a geothermal power plant.]
8406.90 (ex)	– Parts [Parts for low-temperature and low-pressure steam turbines for use in a geothermal power plant.]
84.18	Refrigerators, freezers and other refrigerating or freezing equipment, electric or other; heat pumps other than air conditioning machines of heading 84.15.
8418.61	– Other refrigerating or freezing equipment; heat pumps : compression type units whose condensers are heat exchangers [Geothermal heat-pump systems]
8418.69	– Other refrigerating or freezing equipment; heat pumps : other [Geothermal heat-pump systems]
84.19	Machinery, plant or laboratory equipment, whether or not heated (excluding furnaces, ovens and other equipment of heading 85.14), for the treatment of materials by a process involving a change of temperature such as heating, cooking, roasting, distilling, rectifying, sterilising, pasteurising, steaming, drying, evaporating, vaporising, condensing or cooling, other than machinery or plant of a kind used for domestic purposes; instantaneous or storage water heaters, non-electric.
8419.19 (ex)	– Instantaneous or storage water heaters, non-electric : other [Solar water heaters.]
8419.50 (ex)	– Heat exchange units [Heat-exchange units for solar-thermal or geothermal applications.]
84.79	Machines and mechanical appliances having individual functions, not specified or included elsewhere in this Chapter.
8479.20 (ex)	– Machinery for the extraction or preparation of animal or fixed vegetable fats or oils. [Biodiesel refineries.]
8479.82	Mixing, kneading, crushing, grinding, screening, sifting, homogenising, emulsifying or stirring machines [Machines for crushing and filtering oil seeds.]
90.32	Automatic regulating or controlling instruments and apparatus.
9032.89	– Other instruments and apparatus : Other [Heliostats.]

Source: OECD, based on the 2002 edition of the Harmonized System.

Table 2.A1.5. Leading exporters of, and highest tariffs applied to, renewable energy and renewable-energy technologies

Product [HS code]	Leading exporters, 2003	Export value (USD 000)	Importers[1] with the highest level of duty	Applied tariff, in % (data year)	Bound rate, %[2]
Fuel wood [4401.10]	***World***	***142 040***	*Libya*	100 (2002)	—
	OECD countries	*82 747*	*Seychelles*	100 (2001)	—
	Estonia	14 303	Angola	35 (2002)	60
	Latvia	14 143	Solomon Islands	35 (1995)	80
	South Africa	6 752	Cameroon	30 (2002)	—
	Croatia	5 822	C. African Rep.	30 (2002)	—
	Lithuania	3 949	Chad	30 (2002)	—
	Russian Federation	3 423	Congo, Rep.	30 (2002)	—
	Romania	3 141	Equatorial Guinea	30 (2002)	—
	Slovenia	2 993	Gabon	30 (2002)	15
	Bulgaria	1 396	Maldives	30 (2003)	30
	Belarus	1 196	Romania	30 (2001)	30
Wood charcoal [4402.00]	***World***	***250 127***	*Libya*	100 (2002)	—
	OECD countries	*109 873*	*Seychelles*	100 (2001)	—
	China	63 494	Angola	35 (2002)	60
	Argentina	13 096	Solomon Islands	35 (1995)	80
	South Africa	11 455	*Bahamas, The*	30 (2002)	—
	Malaysia	10 032	Cameroon	30 (2002)	—
	Bulgaria	7 462	C. African Rep.	30 (2002)	—
	Singapore	6 861	Chad	30 (2002)	—
	Romania	4 671	Congo, Rep.	30 (2002)	—
	Latvia	4 521	Equatorial Guinea	30 (2002)	—
	Namibia	3 002	Gabon	30 (2003)	15
	India	2 641			
Hydraulic turbines, < 1 MW [8410.11]	***World***	***28 239***	Djibouti	33 (2002)	40
	OECD countries	*23 695*	India	25 (2004)	25
	— of which Mexico	*230*	*Vanuatu*	25 (2002)	—
	Slovenia	1 356	Bermuda[4]	22.25 (2001)	—
	India	1 014	*Belarus*	15 (2002)	—
	China	689	Cambodia	15 (2003)	—
	Israel	250	Colombia	15 (2004)	35
	Aruba	218	Romania	15 (2001)	35
	Argentina	204	*Russian Federation*	15 (2002)	—
	South Africa	165	Rwanda	15 (2003)	35
	Singapore	160	*Seychelles*	15 (2001)	—
	Peru	151	Venezuela	15 (2004)	35
Hydraulic turbines, > 1 MW but < 10 MW [8410.12]	***World***	***27 424***	Djibouti	33 (2002)	40
	OECD countries	*22 941*	*Vanuatu*	25 (2002)	—
	— of which Mexico	*187*	India	25 (2004)	25
	Malaysia	2 805	*Belarus*	15 (2002)	—
	China	1 274	Cambodia	15 (2003)	—
	India	178	Colombia	15 (2004)	35
	Bulgaria	92	Romania	15 (2001)	35

Product [HS code]	Leading exporters, 2003	Export value (USD 000)	Importers[1] with the highest level of duty	Applied tariff, in % (data year)	Bound rate, %[2]
	Peru	48	*Russian Federation*	15 (2002)	—
	Singapore	36	Rwanda	15 (2003)	100
	Bolivia	19	*Seychelles*	15 (2001)	—
	Belarus	13	Venezuela	15 (2004)	35
	Brazil	6	Brazil	14 (2004)	35
Hydraulic turbines, > 10 MW [8410.13]	***World***	***46 848***	India	25 (2004)	25
	OECD countries	*40 041*	*Vanuatu*	25 (2002)	—
	— of which Mexico	815	*Belarus*	20 (2002)	—
	— of which Turkey	4	Cambodia	15 (2003)	—
	Slovenia	5 695	Colombia	15 (2004)	35
	Russian Federation	670	Romania	15 (2001)	35
	Bulgaria	244	*Russian Federation*	15 (2002)	—
	India	119	Rwanda	15 (2003)	100
	Singapore	72	*Seychelles*	15 (2001)	—
	Malaysia	5	Venezuela	15 (2004)	35
	South Africa	2	Brazil	14 (2004)	35
			Mexico	0–13 (2004)	35
Parts for hydraulic turbines, incl. regulators [8410.90]	***World***	***436 398***	India	25 (2004)	25
	OECD countries	*351 569*	*Vanuatu*	25 (2002)	—
	— of which Mexico	11 019	*Belarus*	15 (2002)	—
	Slovenia	23 989	Cambodia	15 (2003)	—
	Brazil	14 018	Romania	15 (2001)	15
	China	10 178	*Russian Federation*	15 (2002)	—
	Romania	9 006	Brazil	14 (2004)	25–35
	Russian Federation	7 760	Mexico	0–13 (2004)	35
	Malaysia	5 199	Burundi	12 (2002)	—
	Singapore	4 613	Bahrain	10 (2001)	35
	Israel	2 056	Bolivia	10 (2004)	40
	India	1 671	Cameroon	10 (2002)	—
Instantaneous or storage water heaters, non-electric, non gas [8419.19]	***World***	***777 167***	Dominica	20–60 (2003)	—
	OECD countries	*739 308*	Iran, Islamic Rep.[3]	50 (2004)	—
	— of which Mexico	*198 994*	Morocco	2.5–50 (2003)	40
	— of which Korea	*4 997*	Syrian Arab Rep.[4]	50 (2002)	—
	— of which Turkey	*1 929*	Tunisia	10–43 (2004)	—
	Israel	16 836	*Bahamas, The*	40 (2002)	—
	China	4 953	Burundi	40 (2002)	—
	Malaysia	3 857	Egypt, Arab Rep.	30–40 (2002)	50–60
	New Caledonia	3 550	Zimbabwe	5–40 (2002)	—
	Slovenia	1 861	China	35 (2004)	35
	Thailand	1 305	St. Lucia	20–35 (2003)	50–93
	Singapore	1 152	Djibouti	33 (2002)	40

Product [HS code]	Leading exporters, 2003	Export value (USD 000)	Importers[1] with the highest level of duty	Applied tariff, in % (data year)	Bound rate, %[2]
Wind-powered electric generating sets [8502.31]	***World (OECD est.)***	***1 128 505***	*Bahamas, The*	35 (2001)	—
	OECD countries	*1 123 859*	Bermuda[4]	33.5 (2004)	—
	— of which Denmark	*964 965*	India	25 (2004)	25
	— of which Korea	23	Mexico	3–23 (2004)	35–40
	Brazil (OECD est.)	2 000	Brunei	20 (2003)	40
	India	771	Maldives	20 (2003)	30
	Singapore	678	Thailand	20 (2003)	—
	Namibia	95	Cambodia	15 (2003)	—
	Tunisia	69	Nepal	15 (2004)	—
	South Africa	33	Nigeria	15 (2002)	—
	Malaysia	23	Romania	15 (2001)	35
	China	16	Tanzania	15 (2003)	—
			Yemen	15 (2000)	—
Photo-sensitive semiconductor devices, including photovoltaic cells; light-emitting diodes [8541.40]	***World***	***8 960 227***	*Bahamas, The*	35 (2002)	—
	OECD countries		Cambodia	35 (2003)	—
	— of which Korea	189 117	Solomon Islands	35 (1995)	80
	— of which Mexico	64 555	Djibouti	33 (2002)	40
	Malaysia	664 015	Libya	25 (2002)	—
	Hong Kong, China	663 557	Maldives	25 (2003)	30
	China	322 799	*Vanuatu*	25 (2002)	—
	Singapore	302 973	*Belarus*	20 (2002)	—
	Thailand	110 705	Ethiopia	20 (2002)	—
	India	57 301	Brazil	14–16 (2004)	35
	South Africa	29 857	India	15 (2004)	0
	Russian Federation	11 947	Nepal	15 (2004)	—
Biodiesel (ex-out of HS 3824.90)	As explained in the text, the WCO confirmed that biodiesel should be included as an ex-out of HS 3824.90. For this reason, trade flow data are not available on a harmonised basis. Bound and applied tariffs for the large OECD markets vary between 0 and 7%. Tariffs applied by developing countries are generally between 15% and 50%.				

Product [HS code]	Leading exporters, 2004	Export value (USD 000)	Importers[1] with the highest level of duty	Applied tariff, in % (data year)	Bound rate, %[2]
Heat pumps, incorporating a refrigerating unit [8415.81]	**World**	**1 451 632**			
	OECD countries	*1 013 320*	China	110 (2004)	17.5
	of which		Bangladesh	100 (1999)	—
	Turkey	61 530	Egypt	64 (1997)	60
	Korea	4 834	Nigeria	45 (2003)	—
			Solomon Islands	40 (1998)	80
	China	384 855	United States	35 (2004)	0.5
	Singapore	20 644	Djibouti	33 (1999)	40
	Hong Kong, China	5 516	Tunisia	32.25 (2004)	—
	Malta	5 355	Cameroon	30 (2001)	—
	Oman	4 126	Gabon	30 (2000)	15
	Tunisia	3 434	St. Kitts and Nevis	30 (2002)	70
	Malaysia	3 210	Rwanda	30 (2003)	6
	India	2 349	Thailand	30 (1999)	30
	Russian Federation	1 981	Cuba	30 (2004)	—
	Slovenia	880	India	30 (2002)	40
Heat pumps, compression type units [8418.61]	**World**	**3 615 381**			
	OECD countries	*3 177 101*	China	110 (2004)	10
	of which		Bangladesh	60 (1999)	—
	Korea	6 336	Nigeria	45 (2003)	—
			Tunisia	43 (2004)	—
	China	368 954	Zimbabwe	42.5 (2002)	—
	Brazil	17 850	United States	35 (2004)	0
	Hong Kong, China	16 113	Djibouti	33 (1999)	40
	Singapore	8 710	St. Kitts and Nevis	30 (2002)	70
	Belarus	3 420	Malaysia	30 (2001)	30
	Russian Federation	3 355	Thailand	30 (1999)	30
	Lithuania	3 263	Sierra Leone	30 (2004)	50
	Chinese Taipei	3 236			
	Slovenia	2 815			
	Malaysia	2 798			
Instantaneous or storage water heaters, non-electric, non gas [8419.19]	**World**	**939 384**			
	OECD countries	*893 613*	China	100 (2004)	35
	of which		Bangladesh	80 (1999)	—
	Mexico	223 501	Egypt	59 (1997)	55
	Turkey	3 411	United States	45 (2004)	0
	Korea	2 936	Tunisia	34.75 (2004)	—
			Djibouti	33 (1999)	40
	Israel	18 201	St. Kitts and Nevis	30 (2002)	81.5
	China	10 148	Rwanda	30 (2003)	100
	New Caledonia	5 366	St. Lucia	27.5 (2002)	71.5
	India	2 461	Morocco	26.25 (2002)	40
	Slovenia	2 323			

Product [HS code]	Leading exporters, 2004	Export value (USD 000)	Importers[1] with the highest level of duty	Applied tariff, in % (data year)	Bound rate, %[2]
	Singapore	1 617			
	Malaysia	1 309			
	Argentina	872			
	Chinese Taipei	727			
	South Africa	614			
Oil extraction machinery [8479.20]	**World**	**368 447**			
	OECD countries	*260 704*	Bangladesh	60 (1999)	—
	of which		United States	35 (2004)	0
	Turkey	6 704	China	30 (2004)	10
			India	25 (2002)	25
	Malaysia	59 289	Slovak Republic	24 (2003)	4.8
	India	12 539	Pakistan	20 (2002)	—
	Singapore	10 253	Sri Lanka	15 (2001)	25
	China	6 582	Solomon Islands	10 1998)	80
	Argentina	5 103	Cameroon	10 (2001)	—
	Peru	3 973	Egypt	10 (1997)	10
	Brazil	2 913	Nigeria	10 (2003)	—
	Colombia	2 772	Romania	10 (1999)	35
	Belarus	2 024	Venezuela	10 (2003)	35
	Russian Federation	1 109	Cuba	10 (2004)	10
			Kyrgyz Republic	10 (2003)	10
			Slovenia	10 (2003)	27
Oilseed crushing machinery [8479.82]	**World**	**1 758 203**			
	OECD countries	*1 608 376*	Bangladesh	60 (1999)	—
	of which		United States	35 (2004)	0
	Korea, Rep.	44 384	Djibouti	33 (1999)	40
	Mexico	8 001	China	30 (2004)	7
	Turkey	4 638	India	25 (2002)	40
			Slovak Republic	24 (2003)	4.8
	Chinese Taipei	52 722	Maldives	20 (2002)	30
	China	31 145	Jordan	15 (2004)	15
	Singapore	14 200	Mexico	13 (2004)	35
	Hong Kong, China	8 108	Slovenia	12 (2003)	12
	Malaysia	5 790			
	Brazil	5 421			
	Slovenia	5 170			
	Argentina	3 762			
	South Africa	3 419			
	Pakistan	3 134			

Product [HS code]	Leading exporters, 2004	Export value (USD 000)	Importers[1] with the highest level of duty	Applied tariff, in % (data year)	Bound rate, %[2]
Wind-powered electric generators [8502.31]	**World**	**1 106 471**			
	OECD countries	*1 102 186*	United States	35 (2004)	1.25
	of which		China	30 (2004)	8
	Denmark	888 221	India	25 (2002)	25
	Mexico	160	Thailand	20 (1999)	—
			Slovak Republic	17 (2003)	4
	Brazil	1 185	Nigeria	15 (2003)	—
	India	1 174	Romania	15 (1999)	35
	Malaysia	918	Cameroon	10 (2001)	—
	Singapore	591	Egypt	10 (1997)	10
	China	197	Chinese Taipei	10 (2003)	10
	South Africa	79	Venezuela	10 (2003)	20
	Senegal	42	Cuba	10 (2004)	11
	Russian Federation	29	Indonesia	10 (2002)	40
	New Caledonia	14	Malawi	10 (2003)	—
	Hong Kong, China	13	Tunisia	10 (2004)	43
Photo-sensitive semiconductor devices, including photovoltaic cells, light-emitting diodes [8541.40]	**World**	**12 826 249**			
	OECD countries	*8 820 912*	Bangladesh	100 (1999)	—
	of which		Djibouti	33 (1999)	40
	Korea	317 324	United States	32 (2004)	0
	Mexico	81 645	Rwanda	30 (2003)	100
			China	30 (2004)	0
	Chinese Taipei	1 175 287	Maldives	25 (2002)	30
	Hong Kong, China	895 463	Egypt	24 (1997)	0
	Malaysia	792 974	*Belarus*	20 (2001)	—
	China	644 213	*Russian Federation*	20 (2001)	—
	Singapore	316 252	Sierra Leone	20 (2004)	50
	India	85 036			
	South Africa	57 810			
	Russian Federation	10 692			
	Cyprus	8 935			
	Croatia	6 044			

1. Italics indicates that the country is an observer to the WTO.

2. — = unbound or not applicable (in the case of observers and non-members).

3. The Islamic Republic of Iran applied for Observer status in 2001, a request that has not been granted to date.

4. Bermuda and the Syrian Arab Republic are neither WTO members nor observers to the WTO.

Source: OECD compilation based on data from COMTRADE (trade values), TRAINS (applied tariff rates), and WTO Integrated Database (IDB), applied and bound tariff rates, World Integrated Trade Solution (WITS), http://wits.worldbank.org/.

