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Deploying Energy-Efficiency and Renewable-Energy Technologies in Residential and Commercial Buildings

What are the Trading Opportunities for Developing Countries?

By **Rene Vossenaar,** Independant Consultant
Veena Jha, Warwick University

ICTSD Global Platform on Climate Change, Trade and Sustainable Energy

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Issue Paper No. 11

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LIST OF ABBREVIATIONS AND ACRONYMS

ACEEE	American Council for an Energy Efficient Economy
BAFA	Federal Office of Economics and Export Control (Germany)
BAT	Best available technology
CFL	Compact fluorescent lamp
CN	Common Nomenclature (European Communities)
ECBC	Energy Conservation Building Code (India)
EE	Energy efficiency
ESCO	Energy service company
HPS	High pressure sodium (lamp)
ETP	Energy Technology Perspectives (published by the IEA)
EuP	Energy-using product
FiT	Feed-in Tariff
GDP	Gross domestic product
GHG	Greenhouse gas
GHP	Geothermal heat pump
GEF	Global Environmental Facility
GwH	Gigawatt hour
HTSUS	Harmonized Tariff Schedule of the United States
HVAC	Heating, ventilation and air conditioning
HVAC-R	Heating, ventilation, air conditioning and refrigeration
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
LED	Light-emitting diode
MAP	Market Incentive Program (Germany)
MEPS	Minimum energy performance standard
PV	Photovoltaic
REHC	Renewable-energy heating and cooling
SEER	Seasonal energy efficiency ratio
SWH	Solar water heating
TERI	The Energy and Resources Institute
WITS	World Integrated Trade Solution (World Bank software developed in close collaboration with UNCTAD)

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FOREWORD

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

While Paragraph 31 (iii) of the Doha mandate calls for a reduction, or as appropriate, elimination of tariffs and non-tariff barriers (NTBs) on EGS, the lack of a universally-accepted definition on EGS has meant that trade delegates have struggled over the scope of goods and services that could be taken up for liberalization. Furthermore, while the aim of the EGS mandate is to liberalize, it provides no indication of the pace, depth or sequencing of liberalization vis-à-vis 'other' goods and services. A major fault line in the negotiations on environmental goods is the dispute over whether only goods intended solely for environmental protection purposes should be included, or if other goods that may have both environmental and non-environmental uses should also be incorporated. A number of developing countries are concerned about the inclusion of goods which they perceive to be only vaguely linked to environmental protection. They are also concerned about the import-led impacts of including a broad range of industrial goods on their domestic industries, employment and tariff revenues. In a broader context, a lack of movement on issues of interest to developing countries, particularly agriculture, also inhibits proactive developing country engagement in EGS negotiations.

Particular attention has been focused on the challenges of climate change and the widespread diffusion of climate-friendly technologies which are viewed as critically important in addressing these challenges. To the extent that the WTO negotiations on EGS can help identify and liberalize specific climate-friendly goods and services, they can enhance their wider diffusion. In the WTO context a number of challenges exist, as they do with many other environmental goods in identifying specific climate-friendly goods. This is partly related to the way climate-friendly goods are classified for the purposes of international trade negotiations and also to the fact that the same goods may have other uses in addition to climate-mitigation. Political economy considerations surrounding international trade negotiations indicate that it is will not be easy to liberalize any good or service even if it is important to climate change, and if doing so will also impact a broad range of industries in producing countries. Furthermore, trade-liberalization done in isolation may not necessarily generate greater trade flows in climate-friendly goods and services if the right policies and incentives that drive markets in these goods and services are missing. Hence, it would also be useful to identify the key market drivers of these goods and services that are related to domestic regulatory policies and measures.

In order to enable a better understanding of the patterns of trade flows and market drivers for climate-friendly technologies and associated goods, it is important as a first step to map the key ones in a number of sectors. This paper by Mr. Rene Vossenaar and Dr. Veena Jha builds on a mapping exercise of climate-friendly technologies and associated goods in the residential and commercial buildings sector carried out by experts from the Energy and Resources Institute(TERI), India and their subsequent classification under the Harmonised System (HS) customs codes at the 6-digit level undertaken by Mr Izaak Wind, an expert and former Deputy-Director at the World Customs

Organisation (WCO). Similar mapping studies and customs classification exercises have already been carried out for climate-friendly technologies and associated goods in the renewable energy supply and transport sectors in order to feed into subsequent trade analyses for these sectors.

This paper highlights the challenges involved in accurately identifying and classifying for trade-statistics purposes many of the energy-efficient goods used in the buildings sector. It also underscores the importance of policy interventions, regulations and incentives as a major driver of technology deployment, and in some cases, as a major determinant of international trade flows in these goods. Consequently, enhanced trade and market creation for these goods require, in addition to low tariffs at the border, the existence of these regulations and incentives. Incentives are particularly important as the high cost for a number of renewable energy and energy-efficiency technologies associated with the buildings sector constrain market diffusion. The paper shows the main exporting and importing countries for equipment associated with key categories of building technologies as well as the prevailing tariff-levels for these. The paper concludes that in order to promote a significant uptake of renewable energy and energy-efficiency technologies in residential and commercial buildings, trade-liberalisation will need to be complemented by an integrated national policy for energy-efficiency and renewable energy generation in the buildings sector supported by international cooperation in technological knowledge-sharing, financing and capacity-building. Policy coordination and collaboration, for instance in the case of standards, can also enable international trade to contribute meaningfully to global market transformation.

Mr. Rene Vossenaar is from the Netherlands and presently lives in Brasilia, Brazil. He worked for the Economic Commission for Latin America and the Caribbean (ECLAC) and also served as the Head of the Trade, Environment and Development Branch at the United Nations Conference on Trade and Development (UNCTAD). Since his retirement in March 2005, he has carried out work for UNCTAD and other institutions as an independent consultant.

Dr. Veena Jha is a Visiting Professorial Fellow at the Institute of Advanced studies, University of Warwick, UK, and a research fellow at the International Development Research Centre, Canada. In addition, she is the Executive Director of Maguru Consultants Limited, London, UK. She has worked with the United Nations in various capacities for over twenty years. She was the Coordinator of an important UNCTAD/ DFID/Government of India initiative on ‘Strategies and Preparedness for trade and Globalisation in India’. She has published twelve books on trade and development issues, articles in journals, and was a member of some consensus-building initiatives on trade and environment issues in the last decade. She has been a member of several national and international Advisory Boards, notably the United Nations Secretary General’s Task Force on Millennium Development goals. She has served as an expert on technical committees of the Government of India, industry associations, and non-governmental organisations on trade and development issues.

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

Ricardo Meléndez-Ortiz
Chief Executive, ICTSD

EXECUTIVE SUMMARY

Among all sectors studied by the Intergovernmental Panel on Climate Change (IPCC) in its *Fourth Assessment Report*, the building sector has the greatest potential to cost-effectively reduce GHG emissions (by 2020) based on commercially available technologies. Improving energy efficiency (EE) presents the largest and most cost-effective mitigation opportunity. Further emissions reductions can be achieved by increasing renewable-energy (RE) use in buildings.

Many EE technologies applied in residential and commercial buildings produce a net economic benefit, i.e. the additional resources invested upfront can be recouped from lower energy spending in the future. Much of the potential for improving EE, however, remains untapped due to the existence of market barriers, such as lack of proper incentives and limited access to financing. The high costs of some RE energy technologies constitute a barrier to their deployment in the absence of subsidies.

A wide range of policy interventions can be implemented to help overcome market barriers and promote the deployment of climate-friendly technologies. These include adjustments in EE requirements in building codes; minimum energy performance standards (MEPS); labeling; a wide array of fiscal and financial incentives (such as low-interest loans, tax credits and subsidies); and feed-in tariffs (FiTs) to stimulate residential renewable electricity generation.

Regulations and incentives have been the major drivers of technology deployment and, in some cases have been a major determinant of international trade flows. For example, international trade in solar PV cells and modules has been driven largely by FiTs, particularly in Spain and Germany. Import tariffs have been a less important factor affecting the deployment of climate-friendly technologies and trade in associated products and components.

Linking Climate-Friendly Technologies with Trade

International trade can contribute to national and international efforts to promote the diffusion of climate-friendly technologies and components in the building sector. First, trade liberalization may help to reduce emissions by making climate-friendly technologies and components cheaper and more readily available, particularly in developing countries. Second, trade and foreign direct investment (FDI) can help promote market transformation (i.e. by increasing the market penetration of climate-friendly technologies and components).

This paper focuses largely on the first link, particularly the question of how the WTO negotiations on Environmental Goods and Services (EGS), which seek to reduce tariff and non-tariff barriers, could contribute to the wider deployment of climate-friendly technologies in the building sector, especially in developing countries. It addresses a number of questions, including: What are the key drivers of technology deployment in different segments of the building sector? Which products and components could be included in the EGS negotiations, taking into account conceptual and pragmatic considerations (including the use of tariff schedules)? Which countries are key exporters and importers of products and components associated with climate-friendly technologies in the building sector? What is the role of trade liberalization vis-à-vis other policy measures?

The paper builds on a technology-mapping study prepared for ICTSD by the The Energy and Resources Institute (TERI), which analyses a wide range of technologies (both commercially available technologies and technologies still requiring research and development). The analysis focuses on the use of technologies (rather than non-technical options, such as changes in occupant behaviour) as a major determinant of energy use and GHG emissions in buildings, more specifically in the following areas: the building envelope (buildings insulation products); heating, ventilation, air conditioning and refrigeration (HVAC-R); lighting; the active collection and transformation of solar energy in buildings; stoves and appliances.

Most technologies seek to enhance EE. However, negotiating trade liberalization based on EE criteria entails significant conceptual and practical challenges. This implies that several product groups, several of which are heavily traded (such as appliances) might not be suitable for EGS negotiations. Nevertheless, certain technologies and products that aim to improve EE may, in principle, be included in the EGS negotiations. These include, for example, insulation products; lighting (there are designated HS codes for efficient light bulbs) and certain components (e.g. for electronic control, such as programmable thermostats).

Negotiating trade liberalization in RE technologies and their components generally poses fewer conceptual problems. Solar energy technologies are discussed in detail in earlier studies prepared for ICTSD on renewable-energy supply (Lako (2008) and Jha (2009)). Some of these technologies, however, are installed mainly on the rooftops of buildings and are, therefore, considered as part of the building sector. These include solar PV panels for electricity generation and solar water heating (SWH) largely for hot-water preparation and space heating. Other technologies include small-scale renewable-energy heating and cooling (REHC) systems, such as geothermal heat pumps and wood-pellet stoves.

It is difficult to estimate international trade flows associated with residential and commercial buildings. However, trade associated with subsectors that, in accordance with the analysis presented above, may, in principle, be relevant in the context of the EGS negotiations (i.e. insulation, lighting, certain components and RE technologies) probably represent only about ten to fifteen percent of the value of total international trade associated with residential and commercial buildings. This is because other segments of the building sector (in particular appliances) are far more important from a trade point of view.

A large part of this paper discusses practical issues related with the identification of items in existing tariff schedules (in particular the Harmonized System (HS)) that may provide an identification of the value and direction of trade flows driven by the deployment of climate-friendly technologies in the building sector. Yet, tariff classifications provide only limited information. First, tariff classifications provide insufficient information to allow for an analysis of most EE technologies (additional information would be required, e.g. through an energy-efficiency label). Given the key role of EE technology as a climate-mitigation option in the building sector, this is a serious constraint. Second, many 6-digit HS codes include unrelated products (the “ex-out” issue). For example, solar and wood-pellet stoves are assigned to 6-digit HS codes for stoves, but represent only a small portion of trade covered by the HS item. Third, products associated with climate-friendly technologies also have other uses (the multiple-use issue). For example, plastic foams may be used not only for building insulation, but also for other applications. Where “ex-out” and “multiple-use” are involved, expert opinions and industry surveys would normally be needed to assess the extent to which trade in a particular 6-digit HS item could be assumed to be driven to a reasonable extent by demand generated by the deployment of climate-friendly technologies. This paper attempts to make classification problems and their possible implications more transparent, for example, by examining more detailed regional and national tariff classification and by using more detailed import statistics of key importing countries as an indication of exports of other countries.

For illustrative purposes, and taking into account the limitations of the use of tariff classifications, ten products (6-digit HS codes) have been selected for a more detailed trade and tariff analysis. These include selected insulation materials (i.e. those that are used mainly in the building sector);

energy-efficient lamps; certain components; stoves; PV modules and solar water heaters. Most of these products have a predominantly environmental end-use.

For most products, the simple average of tariffs applied on a most-favoured nation (MFN) basis is in the five to ten percent range, but some developing countries have relatively high applied rates. Although tariff reductions alone will have little impact on the deployment of climate-friendly technologies, in certain cases tariff reductions may facilitate the implementation of EE and RE strategies. For example, tariffs facing insulation materials are not very high, but may nevertheless be a relatively important cost element. Some developing countries have relatively high tariffs for compact fluorescent lamps (CFL), although these countries in general apply similar tariffs to other lamps. Import tariffs, however, have very little impact on international trade in RE products and components. PV cells and modules (by far the most important technology from a trade perspective) already enter most markets at zero MFN rates. The simple average of applied rates is only about one and a half percent and the trade-weighted average is close to zero. In the case of solar water heaters (included in HS 841919), several countries have relatively high tariffs, but trade-weighted average tariffs are low.