Annex 2.A2

International Efforts to Promote Trade in Renewable Energy and Related Technologies

Because of the importance of minimising barriers to trade in renewable-energy technologies, several inter-governmental organisations and regional bodies are already addressing certain of these issues. A number of projects are conducted under the Johannesburg Renewable Energy Coalition (JREC).[37] Formed in August 2002 at the Johannesburg World Summit on Sustainable Development, the JREC's membership includes Iceland, New Zealand, Norway, Switzerland and Turkey and the European Union. During the first week of June 2004, Germany, a member of the JREC, hosted a major International Conference for Renewable Energies, in Bonn.

Another public-private partnership launched at the Johannesburg Summit is the Renewable Energy & Energy Efficiency Partnership (REEEP). In June 2004, the REEEP was formally established as a legal entity in Austria with the status of an international NGO. The partnership is funded by a number of governments, including Austria, Canada, Ireland, Italy, Spain, the Netherlands, the United Kingdom, the United States and the European Commission. One of its primary goals is to get developing countries to use energy more efficiently and increase the share of indigenous renewable resources in their total energy mix. REEEP helps structure policy initiatives for clean energy markets and facilitates the financing of energy projects it considers to be sustainable. By providing opportunities for concerted collaboration among its partners, it aims to create a more vibrant market for renewable energy and energy efficiency.

The International Energy Agency (IEA) has also taken an interest in reducing barriers to trade in renewables. Work undertaken by its Renewable Energy Unit (IEA/REU) in 2003 showed that, while tariffs applied by OECD countries on goods such as wind turbines, solar water heaters and photovoltaic cells are low, they remain high (above 15%) in quite a few developing countries. Even among OECD countries, differences in national requirements relating to safety and electrical performance, and in related procedures for conformity assessment, may act as non-tariff barriers to trade (IEA, 2004b). The IEA/REU has also been active in promoting a regional model (starting with the Mediterranean region) for liberalising trade in renewable energy.

Various IEA Implementing Agreements are also looking at trade barriers. For example, IEA Bioenergy (www.ieabioenergy.com/) currently has a three-year project (Task 40) looking at "Sustainable International Bioenergy Trade: Securing Supply and Demand". Among the specific aims of this project are:

- To document trade experiences (*e.g.* of Sweden, Finland, Brazil, the Netherlands), and survey the possible effects on existing markets for pulp wood, forestry and

37 Its declaration can be found at http://europa.eu.int/comm/environment/wssd/energy_declaration.pdf.

agricultural products and residues, of trade in energy derived from renewable biomass;

- To identify existing barriers to development of a (global) market in biofuel commodities, and to identify strategies to overcome these barriers.

The Secretariat of the Energy Charter is investigating ways both to promote growth in the supply of renewable energy and to lower barriers to trade.[38] On 2 November 2004 the Charter hosted an "Expert Meeting on Trade Friendly Promotion of Renewable Energy" (www.encharter.org//index.jsp?psk=07&ptp=tDetail.jsp&pci=162&pti=9). Currently the Energy Charter is investigating the compatibility of various policies and measures aimed at promoting the use of renewable energy with the provisions of the trade rules of the Energy Charter Treaty and the WTO (EEC code: `CS (03) 765 T 67/Rev.1, 2 April 2004).`

In the UN system, four inter-governmental organisations have programmes relating to renewable energy:

- *Food and Agricultural Organization of the United Nations (FAO):* The FAO has been engaged in activities relating to bioenergy since the 1970s, and has sponsored studies and established a number of bioenergy information systems and databases, projects and partnerships. Recently it has called for an International Action Plan on Bioenergy that would bring together disparate sources of information on biomass energy globally and mobilise existing technologies. A meeting in Rome was planned for late 2005 to work out ideas for the Action Plan.
- *United Nations Conference on Trade and Development (UNCTAD):* UNCTAD has identified renewable energy products, including biofuels, as among the new and dynamic sectors of world trade. It hosted an Expert Meeting on New and Dynamic Sectors from 7 to 9 February 2005 in Geneva, devoting one of the days to renewables.
- *United Nations Economic Commission for Europe (UN-ECE):* The UN-ECE's Committee on Sustainable Energy (www.unece.org/ie/se/com.html) focuses on norms, standards, and labelling and classification systems relating to renewable energy.
- *United Nations Environment Programme (UNEP):* UNEP's Energy Branch focuses on the needs of developing and transition economies in various facets of renewable energy technology research, development and commercialisation. Its Solar and Wind Energy Resources Assessment (SWERA) is helping countries around the world to identify areas of renewable energy potential. A specific bio-energy tool, RETScreen (developed in collaboration with Natural Resources Canada), provides data on renewable energy.

The World Bank Group (including the International Finance Corporation), finances a significant number of renewable-energy projects throughout the developing world, sometimes with private sector co-financing. It, together with the United Nations Development Program and UNEP form the three implementing agencies of the Global

38. The shared principles that underpin the Charter Treaty are non-discrimination, transparency and a commitment to the progressive liberalisation of international trade. The 1998 Trade Amendment expanded the Treaty's scope to cover trade in energy-related equipment, and set out a mechanism for introducing in the future a legally binding stand-still agreement on customs duties and charges for energy-related imports and exports.

Environmental Facility (GEF), the largest source of funds for renewable energy in the developing world. As the financial mechanism for the United Nations Framework Convention on Climate Change (UNFCC), the GEF has provided about USD 900 million for more than 110 projects in 50 countries. This support has leveraged almost USD 6 billion in additional co-financing (GEF, 2004).

Various bilateral and regional programmes have also been established to promote renewable energy in developing countries. In 1995, for example, with the signing of the Barcelona Declaration, the EU entered into wide-ranging partnership with its southern and eastern Mediterranean counterparts (Algeria, Cyprus, Egypt, Israel, Jordan, Lebanon, Malta, Morocco, the Palestinian Authority, Syria, Tunisia and Turkey) aimed at establishing a Euro-Mediterranean free trade area by 2010. Co-operation in the field of energy lies at the heart of the economic partnership. Among the energy priorities for the period 2003-06 is promoting the potential of renewable energy sources. In the Americas, the Renewable Energy in the Americas (REIA) initiative, supported by the Office of Sustainable Development and Environment of the Organization of American States (OSDE/OAS), has since 1992 facilitated long-term hemispheric co-operation in renewable energy and energy efficiency.

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Chapter 3

Can Energy-Efficient Electrical Appliances Be Considered “Environmental Goods”?

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Public policies in a large number of OECD and non-OECD countries seek to steer producers and consumers towards relatively more energy-efficient goods. This chapter considers electrical appliances for home and office, which are produced and consumed in large and increasing numbers in industrialised and, increasingly, in developing economies. Since most relatively energy-efficient appliances achieve high performance levels through combinations of features that would be difficult to characterise succinctly under the product descriptions normally used for customs purposes, it may be necessary and desirable to distinguish them according to a single criterion: their energy performance in use. While international standards for defining and testing for energy performance exist, they differ for each appliance and in practice are not universally applied. This chapter notes progress made at the regional and international levels to harmonise these standards. But for products exhibiting large regional variation, differentiating more from less efficient models at the multilateral level — a necessary condition for co-ordinated tariff reductions in the WTO — is more difficult. However, work towards harmonising test procedures for measuring the energy performance of household and office electrical appliances would in itself help to lower non-tariff barriers affecting energy-efficient goods, which may be more important than lowering tariffs.

Introduction

Public policy in a large number of OECD and non-OECD countries clearly reflects a preference for goods that use energy more efficiently than less energy-efficient versions of the same goods. Such preferences are manifested through regulations requiring a minimum energy performance from 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 energy performance superior to competing products on the market. Some 57 countries with a combined population of 4.4 billion, currently have energy-performance standards or labels for one or more energy-using products. Many more are in the process of developing such schemes, and the scope of most existing schemes is being enlarged. In most cases the energy performance of energy-using equipment, such as refrigerators and clothes washers, is the dominant component of their environmental impact,[1] and there is generally a large potential for reducing energy consumption by such goods.[2]

Can goods with better-than-average energy efficiency therefore be considered as environmentally preferable goods, or even "environmental goods"? Until about ten years ago, such a question might have seemed odd. Since the mid-1990s, however, various governments and inter-governmental organisations have been trying to decide what constitutes an "environmental good", initially for the purpose of estimating the size and growth of the environmental goods and services industry. Whether energy-efficient goods may be defined as environmental products has become even more relevant since World Trade Organization (WTO) ministers, in paragraph 31(iii) of the November 2001 Doha Ministerial Declaration, called for "negotiations, without prejudging their outcome", on "the reduction or, as appropriate, elimination of tariff and non-tariff barriers to environmental goods and services". A particular challenge in the ongoing discussions is how to identify modalities for discussing environmental goods and services in a way that is both useful to the WTO in pursuit of its liberalisation objective and contributes to higher levels of environmental protection.

Currently, discussions in the WTO on environmental goods have focused largely on products used to provide environmental services, such as equipment for monitoring noise levels or cleaning up oil spills. Nevertheless, several of the product lists that have been submitted to the WTO's Committee on Trade and Environment in Special Session contain goods that are deemed by the sponsoring countries to be environmentally preferable because of their intrinsic performance characteristics. Qatar, for example, has proposed electric power turbines and fuel-cell technologies designed to run on natural gas, which burns more cleanly than other fossil fuels. Japan has proposed that certain innovative designs for household appliances — such as inverter-type air conditioners and refrigerator-freezers, ultrasonic dishwashers and clothes washers, and induction-heating electric stoves — be included in a list of environmental goods. In its submission, Japan noted that "Cleaner/Resource Efficient Technology and Products and Resources Management as a product group … are worth reflecting on in the course of the Market

1. See, for example, the life-cycle impact analyses conducted for European eco-labels applied to energy-using goods.

2. *Cool Appliances: Policy Strategies for Energy Efficient Homes*, International Energy Agency, Paris, 2003.

Access Negotiations". The Commission of the European Communities has suggested that environmental performance, including energy efficiency, should be one of the objective parameters used in identifying environmental goods, and mentions fluorescent lighting as an example. Other WTO members have remarked on the significant feasibility questions raised by including relatively energy-efficient goods (indeed, any goods defined by changing relative performance over time) on a list of environmental goods. This chapter attempts to address these questions.

Although some relatively energy-efficient electrical appliances, like those on Japan's list, employ technologies that are readily distinguishable from those used in their less-efficient counterparts, many achieve their high performance levels through combinations of features that would be difficult to characterise succinctly in the types of product descriptions normally used for customs purposes. Should there be interest in defining a wider range of relatively energy-efficient goods as "environmental" for the purposes of market-access negotiation, it might be necessary and desirable to distinguish products by a single criterion: their energy performance in use. Distinguishing goods on the basis of energy-performance criteria presents no insurmountable problem for customs clearance in as much as conformity with product performance standards can, if need be, be physically verified.

Energy performance is not a universally defined quotient like acceleration or density, however, and each class of appliance requires its own measurement method. Across countries, these methods ("test procedures") and performance requirements vary in ways that are not trivial. They pertain to:

- *How countries classify and describe products for which minimum energy-performance standards (MEPS) or energy labels are regulated*. Owing to a wide range of cultural, commercial and historical factors, the features available on, and the configurations of, basic household appliances — particularly refrigerator-freezers and washing machines — may exhibit wide regional differences. This variability is typically reflected in the categories within a product group for which individual standards or labels are developed but may also be manifested in differences in product categories applied in energy-performance test procedures.
- *The test procedures used to measure energy performance*. International standards for testing energy performance exist for most household appliances and types of office equipment, but there are sometimes significant departures from these test procedures at the national level in ways that make their results hard to compare. Tests in some large OECD countries can predate the international ones, and are favoured. The degree of departure from international test procedures varies by the product.
- *The ways in which the standards are specified*. Most MEPS, energy labels and energy-performance targets require the energy efficiency of the product to be calculated, where the efficiency is expressed in terms of the energy used to perform a given service or function. Even when countries apply identical test procedures to measure energy consumption, they do not necessarily apply identical energy-efficiency metrics. For example, the formulas for calculating the energy performance of an appliance may differ in how they adjust for particular functionality variables such as storage volume or cleaning performance. This leads to comparability issues.
- *The stringency of energy-performance thresholds required of products*. Even where formulas for specifying efficiency requirements are similar, there are often differences in the stringency of efficiency thresholds specified for MEPS, labels or

targets. This may reflect diversity in the efficiency of product markets, varying levels of policy ambition, variations in energy prices or simply differences in the timing at which regulations were introduced.

- *The scheduling of reviews of regulations and test procedures.* In the case of household electrical appliances and electrical office equipment, the pace of innovation is often faster than for household goods in general, especially with the incorporation of digital technology into many appliances.[3] Clearly, for energy-efficiency standards to be relevant, they must keep pace with technological changes that affect design and performance. This is reflected in government regulations, which often mandate reviews of MEPS and labels every three to five years. However, different starting dates for programmes have meant that review cycles are not in sequence.

Reconciling these differences across a large number of countries would be a major undertaking. Any multilateral decision to start developing internationally agreed criteria for relatively energy-efficient goods, based on comparable test procedures, would therefore presumably have to be justified by an expectation that the net benefits of liberalising trade in the goods would be correspondingly large. Those benefits would depend on: the potential size of each product's international market; the contribution that the product makes to world energy consumption and the spread of energy performance among the different models on offer within the same product class; and the degree to which tariff and non-tariff barriers currently restrict trade.

This chapter concentrates on household and office electrical appliances, which are produced and consumed both in industrialised and, increasingly, in developing countries. (Cars and trucks are also major consumers of energy, and vehicle fuel-economy regulations and targets have been established by several countries, but are not examined here.) First, contextual information is provided on trends in the consumption of this category of goods, differences in the energy performance of the least and most energy-efficient models, and the tariffs that are currently applied to them. The following section presents an overview of the types of regulatory and voluntary measures being used in different countries to shift consumption towards more energy-efficient products. The discussion then turns to obstacles to aligning energy-performance standards and test procedures, which could be one goal of a trade liberalisation initiative. Differences in national regulations and standards pertaining to energy performance are pointed out, based on an analysis of existing requirements. In particular the chapter examines the treatment under various national and private energy-performance standards of four representative product groups: refrigerator-freezers, air conditioners, fluorescent lighting and personal computers (see Annexes 3.A1 to 3.A4. Several ways for countries to agree to differentiate relatively less energy-efficient from relatively more energy-efficient goods for the purpose of applying a lower or zero tariff to the latter class of goods are explored. At the same time, some of the arguments for and against creating preferential tariff margins are discussed. Next, international alignment efforts by some regional and bilateral groups of countries, which are currently trying to harmonise their energy-

3. While most performance advances involve technology-related advances, product design changes are also very important in improving energy efficiency levels. For example, many European refrigerator-freezer models have improved energy efficiency by using more efficient compressors, optimisation of the sizing and thermal heat transfer properties of heat exchangers, improved control and better quality insulation. In some cases low-conductivity evacuated panels have been installed, which allows for higher efficiency levels with thin walls.

performance requirements and test procedures, are described. In the conclusions a few final observations are made.

Background and context

Household and office appliance markets

After transport, household and office electrical appliances represent the world's fastest-growing segment of total energy consumption. World purchases of major appliances and equipment — refrigerators, clothes washers, lighting, water heaters, air conditioners, computers, fax and photocopying machines — increased by roughly 3.7% a year from 1992 to 2002 and are projected to grow at about 3.8% a year from 2002 to 2005. Estimates of production, consumption and trade in household and electrical appliances are difficult to obtain at the aggregate level. According to the *2003-2008 World Outlook for Household Refrigerators*, global sales of refrigerator-freezers and room air conditioners were each worth around USD 12 billion in 2001. Other sources suggest that global sales of refrigerators and freezers were approximately 90 million units in 2002, compared with some 14 million clothes dryers, 17 million dishwashers, 60 million clothes washers and 120 million cooking appliances.

There are important differences in countries' demand patterns, however. In the richer countries of the OECD, growth in sales of large household electrical appliances is driven mainly by product replacements. Demand is nonetheless large in these mature markets. In EU15 countries, roughly 19 million refrigerator and freezer units were sold in 1999 (Waide *et al.*, 2000). A major exception may be air conditioners, sales of which are rapidly expanding across Europe, especially in the south. There is still much potential for growth in sales of household appliances in the new member states of the EU and in central and eastern Europe and the former Soviet Union.

Generally, rates of growth in appliance ownership in rapidly industrialising developing countries are much higher than in mature markets. For example, nowadays most first-time buyers of microwave ovens live in developing countries.[4] The Asia-Pacific region accounts for roughly 35% of appliance demand, compared with 23% for western Europe and North America and 19% for the rest of the world. The shift in consumption towards the Asia-Pacific region is exemplified by the growth in demand in China. For example, consumption of room air conditioners in China increased from a total annual production of roughly 0.22 million units in 1990, to 33 million in 2002. Growth rates have been near 20% a year, and domestic production now represents one-third of the world market.[5]

New demand in several developing countries — notably China and neighbouring Asian countries — and the shift in regional production to countries like Korea and Mexico, is signalling potentially important longer-term changes in patterns of trade. According to the International Trade Centre (ITC) (Table 3.1), there were several developing countries among the world's top 16 producers of household refrigerators, freezers and refrigerator-freezers in 2002, and even more among the world's top producers of room air conditioners. Rates of annual growth in exports from these countries have been in the double digits for some countries.