Beyond the EGS negotiations, trade can help promote market transformation. For example, an analysis of trade flows for the period 2002-2008 shows that the share of energy-efficient lamps in total world trade in lamps has been growing. China is the world's largest exporter of CFL and has played an important role in market transformation. Multilateral efforts to help developing countries set up certification mechanisms for high-quality products have also been a significant factor.

Conclusions and Policy Recommendations

There is significant potential to cost-effectively reduce GHG emissions in residential and commercial buildings through the larger deployment of best available technologies.

Trade liberalization alone is unlikely to stimulate a significant uptake of EE and RE technologies in residential and commercial buildings in developing countries. Trade liberalization, however, may be effective if it is implemented as part of an integrated national policy to promote EE and RE generation in the building sector supported by international cooperation in sharing knowledge of the technologies and their components, financing and capacity-building. For example, developing countries need to strengthen or develop EE requirements in building codes and establish standards for household electrical appliances that are likely to become more popular as incomes increase. In addition, developing countries need to strengthen local capacities, including through better quality control, the strengthening of capacities of small and medium-sized enterprises (SMEs) and the development or strengthening of supply chains and distribution channels.

The deployment of climate-friendly technologies and international trade in associated products is driven largely by regulations and incentives. For example, trade in PV equipment has been driven largely by FiTs in key import markets. Subsidies may be justified on the basis of infant-industry arguments and for achieving the economies of scale that are necessary to decrease costs, in particular of RE technologies, but should be phased out over time to stimulate technological progress and reduce costs. Subsidies and other incentives should not be implemented in a way that may adversely affect the possibilities for developing country suppliers to participate in global supply chains. Developing countries may want to keep a certain level of tariff protection to build up local capacities, where economically viable, to supply goods and components associated with the deployment of RE and EE technologies, in particular if the scope for other support measures is limited.

Although import tariffs have only limited impact on the deployment of climate-friendly technologies in buildings, in certain cases tariff reductions may create political goodwill and contribute to the EGS negotiations. However, only few products may be identified within the building sector. One reason is that EE improvements represent the largest mitigation opportunities, but in general cannot be identified on the basis of tariff schedules. While RE technologies and associated products can, in most cases, be linked with tariff schedules, international trade in PV cells and modules (by far the most important technologies from a trade point of view), is already duty-free on an MFN basis (in some developing countries, however, bound rates are still high).

Beyond the EGS negotiations, international trade can make an important contribution to market transformation at a global scale, in particular if there is policy coordination and collaboration, e.g. in the area of standard setting and conformity assessment.

1. INTRODUCTION

1.1 Background

Energy use in residential and commercial buildings accounts for thirty to forty percent of global energy consumption and contributes significantly to carbon dioxide (CO_2) emissions, depending largely on the carbon intensity of the electricity used. Energy use in buildings in many developing countries is projected to continue to grow rapidly.

The IPCC estimates that there is a global potential to cost-effectively reduce emissions in residential and commercial buildings by approximately twenty-nine percent of the projected baseline emissions by 2020, the highest reduction among all sectors studied in its *Fourth Assessment Report* (AR4). According to the IPCC, improving energy efficiency (EE) in new and existing buildings encompasses "the most diverse, largest and most cost-effective mitigation opportunities in buildings" (IPCC, 2007). Similarly, the International Energy Agency (IEA) estimates that, by 2050, CO_2 emissions in the building and appliances sector could be thirty-five percent below its baseline scenario level if existing EE technologies were applied more broadly (IEA, 2008a).[1] Such reductions can be achieved through the wider deployment of best-available technologies (BAT) to the building envelope, heating, ventilation and air conditioning (HVAC), appliances, cooking and lighting.

Further reductions are possible by increasing renewable-energy use, e.g. the active collection and transformation of solar energy in buildings and small-scale renewable-energy heating and cooling (REHC) systems, such as geothermal heat pumps and wood-pellet stoves.[2]

The fact that despite the availability of cost-effective mitigation measures and mature technologies there remains an important untapped potential for energy savings, or "efficiency gap," points to the existence of strong and numerous market barriers in the building sector. These barriers include, for example, the high costs of gathering reliable information on EE measures, lack of proper incentives and limitations in access to financing and, at times, limited availability of energy-efficient equipment along the retail chain. The long lifetime of buildings and their equipment also slows the introduction of BAT.[3]

A wide range of policy interventions can be implemented – and have already been applied in many countries – to help overcome these barriers. These include EE requirements in building codes; EE standards and labelling for HVAC and appliances; incentives such as tax credits and subsidies; engaging the utility sector in promoting EE as well as the use of renewable sources of energy; and public procurement.

Trade liberalization, or the reduction of tariff and non-tariff barriers facing trade in climate-friendly technologies and components, may also contribute to climate mitigation by making these technologies and components cheaper and more readily available, particularly in developing countries. Trade – and foreign direct investment (FDI) – can promote market transformation (i.e. by increasing the market penetration of climate-friendly technologies and components) and the wider dissemination of BAT, especially to developing countries.

The role of trade in reducing energy demand and GHG emissions in buildings is, however, relatively little researched. This could in part be attributed to the fact that the sector has a relatively small international-trade component. Buildings themselves are "non-tradables," and certain insulation products and HVAC categories are designed mostly for local or regional markets. Also, companies, for example manufacturers of insulation products, often prefer to service foreign markets by setting up local facilities in other countries rather than by exporting. It is true that appliances such as energy-using consumer goods and office equipment are heavily traded internationally, but these products are only loosely connected with buildings.

Because of the existence of strong barriers, the deployment of EE technologies and renewable sources of energy in buildings is to a large extent driven by regulations, incentives and other policy interventions. Trade liberalization, by itself, could play only a small role in boosting the use of BAT in buildings in developing countries. It is nevertheless useful to examine how trade liberalization and international coordination and cooperation on trade-related issues can complement other policy interventions in promoting the deployment of climate-friendly technologies in the building sector in developing countries. In this context, it is worth noting that the IPCC argues that "[T]here is no single policy instrument that can capture the entire potential for GHG mitigation. Due to the especially strong and diverse barriers in the residential and commercial sectors, overcoming these is only possible through a diverse portfolio of policy instruments for effective and far-reaching GHG abatement and for taking advantage of synergistic effects" (IPCC, 2007).

There is also growing interest in examining how the drive towards higher EE and larger use of renewable energy in buildings, reinforced by incentives (including in the context of stimulus packages) and regulations, creates demand – and trade opportunities – for climate-friendly products, technologies and services.

This paper attempts to identify key drivers of the deployment of EE and renewable-energy technologies in the residential and commercial building sector and their interactions with international trade, in particular developing country exports and imports. It pays special attention to certain conceptual and practical issues involved in using tariff classifications and trade statistics to link information on EE technologies with international trade. This may provide some useful information to policy makers and facilitate further study on trade-related issues associated with the deployment of climate-friendly technologies.[4]

1.2 Methodology

The paper builds on a mapping study commissioned by the ICTSD and prepared by The Energy and Resources Institute (TERI), which identifies a wide range of climate-mitigation technologies and components that are commercially available in the building sector (Goswami, Dasgupta and Nanda, 2009).[5]

The commercially-available technologies and associated goods identified were then assigned, where possible, to 6-digit HS codes (Wind,[6] 2009). This is because common HS codes for all products and for almost all countries are available only at the 6-digit level. Some countries or regions (e.g. the European Union) use more detailed tariff classifications (e.g. eight or ten digits) to specify a greater level of product detail, but the corresponding codes and product descriptions differ across countries or regions.

The technologies and components identified by TERI and their HS codes can be divided into five groups: the building envelope (insulation materials); heating, ventilation, air conditioning and refrigeration (HVAC-R); lighting; renewable-energy use in buildings; and stoves. These groups involve a number of conceptual and methodological issues as follows:[7]

- *The building envelope*: A number of building insulation products can be easily defined at the 6-digit HS level and can be considered as "single environmental end-use" products. However, some other products that are used for buildings insulation also have other applications, particularly in the area of plastic foams. In such cases, "multiple-use" issues are relevant.

- *HVAC-R*: Improving energy efficiency (EE) in the HVAC-R sector makes an important contribution to energy savings and, indirectly, the reduction of CO_2 emissions. However, it is very difficult to identify EE technologies based on the 6-digit HS classification. For example, condensing boilers are more energy efficient than most other central heating boilers, but they are hidden in the 6-digit HS code 840310, which also includes less-efficient central heating boilers. Even when more detailed national (the 10-digit Harmonized Tariff Schedule of the United States (HTSUS)) and regional (the 8-digit Common Nomenclature of the European Union) are taken into account, it is, by and large, not possible to identify (relatively more) energy-efficient products in tariff schedules. Most of the analysis on HVAC-R in this paper is, therefore, limited to a discussion on the role of trade and trade liberalization in promoting market transformation. However, a number of products of particular importance for achieving energy savings in the building sector can be defined at the level of 6-digit HS codes, in particular heat pumps, heat exchange units and thermostats. Even though these products also have applications outside the building sector, they represent technologies that generally contribute to climate-change mitigation efforts and have therefore been selected for further analysis.

- *Lighting:* Contrary to the HVAC-R sub-sector, tariff schedules, including at the 6-digit HS level, allow for the identification of energy-efficient light bulbs. One prominent example of the latter is the compact fluorescent lamp (CFL). Light-emitting diodes (LED) are a highly efficient source of lighting, but the corresponding 6-digit HS code also includes PV cells and panels; LEDs are, therefore, included in the next group.

- *Active collection and transformation of solar energy in buildings:* This group includes solar panels and solar water heaters.[8]

- *Stoves:* The TERI list includes certain household stoves, in particular wood-pellet burning stoves (for heating) and solar cooking stoves. In both cases, these stoves are hidden within 6-digit HS codes that also include other stoves.

In addition to these five groups, *appliances* (which include energy-using consumer goods and office equipment) account for a significant share of energy use in residential and commercial buildings and – indirectly (depending on the carbon intensity of the electricity used) – contribute to CO_2 emissions. Since energy-using consumer goods and office equipment[9] are heavily traded,[10] it is important to analyze how international trade can contribute to market transformation, i.e. the larger penetration of energy-efficient products in world markets. However, as in the case of HVAC, 6-digit HS codes (and more detailed national or regional tariff schedules) do not allow for distinguishing relatively more energy-efficient appliances from less efficient appliances with the same end-use. Also, where the IPCC and the IEA include appliances under the "building sector," policies and measures to enhance the EE of appliances have their own dynamics, and (unlike some HVAC) the energy performance of appliances is, in general, not directly targeted by policies and measures typical of the building sector (such as EE requirements in building codes and, with some exceptions, incentives). This group is, therefore, analyzed only very briefly in this paper.

This paper analyzes in more detail trade issues for selected (predominantly) "environmental end-use products," in particular: slag wool and rock wool (HS 680610); mineral insulating materials and articles (HS 680690); multiple-walled insulating units of glass (HS 700800); glass-fibre insulation products (HS 701939); heat pumps (HS 841581); solar water heaters (HS 841919); heat-exchange units (HS 841950); compact fluorescent lamps (HS 853931); solar panels and light-emitting diodes (HS 854140) and programmable thermostats (HS 930210).

In most cases these 6-digit HS codes include products used exclusively or predominantly in the building sector. In some other cases, such as heat pumps, heat exchange units and programmable thermostats, these technologies and components are also used outside the building sector.

The trade figures shown in the tables presented in this paper, in particular those for groups presented in Annex A.1, have to be interpreted very carefully. These trade figures are much larger than actual trade in the technologies and components analyzed. First, several 6-digit HS codes that cover (predominantly) “environmental end-use technologies and products” also include unrelated products. Second, in the case of multiple-use products, total trade under the provisions of a particular 6-digit HS code is included, although only a small part, if any, may be used in the building sector. For instance, plastic foams are included because they are used as building insulation, but the relevant table will include total trade in plastic foams, which have much broader end-use. Trade figures on HVAC-R and appliances (automatic data processing equipment and selected consumer products) shown in Annex A.1 do not refer to specific technologies and are presented for reference purposes only (to illustrate the importance of trade in these groups).

In some cases where HS items in the TERI list (which contains forty-nine 6-digit HS items) are defined so broadly that there is hardly any chance that developments in the building sector are a significant driver of trade, these HS numbers were excluded from the analysis. For analytical purposes, a few HS codes have been added to the TERI list.

1.3 Structure of this Paper

The next section briefly analyzes trends in energy use in the building sector and identifies key drivers of trade in climate-friendly technologies and products relevant to this sector in general. It is argued that the deployment of climate-friendly technologies in residential and commercial buildings is driven to a large extent by policy interventions, such as regulations, incentives, standards and labelling and other government interventions addressing obstacles to harnessing the full potential for cost-effective EE improvements. Section Three then analyzes some key characteristics of trade in each of the groups of technologies and components and identifies top exporting and importing countries as well as import tariffs, particularly in “single environmental end-use” products. It also identifies specific drivers of trade and discusses some technical issues (including with regard to the use of tariff classifications). The conclusions of this paper are presented in Section Four. Additional information is provided in the Annexes.

2. KEY ISSUES

2.1 Energy Use in Buildings

Energy use in buildings represents thirty to forty percent of total final energy use. The IEA estimates that residential buildings account for about two thirds and commercial buildings for about one third of total energy use in the building sector. Approximately a quarter of energy used is electricity (IEA, 2008a). The IEA also estimates that, globally, space and water heating account for about two thirds of final energy use in buildings and cooking for about ten to thirteen percent. The rest of final energy use is for lighting, cooling and appliances (IEA, 2008a).

However, the relative importance of energy use varies considerably owing to many factors (including climate). The IPCC compares energy use in the United States and China in residential and commercial buildings as indicated in Figure 1.

Figure 1. Energy Use Required for Different Energy Services in the United States and China

United States (2004)		China (2000)	
Residential	Commercial	Residential	Commercial
Space heating (29%) Lighting (11%) Space cooling (11%) Water heating (11%) Refrigeration (8%) Cooking (3%) Other uses (27%)	Lighting (21%) Space heating (12%) Space cooling (10%) Water heating 7%) Refrigeration (4%) Other uses (44%)	Space heating (32%) Water heating (27%) Appliances (21%) Lighting (9%) Cooking (7%) Other uses (4%)	Space heating (45%) Water heating (22%) Space cooling (14%) Lighting and other uses (19%)

Source IPCC, 2007.

2.2 Trends in Energy Use and GHG Emissions and Scenarios for the Future

In developed countries, growth in energy use has slowed as a result of EE improvements. Household electricity consumption, after slowing for some time as a result of both saturation in appliances ownership and the impact of policies aimed at improving the EE of those appliances, has again been increasing slightly since 2000. This may be due to the growing numbers of new appliances (such as IT devices), increased use of air conditioning in Europe, and increased active-mode consumption of appliances, such as TVs (as larger screen sizes dominate the market) and home-networked products (World Energy Council, 2008).

In low-income developing countries, household energy consumption tends to shift from traditional biomass fuels to commercial fuels when disposable income increases.

Projections for future energy use illustrate the need for accelerated EE improvements. The IEA projects that, in a business-as-usual scenario, final energy demand in residential and commercial buildings will be 80 percent higher by 2050 than in 2005. According to the IEA, "[T]his is driven by a doubling of the residential building area and a tripling of services building area between 2005 and 2050, higher ownership rates for existing energy-consuming devices and new types of energy services, and the only modest improvement in energy efficiency in the baseline scenario." In the same scenario, CO_2 emissions are projected to increase by about 129 percent above 2005 levels by 2050 (IEA, 2008a).

Limiting future climate change to more acceptable levels requires far-reaching policies and measures. These policies and measures will, in turn, be important drivers of future technology deployment. The IEA, in its *Energy Technology Perspectives 2008*, presents different lower-emissions scenarios. According to one scenario, which assumes the wide deployment of existing technologies, CO_2 emissions from buildings will be thirty-five percent below the baseline scenario level in 2050 (IEA, 2008a). In a more ambitious scenario, emissions from buildings will be 85 percent lower than the baseline scenario level in 2050 and 65 percent lower than their 2005 level. This scenario requires the deployment of tighter standards and new technologies, and assumes that electricity will be largely decarbonised in 2050.[11] The analysis presented in this paper focuses on issues related with the deployment of commercially available technologies identified in the TERI mapping study (Goswami, Dasgupta and Nanda, 2009) and, in this respect, is broadly comparable with the first of the two IEA lower-emissions scenarios.

The IEA, in its *World Energy Outlook 2009,* presents an updated Reference scenario (RS) for the period 2007-2030 and a "450 Scenario"[12] (IEA, 2009). According to the "450 Scenario", energy use in the building sector in 2020 is five percent lower compared to the RS. By 2030, energy use is ten percent lower as a combined result of savings of fourteen to thirty (in the case of coal) percent in the use of fossil-fuel-based energy and an increase of five percent in the use of renewable sources of energy (*World Energy Outlook 2009*, Table 6.5). Direct CO_2 emissions from fossil-fuel combustion are six percent lower in 2020 and seventeen percent lower in 2030. These savings result from policies and measures aimed at increasing EE and the use of renewable energy as well as higher energy prices[13] compared to the RS. Nearly two thirds of the additional investment in buildings required in the 450 Scenario (USD 2.6 billion over the period 2010-2030, over and above the investment in the RS) is needed in residential buildings and the remainder in commercial buildings (including government offices). Close to thirty percent of this investment is going into renewables.

2.3 Barriers to the Implementation of EE and Renewable Energy Measures

Barriers to implementing EE measures are generally well documented (e.g. in IPCC, 2007) and include the following:

- Limitations of the traditional building design process and fragmented market structure
- The "split incentive" or "landlord-tenant" problem: those who make investments in energy efficiency are often not the final users who pay the energy bill
- Consumer discount rates that exceed society's discount rate
- Energy subsidies
- Regulatory barriers
- Small project size, high transaction costs and perceived risk
- Imperfect information
- Culture, behaviour, lifestyle and the rebound effect
- Limited availability of capital and limited access to capital markets of low-income households and small businesses, especially in developing countries. This may prevent investment in EE, which typically has higher upfront costs, although it is cheaper over a longer period (see box 1)
- Lack of an effective EE and renewable energy policy at the national level in many developing countries
- Limited availability of energy-efficient equipment along the retail chain

Similarly, there are several barriers to the deployment of renewable energy technologies. For example, the high cost of some technologies (e.g. PV technologies)[14] constitutes a barrier to their deployment in the absence of subsidies (IEA, 2008b). Some barriers are particularly relevant in developing countries. For example, the deployment of PV technologies requires a local infrastructure of companies to sell, install and service the equipment. Also there is a need for financing, which often is not available.[15]

2.4 Climate Mitigation Policies as Drivers of Technology Deployment

A number of policy interventions can be used, often in combination, to address barriers to the implementation of EE measures in buildings (IPCC, 2007). These interventions are key drivers of the deployment of EE technologies and may include:

- Building codes
- Standards and labelling
- Building certification and labelling systems
- Voluntary agreements in which manufacturers commit to improve the EE of appliances and equipment (e.g. by reducing the standby consumption)
- Utility demand-side management programmes
- Adequate energy prices and appropriate use of energy price subsidies
- Investment subsidies, financial incentives and other fiscal measures
- Public sector leadership programmes and public procurement policies
- Promotion of energy service companies (ESCOs) and energy performance contracting (EPC)
- Energy-efficiency obligations and tradable EE certificates
- Technology research, development, demonstration and deployment (RD&D)

Some of these policy interventions, in particular those that are most likely to have a potential impact on trade in products and components used in buildings, are briefly elaborated below.

2.4.1 Building codes

EE standards in building codes set requirements concerning the EE of new buildings. In addition, they frequently serve as an EE target for refurbishment or other improvements of existing buildings.[16] As a minimum, building codes generally include regulations for the efficiency of the building envelope. EE standards in building codes often also address building-related end-uses, e.g. HVAC and the preparation of hot sanitary water (which often requires approximately 75 percent of a residential building's energy demand). Occasionally, building codes cover other end-uses, like lighting in commercial buildings (Lausten, 2008). Some building codes address renewable energy systems. Almost all OECD countries, and a number of developing countries, including China, India,[17] Indonesia, the Republic of Korea, Malaysia, Mexico, the Philippines, Singapore, South Africa, Thailand and Turkey, have implemented building codes that include EE standards.[18] In the European Union, the Energy Performance in Buildings Directive (EPBD) requires all member states to set standards for EE in new buildings based on the energy performance of the building.

To remain effective, EE regulations in building codes need to be revised periodically and become more stringent over time as technologies improve and costs of energy-efficient features and equipment decline (IPCC, 2007). Several European governments have committed to target the passive (energy-neutral) house as their new construction standards before 2020.

There are several types of building codes. A prescriptive building code may set thermal values for essential building parts or, in more complicated versions, set EE requirements for all parts of building and installations, including HVAC and lighting. A prescriptive code could require an appliance to be labelled, e.g. class "A" or "B" or energy star (Lausten, 2008).

2.4.2 Standards and labelling

Many governments have implemented minimum energy performance standards (MEPS), including for HVAC, lighting and appliances. MEPS define an EE performance threshold that energy-consuming equipment must meet. In most cases MEPS are mandatory and seek to remove inefficient products from the market.

Energy labels provide information to consumers on the energy performance of products. There are basically two categories: comparative and endorsement labels. Comparative labels rate the EE of different models of an appliance in terms of a set of EE classes, usually ranging from “A” (most energy efficient) to “G” (least energy efficient). Endorsement labels identify only the best-performing products in the marketplace. ENERGYSTAR is a good example of an endorsement label.

MEPS and mandatory energy labels have already made important contributions to energy savings (Ellis, 2007). In general, EE gains have been made without sacrificing levels of service and have not resulted in price increases. In many cases, the adoption of standards and labelling has been successful in promoting market transformation.[19]

2.4.3 *Investment subsidies, financial incentives and other fiscal measures*

Governments in OECD countries and, to a much-lesser extent, some developing countries, provide a range of financial incentives to encourage EE improvements and the use of renewable sources of energy in residential and commercial buildings. These incentives include, for example, tax credits, low-interest loans and reduced value-added taxes (VAT) for EE equipment. Incentives are available for most groups of products analyzed in this paper, i.e. insulation and upgrading HVAC (in existing buildings), energy-efficient light bulbs and the renewable-energy installation in residential and commercial buildings.[20]

A number of incentive programmes cover several areas simultaneously. In the United States, for example, under the Tax Incentives Assistance Project (www.energytaxincentives.org) homeowners can qualify for a variety of federal tax credits as an incentive for home envelope improvements (insulation, windows, roofs); home heating and cooling upgrades (furnaces and boilers, air conditioners and heat pumps, geothermal heat pumps, biomass stoves, fans, non-solar water heaters) and onsite renewable energy generation (solar water heaters, photovoltaic and small wind systems).[21] Other programmes target specific areas, such as improving the household envelope, replacing energy-inefficient boilers or installing renewable-energy generating capacity in buildings. Some programmes provide incentives for carrying out energy audits (if not required by law) and then for the implementation of certain EE measures recommended in these audits.

A number of recent stimulus packages implemented to promote economic recovery also expand existing programmes or introduce new programmes to improve EE and promote the use of renewable energy in existing buildings.[22] For example, in November 2008, the German government increased funding for the Climate Protection Programme for Existing Buildings[23] (launched in January 2001) by EUR 3 billion (USD 4.2 billion) over 2009-11 as part of its economic stimulus package.[24]

The IEA *Energy Efficiency Policies and Measures Database* (http://www.iea.org/textbase/pm/index_effi.asp) provides detailed information on incentives and financial measures (as well as other policies and measures) applied in IEA countries and key developing countries, including China and India. It also provides information on policies and measures to promote the use of renewable energy.

2.4.4 *Demand-side management programmes*

Demand-side management programmes seek to reduce energy demand during peak hours when energy supply is constrained. Successful programmes do not necessarily reduce total energy demand, but they reduce the need for investment in energy-supply capacity and networks. In the context of this paper, demand-side management programmes are important because they create demand for smart appliances and advanced metering.

Box 1. Abatement Cost and Capital Intensity of GHG Abatement Opportunities: The Building Sector

A recent report by McKinsey compares a large range of GHG abatement opportunities, including EE opportunities in the power sector and different end-use sectors (including residential and commercial buildings) as well as renewable-energy opportunities. The report focuses on opportunities to reduce GHG emissions at a cost of up to EUR 60 per tonne of CO_2e emissions avoided by 2030. The report concludes that almost one third of the abatement measures would produce a net economic benefit, i.e. the total additional resources invested upfront can be recouped from lower energy spending in the future. These measures, which would have a net economic benefit over the lifetime of the investment even without an additional CO_2 incentive, include almost all EE measures in the residential and commercial building sector.

The report also compares the capital intensity of different abatement measures (additional upfront investment relative to a business-as-usual technology development divided by the total amount of avoided emissions over the lifetime of the investment). This indicator looks only at the additional resources that need to be invested upfront and does not take financial savings through lower energy consumption into account. It makes clear that the cheapest abatement opportunities are not always those with the smallest upfront investment. For example, many EE opportunities that appear on the left-hand side of the abatement cost curve move to the right in the capital intensity curve.

The figure below, which only considers opportunities in the residential and commercial building sector, shows that almost all these abatement measures in the building sector have a net economic benefit. The cheapest opportunity analysed is lighting (switching from incandescent lamps to LEDs) in the residential sector. Under the assumptions of the business-as-usual scenario used in estimating abatement costs per measure, only two measures (building efficiency in new buildings and PV modules) would cost (slightly) more than EUR 60 per tonne of CO_2e emissions and not have an economic benefit without an additional incentive. However, if the average price of oil is higher than the USD 60 per barrel assumed in the business-as-usual scenario, EE measures become even more attractive.

The most economically rational way of prioritising abatement measures would be on the basis of the cost curve, i.e. taking into account both the up-front investment and resulting energy savings. However, if capital is scarce investors might choose to fund opportunities with the lowest capital intensity rather than the lowest cost over time. This could make the cost of abatement substantially higher over time. The capital intensity of some opportunities in the buildings is relatively high (e.g. retrofit of residential HVAC and building efficiency of new buildings). Financing such opportunities may be challenging.

Abatement cost curve	Capital-intensity curve
Lighting (incandescent to LED), residential	Residential water heating
Residential electronics	Lighting (switch incandescent to LED – residential)
Residential appliances	Insulation retrofit (commercial)
Insulation retrofit (commercial)	Residential electronics
Retrofit residential HVAC	Geothermal
Insulation retrofit (residential)	Solar PV
Geothermal	Insulation retrofit (residential)
-------------------------------	Residential appliances
Building efficiency (new buildings)	Retrofit (residential HVAC)
PV modules	Building efficiency (new buildings)

Source: McKinsey (2009a), exhibits 1 (global GHG abatement cost curve beyond business-as-usual, 2003) and 4.2.3 (capital intensity by abatement measure).