4. MindBranch, *World Major Household Appliances* (www.mindbranch.com).

5. FriedNet, Air Conditioning Industry Report (www.friednet.com).

Table 3.1. Exports of household refrigerators, freezers and refrigerator-freezers (HS 8418.10 through 8418.30), and air conditioners (HS 8415.10) in 2002

Freezers and refrigerator-freezers				Air conditioners			
Exporting country	Value USD millions	Growth, 98-02 (%)	Share of world exports	Exporting country	Value USD millions	Growth, 98-02 (%)	Share of world exports
Italy	1 160	-2	16%	*Korea*	*1 173*	*25*	*32%*
Korea	*806*	*12*	*11%*	*China*	*954*	*51*	*27%*
Mexico	*646*	*~50*	*9%*	*Thailand*	*307*	*12*	*8%*
USA	585	-1	8%	*Malaysia*	*249*	*-1*	*6%*
China	*471*	*~40*	*7%*	Belgium	197	176	5%
Germany	419		6%	*Singapore*	*93*	*-2*	*2%*
Sweden	282		4%	USA	84	-7	2%
Turkey	*274*		*4%*	*Saudi Arabia*	*72*	*-2*	*2%*
Spain	255		4%	Italy	67	4	1%
Thailand	*251*		*3%*	*Mexico*	*42*	*50*	*1%*
Singapore	*185*		*3%*	*United Arab Emirates*	*38*	*21*	*1%*
Belarus	176		2%	*Chinese Taipei*	*28*	*-16*	*0%*
Slovenia	167		2%	*Brazil*	*22*	*-4*	*0%*
Canada	75		1%	*Indonesia*	*20*	*154*	*0%*
Netherlands	75		1%	*Philippines*	*18*	*59*	*0%*
Brazil	*72*		*1%*	*Bahrain*	*18*	*36*	*0%*
Subtotal	5 899		82%				

1. Italics indicates developing-country exporter.

Source: International Trade Centre, TradeMap database.

Much of this shift in regional production is linked to the opening to foreign investment of formerly restricted national markets, as in China, and a trend towards globalisation in appliance manufacturing. For example, Electrolux has developed an appliance joint venture in China, and Whirlpool has established manufacturing in India. In the lighting sector Osram (Osram Foshan Lighting Co., Ltd.), Philips (Philips & Yaming Lighting Co., Ltd.) and General Electric (GE Lighting Co. Ltd.) have all established joint ventures, or fully owned production facilities, in China. The last decade has seen many other examples of the globalisation of appliance production.

The environmental rationale for energy-efficiency standards and labels

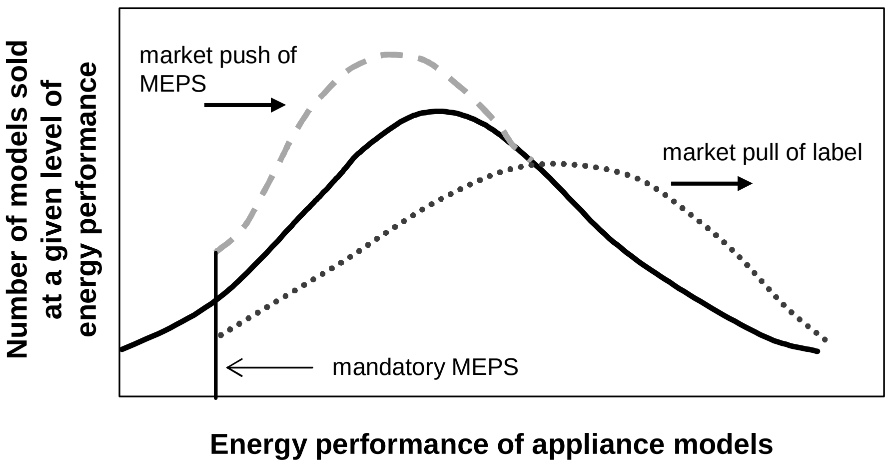
Residential electricity consumption in the OECD area was 2 612 TWh in 2002 which amounted to 31% of total electricity consumption in the region. Of this, space heating and cooling accounted for about 22%, water heating and lighting for 14%, and other appliances such as white goods, home entertainment, miscellaneous cooking appliances and office equipment for 51%. Because of differences in such variables as climate conditions, building codes and disposable income levels, the share of national final energy consumption accounted for by household and office products varies considerably.

Energy-efficiency standards, targets and labels are intended to lower the energy requirements of new appliances for delivering a given appliance service, either through forcing inefficient appliances from the market or making the choices more transparent for consumers, who will presumably respond by buying relatively more of the efficient models. These effects are sometimes referred to, respectively, as "market push" and "market pull" (Figure 3.1). It has long been recognised that labels can be effective market-based instruments for promoting energy-efficiency goals. For example, Australia's Greenhouse Office (www.greenhouse.gov.au) reasons that:

> Labelling of appliances empowers consumers through the provision of the information they need to take energy efficiency into account when purchasing a new appliance. The provision of energy efficiency information ensures a healthy, competitive appliance market, where purchasers are able to consider whole-of-life costs for the appliance, not just the purchase price.

Similarly, in its enabling legislation for electrical appliances (Directive 92/75/EEC), the European Commission states that its mandatory labels are intended to promote the "reduction of environmental damage or risks related to the use of energy (global warming, acidification, depletion of non-renewable energy sources) by reducing energy consumption" (European Commission, 2000b).

Figure 3.1. How mandatory minimum energy-performance standards (MEPS) and labels affect the market for an electrical appliance

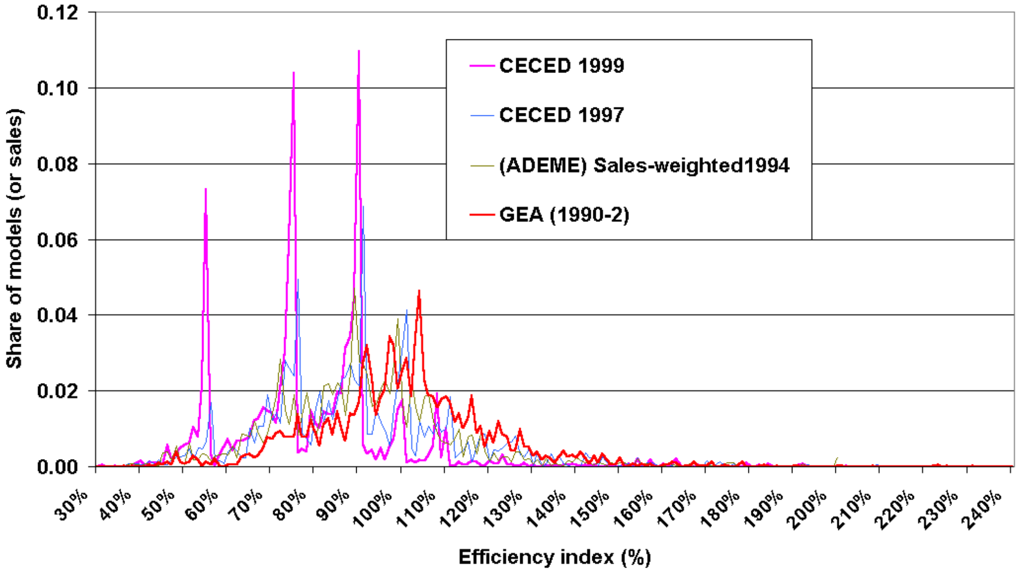


Source: Adapted from NAEWG (2002), Figure 1.

Differences in the energy performance of similar appliances can be large. In the European Union, the least energy-efficient refrigerators on sale consume up to three times the electricity of the most efficient, even though MEPS have been in place since 1999. The influence of the EU's energy label on the efficiency of the refrigerator market is clear from Figure 3.2, which shows the evolution of the share of refrigerator models as a function of the energy-efficiency index (a low index indicates high efficiency). By 1999 almost all models on the market were designed to attain a specific energy label class and most had efficiency indices very close to the thresholds separating the label classes (Waide *et al*., 2000).

Even among compact fluorescent lamps (CFLs), which are by design up to five times more energy-efficient than the more common incandescent light bulbs, the most efficient lamps have an efficacy (*i.e.* produce more lumens per Watt) that is at least 20% better than the least efficient CFLs. The reduction in Mexico's electricity consumption following the introduction of MEPS for several categories of goods in that country during the mid-1990s was expected to be of the same magnitude, with the biggest percentage savings associated with refrigerators, air conditioners and water pumps (Table 3.2).

Figure 3.2. Distribution of refrigerator and freezer sales as a function of their energy-efficiency index in the European Union



Source: Waide *et al.* (2000), Cold II: The revision of energy labelling and minimum energy-efficiency standards for domestic refrigeration appliances.

Table 3.2. Expected electric energy savings from Mexico's MEPS

Regulated appliance or piece of equipment	Sales of units per year	Expected reduction in electricity consumption, %	First-year estimated savings giga-Watt hours
Residential refrigerators	1 050 000	41	579.0
Room air conditioners	182 108	20	323.*
Central air conditioners	4 000	3	18.5
3-phase AC induction electric motors	171 396	7	669.*
Clothes washers	1 000 000	10	7.9
Vertical pumps	2 500	13	18.0
Centrifugal residential water pumps	300 000	18	6.0
Electromechanical efficiency of deep-well pumps	4 500	30	578.0
Submersible pumps	1 100	3	11.4

*Savings are after year three.

Source: Energy Efficient Strategies, Australia (1999a), Review of Energy Efficiency Test Standards and Regulations in APEC Member Economies: Main Report, APEC Secretariat, Singapore.

Box 3.1. Quantifying the benefits of energy standards and labels for household appliances and office equipment

Many claims are made about the benefits for the environment — mainly in terms of emissions of air pollutants and greenhouse gases avoided through reduced electricity consumption — resulting from the implementation of MEPS and labelling. Estimating the counterfactual situation, that is, what energy consumption and emissions would have been in the absence of such measures, is difficult, however, because of the need to take into account changes in technologies and consumer preferences that would have occurred even in the absence of government intervention. Nonetheless there is a growing body of evidence, such as that illustrated for the EU refrigerator market in Figure 3.2, that appears to demonstrate that such programmes have a clear influence and render the hypothesis that such transformations would have occurred without the introduction of energy-efficiency measures highly improbable.

The voluntary ENERGY STAR programme estimates that it saved 80 billion kilowatt hours and 10 000 megawatts of peak power in 2002, thereby avoiding emissions of 38 million metric tonnes of carbon equivalent, and 140 000 tonnes of nitrogen oxides.[1] One study estimates that energy-efficiency programmes for the residential sector (including building codes as well as MEPRs) avoided the equivalent of 4% of total GHG emissions in the United States (Koony *et al.*, 1998). The Government of Japan expects that its Top Runner programme will achieve energy savings of 13% to 72% (depending on the appliance) by the target year set for each appliance, compared with current energy use patterns (IEA, 2003, p. 73). The IEA has estimated that appliance efficiency policies put in place in OECD countries between 1990 and 2002 were on course to save 292 TWh of residential electricity demand in 2010 and 393 TWh in 2020 (some 13.5% of the forecast total residential electricity consumption). The same study estimates that if all appliances sold from 2005 onwards had an efficiency level that resulted in the lowest product life-cycle costs for the consumer (the combination of purchase price and discounted lifetime operating costs) that total residential electricity consumption in OECD countries could be 35% lower in 2020 than with current policies. If this happened it would result in about 524 Mt of annual CO_2 savings and reduce total annual consumer costs by USD 24.7 billion in OECD-North America and EUR 30.9 billion in OECD-Europe (IEA, 2003).

Estimating the environmental benefits worldwide from current programmes would be a highly data-intensive and imprecise exercise, owing to differences in regulations, in standards and in patterns of use.

1. Environmental Protection Agency (2002), "Consumers and the Environment Score Big with ENERGY STAR Products" (www.epa.gov).

In the United States and Canada, energy-efficiency programmes are credited with helping to reduce the amount of energy used to power new models of refrigerator-freezers by over two-thirds between 1973 and 1998.[6] This improvement contributed to a net decrease in annual residential electricity consumption from refrigerator-freezers, even though the number of units in use increased over the period. As Box 3.1 explains, claims regarding the benefits of energy labelling and standards programmes are not always simple to substantiate. Moreover, the net environmental benefits also depend on how the electricity that powers the appliance is generated. If the avoided electricity would have come from a coal-fired power plant, less carbon dioxide will be produced, all else being equal. If most of the electricity would have come from hydropower stations, as would be

6. A new refrigerator-freezer in one year consumes typically less than 500 kWh, compared with over 1 800 kWh for an average model sold in 1973.

the case in Norway, emissions would be less, but other environmental impacts related to the building of new dams and electricity distribution lines would also be reduced.[7]

Tariffs on household appliances and office equipment

In the OECD countries with the highest GDP per capita, applied most-favoured-nation (MFN) tariffs on household appliances and office equipment are already low (Table 3.3). The main exception is Mexico, which applies a tariff of 20% on several categories of goods. However, as the majority of Mexico's trade in these products now takes place within the context of regional and bilateral trade agreements with OECD countries, tariffs on most of its imports are much lower than indicated here.

Table 3.3.Average applied MFN tariffs on selected household appliances and office equipment in OECD and selected non-OECD economies (% *ad valorem*)

Country	Year of data	Refrigerator - freezers HS 8418.10	Air conditioners HS 8415.10	Heat pumps HS 8415.81	Incandescent lamps HS 8539.22	Fluorescent light bulbs HS 8539.31	Portable computers HS 8471.30	Desktop computers HS 8471.41
Australia	2004	5.00	5.00	5.00	5.00	5.00	—	—
Canada	2003	4.00	—	3.00	4.00	7.00	—	—
EU	2003	1.27	4.00	1.35	2.70	2.70	3.50	1.75
Iceland	2003	6.25	10.00	10.00	7.50	7.50	—	—
Japan	2004	—	—	—	—	—	—	—
Korea	2002	8.00	8.00	8.00	8.00	8.00	—	—
Mexico	2004	23.00	23.00	23.00	12.00	25.00	—	3.60
New Zealand	2004	7.00	7.00	7.00	7.00	7.00	—	—
Norway	2003	—	—	—	—	—	—	—
Switzerland	2004	1.92	1.50	0.83	specific-rate	specific-rate	—	—
United States	2004	—	—	1.00	4.20	2.40	—	—
Turkey	2003	1.27	2.20	1.35	2.70	2.70	—	—
Brazil	2004	21.50	18.33	16.75	19.50	19.50	18.25	20.00
China	2004	14.43	15.00	17.50	7.75	8.00	—	—
Egypt	2002	38.00	40.00	40.00	30.00	25.00	5.00	5.00
India	2004	25.00	30.00	30.00	30.00	30.00	15.00	15.00
Indonesia	2003	15.00	10.00	10.00	10.00	8.33	—	—
Malaysia	2003	30.00	30.00	10.00	26.25	30.00	—	—
Nigeria	2002	55.00	55.00	55.00	25.00	40.00	2.50	5.00
Philippines	2003	5.00	7.00	7.00	6.50	6.50	—	—
South Africa	2004	25.00	17.00	17.00	20.00	20.00	—	—
Chinese Taipei	2003	4.00	11.00	11.00	4.67	5.00	—	—
Thailand	2003	30.00	30.00	30.00	20.00	20.00	—	—

— = no tariff is applied.

Source: OECD, based on various national and international databases.

7. Displacement of electricity use in interconnected systems can provide a benefit also. In North America, for example, hydroelectricity produced in Québec but not used in the province can be sold to other markets, displacing coal-generated electricity. The same is true for Norwegian electricity which can be sold into the Scandinavian Nordpool.

In non-OECD developing economies, by contrast, there is a wide variation in tariffs, both among economies and across products imported into the same economy. The Philippines and Chinese Taipei already apply low tariffs to most manufactured goods, whereas Egypt, Malaysia, Nigeria and India apply tariffs of 25% or more on refrigerators, air conditioners and lamps. Tariffs levied on personal computers are zero in many developing countries, but remain at 15% or higher in Brazil and India.

Standards, regulations and labels: general considerations

Analyses of energy-efficiency standards and labelling programmes distinguish four types of measures: mandatory minimum energy-performance standards (MEPS), energy-performance targets, comparative energy labels and seal-of-approval energy labels (also sometimes called "endorsement labels"). MEPS are, by definition, mandatory and seal-of-approval labels are voluntary, but comparative labels may be mandatory or voluntary. The majority of labelling schemes are administered by governments, but some, mostly seal-of-approval labels, are administered by not-for-profit organisations or even industry associations.

From the perspective of trade policy, a mandatory technical requirement is more significant than a voluntary one. Both MEPS and mandatory labelling requirements impose an obligation on suppliers, including foreign suppliers, to engage in conformity assessment. This involves subjecting samples of the product to an approved test procedure, which is itself issued in the form of a standard. Often manufacturers are allowed to carry out the testing themselves, and to certify the results, but depending on the conformity requirements they may need to be accredited to do so. In other cases a third-party certifier or the importing government carries out the test.

A seal-of-approval energy label indicates that a product meets or exceeds a predetermined set of eligibility criteria. Some seal-of-approval labelling schemes require only conformity with a (voluntary) minimum energy-performance standard. So-called "eco-labels" set additional environmental criteria — such as those relating to chemical content or recyclability — that must be met. Other than the fact that participation in a seal-of-approval labelling programme is voluntary, the same conformity assessment procedures may be followed as for mandatory labels. However, since voluntary seal-of-approval energy labelling programmes sometimes set their standards at a more demanding but related level to those applied in local mandatory MEPS, or sometimes on a standard applied by a voluntary labelling scheme in another (usually larger) country, a manufacturer can sometimes use the test results it obtains for demonstrating conformity with the MEPS when applying for a voluntary label. The same is usually true for mandatory labels when MEPS are in place.

As of April 2005, at least 51 economies, including the EU and its 25 member states, had established MEPS for household appliances or office equipment, and 57 had established either mandatory or voluntary labelling schemes to encourage consumers to purchase the most energy-efficient of these goods. A growing number of developing countries, particularly in Asia, South America, Africa and the Middle East, have established energy labelling schemes in the past decade, often building upon the experience of OECD countries.

A brief summary of the different approaches to regulating and labelling the energy performance of household appliances and office equipment follows. In order to appreciate the technical underpinning of MEPS and labels, the discussion begins with an overview of test procedures for appliances which, as Meier and Hill (1997) have underscored, serve as "the foundation for energy-efficiency standards, energy labels, and other related programs."

Test procedures

An energy test procedure is a standardised method for measuring the energy performance of an appliance or piece of equipment (Meier, 2001). Depending on what is being tested, the result of an energy test procedure may be expressed in terms of the product's annual energy use, energy consumption over a specified cycle, efficiency or efficacy (in the case of lighting products). Generally, if an appliance, such as a refrigerator, needs to be available all the time, the test procedure is likely to stress annual energy use; if it is used seasonally or intermittently, the stress will be on energy efficiency or efficacy (Table 3.4).

Table 3.4. Generic descriptions of energy test procedures for selected household appliances

Appliance	Description of energy test procedure
Domestic refrigerator *(annual energy use)*	The refrigerator is placed in an environmental chamber with the door(s) of the refrigerator (and freezer, if applicable) closed. The ambient temperature of the chamber is maintained at a level slightly higher than would be normal for room temperature, to account for door openings and food loading. In Japan, the refrigerator's doors are opened at specified intervals. Depending on the test procedure, the appliance has to be able to maintain different pre-determined internal temperatures during testing. The choice of ambient test temperature may also vary from one test procedure to another.
Room air conditioner	The air conditioner is placed in a calorimeter chamber. Heat removal rate is measured under steady-state conditions and at only one level of humidity.
Furnace or boiler	The furnace or boiler is operated under steady-state conditions. Heat output is determined indirectly by measuring temperature and the concentrations of combustion products. The energy required to operate any fan or pump is sometimes added to the input energy.
Lamp (light bulb)	Light *output* is measured in an integrating sphere. Light *input* is measured differently for each component, depending on type of light, ballast (in the case of fluorescent lamps), and other features. Combining these elements yields a measurement of *efficacy*.

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

International energy-test procedures exist for all major household appliances. Test procedures typically originate with manufacturers' associations, government agencies or professional societies, and are eventually adopted by a national or international standard-setting body. The leading international standard-setting bodies for energy tests are the International Organization for Standardization (ISO), which mainly focuses on mechanical performance, and its sister organization, the International Electrotechnical Commission (IEC), which mainly focuses on electrical performance. Implementation and refinement of international standards is left to national and regional counterparts of ISO and IEC. Thus the European Committee for Standardization (CEN) and the European Committee for Electrotechnical Standardization (CENELEC) have assumed responsibility for developing EU-wide test procedures for mechanical and electrical performance, respectively. The Japan Industrial Standards Association (JIS) is responsible for developing all appliance test procedures in that country. In the United States several organisations are involved in developing test procedures. Chief among these are the American National Standards Institute (ANSI), the Air-conditioning and Refrigerating Institute (ARI), and the American Society of Heating, Refrigerating, and Air-

Conditioning Engineers (ASHRAE), although final responsibility for the appliance energy test procedures used in MEPS regulations resides with the Department of Energy.

Ideally, a well-designed test procedure will be inexpensive, accurate and closely reflect actual operating conditions. In reality, compromises have to be made. Meier (2001), using the example of air conditioners, provides an excellent illustration of the illusiveness of the ideal test procedure:

> A test that tries to accurately duplicate actual usage will probably be expensive and not easily replicated. For example, most energy test procedures for room air conditioners measure efficiency while a unit is operating at steady-state at a specified outdoor temperature. This is a relatively easy mode to test after the test chamber has been created; efficiencies can be measured quickly and reliably. In practice, however, air conditioners operate mostly at part load or at a higher outdoor temperature, where the efficiency will typically be lower. Part-load performance is much more complicated to measure, and results are more difficult to duplicate reliably. Likewise, most energy test procedures measure energy efficiency at a single specified ambient air temperature. Testing at different ambient temperatures requires costly retesting and still fails to capture all the differences in ambient conditions. Testing to country-specific ambient temperatures makes it difficult to compare product performance across borders.

Geographic, climatic and cultural differences among countries further complicate efforts to develop internationally standardised test procedures that are sufficiently flexible to reflect local conditions while still allowing for comparging results from different countries. In North America, for example, clothes are washed in warm or hot water drawn from hot-water pipes, *i.e.* energy to heat the water comes from another appliance. Most European clothes washers connect only to ambient-temperature pipes and so heat the water. In Japan, which is largely blessed with naturally soft water, people tend to wash clothes in unheated water. Beyond these basic differences, appliances often vary greatly in their configuration (*e.g.* top-loading or front-loading clothes washers) and range of options offered (*e.g.* through-the-door ice dispensers in refrigerators). The variety of configurations and options, because it can affect energy efficiency, often necessitates the creation of separate standards.

Interest in making test procedures better reflect local conditions and available appliance models has therefore led many countries to adapt international standards in non-trivial ways. However, many newly industrialising countries, such as Thailand, tend to align their national test standards with those of ISO, usually with only minor differences.[8] In general, European, African and most Asian countries, including China and Russia, align their test procedures with ISO/IEC test procedures. Japan and Korea are often aligned with ISO/IEC, with some significant differences for certain products. India, the Philippines, and Sri Lanka base most of their test procedures on ISO/IEC procedures but there are sometimes important differences. Chinese Taipei often uses test methods similar to ISO/IEC but frequently introduces significant variations. In the Americas, the United States uses its own test procedures which occasionally align to ISO/IEC tests. Canada and Mexico are essentially aligned with the United States. Most South American countries, including Brazil, use ISO/IEC test procedures but some (*e.g.* Venezuela) use variants of US test procedures. Australia and New Zealand use harmonised test procedures, which are loosely based on ISO/IEC test procedures and often exhibit significant differences.

8. See, for example, http://www.apec-esis.org/economy.asp?id=19.

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 which all products must meet or a sales- or production-weighted target level that products must attain on average. Among non-OECD economies, China, India, Iran, Israel, Jamaica, Malaysia, the Philippines, Russia, Saudi Arabia, Singapore, Sri Lanka, Chinese Taipei, Thailand and Tunisia regulate the energy performance of at least one household appliance. Many others, 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 appliance energy-performance regulations. Sources of information on MEPS are listed in Box 3.2.

National and supra-national MEPS generally pertain to one or more product groups. A product group may include several product classes (generic models). Thus, in the product group “refrigerators, freezers and combinations thereof”, Australia, Canada, the EU and New Zealand specify separate MEPS for ten primary product classes, and the United States specifies separate MEPS for 18 product classes. Each set of MEPS reflects typical combinations of refrigerators, freezers, and features, such as automatic defrosting, sold in the countries’ or regions’ respective markets. Separate product classes are used because the energy efficiency of refrigerators is defined in terms of their consumption relative to other products on the market providing an identical service.

The nature of the service provided has a fundamental impact on energy consumption. For example, chest freezers and upright freezers both provide the same cooling and storage service if they have the same volume and freezing capacity, but a chest freezer is likely to use less energy to do so. This is because chest freezers are liable to have fewer constraints on the thickness of insulation as they do not have to fit into a predetermined rectangular space in a kitchen. Also, cool air in chest freezers sinks to the bottom of the chest away from the gasket, whereas gasket losses are likely to be higher in upright freezers. The type of evaporator used is also different. As upright freezers provide a slightly different functionality or service than chest freezers it is appropriate to treat them as a separate product category.

In some federal systems of government, sub-national MEPS operate alongside federal ones. Five of Canada’s provinces have established their own MEPS, for example. For the most part, these are harmonized with the federal MEPS. In a few cases, however, provinces regulate products for energy efficiency that are not covered federally. Canada’s federal regulations do not take precedence over provincial regulations for locally manufactured and sold products (Harrington and Damnics, 2001). During the mid-1970s, several individual states in the United States began promulgating their own MEPS. With the passage of the National Energy Policy and Conservation Act of 1978, federal law took precedence over state laws, unless the federal government determines that no standards are warranted for a particular product, in which case states are free to establish local MEPS. The US Department of Energy (DOE) currently imposes MEPS for 25 products including 15 used in the residential sector; however, states such as California have imposed additional requirements. In Australia the federal (Commonwealth) government has no constitutional powers to regulate the energy performance of appliances, hence MEPS are mandated by the states and territories. However, with the adoption of uniform regulations by all the states and territories in 1999, the regulatory system operates largely as if it were a national one. Australia now has MEPS for 12 products but is the process of developing more.

The Korean government sets both MEPS and a more stringent “target energy performance standard”, or TEPS. The MEPS establish the bottom (a rating of 5) of Korea’s mandatory comparative energy labels, and the TEPS value (a rating of 1) the top. When MEPS are revised upwards, typically every three to five years, the TEPS are as well. Often, the former TEPS value for a particular appliance becomes its new MEPS value.

Technically, Japan does not have MEPS. Rather, it has requirements for fleet-average energy-efficiency levels for products, which manufacturers and importers must meet by a given (target) year, usually four to ten years after the target has been announced. Companies that do not achieve the target, determination of which is calculated on the weighted average of their sales of different models, risk being singled out in public announcements, and possibly fined (Harrington and Damnics, 2001). Japan announced its first target average energy-efficiency standards in 1979, for refrigerators, refrigerator-freezers, and household air conditioners. In 1998 the country revised its Energy Conservation Law and in the following year issued new energy-efficiency targets for products delivered to the domestic market during the years starting 1 April 2003 (for televisions and video cassette recorders), 1 April 2004 (for refrigerators and freezers), 1 April 2005 (for fluorescent lamps, computers and computer disk drives), 1 October 2006 (for air conditioners and copying machines), and 1 April 2010 (for gasoline-fuelled passenger cars and motor trucks). These targets were set at the level of the most energy-efficient model in each product category on the market as of 1999, hence the name “Top Runner”. In April 2003, coverage of the programme was expanded to include stoves, gas cookers, gas or oil water systems, electric-heated toilet seats, vending machines and transformers.

The European Union has used a mixture of MEPS and negotiated agreements with industry. MEPS are currently in place for refrigerators, freezers and their combinations, boilers and ballasts. Voluntary agreements with industry, whereby industry has committed to either phase out equipment with less than a prescribed efficiency level or reach a production-weighted efficiency threshold or a mixture of both, have been developed for: domestic electric water heaters; dishwashers; clothes washers; external power supplies; TVs and VCRs, set-top boxes and audio equipment in standby mode. The EU is currently poised to implement a new Directive which will give the European Commission the authority to impose MEPS or negotiate voluntary agreements for a very wide range of energy-using equipment, without needing to pass primary legislation as at present.

Brazil has developed two types of voluntary energy label: one is a comparative energy label and grades the efficiency of appliances from A to G as in the EU; the other is an endorsement energy label. Labels are currently in place for room air conditioners, freezers, refrigerators and refrigerator-freezers, ballasts, clothes washers and lamps. The Brazilian government also recently passed legislation allowing the imposition of mandatory MEPS for a broad range of equipment and these are currently under development.

China first introduced MEPS in 1989 and has since been extending their coverage and increasing their ambition. In 2004 China had MEPS for refrigerators and freezers, room air conditioners (windows and split types), TVs, fans, rice cookers, radios and audio receivers, fluorescent lamp ballasts, clothes washers, motors and irons. Requirements for external power supplies were under development. China’s energy-performance test procedures are mostly harmonised with ISO/IEC procedures.

Russia first implemented MEPS in 1983 and between then and 1991 introduced regulations for room and other types of air conditioners, audio signal amplifiers, computers, dishwashers, refrigerators, refrigerator-freezers, freezers, graphical input devices, monitors, printers, ranges & ovens, TVs and electric water heaters. Most of these standards have not been updated and hence have since become largely obsolete; however, in 2001 Russia passed a general law allowing the issuing of MEPS and labels for a large range of appliance types. Since then energy labels and voluntary MEPS have been developed for refrigerators.

Box 3.2. Sources of information on energy-efficiency standards and labels

At the national level, government-administered programmes issue public notices as required for regulatory changes in general. For example, in Mexico, any proposed new or revised MEPS are preceded by the publication of proposed standards in the *Diario Oficial de la Federación* followed by a 60-day period for public comment, and an additional 45 days for additional consultation within the Committee. Proposed changes to Canadian and US standards are notified in the *Canada Gazette* and *Federal Register*, respectively, followed by mandated periods to allow for public comment. In Europe, revisions to laws or the introduction of new laws are published in the *Official Journal of the European Commission*. Most countries also make available copies of their energy-efficiency regulations and any criteria for voluntary labels on dedicated Internet Web sites.

At the international level, all WTO member countries are obliged under the Agreement on Technical Barriers to Trade (TBT) to notify the organisation of any new regulations, including MEPS. Indeed, energy-efficiency-related notifications appear to be one of the largest single categories of all TBT notifications, providing a useful insight not only into the degree of their transparency but also the pervasiveness of these programmes.

Several organisations have established Web sites that provide information on energy-efficiency standards and labels. The Asia-Pacific Economic Co-operation (APEC) is funding an Energy Standards Information System (ESIS) which provides comprehensive information on test standards, MEPS, and labelling requirements for countries in the Asia-Pacific region. Its Web site (www.apec-esis.org/home.asp) allows searching by country, type of equipment, or test standard. The Collaborative Labelling and Appliance Standard Programme (CLASP) provides similar information on energy-efficiency standards and labelling schemes, for more countries, at (www.clasponline.org), but its information is sometimes less up to date than that reported by the ESIS.

Details of particular countries’ MEPS and energy labelling requirements are usually posted on the Internet:

Australia: www.energyrating.gov.au.

Canadian: www.oee.nrcan.gc (MEPS) and www.energuide.nrcan.gc.ca (labelling requirements).

EU: http://europa.eu.int/scadplus/leg/en/lvb/l32004.htm. and energyefficiency.jrc.cec.eu.int.

Japan: www.eecj.or.jp.

Korea: www.kemco.or.kr.

New Zealand: www.eeca.govt.nz.

United States: www.eren.doe.gov (MEPS and energy test procedures) and www.energyguide.com (labelling requirements).

For other countries’ standards and labelling programmes, see www.clasponline.org.

Mandatory energy-information labels

Most countries that regulate MEPS also require energy-information labels to be displayed on the same products. The exceptions are Chinese Taipei, Ghana and Saudi Arabia, which regulate MEPS but do not yet require energy information labels.[9]

France was the first country to mandate the display of energy labels on household appliances, in 1976, rapidly followed by Canada and the United States. 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/EU countries, for at least one product, and often for several. Canada and the United States each require energy labels on 15 or more product groups, from air conditioners to water heaters. The EU introduced a harmonised labelling programme for household appliances in the early 1990s and now has mandatory comparative energy labels for nine domestic appliance types. There is an ongoing discussion in the EU about whether to change the primary labelling legislation to allow non-domestic energy-using products to be labelled. EU member countries also have the right to impose mandatory energy labelling for cars and many have recently implemented car-labelling requirements.

Typically, the main piece of information provided by a mandatory energy-information label is the appliance's estimated energy consumption in kWh/year, or per operating cycle (or EER for room air conditioners), which is derived from standard tests. Usually the label also shows the product group type and size category (cooling capacity category in the case of air conditioners) within which the model should be compared, as well as the energy consumption (or EER) of the most and least energy-efficient models within the product group that are currently on the market. In some cases the energy labels also provide information on typical operating costs or on non-energy performance, such as the cleaning performance of clothes washers, but this depends on the labelling scheme.

Increasingly popular are the use of visual aids, such as dials or bars, to facilitate quick comparison between different appliances and 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). Colour-coding of the bars, with red representing G, and green representing A, adds to ease of use. The label has been standardised, except for differences in language, across all EU member states. It appears also on products sold in Iceland, Lichtenstein and Norway, where it is mandatory, and in Switzerland, where it is not. The EU energy label has recently been adopted in Russia and in Turkey, and is poised for adoption in Bulgaria, Croatia, Romania and South Africa. Other countries, including Argentina, Brazil, China, Columbia, Iran and Tunisia have utilised some aspects of the EU energy label in their own labelling schemes.