3. SUB–SECTORS

This section analyses some key characteristics of trade in each of the groups of technologies and components (sub-sectors) defined on the basis of the TERI mapping study and identifies key drivers of trade in climate-friendly technologies and components. It also discusses some issues related to the use of tariff classifications (in particular the 6-digit HS nomenclature) with a view to establishing a link between the mapping study and the analysis of trade-related issues. An effort is made to identify 6-digit HS codes that include technologies and products with a predominantly “environmental end-use”.

3.1 Insulation

3.1.1 Background

A variety of very different insulation products, such as foamed plastic, fibreglass, rock wool, cellular concrete and cellulose are commercially available. Foamed plastic and fibreglass represent the most widely used insulation materials on a global level, accounting for more than three quarters of total demand in 2007 in dollar terms.[25] Foamed plastics are already widely used in many countries. Fibreglass is used in particular in North America, although its use in other geographic markets is expanding.

Some products used for building insulation, in particular plastics also have other applications. The four major plastic-foam insulations commonly used for residential, commercial and industrial insulation are: extruded polystyrene (XEPS), expanded polystyrene (EPS), polyurethane (PUR) and polyisocyanurate (PIR). Extruded polystyrene and EPS are also used, for example, for protection in packaging and transportation of food in refrigerated containers. Polyurethane and PIR are also used in, for example, automotive interiors, furnishing, HVAC and electronics.

North America, Europe and Asia are the largest markets for insulation products, accounting for nearly two thirds of demand in 2007. The fastest growing markets are in developing countries, particularly in Asia.

3.1.2 Drivers of demand

The fall or slowdown in housing construction in many countries has had an adverse impact on the demand for insulation products in recent years. However, over the medium and long term demand for building insulation material is expected to increase considerably. The main drivers of demand, particularly in developed countries, are:

- EE requirements in building codes (tightening of existing building codes and the introduction of new building codes for new buildings)
- Incentives, especially for building renovations

High energy prices provide incentives for insulation, although they are an important cost element in the production of petroleum-based insulation materials (such as plastic foam and rock wool).

Several governments in Europe are expected to base their standards for newly constructed buildings on the passive (energy-neutral) house concept before 2020.[26] It has been argued that this would necessitate insulation levels (including thickness of lining) that could double the levels required by current standards (*Global Insulation Magazine*, May 2008).

3.1.3 Producers of insulation materials

This paper does not provide a detailed analysis of producers of insulation materials. However, some information on European companies is provided by way of example. According to the Exane BNP Paribas study (*Global Insulation Magazine*, May 2008), Saint-Gobain (which has its headquarters in France), Knauf (UK) and Uralita (Spain) have a combined share of more than 90 percent of Western European glass wool production, whereas Rockwool (Denmark) and Knauf are the two largest producers of stone wool. The European EPS and XPS market includes several players: (a) traditional building materials companies, such as CRH (Ireland), Knauf, Saint-Gobain and Uralita; (b) chemical companies (e.g. Dow, BASF) that turn styrene chemicals into insulation products (vertical integration) and (c) a considerable number of independent players (since entry barriers are low). The PIR, PUR and phenolic market comprises mainly regional players, but may become more consolidated. Currently, the largest players are Kingspan (Ireland), Knauf, Recticel (Belgium) and CRH.

One lesson learned from the above is that large companies may use subsidiaries or joint ventures rather than direct exports to supply foreign markets. For example, the Rockwool Group operates twenty-three factories on three continents.

3.1.4 HS codes

Izaak Wind (2009) and with a refrence to the Izaak Wind paper title available at www.ictsd.org. Some of these 6-digit HS codes exclusively or predominantly cover building insulation products (in particular HS code 700800 multiple-walled insulating units of glass). In other cases, products used for building insulation may also have other applications. For example, phenolic resins and plastic foams have many applications. This implies that trade, which is measured at the 6-digit HS level, may significantly over-estimate actual trade in these building insulation materials. In order to reduce this problem, four 6-digit codes corresponding to products on the TERI list have been excluded from the analysis, in particular HS 392690 (other articles of plastics) which includes a wide range of products that are not used for insulation. The analysis is therefore based on ten different 6-digit HS codes.

3.1.5 Trade flows

World exports in items included in the ten 6-digit codes analyzed amounted to USD 14.3 billion in 2007 (table 1). This figure largely overestimates actual trade in building insulation products as some 6-digit codes include other products. However, it is probably fair to conclude that most trade takes place between developed countries (around two thirds, in value terms, in 2007), with developing countries (including countries in transition in Asia)[27] representing only a small share of world exports and imports.

The top twenty exporters and importers of insulation products are shown in Annex Tables A1.1 and A1.2.

Table 1. Shares of Developing Countries in World Exports of Insulation Products, 2007

HS code	Short description	World Exports in 2007 ($ millions) (Including intra-EU trade)	Share of world exports (%)		
			Intra-developed countries as a share of world exports	Developing countries' exports	
				Share of world exports	Share of world exports excl intra-EU
390940	Phenolic resins, in primary forms	1729.8	50.5	21.1	32.1
392030	Plates, sheet etc, non-cellular and not reinforced, of polymers of styrene	1769.6	70.0	14.4	34.7
392111	Plates, sheet etc, cellular of polystyrene	1027.4	74.7	11.4	25.0
392113	Plates, sheet etc, cellular of polyurethane	2611.2	67.6	10.7	22.1
400259	Acrylonitrile-butadiene rubber (NBR)	728.3	31.1	39.9	47.0
540500	Man-made textile materials	52.5	47.8	14.3	25.6
680610	Mineral wools (slag wool, rock wool)	1896.0	65.9	11.7	26.1
680690	Mineral insulating materials and articles	1402.1	70.9	4.5	8.7
700800	Multiple-walled insulating units of glass	1229.8	79.4	13.5	33.3
701939	Glass-fibre insulation products	1813.3	55.6	17.8	28.7
	All items	14260.0	64.0	14.6	28.0

Source: Based on COMTRADE, using WITS.

For the purposes of the analysis presented in this paper, four products are selected as having a (predominantly) "environmental end-use": slag wool and rock wool (HS 680610); mineral insulating materials and articles (HS 680690); multiple-walled insulating units of glass (HS 700800) and glass-fibre insulation products (HS 701939). The developing country share in world exports (excluding intra-EU trade) of these products was around twenty-five percent in 2007 (see table 17). Trade in these products is analysed in some more detail below (tables on imports are presented in Annex A2).

Slag wool and rock wool (HS 680610)

The top 20 exporters are presented in Table 2. About two thirds of world trade in value terms is between developed countries. China is the only significant developing country exporter of this product. The top 20 importers are listed in Annex Table A2.1.

With respect to tariffs, the EU (the largest import market) has bound zero-duty rates. Among other importers, Belarus, China, Mexico, the Russian Federation and South Africa have applied tariffs of 10 percent or more (Table A3.1).

Table 2. Slag Wool, Rock Wool and Other Mineral Wools: Top Twenty Exporters in 2007

Exporter (all countries)	Exports ($million)	Exporter (developing countries*)	Exports ($million)
All countries	1896.0	All developing countries	221.1
Germany	296.9	China	155.0
Netherlands	220.2	Malaysia	16.8
Poland	193.4	Turkey	11.9
China	155.0	Korea, Rep.	8.8
United Kingdom	117.2	South Africa	8.5
France	114.4	Mexico	5.5
Denmark	104.9	India	4.1
Slovenia	70.4	Thailand	3.8
Finland	51.4	United Arab Emirates	2.2
Russian Federation	50.0	Singapore	1.3
Slovak Republic	47.8	Brazil	1.0
Lithuania	45.6	Colombia	0.6
Canada	42.5	Syrian Arab Republic	0.3
Sweden	41.3	Jordan	0.2
United States	41.1	Guatemala	0.2
Hungary	40.5	Argentina	0.2
Spain	30.8	Chile	0.1
Portugal	25.0	Lebanon	0.1
Belgium	23.7	Tunisia	0.1
Japan	22.7	Senegal	0.1
EU-27	1475.8		
Intra-EU	1047.5		
EU (excl intra-EU trade)	428.3		

Source: Based on COMTRADE, using WITS.
** Includes countries in Eurasia*

Mineral insulating materials and articles (HS 680690)

The top twenty exporters of mineral insulation materials and articles are presented in Table 3. Again, the largest part of world trade is between developed countries. The share of developing countries in world exports is less than ten percent.

The top twenty importers are listed in Annex Table A2.2.

With respect to tariffs, the EU and the United States (the two largest import markets) have bound zero-duty rates. Among other relatively large importers, China, India, Mexico and the Russian Federation have applied tariffs of ten percent or more (Table A3.2)

Table 3. Mineral Insulating Materials and Articles: Top Twenty Exporters in 2007

Exporter (all countries)	Exports ($million)	Exporter (developing countries*)	Exports ($million)
All countries	1402.1	All developing countries	63.7
Germany	288.9	China	22.6
United States	195.5	Korea, Rep.	7.4
Belgium	160.9	Mexico	5.4
Japan	158.6	Brazil	5.1
Italy	124.3	Turkey	5.0
United Kingdom	122.5	Saudi Arabia	4.2
France	75.7	Malaysia	3.4
Czech Republic	44.6	Thailand	2.6
Netherlands	33.5	India	1.9
Switzerland	30.8	Taiwan, China	1.4
Denmark	24.9	Jordan	1.2
Canada	24.2	United Arab Emirates	1.1
China	22.6	Singapore	0.8
Austria	21.2	South Africa	0.6
Spain	8.1	Argentina	0.6
Korea, Rep.	7.4	Peru	0.1
Slovenia	6.4		
Mexico	5.4		
Brazil	5.1		
Turkey	5.0		
EU-27	921.3		
Intra-EU	668.0		
EU (excl intra-EU trade)	253.3		

Source: Based on COMTRADE, using WITS.
** Includes countries in Eurasia*

Multiple-walled insulating units of glass (HS 700800)

The top twenty exporters of multiple-walled insulating units of glass are shown in Table 4 below. Developing countries account for approximately one third of world exports (excluding intra-EU trade), but the only significant developing country exporters are China, Mexico and Turkey.

The top twenty importers are listed in Annex Table A2.3. Most EU trade is among Member States. If intra-EU trade is excluded, the United States is the largest import market.

With respect to tariffs, both the United States and the EU have bound their duty rates at about five percent ad valorem. Belarus, China, Malaysia and the Russian Federation have applied tariffs of ten percent or more (Table A3.3).

Table 4. Multiple-walled Insulating Units of Glass: Top Twenty Exporters in 2007

Exporter (all countries)	Exports ($million)	Exporter (developing countries*)	Exports ($million)
All countries	1229.8	All developing countries	166.3
Germany	402.9	China	61.4
Poland	89.1	Mexico	59.3
United States	87.2	Turkey	35.7
Belgium	69.5	Korea, Rep.	1.7
China	61.4	Singapore	1.7
Mexico	59.3	Thailand	1.1
Austria	55.8	Saudi Arabia	0.8
Canada	55.0	Malaysia	0.8
Turkey	35.7	India	0.8
Italy	33.1	United Arab Emirates	0.8
Hungary	30.4	Argentina	0.8
Spain	28.8	Syrian Arab Republic	0.5
Finland	26.2	Taiwan, China	0.4
France	23.8	Uruguay	0.2
Denmark	21.7	Lebanon	0.1
Ireland	18.3	Brazil	0.1
Sweden	16.9	Chile	0.1
Netherlands	15.2		
Czech Republic	14.0		
Belarus	12.1		
EU-27	888.3		
Intra-EU	729.5		
EU (excl intra-EU trade)	158.8		

Source: Based on COMTRADE, using WITS.
** Includes countries in Eurasia*

Glass-fibre insulation products (HS 701939)

The top twenty exporters of glass-fibre insulation products are shown in Table 5 below. Developing countries account for less than thirty percent of world exports (excluding intra-EU trade); China is the only significant developing country exporter.

Table 5. Glass-fibre Insulation Products: Top Twenty Exporters in 2007

Exporter (all countries)	Exports ($million)	Exporter (developing countries*)	Exports ($million)
All countries	1813.3	All developing countries	322.8
China	256.1	China	256.1
Germany	246.1	Mexico	18.7
United States	219.2	Hong Kong, China	11.9
Belgium	207.0	Colombia	7.5
Canada	105.1	Singapore	6.9
Czech Republic	93.3	Turkey	4.6
Sweden	89.2	Argentina	4.0
France	86.3	Korea, Rep.	3.8
United Kingdom	72.6	Saudi Arabia	3.4
Poland	56.6	Chile	2.1
Finland	50.4	Brazil	0.8
Netherlands	46.3	Thailand	0.8
Russian Federation	37.1	Taiwan, China	0.6
Switzerland	34.9	South Africa	0.5
Slovenia	31.0	Malaysia	0.4
Denmark	21.0	India	0.3
Mexico	18.7	Vietnam	0.2
Slovak Republic	18.6	Lebanon	0.1
Spain	18.1		
Japan	13.8		
EU-27	1055.3		
Intra-EU	689.3		
EU (excl intra-EU trade)	366.0		

Source: Based on COMTRADE, using WITS.
** Includes countries in Eurasia*

The top twenty importers are listed in Table A2.4. The United States is the largest import market if intra-EU trade is excluded. The HTSUS breaks HS 701939 down into insulation products (HTSUS 7019.39.10) and “other”. The latter represented less than two percent of US imports under HS 701939 in 2006-2008.