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, including requirements 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 the EU's Eco-label award scheme, China's Great Wall energy

9. Chinese Taipei is currently investigating information labelling but already has seal-of-approval energy labelling. Ghana is considering energy labelling and has already conducted related research into an appropriate label design.

certification label, India's Ecomark scheme, Korea's "Energy Boy" label, Singapore's Green Labelling Scheme, Chinese Taipei's Greenmark, and the United States' ENERGY STAR programme. In addition there are several voluntary labelling schemes administered by non-profit organisations, such as Japan's Eco Mark scheme, Korea's "Energy winner", the United States' Green Seal, and Thailand's Green Labelling Scheme. Canada's third-party, multi-criteria[10] Environmental Choice[M] Programme is owned by the federal government and licensed to a "for-profit" organisation to administer. Several schemes, notably the Nordic Swan label and Germany's Blue Angel label, are administered jointly by representatives of governmental and non-governmental organisations. In Australia and Thailand, associations of gas and electric utilities sponsor their own voluntary energy-labelling schemes. Some Web sites providing information on voluntary schemes are given in Box 3.3.

ENERGY STAR has proved to be among the most internationally successful of the government-administered seal-of-approval programmes (Meier, 2003). In the United States it covers a wide range of products including clothes washers, different models of air conditioners, dehumidifiers, dishwashers, fluorescent lamps and ballasts, compact fluorescent lamps, computers and peripherals (monitors, printers, scanners), ceiling fans and ventilation fans, fax machines, freezers, furnaces, heat pumps, refrigerator-freezers, cordless telephones and answering machines, televisions, traffic signals, vending machines and water coolers. In Canada, the ENERGY STAR programme covers a slightly smaller number of product categories, while in most other participating countries it covers only one or two categories, namely office equipment (EU, Japan, Chinese Taipei) and home electronics (Australia and New Zealand).

Where a mandatory MEPS already exists for a given product, the minimum energy-performance level that the same product must meet to be eligible to display the voluntary label will typically be set, in the case of government-run schemes, at a value representing anywhere from a 10% to a 55% improvement over its corresponding MEPS value. Similarly, most private schemes either reference a MEPS and set a percentage target improvement that is similar to these labels, or refer to target values set out in one of the major government-administered schemes. For example, the Nordic Environmental Label for Refrigerators and Freezers (037/3.0) uses an energy-performance target value for refrigerator-freezers that is identical to that of the EC Eco-label, which is also identical to the requirement for the second-highest label class (the A+ class) on the EU mandatory energy label.[11]

Ecological or environmental labelling schemes ("eco-labels") often augment energy-efficiency criteria with other product performance criteria, such as for noise, water use or product durability, specifications relating to the composition of the product, or the product's re-use, recycling and disposal characteristics.[12] The criteria set by the EU Eco-label for portable computers, for example, include restrictions on the use of harmful substances, such as flame retardants, heavy metals and plastics; criteria for durability; and

10. Many of these criteria reference other programmes, such as the United States' ENERGY STAR.

11. The index requires an efficiency level that is akin to using just 42% of the energy of an average equivalent refrigerator or freezer on the EU market in 1992 (Nordic Ecolabelling, 2001).

12. Rules covering the use of the EU label pertain to various design and use criteria, such as the manner in which it is displayed on the appliance at the point of sale, and content involving information about its average energy performance, including its annual average energy consumption (in kWh per year), the storage volume of its compartments (in litres), and its comparative ranking according to the seven efficiency classes set out by the Commission.

end-of-life criteria. Most private third-party voluntary labelling schemes contain similar criteria unrelated to the product's energy performance.

Box 3.3. Sources of information on voluntary energy-efficiency standards and labels

Australian energy-star programme: www.energystar.gov.au.

Brazilian voluntary comparative and endorsement energy labels can be seen at www.inmetro.gov.br and www.eletrobras.gov.br/procel/site/home/index.asp.

EU Eco-label requirements: http://europa.eu.int/comm/environment/ecolabel/.

Switzerland's voluntary energy labelling requirements: www.energielabel.ch.

US ENERGY STAR label: www.energystar.gov.

Creating preferential tariff margins for relatively energy-efficient electrical appliances

Multilateral sectoral liberalisation initiatives normally lead to the removal of, or at least substantial reduction in, tariffs applied to goods covered by the initiative. The mandate for the WTO negotiations on environmental goods and services is no exception, calling for "the reduction or, as appropriate, elimination of tariff and non-tariff barriers" to environmental goods.

Normally, when a sector, or group of similar products, is the subject of a negotiated reduction in tariffs, the demarcation of the sectoral coverage is clear or differences among countries are of secondary importance. Were countries to consider creating preferential tariff margins for relatively energy-efficient electrical appliances, however, they would be starting from a situation in which some of the products concerned are not described by separate commodity descriptions and codes. Either new, internationally standardised descriptions and codes would have to be agreed upon (perhaps at the national, 8- or 10-digit level), or an alternative approach would need to be adopted whereby common rules regarding energy-performance thresholds would be established and tied to existing national MEPS or labelling categories.

This section sets out some of the practical obstacles to defining relatively energy-efficient electrical appliances as environmental goods for the purposes of such a tariff-reduction initiative.

The starting point: differences in MEPS, voluntary standards and test procedures

The starting point for any discussion is the great variety of approaches to regulating and labelling the energy-efficiency of existing electrical appliances. Annexes 3.A1 to 3.A4 look at these differences for four representative products: refrigerator-freezers, room air conditioners, compact fluorescent lamps and personal computers. Refrigerators and freezers were the first consumer goods for which efficiency standards were established and labels issued and hence, of all appliance categories, they are subject to the greatest number of MEPS and mandatory labelling programmes. Most OECD countries, along with many developing countries, have established MEPS or labelling schemes for air conditioners and compact fluorescent lamps. Personal computers are included in the list as an example of an office product that is traded widely and for which differences among energy-consumption standards are small.

From the evidence provided in the annexes, and the recent work of other investigators (Energy Efficient Strategies, 1999a and 1999b; Meier, 2001), it is clear that there is a significant difference in the relative ease of establishing international standards for some appliance types than for others. White goods such as refrigerators, clothes washers and dishwashers tend to exhibit the largest differences in test procedures, product categorisation and energy-performance requirements from one region to another. Office equipment, such as personal computers (PCs), monitors and printers exhibit the smallest differences, especially when measuring standby mode. Other appliance types such as lamps, ballasts, room air conditioners, water heaters and home entertainment devices exhibit an intermediate degree of variation. Personal computers, especially portable computers, have become a globalised commodity: variation is mainly found in combinations of features rather than in the models available across countries. Given that the United States, as the world’s largest importer of PCs, was one of the first countries to establish a test standard and voluntary energy label (the ENERGY STAR label) for standby power, it was relatively easy for the test standard and efficiency threshold to be adopted and recognised by other countries.

By contrast, in establishing labelling schemes and MEPS for electrical appliances like refrigerators and air conditioners, individual countries have typically taken into consideration country-specific variables such as domestic energy prices and climatic conditions, as well as the features and configurations that most aptly describe the appliances sold in their markets. These differences are also reflected in the standards relating to test procedures, many of which were first developed nationally and may have been established more than two decades ago. Judged by current differences in product descriptions, standards and test procedures, prospects for developing and implementing common international energy-performance standards for white goods appear to be poor in many cases.[13] The major obstacles include:

- *Differences in the test procedures used to measure energy performance*. There are significant variations in the test procedures adopted for the purposes of energy-related regulations and labelling programmes currently in use around the world. Differences among test procedures for refrigerators are substantial, while those for compact fluorescent bulbs, PCs and room air conditioners are probably close enough to be harmonised, at least partially, if there is a will to do so.
- *Differences in how countries classify and describe the products for which energy-performance standards are regulated*. Permutations of features and configurations for refrigerators and freezers lead to inconsistent descriptions and varying numbers of product categories. International standards for the terms used to describe air conditioners exist, but are not universally used. The United States and Canada, for example, categorise single-package split air conditioners as “central air conditioners” and apply a more complex test procedure for their energy-performance rating than for single-packaged window air conditioners. Other countries test these air conditioner types in the same way, but may apply different categorisations depending on the maximum cooling capacity.

13. The same is not necessarily true of other residential and commercial appliances such as information and communication technologies, entertainment appliances, lighting products, water heaters, etc.

- *Differences in how energy performance or efficiency is defined.* The energy performance or efficiency metric is often specified in regulations separate from the test procedure (depending on the product and country concerned) and can differ considerably from one jurisdiction to another. For example, most countries define refrigerator energy performance in terms of energy consumption per unit of adjusted volume[14] compared to a reference level that has been defined relative to the historic performance of refrigerators on the local market. Sometimes a country will harmonise these relative levels to those already in use elsewhere, as China has recently done with respect to EU regulations, but generally these efficiency metrics are not directly comparable outside the jurisdiction in question. For other products, the efficiency metric applied might be a pure and hence universally transferable efficiency measure, as is the case of the energy efficiency ratio (EER) of room air conditioners, or the luminous efficacy measure of lamps. In this case there may be differences in the units applied (*e.g.* W/W or Btu/kcal for EER measurements) but the values can still be directly compared across programmes.

- *Differences in the ways in which the standards are specified*. Most countries specify the annual energy use of refrigerator-freezers using a fixed and a variable factor, but the adjustment factors, and the way they are included in the calculations, differ widely. In respect of compact fluorescent lamps, some countries specify evenly spaced increments for efficacy (usually in 5-lumen steps), while the EU uses a non-linear formula. Some eco-labelling schemes specify only two categories of input wattage for CFLs (*e.g.* less than and greater than 15 W), while others specify as many as five.

- *Differences in the energy performance required of products.* Given the aforementioned problems, MEPS levels for refrigerator-freezers cannot be directly compared, but the levels seem to vary more widely than for air conditioners. For a typical 15 W CFL, the minimum efficacy requirements needed to qualify for various voluntary seal-of-approval labels range from 50 to 65 lumens/watt (and only can be as low as 33 lumens/watt for a CFL equipped with a reflector). These differences reflect significant variations in energy prices, appliance use profiles, usage environments and appliance characteristics from one jurisdiction to another; however, they also reflect important differences in the ability of local market actors to supply products of a designated efficiency level and in the political mandate, or ambition, of the programmes concerned.

- *Differences in the scheduling of reviews of the regulations*. Appliance standards and labelling programmes generally do not follow a fixed schedule for considering the revision of performance criteria. Many programmes are vague about the periodicity of their revisions, saying only that they update their efficiency standards “regularly” or “periodically”. Based on historical evidence, most programmes appear to work on a 2-4-year review and revision cycle for endorsement labels and a 2-8-year revision cycle for mandatory labels. Some are extended and some appear never to have been revised. The timing of these revisions is not co-ordinated internationally. Similar observations can be made for MEPS and energy-performance targets.

14. Adjusted volume is the storage volume normalised to be equivalent in energy usage terms to a compartment having a given internal temperature, *e.g.* 5°C in the case of a fresh food compartment.

Identifying energy-efficient goods via simple physical inspection

From a trade negotiation perspective it is simpler to countenance the liberalisation of trade in energy-efficient goods that can be distinguished simply through inspection. However, as already mentioned, this is usually insufficient to identify an energy-efficient appliance, because the relative energy performance of the appliance is generally not apparent from its appearance.

Lamps are an exception. The luminous efficacy (light output per unit power input) of fluorescent lamps is three to four times greater than that of incandescent lamps; hence, despite significant differences in efficacy and other performance characteristics of fluorescent lamps, they are always appreciably more efficient than incandescent lamps and will remain so regardless of any foreseeable future technological developments. Currently there is very little variation in the import duties applied to incandescent and fluorescent lamps (Table 3.5), so there could be an argument for differentially lowering duties applied on fluorescent lamps. For other products, it is rarely possible to determine their relative efficiency on the basis of a simple assessment of their physical characteristics. However, it may be possible for a small number of appliances, including:

- Water-cooled air conditioners or heat pumps, which are almost invariably more efficient than their air-cooled counterparts.
- Liquid crystal display (LCD) computer monitors, which almost invariably use less energy in the on-mode than equivalently sized cathode ray tube (CRT) monitors.
- Solar water heaters, which are inherently less polluting than those that heat via electricity, gas or oil although they are not necessarily more efficient in a narrow engineering sense.
- Electric clothes dryers using a heat pump, which are typically twice as efficient as conventional electric clothes dryers.
- Electric space or water heaters using a heat pump, which are typically two to three times as efficient as their electric counterparts using electric-resistance heating elements.

There are two other groups of appliances that make use of a technology that could be deemed to be inherently more energy-efficient than the conventional alternative and hence could arguably be given favourable treatment: air conditioners, heat pumps, fans or refrigerators using a variable or rated-speed drive system, and refrigerators, freezers and refrigerated cabinets using vacuum insulation panels.

The difficulty with this approach is that it is often possible to produce an efficient appliance which does not use these technologies and in some cases an equivalent energy-efficiency improvement might be attained more cheaply. Thus, deployment of these technologies may be helpful for raising efficiency but is neither necessary nor sufficient. A more compelling case can be made for reduced duties on energy-efficient components that might include variable or rated speed drive units and vacuum insulation panels.

Lastly, there is another group of products that either do not use energy directly, or do so to a minimal degree, but which, through their inherent properties, are instrumental in conserving energy. These products are beyond the scope of this chapter because they are not household electrical appliances but are listed below for the sake of completeness:

- Insulation (it comes in very wide range of types and qualities).

- Insulated or energy-controlling glazing (double or triple glazing, argon-filled double glazing, glazing with infrared-reflecting coatings, special types of solar control glazing, etc.).
- Devices to minimise summertime solar overheating while maximising daylight and wintertime solar gains; these include daylight collection and guidance devices, daylight optimisation blinds and photosensitive glazing.
- Heat recovery systems for buildings, such as certain types of heat exchangers.
- Building thermal energy-storage systems including phase-change materials purposely designed for this task.
- Electronic building energy-management systems (BEMS).

Establishing common reference energy-performance standards

If, as is true for most cases, energy-efficient goods cannot be distinguished simply by appearance, selective liberalisation of tariffs would require their performance to be determinable via testing. It would also require establishing a common set of rules regarding the efficiency threshold to be attained in order to qualify for the reduced tariff. 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:

- The use of either common or mutually convertible energy-performance test procedures.
- Either common or mutually convertible energy-efficiency metrics and product categories;
- Common energy-efficiency thresholds.

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

Test procedures

Common or close-to-common test procedures appear to be applied in most countries using energy labels and or MEPS for computers, with almost all of them using the US EPA’s ENERGY STAR test procedure. Exceptions include Russia and China although the latter’s test procedure is thought to be very similar. The vast majority of countries use the same international test procedures for CFLs, namely IEC 60901 and IEC 60969; however, the United States and Canada use their own aligned procedures (IES LM 66). Japan and Korea use aligned procedures that are not identical to IEC procedures, but produce equivalent results for efficacy.

Almost all countries test room air conditioners (whether single-packaged window, wall or split units) according to the ISO 5151 T1 test condition; hence it is possible to make direct comparisons between air conditioner energy efficiency ratios (EER). In several countries, including Canada, Japan, Korea, Chinese Taipei and the United States, there are sometimes minor deviations from this test condition, usually deviations of up to 0.5°C in one of the design temperatures, which have only a small impact on the rated EER. In the case of the Philippines there is a more significant deviation for the outdoor wet bulb temperature. Despite these deviations, an accurate test procedure conversion algorithm has been developed and tested under the auspices of APEC to enable converting room air conditioner energy and cooling capacity test results when all but the most accurate comparisons are required.

The situation is less favourable for refrigerator-freezers. Not only do different regional or national test procedures require maintaining different internal temperatures under different steady-state ambient test temperatures, they also specify different ways of measuring internal temperatures which are not easily comparable.[15] Making matters worse, the fact that appliances are designed with a view to satisfying specific test procedures means that their performance is usually optimised for that procedure. A refrigerator-freezer that is optimised to perform well under the Japanese test procedure, which includes door openings, might place relatively greater design emphasis on an efficient refrigeration system than one that is optimised for other test procedures in which the door is not opened and the quality of insulation plays a relatively greater role.

Product categories and efficiency metrics

The product categories and efficiency metrics applied by countries for computers and CFLs are directly equivalent. For room air conditioners the efficiency metric applied is identical across all countries (the EER) although different units are often used in the numerator and denominator (recalculating is a trivial matter in this case). There are greater differences in product categorisation, but it would nonetheless be relatively straightforward to make an adjustment to a common basis for tariff application purposes.

There is much commonality in the basic methodology used to define refrigerator-freezer energy-efficiency metrics across countries, as efficiency is usually specified in terms of the energy consumption of the appliance as compared with a reference appliance of comparable size and features, the energy consumption of which is determined from a linear equation relating energy use to adjusted storage volume. However, the significant differences in product categories, which reflect the different demands of the energy test procedures applied in different countries, results in a basic problem of comparability, even once differences in units are adjusted for. Furthermore, the reference appliance equations used in the older programmes invariably have their origins in regressions on the efficiency of products on the market concerned at some point in the past. That is, they allow the energy consumption of a specific appliance type to be measured against an equivalently featured appliance with average energy performance at some point in the past. 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; Argentina, China, Russia, South Africa, Tunisia and Turkey have, for example, used the European Union’s efficiency metric for refrigerators and freezers. In spite of the considerable difficulties, conversion between refrigerator-freezer test procedures and efficiency metrics is possible providing that accuracy is not paramount and only indicative results are required. A simplified conversion algorithm has been developed and applied to help establish Australian MEPS requirements as explained below.

15. For example, ISO test procedures require the freezer compartment to be fully loaded with test packs and specify that the temperature of any of the test packs must not exceed a maximum level, whereas the NAFTA and Australia-New Zealand test procedures simply require that the average air temperature of an empty freezer compartment must not exceed a prescribed level. These two means of prescribing the compartment temperatures are not easily compared in energetic terms.

Common energy-efficiency thresholds

For reasons already outlined, internationally applied MEPS or energy labelling efficiency thresholds are rarely common or harmonised beyond programme borders. Computers are rarely subject to MEPS, and only Japan and Russia (with an obsolete requirement) currently specify MEPS levels. Voluntary endorsement labels are far more common than mandatory requirements, whether labels or MEPS, for computers, largely because of the rapid pace at which the technology is evolving. Most countries that have requirements have harmonised them with ENERGY STAR, which has become a kind of international standard for this product.[16] They include Australia, Canada, the EU, Japan and Korea, as well as the United States.

CFLs are also rarely subject to MEPS, with just six countries (Canada, Colombia, Korea, Mexico, Thailand and the United States) having imposed mandatory minimum energy-performance requirements. China, the EU, the Philippines and Korea impose mandatory energy labels on CFLs (and on all household lamps in the case of the EU). At least eight countries apply voluntary energy labelling to CFLs and at least another 30 apply voluntary eco-labels for CFLs. As discussed below, the international Efficient Lighting Initiative (ELI) programme has developed common quality criteria for CFLs, which relate to their energy performance (efficacy and power factor) and lifetime. These criteria have been adopted by eight countries.

Room air conditioners and refrigerator-freezers are the products most commonly subject to MEPS and mandatory energy labels, and thresholds are very diverse for both. For room air conditioners there has been almost no attempt to harmonise efficiency thresholds for MEPS or labelling beyond national or regional programme boundaries (e.g., NAFTA, EU, China, Japan, Korea, Australia-New Zealand). A sole exception is the matching of the Australia-New Zealand MEPS requirements with Korea’s, as described below. The situation is similar for refrigerator-freezers except that several countries have harmonised their labelling efficiency threshold with the EU’s (Argentina, Iceland, Lichtenstein, Norway, Russia, South Africa, Tunisia and Turkey) and Australia-New Zealand have roughly aligned their MEPS with those applying in the United States.

Necessary steps

If, for the purposes of selective tariff liberalisation, a common energy-performance standard were to be developed for all or some of these products it would be necessary to establish common, or alternatively, convertible test standards, product descriptions, efficiency metrics, efficiency thresholds and revision schedules across countries. In an ideal situation the same common test procedures, product classes and efficiency thresholds would also be used for national energy labels and MEPS; however, for the reasons already discussed, a major international alignment effort would be required to bring this about. For some product types this would present a formidable challenge. For other products there have already been efforts to align efficiency requirements, and the route towards fully aligned liberalised tariff efficiency requirements would be much smoother. These efforts are discussed below.

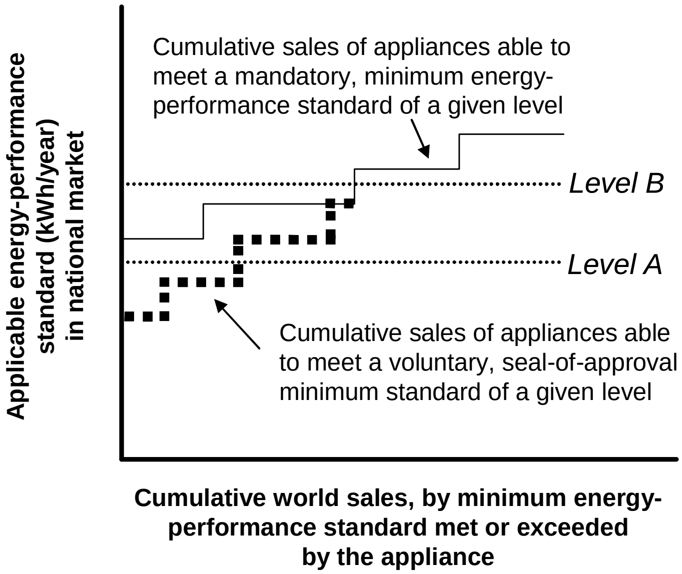
It is worth considering the interaction between a common energy performance standard applied for tariff liberalisation and existing national or regional efficiency

16. The same is broadly true of all office equipment, including, to a lesser extent than for computers, monitors, printers, photocopiers and fax machines. Consequently the vast majority of computers now comply with ENERGY STAR requirements.

requirements. In theory, differences in MEPS across countries could be allowed to continue. But under such conditions, and assuming that many MEPS would co-exist with mandatory or voluntary schemes for labelling appliances with higher levels of energy performance, reaching a collective decision on where to set a commonly used dividing line would, for many products, present a formidable challenge.

Figure 3.3 illustrates the situation that would confront negotiators. The vertical axis represents energy performance (improving as one moves closer to the origin), and the horizontal axis cumulative worldwide sales of the product in question, according to the energy performance that it must achieve at a minimum. The upper, solid, stepped line relates to mandatory MEPS; the lower, dashed, stepped line to a higher (in the sense of more difficult to achieve) voluntary standard. They are illustrative only; they are not based on the market for any particular appliance.

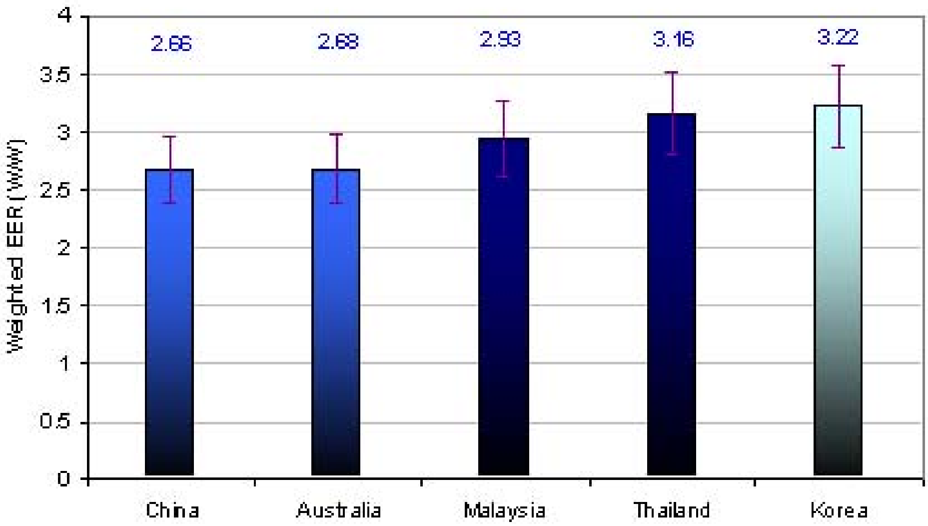
Figure 3.3. Choosing an international energy-performance reference standard



Negotiators might look to find an energy-efficiency criterion — a dividing line between two descriptions of an electrical appliance — that was equal to or exceeded the most-stringent MEPS applied by any participating country (level A in Figure 3.3). If the level was set to be less ambitious than the most stringent MEPS (level B), the country applying that MEPS might find itself accused of excessive strictness, given that the international community had ruled that a lower standard could be considered adequately "environmental". On the other hand, there may be cases in which a voluntary standard in one country, established for the purposes of a voluntary seal-of-approval label, has been set at a level lower (*i.e.* less stringent) than the MEPS set by another country. In that situation, setting an international reference standard at level A in Figure 3.3 could call into question the adequacy of any standards linked to seal-of-approval labels set below that level. The affected regulations and schemes could, of course, revise their energy-performance criteria. But that is usually difficult in the short term, since manufacturers will have designed their models to satisfy those criteria. These observations reflect the fact that national product markets are often not at similar efficiency levels and that the ambition of their MEPS and labelling requirements is likely to vary.

A concrete example of this is illustrated in Figure 3.4, which shows a recent analysis of the spread in energy-efficiency levels of room air conditioners sold in four Asian countries and Australia.

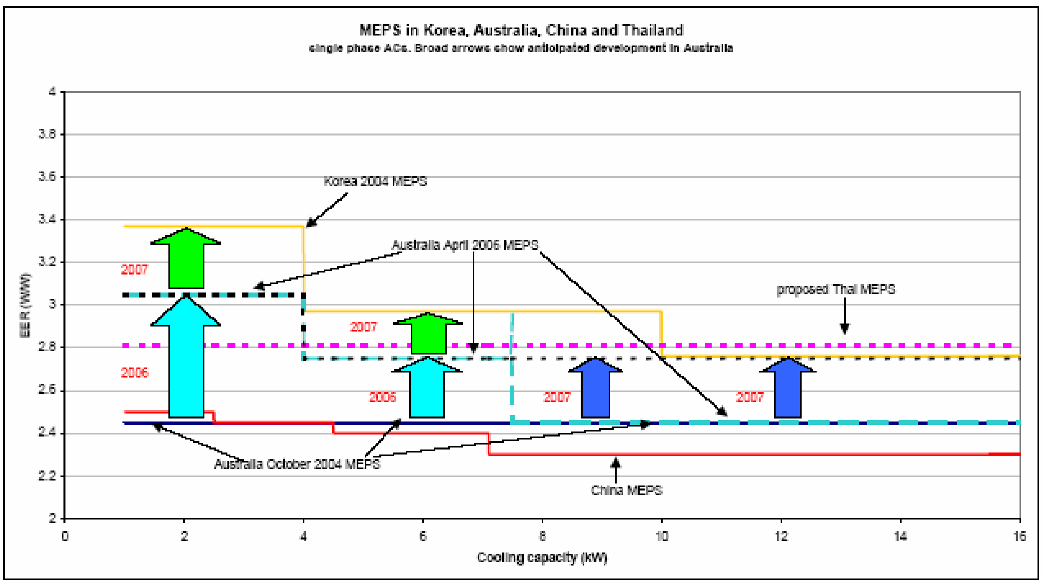
Figure 3.4. The average energy efficiency ratio (EER) upper and lower values of room air conditioners sold in five national markets



Source: DEM (2004).

The existing and proposed MEPS for room air conditioners in the same countries are shown in Figure 3.5.

Figure 3.5. Air conditioner MEPS in five national markets



Source: DEM (2004).

The process would not end once an international reference standard was established, however. The standard would likely be a moving target, requiring updating as technology evolved. Some institutional mechanism for reviewing and revising the standard would be required. As described in Steenblik (2005, p. 22), countries could agree to assign the task of reviewing the technical criteria to a WTO committee or technical working group. Such a body would presumably meet at regular intervals to consider the suitability of the current criteria (much as national standard-setting bodies responsible for updating specifications for energy-performance standards already do). Alternatively, for some products countries could decide, rather than duplicate work undertaken elsewhere, to agree simply to reference an established, recognised international standard, either private or public. They could even agree that the product specifications would automatically change as the standard is updated, thus obviating the need to create an entirely new international body of technical experts.

However, there are several potential drawbacks to such an approach. First, changes in the standard would have to be communicated to customs agents, and time allowed for their translation into local languages and procedural manuals. Second, relinquishing control of the key technical criteria of a product description to another body, particularly a private standardising body, could raise difficult issues. Not the least of these would be the question of what to do if some WTO members declared that they were not in agreement with a decision taken by the standardising body.

A "MEPS plus" approach

Because of all the problems related to differences among countries in how they have specified their MEPS and labels — the efficiency levels set, the associated standards for test procedures ("testing standards"), and the frequency with which MEPS, labels and testing standards are revised — the simplest way to introduce preferential tariff margins would be to make the threshold for lower tariff treatment a function of each country's national MEPS or labelling requirements and to implement it at the national (*i.e.* 8- or 10-digit) level. In the case of refrigerators, for example, countries could all agree to establish a standard that reflected, say, a 15% improvement over the minimum performance required by their own MEPS or upper efficiency thresholds applied in their energy labels. For countries that have already established MEPS or labels, or both, this approach would avoid the need to wait until national differences in MEPS and testing standards had been resolved.[17] The element of subsidiarity allows rapid agreement over the presumed common objective, to selectively favour efficient goods, while avoiding the difficulty of defining common efficiency thresholds.

A major problem with such a "MEPS plus" approach is that not all countries have established MEPS or labelling requirements for electrical appliances. While the number of countries with regulations or standards, or both, relating to the minimum energy performance of one or more electrical appliances is significant, and growing,[18] many countries, particularly less developed ones, have not yet developed such regulations or standards, and therefore may not have the means for verifying compliance with them. According separate tariff treatment to two versions of a product which is distinguished by

17. Individual countries always have the option of creating 8- or 10-digit national customs codes for relatively energy-efficient products, at some level above their corresponding MEPS values.

18. About 80% of the world's population live in countries that have defined or are in the process of defining such requirements at least for some product types.

characteristics that cannot be readily verified without testing would oblige an importing country: *i)* to accept the manufacturer's claims, or a testing facility used by the manufacturer, regarding the energy performance of the good; *ii)* to establish its own means for testing the energy performance of the product in question; *iii)* to send goods for testing to a third-party laboratory outside the country; or *iv)* to ignore energy-performance differences and apply the preferential tariff to *all* versions of the good.

Benefits from liberalising tariffs on energy-efficient goods

All of the foregoing presumes a certain logic. That logic maintains that creating tariff preferences favouring relatively energy-efficient appliances would reduce final consumer prices for the affected goods, thereby encouraging a shift in consumption patterns away from products that are relatively wasteful in their energy use. In addition, manufacturers would be expected to respond to the price changes by shifting the part of their output that is exported towards the more efficient models. The higher the current applied tariff in its export markets, the greater the magnitude of the "market pull" effect following liberalisation of trade in the more energy-efficient good. Partially offsetting these two effects would be the consequence of lowering life-cycle costs for operating any given appliance, which, all else equal and depending on the circumstances, could encourage some consumers to purchase more and larger-capacity appliances than they might have purchased prior to the tariff reductions.[19] While this effect is not likely to be large it also implies rising standards of living and hence is not inconsistent with economic development goals.

Accelerating tariff elimination for essentially nuisance tariffs would not substantially change relative prices between efficient and inefficient models in the developed world, however: tariff levels for household and office appliances are already low in most OECD countries (Table 3.5). It could still make a difference for some products for which demand is sensitive to even small changes in relative prices (*e.g.* through substitution effects). And it could be argued that differential tariffs — however small the differential — would still have symbolic value, and be seen to contribute to fulfilment of the Doha mandate. Moreover, tariff levels in developing countries for several major household appliance products are significantly higher than those of OECD countries, by as much as 20% or 30%. Given the robust demand forecasts for household and office appliances in these countries, differential tariffs between efficient and inefficient products would yield significant environmental benefits, via displaced pollution emissions from reduced energy consumption.

As it appears that the selective liberalisation of tariffs for energy-efficient goods is likely to have a much more significant impact on the market in less-developed and middle-income countries than in OECD countries, it is worth considering what the consequences of such a measure might be in terms of these countries' total imports. Tariffs for computers are quite low in most less-developed countries and average about 9.7%, but for other appliances the duties can be much higher. For example average tariffs

19. This notion is known as the *rebound effect* and has been much discussed in the literature. An in-depth literature review by Greening et al. (2000) examined econometric studies and direct measurements of the rebound effect for different sectors and major end uses. They found that the effect is very small (less than 10%) for residential appliances, residential lighting and commercial lighting, and less than 20% for industrial process uses. For residential space heating, water heating and automotive transport, they find the rebound effect is small to moderate (<10-40%). And for residential space cooling, they find the rebound effect is in the range of 0-50%. They conclude that, overall, the rebound effect ranges from very low to moderate.

are 24.5% for refrigerator-freezers, 24.9% for room air conditioners, 26.2% for fluorescent lamps and 17.7% for incandescent lamps.