Applied tariffs in the EU and the United States are five and four and nine tenths percent ad valorem, respectively. Among relatively important import markets, Belarus, China, Malaysia and the Russian Federation have applied rates of ten percent or more ad valorem (Table A3.4)

3.2 Heating, Ventilation, Air Conditioning and Refrigeration (HVAC–R)

3.2.1 Background

In this paper, HVAC includes refrigeration equipment (and therefore the term HVAC-R is employed). The TERI list identifies specific technologies applied in boilers, air conditioners and refrigeration equipment (refrigerators and freezers) and includes a number of components that play an important role in enhancing EE. This section analyses some general trends in trade in HVAC-R and identifies major exporters of selected products, in particular heat pumps, heat exchange units and programmable thermostats. Additional information on imports and tariff protection for these products is presented in Annexes 2 and 3, respectively.

3.2.2 Drivers of demand for energy-efficient HVAC-R

High energy prices generally stimulate demand for energy-efficient HVAC-R. Yet, because of the existence of many barriers, many countries have implemented regulatory requirements (in particular MEPS) and labelling to promote market transformation. EE requirements in building codes as well as financial and fiscal incentives are particularly important drivers of demand for energy-efficient HVAC, in particular for new products coming into the market. Examples of new products having gained a market share over the last decades are condensing gas boilers and highly efficient heat pumps. Financial and fiscal incentives have been implemented, particularly in developed countries.

3.2.3 HS codes

Enhanced EE in the HVAC-R sector makes an important contribution to energy savings. However, it is almost impossible to clearly identify EE HVAC-R technologies and products in existing tariff classifications. For example, TERI describes specific highly efficient technologies for air conditioners (in addition to heat pumps), but air conditioners incorporating these technologies are assigned (as an “ex”-item) to the heavily traded item HS 841510 (air conditioners, window or wall types, self-contained or split-system).

The TERI list also includes HS 841581 (air conditioners incorporating a reversible heat pump). The 6-digit HS classification allows for a distinction of air conditioners (other than window or wall types)[28] that incorporate a reversible heat pump (HS 841581) - and can therefore be used for both cooling and heating - from air conditioners that do not and which are mainly classified under HS 841582.[29]

While this enables a trade analysis of air-source heat pumps, in general it may be difficult to clearly identify relatively more (or relatively less) energy-efficient air conditioners simply on the basis of tariff classifications. In the United States, for example, both central air conditioners and air-source heat pumps are widely used. According to the American Council for an Energy Efficient Economy (ACEEE), heat pumps are far more efficient than central air conditioners.[30] However, a rating of central air conditioners and air-source heat pumps available on the US market based on their seasonal energy efficiency ratio (SEER), i.e. the cooling output divided by the power input for a hypothetical average climate, shows considerable overlap.

The above example shows that while physical characteristics can provide some preliminary indication of relative EE of air conditioners[31] (and other products), tariff classifications generally cannot clearly differentiate relatively energy-efficient products from other products with similar use (see also the discussion on boilers in the introduction of this paper). For a consumer, the most important thing to look for is an energy-efficiency label.

However, a number of products of particular importance to enhanced EE (and renewable energy-use) in the building sector have been technologies defined at the 6-digit HS level: heat pumps (other than those covered by HS 841581), heat exchange units and automatic thermostats. Trade in these products is analysed below.

In the next segment, trade patterns in HVAC-R are analysed because these patterns may provide some indication of how trade-induced EE improvements may play a role in market transformation on a global scale. By and large, the group HVAC-R defined in this paper is based on the TERI list. The reader should be aware that export and import figures for HVAC-R are presented exclusively with a view to facilitating an analysis of trade patterns in HVAC-R in general (rather than to identify trade in energy-efficient HVAC-R). For that purpose, a few products have been added to the TERI list.

3.2.4 Patterns of trade

Developing countries account for a significant portion of world exports of HVAC-R (Table 6). Their share in 2007 world exports (excluding intra-EU trade) of HVAC-R, in value terms, was over 60 percent on average. However, their share varies widely from one category of HVAC-R to another.

Table 6. Shares of Developing Countries in World Exports of HVAC-R, 2007

HS Code	Short description	Exports in 2007 ($ millions) (Including intra-EU trade)	Share of world exports (%)		
			Intra-developed countries as a share of world exports	Developing countries' exports	
				Share of world exports	Share of world exports excl intra-EU
732211	Radiators for central heating	209	20.6	54.6	65.2
732219	Radiators, central heating, of cast iron	2450	71.4	19.5	55.4
732290	Air heaters, non-electric	1128	74.4	11.5	19.5
840310	Central heating boilers	4509	73.6	4.9	13.6
841510	Air conditioners, window or wall types	10085	13.9	83.2	94.9
841581	Other air conditi-oners incorporating a reversible heat pump	2239	52.1	33.7	52.7
841810	Combined refrige-rator-freezers	8479	29.9	58.2	75.7
841821	Refrigerators, compression type	5724	33.8	61.8	89.0
841829	Other household refrigerators	598	53.3	35.3	46.1
841830	Freezers, chest type (<800 l. capacity)	1073	45.9	36.0	59.2
841840	Freezers, upright type (<900 l. capacity)	1267	68.1	20.1	45.9
841850	Other freezing equipment	4792	60.3	22.3	44.4
841861	Heat pumps	4415	63.7	17.2	31.8
841950	Heat exchange units	8414	51.1	15.2	23.9
851610	Electric water heaters	1715	43.9	34.5	50.6
903210	Automatic regula-ting thermostats	2807	59.7	24.6	47.8
	All items	59903	45.2	39.7	61.8

Source: Based on COMTRADE, using WITS.

The share of developing countries in exports of central heating boilers (HS 840310) was only fourteen percent in 2007. Central heating boilers are mostly used in developed countries and manufacturers largely produce for domestic and regional markets. Almost three quarters of trade in central heating boilers was between developed countries (including intra-EU trade).

Developing countries supplied 84 percent of world imports of air conditioners (excluding intra-EU trade) and 74 percent of world imports of refrigerators. Both developed country markets and developing country markets were largely supplied by developing countries. As shown in Table 7, developing countries (in particular China and Thailand) were the key suppliers of air conditioners to all regions. In the case of refrigeration equipment, regional trade plays a larger role.[32] However, developing countries supplied between 70 and 95 percent of imports in all regional markets the market of developing countries and countries in Eurasia, the EU countries together had a slightly higher participation than China and Thailand individually.

Table 7. World Imports of Air Conditioners and Refrigeration Equipment and Key Suppliers, 2007

Market	Imports ($m)	Share of developing countries	Principal suppliers and their market share, as a percentage of total imports, in value terms (%)
Air conditioners			
World	11088	83.7	China (47.3); Thailand (18.3)
Developed countries	6471	84.9	China (54.8); Thailand (20.1)
- EU	3421	79.3	China (35.5); Thailand (16.5); Malaysia (8.2)
- United States	1448	89.6	China (40.9); Thailand (26.2)
- Japan	720	99.6	China (84.7); Thailand (13.6)
Developing countries	4220	82.3	China (35.0); Thailand (16.6)
Refrigeration equipment			
World	13025	73.5	China (19.0); Mexico(18.0); Rep of Korea (11.5)
Developed countries	8898	80.2	Mexico (26,9); China (21.3); Rep of Korea (13.2)
- EU	2854	92.1	Turkey (35.9); China (30.7); Rep of Korea (18.6)
- United States	3697	89.6	Mexico (59.3); China (14.1); Rep of Korea (14.0)
- Japan	660	95.4	China (49.5); Thailand (43.9)
Developing countries	3904	69.5	EU(14.7); China (13.2); Thailand(12.2)

Source: Based on COMTRADE, using WITS.

The major developing country exporters to world markets have already had large exposure to increasingly stringent mandatory and voluntary EE requirements in key markets (which are applied to both domestically produced and imported products). Chinese exporters, for example, have made considerable efforts to comply with the EE requirements in external markets. China, Thailand and other key developing country exporters also have developed their own MEPS programmes and, where feasible, sought to harmonize their requirements with programmes in export markets. China has received considerable international support for the development of its MEPS programme (IEA, 2007). As shown in Table 7, key developing country exporters to developed country markets also supply the markets of other developing countries.

To the extent that products exported to other developing countries meet similar energy performance standards as the models that are shipped to developed countries (or sold in domestic markets of developing countries with stringent MEPS), there may be further progress in market transformation (Vossenaar, 2009). However, there is also a risk that less-efficient products that are no longer competitive in more demanding markets may be shipped to developing countries with no or less-stringent EE requirements.

3.3 Specific Technologies and Components

This section analyses trade in three products that could be considered to have predominantly "single environmental end-use".

3.3.1 Heat pumps

Heat pumps play an important role in enhancing EE in HVAC-R. Heat pumps are also used in sectors other than residential and commercial buildings. They are used, for example, to recover heat or as an integral part of an industrial process. However, to the extent that heat pumps are more energy efficient, they could be considered to have an environmental end-use.

This section focuses on heat pumps for heating purposes. If sold as an entire unit for heating only, heat pumps are classified under HS 841861.[33] This item includes geothermal heat pumps (GHP), although the HS code it is not specific to earth-to-air or earth-to-water heat pumps and is probably dominated by trade in air-to-water and air-to-air heat pumps (Steenblik, 2006).

Increased demand for heat pumps in many developed countries has been driven by incentives. France, for example, has been providing tax rebates of fifty percent (decreased to forty-nine percent in 2009 and twenty-five percent in 2010) for heat pumps devoted primarily to heat production. Tax credits are also available in, for example, Japan and the United States (geothermal heat pumps). In some countries, regulations have also boosted demand for heat pumps. For example, Sweden's prohibition (in building codes) of direct electric-resistance heating systems has led to the rapid introduction of heat pumps in recent years (IPCC, 2007).

In Sweden, almost half of all electricity-heated homes have heat pumps. In Switzerland, around 60 percent of new single-family houses are equipped with a heat pump, and a growing number of house owners are replacing their old heating systems with environment-friendly heat pumps (Swiss Federal Office of Energy (SFOE)). Heating-only heat pumps have a significant market share in Austria, Canada, France and the United States.

Table 8. Heat Pumps: Top Twenty Exporters in 2007

Exporter (all countries)	Exports ($million)	Exporter (developing countries*)	Exports ($million)
All countries	4414.7	All developing countries	760.2
France	1079.0	China	600.1
Japan	867.4	Mexico	100.3
China	600.1	Malaysia	18.0
Ireland	454.2	Korea, Rep.	8.9
Germany	330.3	Singapore	7.4
Italy	251.9	Jordan	5.7
Netherlands	188.8	Turkey	4.0
Sweden	102.9	Brazil	3.2
Mexico	100.3	Taiwan, China	2.7
United States	77.9	India	2.2

Table 8: *Continued*

Exporter (all countries)	Exports ($million)	Exporter (developing countries*)	Exports ($million)
Spain	63.0	South Africa	1.6
Austria	49.3	Philippines	1.0
Denmark	37.8	Thailand	1.0
United Kingdom	25.9	Trinidad and Tobago	0.7
Belgium	21.5	Vietnam	0.6
Slovak Republic	21.2	Lebanon	0.4
Poland	19.1	Colombia	0.4
Switzerland	18.5	Kyrgyz Republic	0.3
Malaysia	18.0	United Arab Emirates	0.3
Canada	9.0	Guatemala	0.3
EU-27	2676.6		
Intra-EU	2021.8		
EU (excl intra-EU trade)	654.8		

Source: Based on COMTRADE, using WITS.
** Includes countries in Eurasia*

3.3.2 Heat exchange units

A heat exchanger is a device built for efficient heat transfer from one medium to another. They are widely used in space heating, refrigeration, air conditioning, power plants, chemical plants, petrochemical plants, petroleum refineries and natural gas processing (Wikepedia). However, since heat exchange units are important components for EE and renewable energy, in this paper the HS code has been maintained as a predominantly "environmental end-use" product. Demand for heat exchange units is not directly driven by EE standards and incentives.

The top twenty exporters are listed in Table 9 below. Developing countries accounted for approximately one quarter of world exports (excluding intra-EU trade) in 2007, with the Republic of Korea accounting for more of half of this.

Table 9. Heat Exchange Units: Top Twenty Exporters in 2007

Exporter (all countries)	Exports ($million)	Exporter (developing countries*)	Exports ($million)
All countries	8414.3	All developing countries	1279.6
Germany	1505.2	Korea, Rep.	692.8
Italy	1146.6	China	197.3
Sweden	903.2	Mexico	68.7
Korea, Rep.	692.8	Malaysia	63.0
United States	668.2	Thailand	49.3
France	649.3	India	48.2
Japan	314.9	Singapore	47.6
Czech Republic	234.4	Turkey	39.1
Netherlands	204.0	Brazil	30.9
China	197.3	Taiwan, China	23.2
Denmark	192.4	Argentina	6.1
United Kingdom	181.6	Vietnam	4.1

Table 9: *Continued*

Exporter (all countries)	Exports ($million)	Exporter (developing countries*)	Exports ($million)
Belgium	156.4	South Africa	2.7
Austria	151.7	Chile	1.5
Switzerland	137.1	Kazakhstan	1.2
Spain	126.3	Namibia	1.1
Poland	108.2	United Arab Emirates	1.0
Canada	101.3	Bahrain	0.4
Finland	76.6	Morocco	0.3
Mexico	68.7	Peru	0.3
EU-27	5797.2		
Intra-EU	3066.3		
EU (excl intra-EU trade)	2730.9		

Source: Based on COMTRADE, using WITS.
** Includes countries in Eurasia*

The top twenty importers are listed in Annex Table A2.5 and tariff information is presented in Table A3.7

3.3.3 Automatic regulating thermostats

The drive toward higher EE creates demand for electronic control and other components incorporating semiconductors, for example variable-speed drives in air conditioners and "smart home solutions".[34] Automatic regulating thermostats are just one example analysed in this paper; they are included in HS 903210. Thermostats are also used in other sectors, but there are some indications that a significant portion of the thermostats included in HS 903210 is for HVAC-R.