Table 3.5. Tariffs of product imports, values of product imports and product energy-related imports for selected household appliances

Product and economy grouping	Weighted average import tariff[1] (% *ad valorem*)	Value of product imports[2] (USD ‘000)	Estimated energy-related imports[3] (USD ‘000)	Estimated total imports[4] (USD ‘000)	Ratio of energy to product imports (%)
Refrigerator-freezers					
Least developed	24.5%	54 128	58 029	112 157	107%
Middle income	22.3%	328 757	632 137	960 895	192%
Transitional	12.2%	125 976	158 811	284 787	126%
High income, non-OECD	3.8%	126 587	118 627	245 214	94%
OECD and EU	2.1%	2 352 811	1 015 124	3 367 935	43%
World weighted average	*4.9%*	*2 934 132*	*1 924 700*	*4 858 832*	*76%*
Room air conditioners					
Least developed	24.9%	177 671	231 508	409 180	130%
Middle income	17.5%	647 704	801 537	1 449 240	124%
Transitional	10.4%	119 047	120 735	239 781	101%
High income, non-OECD	2.5%	560 664	780 232	1 340 896	139%
OECD and EU	1.9%	1 618 881	526 845	2 145 726	33%
World weighted average	*5.8%*	*2 946 295*	*2 229 349*	*5 175 644*	*87%*
Fluorescent lamps					
Least developed	26.2%	28 397	54 748	83 145	193%
Middle income	14.4%	281 740	515 884	797 623	183%
Transitional	11.3%	23 650	28 391	52 041	120%
High income, non-OECD	2.4%	118 665	163 827	282 492	138%
OECD and EU	3.4%	1 107 236	938 376	2 045 612	85%
World weighted average	*5.4%*	*1 531 291*	*1 646 478*	*3 177 769*	*108%*
Incandescent lamps					
Least developed	17.7%	11 568	124 898	136 466	1080%
Middle income	15.6%	170 651	1 749 848	1 920 499	1025%
Transitional	14.7%	26 733	179 722	206 455	672%
High income, non-OECD	1.0%	39 696	306 901	346 597	773%
OECD and EU	3.8%	693 966	3 293 541	3 987 507	475%
World weighted average	*6.1%*	*931 047*	*5 530 011*	*6 461 058*	*594%*
PCs					
Least developed	9.7%	120 006	25 080	145 085	21%
Middle income	1.3%	896 483	177 934	1 074 417	20%
Transitional	3.5%	119 033	10 915	129 948	9%

Product and economy grouping	Weighted average import tariff[1] (% *ad valorem*)	Value of product imports[2] (USD '000)	Estimated energy-related imports[3] (USD '000)	Estimated total imports[4] (USD '000)	Ratio of energy to product imports (%)
High income, non-OECD	0.1%	132 869	10 008	142 877	8%
OECD and EU	0.3%	2 446 784	94 281	2 541 066	4%
World weighted average	*0.6%*	*3 595 169*	*293 139*	*3 888 308*	*8%*
Laptops					
LDCs	9.6%	160 530	7 681	168 212	5%
Middle income	1.2%	1 966 524	89 365	2 055 889	5%
Transitional	1.6%	104 870	1 875	106 745	2%
High income, non-OECD	0.1%	726 880	14 943	741 823	2%
OECD and EU	0.0%	27 262 508	286 705	27 549 213	1%
World weighted average	*0.1%*	*30 060 782*	*392 887*	*30 453 669*	*1%*

1. The tariffs applied to product imports weighted by their sales value.

2. The value of imports into the countries concerned in the year 2003.

3. The estimated value of the imports related to the energy use of the product over its useful lifetime.

4. The sum of columns 3 and 4.

In theory, selectively reducing tariffs for relatively energy-efficient products would encourage importing a greater share of efficient goods and perhaps also a greater share of such products. This latter factor could increase total imports. However, appliances also use energy, which is often imported. The electricity powering the appliances may be directly imported from another country, but is more often generated locally. In this case, it is highly probable that a significant proportion of the generation, transmission and distribution equipment is imported as well as the components used to maintain and repair the generation and distribution system. Fuel to power the plants is also often imported. For a typical developing country, importing 90% of the capital equipment needed for generating and distributing electricity and 70% of the fuel used to power the plants, average marginal imports would amount to roughly USD 0.05 per kWh of electricity consumed. If a typical refrigerator-freezer uses 525 kWh/year and lasts for 15 years, it would require additional capital and fuel imports valued at USD 405 over its lifetime. The appliance itself may only cost USD 200 to import, thus the energy-related imports would be more than twice the direct import cost of the product. If, for the sake of argument, the same product had an efficiency equivalent to the EU class A label rating, which now account for more than 50% of sales in Europe, it is likely to consume just 278 kWh/year, but would be slightly more expensive to import, say USD 277. This appliance would require energy-related imports over its lifetime of USD 214 and hence its total imports (direct plus energy-related) would be USD 491, compared with USD 605 for the traditional, less-efficient appliance. If the lower price encouraged 1.1 more-efficient appliances to be imported for each substituted appliance previously imported, the net import cost would be USD 540 per less-efficient appliance no longer imported, *i.e.* a net import saving of USD 65 per appliance.

The effect on competing domestically produced products of reducing tariffs on relatively energy-efficient goods will vary, depending on several factors. Generally, local manufacturers would see domestic prices fall for models they produce that meet or exceed the international reference standard, but they would continue to benefit from the price-supporting effects of the tariff on less efficient models, which are often less costly to produce. If most domestic consumers who purchase the good in question, say an air conditioner, use it sparingly and are therefore more influenced by capital costs than the discounted lifetime costs of the electricity needed to run it, they may not be persuaded to switch to more efficient models. Under such circumstances, it is possible that the reduction in price induced by the lower tariff might not be great enough to induce a corresponding shift in the domestic manufacturer’s production mix. However, if the domestically produced goods are considerably less efficient than goods that would qualify for a lower tariff, and the tariffs on both efficient and inefficient goods were previously high (*e.g.* 15% or more), there could be a significant shift to imports if local producers do not improve the energy efficiency of their products or reduce their prices, or both.

Aligning energy-performance standards and test procedures

Differences in technical regulations and standards can create barriers to trade in electrical appliances, and some countries are now working together to iron out those differences. Their efforts differ in scope and approach. Many countries already allow labels issued by another country to appear on appliances sold within their borders. Some are working to harmonise or align standards, including mandatory MEPS. A few have agreed to adopt another country’s (usually voluntary) standard. This generally involves, at the same time, adoption or alignment of related test procedures and review schedules. Other efforts are aimed at better understanding differences in test procedures, as the first step to aligning these bilaterally or within a region. A consequence is that international co-operation is increasing in several important areas, resulting in the emergence of *de facto* international standards in several large, regional markets. This section describes some of the ongoing bilateral and international efforts in this area.

Bilateral and regional agreements involving energy-efficiency

The ENERGY STAR programme forms the basis for several bilateral agreements, notably between the United States and, respectively, Australia, Canada, the European Union, Japan, New Zealand and Chinese Taipei. Under the general terms of these agreements, the ENERGY STAR label may appear on various products marketed in those countries. For example, in 2001, Canada agreed to promote the marketing of ENERGY STAR labels for a broad range of products, including office equipment, consumer electronics, heating and cooling equipment, home appliances, lighting and signage, distribution transformers, commercial solid-door refrigerators and freezers, and windows. Australia already refers to ENERGY STAR as an international standard for standby power,[20] though it uses its own Energy Rating Label for labelling energy-efficient major domestic appliances. The ENERGY STAR programme itself notes that international “partnerships are intended to unify voluntary energy-efficiency labelling programmes in major global markets”.

20. The Australian Greenhouse Office (www.energystar.gov.au) refers to ENERGY STAR as “an international standard for [stand-by power in] energy-efficient office equipment like computers, printers, photocopiers, and home electronics like TVs, VCRs, audio products and DVD players”. See also Australian Greenhouse Office, “Appliance Labelling” (www.greenhouse.gov.au/appliances/index.html).

In December 2000 the United States and the European Communities signed an administrative agreement on the co-ordination of labelling programmes for energy-efficient office products. Under the agreement, which initially remains in force until 2006, the ENERGY STAR programme is the recognised reference standard in the European Union for computers, monitors, printers, fax machines, copiers, scanners and multifunctional electrical office equipment. The European Union also shares responsibility with the US EPA for establishing and maintaining the efficiency metrics and thresholds applicable to office equipment under ENERGY STAR. Among the goals of the agreement is to stimulate international trade in (energy-efficient) office equipment, by adopting a single reference standard. Following the agreement, various national voluntary labelling programmes, such as Germany's Blue Angel, have adopted ENERGY STAR energy-efficiency criteria for computers and other appliances. In August 2004, three of the members of the European Free Trade Association (EFTA), Norway, Iceland and Liechtenstein, signed onto the ENERGY STAR programme for office equipment; they rely on the European Commission for programme implementation. In effect, the ENERGY STAR programme has emerged as the most prevalent international standard for office products in the world's two largest regional markets.

In late 2002, the North American Energy Working Group (NAEWG), comprised of representatives of the governments of Canada, Mexico and the United States, announced the "North American Energy Efficiency Standards and Labelling" initiative (NAEWG, 2002). One of the objectives of the initiative is to enhance co-operation for voluntary endorsement labels such as ENERGY STAR. Although the 2002 Energy Efficiency Report of the NAEWG does not explicitly identify the ENERGY STAR programme as the basis of harmonisation or a continent-wide energy-efficiency labelling programme, the ENERGY STAR programme is the only example cited in the context of harmonisation of standards.

Other notable regional harmonisation efforts include:

- In Europe, EU25 countries are working with new accession states (Bulgaria, Croatia, Romania and Turkey) to assist them in introducing EU appliance energy-performance regulations. This mirrors the process which took place for the ten new members prior to their becoming EU member states.
- Australia and New Zealand have a formal arrangement to develop common energy-efficiency requirements for energy-using products and apply harmonised test procedures.
- ASEAN countries are working together to develop a common regional endorsement energy label for energy-using products.
- Six countries in and around the Indian sub-continent have been co-operating under the auspices of the South Asian Regional Initiative programme to share experiences and possibly co-operate in the development of regional appliance efficiency requirements.
- Members of the ANDEAN pact countries are co-operating on a regional initiative to develop energy-efficiency labels and standards for energy-using appliances.
- A May 2003 workshop[21] sponsored by the International Energy Agency examined the rapidly rising energy consumption of television set-top boxes. The digital adapter (needed to convert digital video signals to analogue signals for existing televisions)

21. www.iea.org/Textbase/work/workshopdetail.asp?textfield=box&Submit2=Submit&id=103.

was identified as an internationally traded energy-using product that exhibited large variations in energy efficiency. A group of countries agreed to study the same efficiency specification. Since then four governments have adopted a nearly identical specification for use in their mandatory and voluntary efficiency programmes.

Informal bilateral agreements

In addition to the formal agreements between the EU and accession states, many other countries have voluntarily adopted some or all EU appliance efficiency regulations, including Norway, Switzerland, Russia, South Africa and Turkey. Many other countries have harmonised some parts of their appliance efficiency regulations with EU regulations, including Tunisia, Algeria, Egypt, Iran, China (for refrigerators), Australia (for ballasts), Colombia, Argentina and Brazil. In a similar manner Venezuela adopted US EnergyGuide requirements for refrigerators and room air conditioners.

The Australian MEPS programme is a particularly interesting example of how appliance efficiency requirements can be applied internationally and across different test procedures and product categorisations. The Australian Greenhouse Gas Office and National Appliance Energy Efficiency Committee have a policy of adopting the most stringent MEPS in place among their major international trading partners. Implementation of this policy usually requires addressing all the obstacles recounted above, namely converting international MEPS requirements into a common test procedure, product categorisation and efficiency metric. In this case all international requirements are converted into corresponding requirements under the Australia-New Zealand test procedure to enable a common comparison of stringency. The methodology applied is not always as accurate as would be expected if all products were tested under the same procedure, but is sufficiently robust for Australian MEPS policy to be established with some confidence that the product will conform to all relevant international MEPS requirements. Reports describing the conversion analyses applied are available at: www.energyrating.gov.au.

The Efficient Lighting Initiative

The Efficient Lighting Initiative was established in the mid-1990s and is implemented by the International Finance Corporation with funding from the Global Environment Facility (GEF). ELI works with lighting manufacturers, lighting wholesalers and retailers, electric utilities, the public sector, NGOs, and educational institutions to accelerate the growth of lighting markets through efficient, high-quality lighting technologies. ELI aims to reduce greenhouse gas emissions by increasing the use of energy-efficient lighting technologies. ELI operated through country-based programmes from 2000 to 2003 in seven countries: Argentina, the Czech Republic, Hungary, Latvia, Peru, the Philippines, and South Africa.[22] A part of this work involved the development of energy- and quality-performance specifications for energy-efficient lamps. Lamps certified as meeting these criteria are entitled to display the ELI logo on their packaging and promotions. Building upon the value created during programme implementation for the ELI product quality certification process and quality mark, the next generation of ELI is due to begin shortly and aims to expand the reach of the quality mark globally across the emerging markets.[23]

22. www.efficientlighting.net.

23. www.cecp.org.cn/englishhtml/showpage.asp?newsid=31.

The IEA's initiative on standby power

The International Energy Agency (IEA) has proposed a 1-watt target for standby power. Standby power for electrical equipment is the electricity consumed by appliances when they are nominally switched off (but still plugged in to an electrical socket) or not performing their primary function. Standby power consumption accounts for an increasing fraction of the world's energy use, and already represents 5–15% of residential electricity use in IEA member countries.

The IEA's open, co-ordinated international initiative has helped to transform the entire electronics market by stimulating manufacturers of products and components to use low-loss components and designs. Its proposed 1-watt target gained legitimacy when Australia formally endorsed the concept and, more recently, in July 2001, when the US president issued an executive order requiring the federal government to purchase products with low standby power consumption, preferably below 1 watt. Japan encourages its manufacturers, on a voluntary basis, to reduce the standby power consumption of the major household electrical appliances they produce. It recommends that appliances with equipment such as timers should be designed to consume less than 1 watt in standby mode, and that electricity consumption should be minimised to as close to zero as possible for all other products. In Europe, several codes of conduct have been proposed by the European Commission to the electronics industry to bring to the market only equipment with standby power below 1 watt.[24] China has recently imposed a 1 watt target for the standby power of TV sets sold there.

Testing and standards

Several efforts are under way at the regional level to reduce trade barriers caused by unnecessary differences in test methods. In North America, Canada, Mexico and the United States are co-operating to verify the test procedures for refrigerator-freezers and freezers, room air conditioners and electric motors. The NAEWG reports near-identical definitions, testing conditions and testing equipment in several product categories, though there are minor differences in test procedures for refrigerators, notably in product definitions, testing calculations and test standards.[25]

Because of the economic dominance of the US market in NAFTA, it is not surprising that test procedures used in Canada and Mexico are substantially similar to those used in the United States. Across more diverse regions, however, variations in test procedures can be large.

In the late 1990s, therefore, the APEC Steering Group on Energy Standards (SGES), one of ten such task groups reporting to the APEC Energy Working Group, was asked by APEC Energy Ministers to develop firm proposals for establishing a basis on which mutual acceptance of accreditation of energy-efficiency testing facilities and of the results of tests performed at these facilities could be achieved, and to work towards the establishment of bases of comparison of the outcomes of testing to different standards so as to reduce or eliminate the need to test to multiple standards. Several major studies were

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24. www.iea.org/Textbase/work/workshopdetail.asp?textfield=standby&Submit2=Submit&id=202.

25. Examples of differences in testing include minor differences in the temperate baseline used to distinguish refrigerator and freezer compartments. Mexico does not include chest or upright freezers in its adjustment factors. In testing procedures, the United States requires greater temperature measurement accuracy, while Mexico requires greater accuracy in measuring power consumption (NAEWG, 2002).

commissioned, and workshops held, to address this request. These efforts produced a detailed list of specific issues and recommended strategies.

One of the recommended strategies, to develop conversion algorithms, holds some promise for avoiding the need for full alignment of test methods. As described by EESA (1999a, p. 231):

> In its simplest form, a conversion algorithm is a simple “fudge” factor which will allow the measure of energy and/or performance under one test procedure to be converted to an equivalent and comparative value under a different test procedure without the need for additional retesting. In its most complex form, an algorithm could consist of a computer model which is used to simulate the performance and energy consumption under a range of conditions, including different test procedures, or conditions of actual use (say in a factory or household).

The potential benefits of developing acceptable algorithms would be large. Where feasible, a conversion algorithm would normally be much less expensive for manufacturers than laboratory testing, which in turn would reduce the costs of trade. A well-specified conversion algorithm could also provide a more accurate estimate of the impact of local usage patterns, produce a better ranking of products under conditions of actual use, and in some cases allow the retention of local or traditional test conditions. The latter alone would make comparing and aligning energy-performance standards much, much easier.

It is easier to create conversion algorithms for some electrical appliances than for others, and it may never be feasible for some. Table 3.6 summarises the findings of the 1999 study for the APEC Steering Group in respect of conversion algorithms for the four appliances discussed above. Although a conversion algorithm would be highly useful for refrigerators and freezers, its successful development remains elusive. Algorithms for florescent lamp ballasts (the test for light output is straightforward enough not to need a conversion algorithm) and standby power for personal computers are not necessary. But both the prospects for, and the utility of, conversion algorithms for air conditioners appear to be good.

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 do not keep 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 (1998), “unscrupulous manufacturers can, under certain conditions, lower the tested energy use by over 30% without a parallel drop in field use”. In his opinion, “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 harmonize their energy test procedures while addressing a serious technical shortcoming”.

Table 3.6. Prospects for developing conversion algorithms for translating the results of energy-performance testing

Appliance	Comments in the EEAS (1999a) study
Refrigerators and freezers	"Ultimately, a conversion algorithm (most likely a rather complex computer model with extensive calibration through physical tests) is the only medium-term prospect to avoid (at least in part) the myriad of test methods that currently exist. However, this is a complex and significant task and would require substantial resources merely to establish feasibility, let alone get it to an acceptable level of performance for regulatory purposes." (p. 250)
Air conditioners	"There are a number of computer models for air conditioners that are used to simulate energy and performance and there is also extensive testing of air conditioners. What appears to be missing is the linking of the two aspects to provide a much more flexible and accurate tool for both energy regulations, modelling and analysis."
Fluorescent lamp ballasts	"If a suitable IEC [International Electrotechnical Commission] standard can be successfully developed, this test method would be already suitable for a range of purposes and conditions and would "characterise" the product to the extent that is required in the market place. Therefore, the development of a conversion algorithm is probably not necessary or recommended for this product (if the new IEC test method is deemed to be acceptable)."
Personal computers	"There is probably no need for a conversion algorithm given the largely uniform approach for testing these products to date. The other issue is that much of the measurement required for these products relates to standby or sleep mode energy consumption, rather than the energy consumed during normal operation (therefore measurement of performance is not required)." (p. 251)

Concluding observations

This chapter considers the feasibility of using energy efficiency as a basis for defining groups of household and electrical appliances as "environmental goods". The results suggest that feasibility depends on several factors, including the characteristics of the technology or the appliance itself, and its susceptibility to categorisation on the basis of relevant energy performance and the characteristics of relevant testing procedures and applicable regulations. While harmonisation of standards would simplify the task in some respects, the process of standards harmonisation itself introduces various issues. This chapter does not address the feasibility or appropriateness of various approaches to improving and harmonising energy performance or other matters of general trade and energy policy.

Some energy-efficient products, such as LCD monitors and CFLs, could be differentiated easily on the basis of their physical characteristics alone. For others, it is necessary to apply an energy-efficiency threshold that is gauged according to an energy-efficiency metric determined through energy-performance formulae and verified by testing. Among these, there are products whose energy test procedures, product categorisation, efficiency metrics and required efficiency thresholds are similar enough to make it feasible to devise a common set of requirements for determining their entitlement to a liberalised tariff. There are other products for which many aspects of the test procedure, product categorisation and efficiency metrics are similar, or could be expressed in a comparable manner across regions, but for which the efficiency thresholds currently applied are very different from one market to another. These differences in efficiency requirements often reflect significant differences in the price of energy and the way the product is used from one region to another which determine the efficiency level at which the product is most cost-effective for the consumer.

Of course, even if product descriptions were harmonised and every country adopted the same international standards for test procedures, differences in the levels at which mandatory and voluntary standards for minimum energy performance are set would likely remain. Even if countries agreed to proceed along these lines on relatively energy-efficient electrical appliances and these products could be differentiated for tariff purposes from less-efficient appliances, on the basis of their compliance with a country's MEPS or labelling requirements or on the basis of their compliance with an internationally agreed minimum energy-performance standard, a number of specific issues would still need to be addressed.

For refrigerators, clothes washers and a few other products exhibiting large regional variations in design features, use patterns, testing procedures and MEPS or labelling requirements, differentiating more from less efficient models at the multilateral level is achievable only over the longer term. Even for this category of electrical appliances, however, opportunities for trade would be improved by continuing or even strengthening international efforts to align test procedures (or develop conversion algorithms), and perhaps product descriptions, if not the actual levels at which mandatory energy-performance standards are set. To date, only a few bilateral and regional efforts to encourage alignment of national test procedures and energy-performance standards have been successful.

It is important to keep trade policy options in perspective. Trade policy, to the extent that it may be enlisted to support trade in energy-efficient goods, can only play a secondary role in promoting energy efficiency. The current multiplicity of national efficiency standards and labelling schemes may itself act in a manner similar to non-tariff barriers and in fact be more important. Non-uniform standards create diseconomies of scale, especially for small and medium-sized enterprises in developing countries seeking to access foreign markets. Further progress in international co-operation would be welcome, and could help to address one element of the Doha mandate on environmental goods: namely, reducing or eliminating non-tariff barriers on environmental goods and services. Needless to say, for such an exercise to effectively address market-access concerns, developing countries would need to be partners and active participants from the outset.

Annex 3.A1

Regulations and Standards for Cold Appliances: Refrigerators, Freezers and Combinations thereof[26]

Summary of current regulations

Table 3.A1.1. Economies that have established, or are considering establishing MEPS and/or labelling schemes for household refrigeration appliances

Economy	Refrigerators and refrigerator-freezers			Freezers		
	MEPS[1]	Labels		MEPS[1]	Labels	
		Compare	Approve		Compare	Approve
Algeria	**M**[1]	**M**[1]		**M**[1]	**M**[1]	
Argentina	UC	**M**[1,2]		UC	**M**[1,2]	
Australia	**M**[5]	**M**[5]	V	**M**[5]	**M**[5]	V
Bolivia	UC	UC		UC	UC	
Brazil	UC	V[3]	V	UC	V[3]	V
Bulgaria	UC[2]	UC[2]	UC[2]	UC[2]	UC[2]	UC[2]
Canada	**M**[4]	**M**[4]	V[4]	**M**[4]	**M**[4]	V[4]
Chile	UC	UC	UC	UC	UC	UC
China	**M**[3]	**M**[3]	V	**M**[3]	**M**[3]	V
Colombia	**M**[1]	**M**[3]		**M**[1]	**M**[3]	
Costa Rica	V	**M**		V	**M**	
Croatia	UC[2]	UC[2]	UC[2]	UC[2]	UC[2]	UC[2]
Ecuador	UC	UC		UC	UC	
Egypt	UC	UC[3]		UC	UC[3]	
EU25	**M**	**M**	V	**M**	**M**	V
Ghana	UC	UC[2]		UC	UC[2]	

26. The following four annexes will be extended in a separate working paper, available on the Web, in the OECD Trade and Environment Working Paper series. In addition to what is included in Annexes 4.A1 to 3.A4, the following elements will also be covered for each product considered:

- Lists of the main energy performance test procedures applied in the various economies with energy-performance requirements.
- When relevant, descriptions of key differences in the energy test procedures.
- Descriptions of the product category definitions and energy-efficiency metrics applied in the main economies (China, EU, Japan and NAFTA)
- Descriptions and/or formulae defining the efficiency thresholds applied in the main economies (China, EU, Japan and NAFTA).

Economy	Refrigerators and refrigerator-freezers			Freezers		
	MEPS[1]	Labels		MEPS[1]	Labels	
		Compare	Approve		Compare	Approve
Hong Kong, China	UC	V	V	UC		V
Iceland	**M**[2]	**M**[2]	V[2]	**M**[2]	**M**[2]	V[2]
India	**M**	(V)	V			
Indonesia	UC	V	V			
Iran	**M**	**M**[3]				
Israel	**M**	**M**[3]		**M**	**M**[3]	
Jamaica		**M**			**M**	
Japan	**M**[6]	**M**		**M**[6]	**M**	
Korea	**M**	**M**		**M**	**M**	
Lichtenstein	**M**[2]	**M**[2]	V[2]	**M**[2]	**M**[2]	V[2]
Malaysia		(M)			(M)	
Mexico	**M**[4]	**M**[4]	V	**M**[4]	**M**[4]	V
New Zealand	**M**[5]	**M**[5]		**M**[5]	**M**[5]	
Norway	**M**[2]	**M**[2]	V	**M**[2]	**M**[2]	V
Peru	UC	UC		UC	UC	
Philippines	UC	**M**		UC	**M**	
Romania	UC[2]	UC[2]	UC[2]	UC[2]	UC[2]	UC[2]
Russia	**M**	M[2]		**M**	M[2]	
Singapore			V			V
South Africa	UC	M[2]		UC	M[2]	
Switzerland		V[2]	V		V[2]	V
Chinese Taipei	**M**		V			V
Thailand	M	M	V			
Tunisia	**M**[3]	**M**[3]		**M**[3]	**M**[3]	
Turkey	UC[2]	**M**[2]	UC[2]	UC[2]	**M**[2]	UC[2]
United States	**M**	**M**	V	**M**	**M**	V
Uruguay	UC	UC		UC	UC	
Venezuela	V[4]	**M**[4]		V[4]	**M**[4]	
Vietnam	UC	UC		UC	UC	

1. Framework legislation is passed but the implementing legislation is believed to still be under consideration.

2. Harmonised with EU.

3. Partially harmonised with EU.

4. Partially or fully harmonised with United States.

5. Harmonised between Australia and New Zealand.

6. Japan requires the sales-weighted average efficiency of any suppliers’ appliances to exceed a prescribed efficiency threshold. These requirements are mandatory but fines for non-compliance are very low and therefore they are sometimes described as voluntary targets; nonetheless, being named and shamed for non-compliance is likely to have severe consequences in the Japanese marketplace and hence is thought to be an adequate deterrent by Japanese regulators.

Source: IEA and OECD, based on various sources. **M** = Mandatory, V = voluntary, UC = under consideration

Annex 3.A2

Regulations and Standards for Air Conditioners

Summary of current regulations

Table 3.A2.1. Economies that have established, or are considering establishing, MEPS and/or labelling schemes for room air conditioners

Economy	Type of air-conditioner					
	Single packaged (window)			Split or multi-split		
	MEPS	Label		MEPS	Label	
		Compare	Approve		Compare	Approve
Algeria	**M**[1]	**M**[1]		**M**[1]	**M**[1]	
Argentina	UC	**M**[1,2]		UC	**M**[1,2]	
Australia	**M**[5]	**M**[5]	V	**M**[5]	**M**[5]	V
Bolivia	UC	UC		UC	UC	
Brazil		V	V		V	V
Bulgaria		UC[2]	UC[2]		UC[2]	UC[2]
Canada	**M**[4]	**M**[4]	V[4]	**M**[4]	**M**[4]	V[4]
China	**M**	**M**	V	**M**	**M**	V
Colombia	**M**[1]	**M**[3]		**M**[1]	**M**[3]	
Costa Rica	V	**M**				
Croatia		UC[2]	UC[2]		UC[2]	UC[2]
Ecuador	UC	UC		UC	UC	
Egypt	UC	UC[3]		UC	UC[3]	
EU25	UC	**M**	UC	UC	**M**	UC
Ghana	**M**			**M**		
Hong Kong, China		V			V	
Iceland		**M**[2]	UC[2]		**M**[2]	UC[2]
India	UC	UC		UC	UC	
Indonesia	UC	V		UC	V	
Iran	**M**[7]	**M**[7]				
Israel	**M**	**M**[3]		**M**	**M**[3]	
Japan	**M**[6]	**M**		**M**[6]	**M**	
Korea	**M**	**M**		**M**	**M**	
Lichtenstein		**M**[2]	UC[2]		**M**[2]	UC[2]
Malaysia	UC	UC		UC	UC	
Mexico	**M**[4]	**M**[4]	V	**M**[4]	**M**[4]	
New Zealand	**M**[5]	**M**[5]		**M**[5]	**M**[5]	
Norway		**M**[2]	UC[2]		**M**[2]	UC[2]
Peru	UC	UC		UC	UC	
Philippines	**M**	**M**		**M**	**M**	
Russia	**M**	UC[1,2]		**M**	UC[1,2]	
Saudi Arabia	**M**			**M**		

Economy	Type of air-conditioner					
	Single packaged (window)			Split or multi-split		
	MEPS	Label		MEPS	Label	
		Compare	Approve		Compare	Approve
Singapore	**M**		V			V
South Africa		UC[2]			UC[2]	
Switzerland		V[2]			V[2]	
Chinese Taipei	**M**		V	**M**		V
Thailand	UC	V	V	UC	V	V
Tunisia	UC	UC		UC	UC	
Turkey		UC[2]	UC[2]		UC[2]	UC[2]
United States	**M**	**M**	V	**M**	**M**	V
Venezuela	V[4]	V[4]		V[4]	V[4]	
Vietnam	UC	UC		UC	UC	

1. Framework legislation is passed but the implementing legislation is believed to still be under consideration.

2. Harmonised with EU.

3. Partially harmonised with EU.

4. Partially or fully harmonised with United States.

5. Harmonised between Australia and New Zealand.

6. Japan requires the sales-weighted average efficiency of any suppliers' appliances to exceed a prescribed efficiency threshold. These requirements are mandatory but fines for non-compliance are very low and therefore they are sometimes described as voluntary targets; nonetheless, being named and shamed for non-compliance is likely to have severe consequences in the Japanese marketplace and hence is thought to be an adequate deterrent by Japanese regulators.

7. Iran has specifications for evaporative coolers not air conditioners as such.

Source: IEA and OECD, based on various sources. **M** = Mandatory, V = voluntary, UC = under consideration.

Annex 3.A3
Regulations and Standards for Compact Fluorescent Lighting

Summary of current regulations

Table 3.A3.1. Economies that have established, or are considering establishing MEPS and/or labelling schemes for CFLs

Economy	MEPS	Label	
		Compare	Approve
Argentina		**M**[1,2]	V
Australia	**M**[5]		V
Brazil			V
Bulgaria		UC[2]	UC[2]
Canada	**M**[4]		V[4]
China	**M**	UC	V
Colombia	**M**[1]	**M**[3]	
Costa Rica	V	**M**	
Croatia		UC[2]	UC[2]
EU25		**M**	V
Ghana	UC		
Hong Kong, China			V
Iceland		**M**[2]	V[2]
Indonesia	UC		
Israel	**M**	V	
Japan	**M**[6]	**M**	
Korea	**M**	**M**	V
Lichtenstein		**M**[2]	V[2]
Malaysia	M[7]	UC	
Mexico	**M**[4]		V
New Zealand	**M**[5]		V
Norway		**M**[2]	V[2]
Peru		UC	V
Philippines		**M**	V
Russia		UC[1,2]	
Singapore			V
South Africa		UC[2]	V
Sri Lanka		V	
Switzerland		V[2]	
Chinese Taipei	**M**		V
Thailand	UC	V	V
Tunisia	UC	UC	
United States	**M**		V
Vietnam	UC	UC	

1. Framework legislation is passed but the implementing legislation is believed to still be under consideration.
2. Harmonised with EU.
3. Partially harmonised with EU.
4. Partially or fully harmonised with United States.
5. Harmonised between Australia and New Zealand.
6. Japan requires the sales-weighted average efficiency of any suppliers' appliances to exceed a prescribed efficiency threshold. These requirements are mandatory but fines for non-compliance are very low and therefore they are sometimes described as voluntary targets; nonetheless, being named and shamed for non-compliance is likely to have severe consequences in the Japanese marketplace and hence is thought to be an adequate deterrent by Japanese regulators,
7. For ballasts used with fluorescent lamps only.

Source: IEA and OECD, based on various sources. **M** = Mandatory, V = voluntary, UC = under consideration

Annex 3.A4

Regulations and Standards for Personal Computers

Summary of current regulations

Table 3.A4.1. Economies that have established, or are considering establishing MEPS and/or labelling schemes for personal computers

Economy	MEPS	Label	
		Compare	Approve
Australia			V[2]
Bulgaria			UC[1,2]
Canada			V[2]
China			V
Croatia			UC[1, 2]
EU25			V[2]
Hong Kong, China			V
Iceland			V[1, 2]
Japan	**M**[3]		V[2]
Korea	**M**		V[2]
Lichtenstein			V[1, 2]
New Zealand			V[2]
Norway			V[1, 2]
Russia	**M**		
Singapore			V
Switzerland	**V**		V
Chinese Taipei			V
Thailand			V
United States			V
Vietnam			UC

1. Harmonised with EU.

2. Partially or fully harmonised with United States.

3. Japan requires the sales-weighted average efficiency of any suppliers' appliances to exceed a prescribed efficiency threshold. These requirements are mandatory but fines for non-compliance are very low and therefore they are sometimes described as voluntary targets; nonetheless, being named and shamed for non-compliance is likely to have severe consequences in the Japanese marketplace and hence is thought to be an adequate deterrent by Japanese regulators.

Source: IEA and OECD, based on various sources. **M** = Mandatory, V = voluntary, UC = under consideration.

Annex 3.A5

Glossary

Appliance category	A group of appliance models with similar technical characteristics from the perspective of their user utility.
Categorical energy label	An energy label that classifies product efficiency into one of several classes. Examples of categorical labels include the EU’s energy labels which rank efficiency from A to G and Australia’s energy label which ranks efficiency from 1 to 6 stars. Brazil, China, India, Iran, Korea, Thailand and Tunisia, among others, have developed categorical energy labels.
Endorsement energy label	A voluntary energy label which entitles the supplier of an appliance that meets some minimum energy performance requirement to apply the label to its products.
Energy efficiency ratio (EER)	A measure of the relative efficiency of a heating or cooling appliance, such as an air conditioner, that is equal to the unit’s thermal output divided by its consumption of energy. The units used to measure the thermal output and energy input may vary from one economy to another although international test standards measure both in watts.
MEPS	Minimum energy-performance standards (some times known as minimum energy-efficiency standards).
Test standard	A standard that sets out a test method but does not indicate what result is required when performing the test.

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