The HTSUS has specific 10-digit codes for automatic regulating thermostats for air conditioning, refrigeration or heating: HTSUS 9032.10.00.30 (designed for wall mounting) and 9032.10.00.60 (other). US imports under the provisions of these two HTSUS codes represented more than half (in value terms) of all imports under HS 903210 in the period 2006-2008. About 85 percent of US imports (in value terms) in the period 2006-2008 came from China and Mexico.

Control instruments for air conditioning, refrigeration or heating systems are also imported into the Unites States under the provisions of HTSUS 9032.89.60.15 (complete systems) and HTSUS 9032.89.60.25 (other). In absolute terms, the value of imports of control instruments under these two items was slightly higher (about fifteen percent on average in 2006-2008) than imports of automatic regulating thermostats for air conditioning, refrigeration or heating (as part of HS 903210). Most imports came from Mexico. However, these imports represented only a small part of all imports under HS 903289. Therefore, HS 903289 has not been included in the analysis presented here.

There are no specific incentives for automatic regulating thermostats in the context of EE policies and measures. Developing countries accounted for almost half the value of world exports (excluding intra-EU trade), and China and Mexico together accounted for more than one third of world exports in 2007 (Table 10).

It may be useful to try to identify other control equipment that may be exposed to the deployment of EE equipment in the building sector (see also the discussion in the next section on lighting).

Table 10. Thermostats: Top Twenty Exporters in 2007

Exporter (all countries)	Exports ($million)	Exporter (developing countries*)	Exports ($million)
All countries	2806.5	All developing countries	690.3
Germany	530.2	Mexico	246.4
Italy	282.1	China	210.4
France	248.3	Malaysia	84.7
Mexico	246.4	Korea, Rep.	48.4
China	210.4	Turkey	22.0
Denmark	153.5	Tunisia	21.4
United States	109.3	Taiwan, China	14.0
United Kingdom	100.1	Brazil	11.9
Japan	94.1	Singapore	10.5
Malaysia	84.7	Thailand	7.4
Hungary	72.2	Hong Kong, China	5.5
Czech Republic	69.1	Argentina	2.3
Netherlands	63.5	India	1.8
Switzerland	59.6	South Africa	1.1
Korea, Rep.	48.4	Chile	0.6
Canada	40.9	Costa Rica	0.6
Slovenia	36.6	Pakistan	0.4
Luxembourg	36.0	Armenia	0.3
Spain	29.7	Colombia	0.1
Austria	29.5		
EU-27	1776.6		
Intra-EU	1362.4		
EU (excl intra-EU trade)	414.2		

Source: Based on COMTRADE, using WITS.
**Includes countries in Eurasia*

With regard to imports, the United States was the largest import market, accounting for about twenty-seven percent of world imports (excluding intra-EU trade) in 2007. The top twenty importers are listed in Table A2.7

Tariffs in major import markets are low: between zero and one and nine tenths percent ad valorem in the United States and between two and one tenths and two and eight tenths percent in the EU. Applied rates in China are seven percent. Applied tariffs in Argentina, Brazil, Thailand and Tunisia, all relatively large import markets, are of ten percent or more (Table A3.10).

3.4 Lighting

3.4.1 Energy savings in lighting

Very large energy savings based on fully commercialized technologies are possible in residential and commercial lighting in both developed and developing countries. "These include incandescent, fluorescent and high-intensity discharge lamps, the ballasts and transformers that drive them, the luminaries in which they are housed, and the controls that operate them" (IEA, 2008a). Time-scheduled switches, occupancy sensors and daylight-responsive dimming systems are also mature and fully proven technologies. Many new lighting systems are so cost-effective that it makes economic sense to prematurely retire the old inefficient systems and retrofit the new ones (IEA, 2008a).

Government interventions, in particular regulations and incentives, are an important driver of the introduction of energy-efficient lighting systems. Several governments, including in developing countries, have taken measures to phase out inefficient lamps through regulations and subsidies to promote their replacement by more efficient ones. Voluntary market transformation programmes have been implemented in some countries. International initiatives have also made an important contribution to promoting efficient lighting, particularly in developing countries. An example is the Efficient Lighting Initiative (ELI) launched in 1999 by the International Finance Corporation (IFC) and the Global Environment Facility (GEF), which, among other things created a certification mechanism for high-quality products.

3.4.2 HS codes

TERI has identified four different categories of lamps: incandescent lamps (ex 853922), tungsten halogen filament lamps (853921), compact fluorescent lamps – CFL (853931) and high-pressure sodium (HPS) lamps (ex 853932).[35] The TERI list also includes ballasts for discharge lamps (ex 8504.10), such as CFL and HPS. In this paper, these five HS codes collectively constitute the group “lighting”.

LED (light emitting diode) lamps, which use light-emitting diodes as the source of light, are also highly efficient. McKinsey (2009) lists the switch from incandescent to LED in residential lighting as one of the cheapest and least capital-intensive GHG abatement options (Box 1). Light-emitting diodes, however, are included in HS 854140, which also includes PV cells and modules. This item is analysed in the next section. HS code 940540 (Other electric lamps and lighting fittings) may be relevant in the context of LED lamps, but it is not included in the TERI list.

As mentioned above, energy-saving policies create a market for certain control technologies and products. The TERI list includes certain switches for daylight-responsive dimming and assigns it to HS code ex-853650. However, switches included in this 6-digit HS code appear to have many other applications. It has therefore been excluded from the analysis in this paper.

Standard incandescent lamps are inefficient and many countries are therefore phasing out their use (several countries and the EU have banned or are planning to ban their use completely). Tungsten halogen filament lamps provide more than double the luminous intensity of the incandescent lamp and last twice as long. Other lamps, however, are far more efficient. The CFL is a highly energy-efficient lamp (according to the US ENERGY STAR website it uses 75 percent less energy and lasts about ten times longer than an incandescent bulb at the same luminosity) and its use is widely promoted. The CFL is one of the very few energy-efficient products that can be identified unequivocally at the 6-digit HS level. HPS lamps are also highly energy efficient. However, HPS lamps are hidden in HS code 853932, which also includes mercury and other lamps.

3.4.3 Trade

An analysis of trade flows shows that energy-efficient lamps (CFL and HPS) increased their share in world trade during the period 2002-2008, while the share of inefficient incandescent and relatively less efficient tungsten-halogen lamps has been falling. The same is true for developing country imports (Table 11).

Table 11. Selected Types of Lamps: Share in Total World Imports of These Lamps, 2002-2008

HS	Category	2002	2003	2004	2005	2006	2007	2008
World imports								
853921ex	Tungsten halogen filament lamps	26.6	25.0	25.5	24.9	23.6	22.1	21.4
853922ex	Incandescent lamps	22.4	21.0	18.5	16.9	14.3	12.9	11.5
853931	Compact fluorescent lamps	35.3	35.4	35.1	36.3	39.9	44.0	47.0
853932ex	High pressure sodium lamps	15.7	18.6	20.9	22.0	22.2	21.0	20.1
	All selected types of lamps	100	100	100	100	100	100	100
Developing country imports								
HS	**Category**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
853921ex	Tungsten halogen filament lamps	25.3	24.2	22.6	20.9	18.3	20.5	21.4
853922ex	Incandescent lamps	21.4	20.8	14.4	12.4	10.0	11.0	9.6
853931	Compact fluorescent lamps	38.3	36.5	34.5	37.2	45.1	44.3	46.4
853932ex	High pressure sodium lamps	15.0	18.5	28.5	29.5	26.7	24.2	22.6
	All selected types of lamps	100	100	100	100	100	100	100

Source Based on COMTRADE, using WITS.
** Estimates may be affected somewhat by the fact that the number of countries reporting trade statistics to COMTRADE has been increasing over time. Estimates for 2008 may be affected by the fact that some countries had not yet reported trade statistics to COMTRADE.*

As shown in Table 12, China is the world's largest exporter of CFLs, with a share of 56 percent of world exports in 2007 (or 75 percent if intra-EU trade is excluded).[36] China's share in world exports of incandescent lamps and tungsten halogen filament lamps is only about fifteen percent. Out of 260 CFL manufacturers participating in the US ENERGY STAR programme, 80 are located in China.

Table 12. Compact Fluorescent Lamps: Top Twenty Exporters in 2007

Exporter (all countries)	Exports ($million)	Exporter (developing countries*)	Exports ($million)
All countries	3960.7	All developing countries	2454.4
China	2213.9	China	2213.9
Poland	329.3	Thailand	50.4
Netherlands	301.7	Vietnam	44.8
France	237.7	Mexico	35.1
Hungary	164.5	India	25.8
Canada	99.4	Brazil	15.4
United States	84.1	Korea, Rep.	15.3
Italy	69.5	Taiwan, China	12.9
Thailand	50.4	Singapore	12.6
Sweden	46.3	Tunisia	8.0
Vietnam	44.8	Malaysia	6.6
United Kingdom	39.0	Turkey	4.2
Belgium	35.6	Colombia	3.9

Table 12: *Continued*

Exporter (all countries)	Exports ($million)	Exporter (developing countries*)	Exports ($million)
Mexico	35.1	South Africa	1.0
Japan	32.0	Azerbaijan	0.9
Spain	31.5	Saudi Arabia	0.9
India	25.8	United Arab Emirates	0.7
Brazil	15.4	Hong Kong, China	0.4
Korea, Rep.	15.3	Guatemala	0.3
Taiwan, China	12.9	Occ. Palestinian Territory	0.2
EU-27	1284.5		
Intra-EU	992.7		
EU (excl intra-EU trade)	291.8		

Source: Based on COMTRADE, using WITS.
** Includes countries in Eurasia*

Information on imports of CFLs is shown in Annex Table A2.8

With regard to tariffs, the EU has bound its import duties for CFL at two and seven tenths percent ad valorem and the United States at two and four tenths percent. The simple average of the applied tariffs is eight and seven tenths percent and the trade-weighted average rate (using 2007 import values) is four and nine tenths percent (Table A3.8). Among the thirty largest importers, Argentina, Brazil, Colombia, India, Malaysia, Mexico, the Philippines, the Russian Federation, South Africa and Thailand have tariffs (applied rates) of ten percent or more. Some of these countries, however, have their own production of CFL and other highly-efficient lamps and apply measures other than tariffs to discourage the use of inefficient lamps. For example, applied rates in Argentina and Brazil are eighteen percent ad valorem (the common external tariff for MERCOSUR), but Brazil is subsidizing CFL, and Argentina is banning the use of inefficient incandescent lamps.

3.5 Active Collection and Transformation of Solar Energy in Buildings

Buildings can serve as collectors and transformers of solar energy, meeting a large fraction of their energy needs on a sustainable basis with minimal reliance on connection to energy grids, although for some climates this may only apply during the summer (IPCC, 2007).

In general, the deployment of renewable energy in buildings has been driven by incentives, such as subsidies for installation of RE equipment, tax credits and low-interest loans, as well as regulations (e.g. in the case of solar water heating). Many developed countries have been promoting small-scale electricity generation in residential and commercial buildings based on incentives, such as feed-in tariffs,[37] in some cases backed up by targets.[38]

This section focuses on solar photovoltaic cells and modules (HS 854140)[39] and solar water heaters (HS 841919).

3.5.1 Solar photovoltaic energy

Solar installations are mainly realized on rooftops and façades. In Spain, however, an increasingly important part of solar photovoltaic energy is generated in *"huertas solares"* (solar gardens) rather than in buildings.[40] It follows that the trade figures shown in this paper may somewhat overestimate the contribution of the residential and commercial buildings to total trade in technologies and components for solar-energy generation.[41]

As shown in Table 13, Asian developing countries (in particular China and Taiwan) accounted for 55 percent of world exports if intra-EU trade is excluded. Developing countries, particularly in Asia, are also relatively large importers (table A2.9). However, on balance they registered a trade surplus in 2007.

Table 13. Solar Panels and Light Emitting Diodes: Top Twenty Exporters in 2007

Exporter (all countries)	Exports ($million)	Exporter (developing countries)	Exports ($million)
All countries	25520.3	All developing countries	10807.2
Japan	5472.2	China	5252.3
China	5252.3	Taiwan, China	2580.0
Germany	3522.3	Malaysia	1068.1
Taiwan, China	2580.0	Korea, Rep.	563.2
United States	1582.2	Singapore	500.3
Malaysia	1068.1	Thailand	213.6
United Kingdom	741.4	India	212.8
Korea, Rep.	563.2	Mexico	200.6
Singapore	500.3	South Africa	118.2
Belgium	492.2	Philippines	61.1
Netherlands	483.0	Hong Kong, China	12.0
Austria	359.6	Macao	9.2
Czech Republic	335.6	Vietnam	6.8
Sweden	282.0	Oman	3.1
France	268.4	Turkey	2.0
Hungary	244.1	Brazil	1.2
Thailand	213.6	Kenya	1.0
India	212.8	Argentina	0.9
Mexico	200.6	Morocco	0.5
Spain	193.6	Ecuador	0.1
EU-27	7244.5		
Intra-EU	5986.1		
EU (excl intra-EU trade)	1258.4		

Source: Based on COMTRADE, using WITS.
** Includes countries in Eurasia*

Trade figures for one year, however, do not reflect the extraordinary growth of exports in recent years (until 2008), particularly exports from China and Germany. These two countries overtook Japan as leading exporters in 2008. The value of Chinese exports has doubled every year since 2004 (Table 14). The growth of exports, first in Japan and then by China and Germany followed significant investments in solar energy, based on ambitious government-support programmes.[42] Strong incentives for solar-energy generation in overseas markets also gave a boost to Chinese exports in recent years. In fact, over 60 percent of Chinese exports in 2008, in value terms, went to Germany and Spain.

Table 14. Principal Exporters of Solar Panels and Light Emitting Diodes in 2002-2008

Exporter	Value of exports ($ million)						
	2002	2003	2004	2005	2006	2007	2008
China	222	323	644	1258	2460	5252	11789
Germany	525	803	946	1309	2203	3522	6314
Japan	2436	3548	4629	4796	5199	5472	6190
Taiwan	-	-	1175	1403	1689	2580	4002
United States	750	897	1193	1298	1298	1582	1976
Malaysia	622	661	793	844	1004	1068	749

Source: COMTRADE, using WITS.

Apart from Germany and Spain, several other relatively large importers (Table A2.9) showed very strong import growth in 2008, particularly Belgium, France, Italy and Sweden. Imports into India have also been growing quickly and, following a 150 percent increase in 2008, the country is now among the twenty largest import markets.

Recent developments, especially in the German and Spanish PV markets, resulted in a significant decline in imports into these markets in 2009, also affecting Chinese exports[43] (Jha, 2009). On the other hand, recent market developments and the economic downturn have resulted in certain product oversupply leading to significant price decreases. While this has affected many companies in the PV supply chain, this offers opportunities for utilities (Wagman, 2009). In the long run, price decreases may also give a boost to developing country imports of PV equipment, in particular in volume terms.

HS code 854140

HS 854140 is a good example of a 6-digit HS code relevant to the building sector that predominantly includes products with environmental end-uses. However, it is not possible to know at the 6-digit level how much trade corresponds to light-emitting diodes (lighting) and solar-energy generating equipment. The more detailed CN (EU) and HTSUS (United States) suggest that most imports, in value terms, under HS code 854140 would be PV cells and modules. The EU 8-digit CN classification includes separate sub-headings for light-emitting diodes and “other”. The latter sub-heading (CN 85414090) represented more than 90 percent of EU imports under HS 854140 in 2008. The HTSUS breaks HS 854140 down into eight sub-headings, two of which explicitly cover solar cells. These two items together represented forty-five percent of total US imports under the provisions of HS 854140 in 2006-2008.

3.5.2 Solar water heaters

Solar water heating (SWH) uses the sun to heat water directly or via a heat-transfer fluid in a collector. SWH is a readily deployable technology to reduce the use of other sources of energy, in particular natural gas.

There is a large economic potential for increased use of solar thermal applications for hot-water preparation in many developing countries with favourable climate conditions. Technology itself does not appear to be a major constraint. However, there is a need to remove barriers to accelerate market uptake of SWH. One of these constraints is the complexity of the market infrastructure for SWH. Decentralized applications require a widely developed infrastructure of SMEs, especially service providers. Creation of a sustainable market infrastructure requires a consistent strategy and stable financial support mechanisms.[44]

The installed capacity of SWH systems is often measured by the total surface area of solar collectors. A household system is commonly comprised of one to three m2 of collector surface area with a storage capacity of between 150 and 300 litres.

Table 15. Solar Water Heating Capacities Per Country in 2007 (MW)

Country	At the end of 2007	Added in 2007	Country	At the end of 2007	Added in 2007
China	79898	14798	India	1505	175
United States	21082	894	France	1088	226
Turkey	7105	490	Taiwan	879	94
Germany	6579	679	Spain	848	185
Japan	4866	119	Italy	702	174
Australia	4027	547	Mexico	638	2
Israel	3473	50	South Africa	613	57
Brazil	2580	401	Jordan	593	8
Austria	2521	203	Cyprus	557	11
Greece	2501	198	Canada	526	31

Source: Weiss et. al. (2009).

According to a recent survey (Weiss et. al. 2009), a collector surface area of about 208 million square meters[45] was in operation worldwide by the end of 2007, equivalent to a solar water-heating capacity of some 146 Gigawatt hours (GWh).[46] The survey indicates that China accounted for more than half of the capacity in operation worldwide by the end of 2007, followed by the United States, Turkey, Germany and Japan (Table 15).

In terms of market penetration (total capacity in operation per 1,000 inhabitants) the survey indicates that Cyprus, Israel, Austria, Greece and Barbados are the leading countries. They are followed by Jordan, Turkey, Germany, China and Australia.

Demand for solar water heaters is driven largely by high energy prices, regulations and incentives. Incentives have played a key role in countries such as Austria and Germany, which have less favourable climate conditions than other countries. For example, in Germany, the deployment of SWH has been supported by the Market Incentive Program (MAP), a subsidy scheme.[47] Over 90 percent of all solar thermal installations in Germany have received financial incentives allocated through the MAP (IEA, 2007). In Austria, another leading producer and exporter of solar water heating panels in Europe,[48] growth of the domestic market has been greatly influenced by subsidies and guidance provided through awareness-raising campaigns, information and consultation services (IEA, 2007).

Regulations that make it compulsory to install SWH in new buildings have become increasingly common in recent years (IEA, 2007).[49] An often-quoted example is Barcelona's Solar Ordinance (2000).[50] In India, the ECBC includes requirements for SWH systems.

However, SWH technology is relatively simple and, in some developing countries, has been deployed even without large subsidies. According to the IEA, the Chinese SWH market has developed since the 1980s with essentially no political backing and continues to have an annual average growth rate of nearly 27 percent per year.[51] The drivers for solar water heater market penetration in China include: an abundant solar resource in many regions, a lack of reliable conventional heating options, a well-developed domestic manufacturing industry, and changes in population demographics that result in increasing demand for hot water (IEA, 2007).

3.5.3 Trade

HS Code 841919

Solar water heaters are included in HS 841919, which also covers other equipment. The HTSUS breaks HS 841919 down into three 10-digit codes: instantaneous water heaters (HTSUS 8419.19.00.20), solar water heaters (HTSUS 8419.19.00.40); and "other" non-electric water heaters (HTSUS 8419.19.00.60). Solar water heaters accounted for less than five percent, in value terms, of all water heaters imported into the United States under the provisions of HS 841919 in the period 2006-2008. Most imports of solar water heaters came from China. However, imports under HTSUS 8419.19.00.60 ("other"), mostly from Mexico, were far more important. These figures suggest that Table 16 may significantly overestimate world trade in solar water heaters.

Table 16. HS 841919 (Including Solar Water Heaters): Top Twenty Exporters in 2007

Exporter (all countries)	Imports ($million)	Exporter (developing countries)	Imports ($million)
All countries	1653.4	All developing countries	396.9
Germany	345.0	Mexico	300.7
Mexico	300.7	China	60.3
Austria	144.9	Turkey	10.6
France	134.2	Saudi Arabia	7.0
United States	92.3	India	3.5
Poland	91.1	Malaysia	3.3
Israel	65.4	Korea, Rep.	2.7
Italy	63.3	Singapore	2.1
China	60.3	Argentina	1.5
Netherlands	52.0	Brazil	1.3
United Kingdom	42.4	Occupied Palestinian Terr.	0.9
Greece	36.3	Taiwan, China	0.8
Switzerland	34.7	Thailand	0.8
Belgium	32.8	South Africa	0.5
Denmark	31.1	Barbados	0.2
Spain	16.4	Kenya	0.2
Sweden	12.7	Trinidad and Tobago	0.2
Czech Republic	11.4	Lebanon	0.1
Turkey	10.6		
Canada	9.8		
EU-27	1046.7		
Intra-EU	859.8		
EU (excl intra-EU trade)	186.9		

Source: Based on COMTRADE, using WITS
** Includes countries in Eurasia*

Table 16 shows that many of the leading exporters of products included in HS 841919 also appear in the list of countries with the largest installed capacity in operation. However, the correlation is not very strong. Table 16 also shows Mexico as a leading exporter, especially when intra-EU trade is excluded. However, Mexico is not a key exporter of solar water heaters. Mexico's exports go largely to the United States, the world's largest import market, which accounted for almost half the value of world imports (excluding intra-EU trade) in 2007. As mentioned above, US trade statistics show that water heaters from Mexico were imported into the United States under the provisions of HTSUS 8419.19.00.60 ("other") rather than HTSUS 8419.19.00.40 (solar water heaters).

Imports of products included in HS 841919 are shown in Table A2.10. The reader should be aware that some of the largest importers (particularly Qatar, Saudi Arabia, the United Arab Emirates, and Viet Nam) were not included in the above-mentioned survey of installed SWH capacity.

In conclusion, since SWH probably represents only a small portion of trade in products included in HS 841919, it may be hard to conclude that the 6-digit HS item adequately covers products with an environmental end-use. However, given the large potential and interest for further development of SWH in developing countries, trade in products included under this code has been included in the detailed analysis presented in this paper. One possible issue for further analysis would be whether water heaters included in HS 841919 as a whole would be more climate-friendly than the water heaters included in HS 841911 (Instantaneous gas water heaters).

3.5.4 Tariffs

With regard to tariffs, PV cells and modules (HS 854140) enter most markets at zero MFN rates. As shown in Table A3.9, the fifteen largest import markets (taking the European Communities as one) have zero applied tariffs on an MFN basis and all but two of these countries (Mexico and South Africa) have bound their duty-free rates. Among the twenty-five largest importers, only Bangladesh, Brazil and the Russian Federation provide tariff protection through applied rates. The simple average applied rate for the twenty-five largest importers is only about one and a half percent and the trade-weighted average tariff is close to zero.

In the case of HS 841919, which includes solar water heaters, several countries apply relatively high tariffs, but trade-weighted average tariffs are low. The United States and Canada (the first and third import markets respectively) have bound their tariffs at zero rates. In the European Communities applied and bound tariffs are two and six tenths percent ad valorem. Among the forty or so largest importing countries, Argentina, Brazil, China, Colombia, Jamaica, Pakistan and Tunisia have applied rates of twenty percent or more.[52] The simple average applied rate for the largest important markets is about nine to ten percent, but the trade-weighted tariff is only three to three and eight tenths percent (Table A3.6).

3.6 Household Stoves

3.6.1 Background

According to the IPCC, about three billion people use solid fuels (biomass and, mainly in China, coal) in household stoves to meet their cooking, water heating and space-heating needs. Most of these people live in rural areas with little or no access to commercial sources of fuel or electricity. Worldwide, most household stoves use simple designs and local materials that are inefficient, highly polluting and contribute to the overuse of local resources (IPCC, 2007).

In the long term, stoves that use biogas or biomass-derived liquid fuels offer the greatest potential for significantly reducing the GHG (and black carbon) emissions associated with household use of biomass fuels (IPCC, 2007). Safe and efficient cooking stoves also significantly reduce mortality and morbidity in developing countries (IPCC, 2007). In Europe and North America, wood-pellet burning stoves are increasingly popular as a means of using a renewable energy (biomass) for residential heating.

The TERI list includes two types of household stoves: solar stoves used for cooking and wood-pellet[53] burning stoves used mainly for heating.

Pellet stoves are becoming popular in Europe (Italy is the largest market in Europe) and North America. Several governments are providing subsidies and other financial incentives to promote their deployment.[54] In Germany, for example, subsidies are provided under the Market Incentive Program for Renewable Energies funded by the Federal Office of Economics and Export Control (BAFA). In the United States, a thirty percent tax credit (capped at $1,500)[55] is available during 2009 and 2010 for the purchase and installation of wood-pellet stoves that meet specified efficiency standards.

3.6.2 HS codes

Solar cooking stoves are hidden within HS 732111 (HS 732119 in the 2007 version of the HS). Wood-pellet burning stoves are part of HS 732183 (HS 732189 in the 2007 version of the HS).[56] It is not possible to know from 6-digit HS codes what proportion of trade corresponds to the technologies described in the TERI list.

3.6.3 Trade

World exports and imports for these two HS items are shown in Annex A.1. World trade was about USD five billion in 2007 (only part of this corresponds to the types of stoves being analysed in this paper). Developing countries accounted for more than half the value of world exports excluding intra-EU trade (Table A1.9).

Almost half of 2007 world imports of stoves (in value terms, excluding intra-EU trade) were imported into the United States. Imports into developing countries and countries in transition in Asia were worth about USD 700 million, accounting for only around eighteen percent of world trade. The top importers were Venezuela, Saudi Arabia and Kazakhstan (Table A1.10), but imports were spread over a large range of developing countries with over 60 developing countries registering imports of more than USD one million each. This suggests that stoves are largely produced locally, with some imports taking place (perhaps to acquire special stoves or filling local shortages).

3.6.4 Tariffs

Applied tariffs on stoves[57] in a relatively large number of developing countries are quite high. For example, among the major developing country importers (listed in Table A1.10), Argentina, Colombia, Mexico, Morocco, Panama and Venezuela have applied tariffs of twenty percent or more. Other countries with applied tariffs of twenty percent or more include Bangladesh, Brazil, China, the Dominican Republic, Ecuador, Jamaica, Jordan, Kenya, Malaysia, Nigeria, Pakistan, Paraguay, Senegal, Sri Lanka, Tanzania, Thailand, Tunisia, Uganda and Zimbabwe, among other countries.

3.7 Appliances

Appliances, which in this paper include energy-using consumer goods and computers, account for a significant share of energy use in residential and commercial buildings (refrigerators and freezers are frequently included in this group, but in this paper have been included under HVAC-R). A wide range of products can be included in this group. The ENERGYSTAR programme, for example, has set EE criteria for battery chargers; clothes washers; dehumidifiers; dishwashers; consumer electronics (battery charging systems; digital-to-analog converter boxes; cordless phones; combination units; DVD products; external power adapters; home audio; televisions and set-top boxes) and office equipment (computers; copiers and fax machines; digital duplicators; enterprise servers; external power adapters; mailing machines; monitors; printers, scanners and All-in-Ones).

Policies and measures to promote energy-efficient appliances consist largely of minimum energy performance standards (MEPS), labelling and public procurement. In some cases, incentives are provided. Some of these products, in particular office equipment, are heavily traded, often with a small group of developing countries dominating exports to both developed and developing country imports. International trade can make a positive contribution to market transformation and the diffusion of EE technologies, in particular if there is appropriate international coordination and cooperation, including in the areas of standards and conformity assessment (Vossenaar, 2009). The drive towards greater EE creates important market opportunities.[58]

Appliances include many products, in particular computers that are only loosely connected with the building sector, but heavily traded internationally. Since negotiating trade liberalization on the basis of EE criteria would be complicated and less efficient than existing policies and measures that specifically target market transformation, the group of appliances is not further analysed in this paper.

The TERI list describes certain EE technologies and components applied in certain office equipment, but these are assigned (as ex-item) to 6-digit HS codes for key automatic data processing (ADP) equipment. Trade figures corresponding to these 6-digit codes simply measure trade in all ADP equipment, irrespective of the technology used.[59] Total world imports under these HS items amounted to almost USD175 billion in 2007, of which more than 80 percent was supplied by developing countries (these figures exclude intra-EU trade). The TERI list does not include HS codes for energy-using consumer products. Based on a sample of key products, it is estimated that 85-90 percent of world imports in 2007 (estimated at almost USD 100 billion) was supplied by developing countries. These figures exclude intra-EU trade.

3.8 Aggregated Trade in Products with "Single Environmental End–Use"

Taking all products identified in this paper as having predominantly "environmental end-use" together shows that China is the largest exporter of such products, followed by Germany, Japan, the United States and France. Developing country exports in these products amounted to USD 17.2 billion (Table 17).

Table 17. Developing Country Exports in Selected Products with Single Environmental End Use

HS code	Products and groups of products	World exports (excl. intra-EU) ($m)	Developing countries		
			Value of exports ($m)	Share in world exports (excl. intra-EU) (%)	Structure (%)
680610	Mineral wools (slag wool, rock wool)	848	221	26.1	1.3
680690	Mineral insulating materials and articles	734	64	8.7	0.4
700810	Multiple-walled insulating units of glass	500	166	33.3	1.0
701939	Glass-fibre insulation products	1167	366	31.3	2.1
	Subtotal insulation	3250	817	25.1	4.8
841861	Heat pumps	2393	760	31.8	4.4
841950	Heat exchange units	5348	1280	23.9	7.4
903210	Automatic regulating thermostats	1444	690	47.8	4.0
	Subtotal HVAC-related	9185	2730	29.7	15.8
853931	Compact fluorescent lamps - CFL	2968	2454	82.7	14.3
854140	Solar panels and light emitting diodes	19534	10807	55.3	62.8
841919	Solar water heaters	794	397	50.0	2.3
	Subtotal residential renewable energy	20327	11204	55.1	65.1
	Total	35731	17206	48.2	100

Source: Based on COMTRADE, using WITS.

Developing countries (including countries in transition in Asia) accounted for almost half of the value of world exports in these products (excluding intra-EU trade). The developing country share was particularly high in CFL and solar panels (including light-emitting diodes), mainly as an expression of China's extraordinary export capacity. Solar panels and light-emitting diodes had a very large weight (62.8 percent) in developing country exports.

The top twenty exporters of products identified in this paper as having predominantly "environmental end-use" are listed in Table 18. The twenty top importers are shown in Table A2.11.

Table 18. Top Twenty Exporters of Products with Predominantly Environmental End Use in 2007

Exporter (all)	Exports ($million)	Exporter (developing countries)	Exports ($million)
All	53154	All developing countries*	17206
China	9029	China	9029
Germany	7468	Taiwan, China	2636
Japan	6979	Korea, Rep.	1353
United States	3157	Malaysia	1265
France	2917	Mexico	1041
Taiwan, China	2636	Singapore	591
Italy	2097	Thailand	331
Netherlands	1608	India	301
Sweden	1520	Turkey	139
United Kingdom	1454	South Africa	135
Korea, Rep.	1353	Brazil	71
Malaysia	1265	Philippines	62
Belgium	1217	Vietnam	57
Mexico	1041	Kuwait	43
Poland	936	Tunisia	30
Austria	831	Hong Kong, China	30
Czech Republic	827	Argentina	16
Denmark	613	Saudi Arabia	16
Hungary	606	Colombia	13
Singapore	591	Macao	9
EU-27 total	24167		
Intra-EU trade	17423		
EU-total (excl intra-EU trade)	6743		

Source: Based on COMTRADE, using WITS.
** Includes countries in Eurasia*

4. CONCLUSIONS

4.1 Reducing Emissions in Residential and Commercial Buildings

There is a large untapped potential to reduce direct and indirect (through electricity use) GHG emissions in residential and commercial buildings through energy-efficiency (EE) improvements and renewable-energy generation, using existing and proven technologies. Apart from reducing GHG emissions, harnessing this potential offers significant “co-benefits”. Economic co-benefits include larger energy security, increased access to energy while reducing the need for investment in new energy infrastructure, enhanced competitiveness and savings in consumers’ energy spending. Other co-benefits are improved indoor and outdoor air quality, increased comfort, health and quality of life (IPCC, 2007). Policies and measures in the building sector can make important contributions to poverty alleviation in developing countries. For example, EE programmes targeted at poor households reduce energy poverty; safe and efficient cooking stoves reduce mortality and morbidity and small-scale solar-energy generation increases rural access to electrification.

Trade liberalization may make climate-friendly technologies and products more widely available and less expensive, thereby facilitating their deployment in developing countries.

However, trade liberalization alone is unlikely to stimulate a significant uptake of EE and renewable energy technologies. The experience of developed countries shows that the uptake of energy-efficient technologies and products as well as the generation of renewable energy in residential and commercial buildings is to a large extent driven by regulations and incentives. These include EE requirements in building codes, minimum energy-performance standards (MEPS), labelling, a wide array of fiscal and financial incentives (such as low-interest loans, tax credits and subsidies), and feed-in tariffs to stimulate residential renewable electricity generation. In addition, removing obstacles to EE and renewable energy in the residential and building sector in developing countries requires strengthening of local capacities, including through better quality control, the strengthening of capacities of small and medium-sized enterprises (SMEs) and the development or strengthening of supply chains and distribution channels. Reaching the very large number of small and dispersed end-users represents a major challenge.

Trade liberalization will be more effective in boosting EE improvements in the residential and commercial building sector in developing countries if it is implemented as part of an integrated national policy. For example, developing countries need to strengthen or develop EE requirements in building codes; develop standards and guidelines for appliances and materials used in buildings, including lighting and insulation; promote energy audits to identify cost-effective opportunities for improving EE and reducing CO_2 emissions in buildings, provide consumer information and establish standards for household electrical appliances that are likely to become more popular as incomes increase.

It should also be taken into account that developing countries may want a certain level of tariff protection to build up cost-effective local production of goods and components associated with the deployment of RE and EE technologies, in particular if the scope for other support measures is limited.

4.2 HS Codes

The paper builds on a mapping study prepared by The Energy and Resources Institute (TERI), which identifies a range of climate-mitigation technologies and components that are commercially available in the building sector. Furthermore, 6-digit HS codes were identified that correspond, as closely as possible, to the goods and components associated with these technologies. To what extent can these 6-digit HS codes be used for an analysis of trade issues related to the deployment of the technologies identified in the TERI mapping study and, eventually, the formulation of trade policies and trade negotiations?

With regard to the building envelope, several insulation materials can easily be identified in 6-digit HS codes, but in other cases (in particular plastic foams) building insulation materials involve multiple-use issues. Tariffs applied to insulation materials are not very high, but may nevertheless be an important cost element. Improved insulation in developing countries requires that inexpensive materials are locally available. Import liberalization may play an important role, in particular if it provides a stimulus for cost-effective local production of building-insulation materials.

With regard to HVAC-R, the key issue is EE. It is, however, not possible to identify the most (or the least) energy-efficient HVAC-R simply on the basis of tariff classifications (whether the 6-digit HS classification or more detailed national or regional classifications are considered). Many countries use MEPS (to exclude the most inefficient models of a specific product category from the market), mandatory energy labels (to provide information to consumers) and endorsement labels (to promote the most-efficient models). Such instruments, if well-designed, can be very effective in promoting market transformation (i.e. the larger market penetration of highly efficient products). Negotiating trade liberalization based on EE criteria would not be practicable. This implies that those groups within the building sector with the largest international trade component, i.e. consumer goods, office equipment and most HVAC-R would not be suitable for EGS negotiations. However, international trade can make an important contribution to promoting market transformation at the global scale, in particular if there is policy coordination and collaboration, e.g. in the area of standard-setting and conformity assessment.

However, certain products and components can be identified, not on the basis of EE criteria, but because they have a predominantly environmental end-use. These include, for example, heat pumps, heat exchange units and control equipment. One should keep in mind that these products may also have industrial applications; therefore, the trade figures shown may overestimate the contribution of the building sector to the deployment of such technologies and products.

In the case of lighting, however, 6-digit HS codes go a long way in identifying certain categories of inefficient lamps on the one hand and highly-efficient light bulbs on the other. This facilitates an analysis of the impact of trade-related measures to promote the use of energy-efficient light bulbs and the phase-out of inefficient lamps. Tariffs on imports of compact fluorescent lamps (an energy-efficient bulb that has its own 6-digit HS code) are still relatively high in some developing countries.

The TERI list also includes certain household stoves, in particular wood-pellet burning stoves and solar cooking stoves. In both cases, these stoves are hidden within HS codes that also include other stoves.

Buildings provide an opportunity for small-scale renewable energy generation. This paper has focused on photovoltaic solar energy and solar water heating (SWH). One problem is that 6-digit HS codes include other unrelated products. HS 854140 includes photovoltaic (PV) panels as well as light emitting diodes and the HS code used for SWH (HS 841919) includes other non-electric water heaters (e.g. gas water heaters). Another issue is that not all photovoltaic solar energy and SWH is generated in residential and commercial buildings. As a consequence, trade figures obtained from the use of these 6-digit HS codes might somewhat overestimate the contribution of the building sector to the deployment of climate-friendly technologies and components.

4.3 Trade Flows

Based on the above-mentioned considerations, this paper has selected ten products (6-digit HS codes) for a more detailed analysis. The 2007 trade figures reported to COMTRADE estimate that developing countries (including Asian countries with economies in transition) accounted for slightly less than half of world exports (excluding intra-EU trade) in value terms, but this portion varies considerably from one group of products to the other (it is only twenty-five percent in the case of insulation materials but over 80 percent in the case of compact fluorescent lamps). However, it should be noted that one 6-digit HS code (HS 854140) accounts for more than 60 percent (in value terms) of total developing country exports of these ten products. China accounts for about a quarter of world exports (excluding intra-EU trade) and over half of developing country exports (in value terms). Taiwan (China), the Republic of Korea, Malaysia, Mexico and Singapore also appear among the top twenty exporters, but export values are much smaller. Other developing countries with some export interest include Brazil, India, South Africa, Thailand and Turkey.

Finally, only in very few cases is there an (almost) perfect match between the technologies described in the TERI study and the products that are included in a particular 6-digit HS code. In any attempt to use the mapping study for analysing trade issues the user will need to make his or her own judgment on how to deal with classification and other issues raised in this paper, taking into account the context and objectives of that use. Even if no watertight solution can be provided for classification problems (e.g. in the context of EGS negotiations), at least these problems and their possible implications can be made more transparent.

ENDNOTES

1 In its "ACT" (Accelerated Technology) scenario, the IEA analyses how global CO_2 emissions can be brought back to 2005 levels by 2050.

2 This paper focuses on the use of technologies as a major determinant of energy use in buildings. Non non-technological options (such as changes in occupant behaviour) also play an important role in energy use and CO_2 emissions, but are not analyzed in this paper.

3 However, significant EE improvements in existing buildings can be made through retrofitting. A considerable portion of buildings is usually changed at shorter intervals. Lighting and HVAC systems are often changed after fifteen to twenty years; office equipment is often changed after three to five years whereas household appliances are changed after five to fifteen years. Consumables such as light bulbs are changed over much shorter timeframes (IEA, 2008a).

4 It follows a similar paper on renewable energy technologies (*Climate Change, Trade and Production of Renewable Energy Supply Goods: The Need to Level the Playing Field*), prepared for ICTSD by Veena Jha (Jha, 2009).

5 Table A1: Climate Mitigation Goods Available on a Commercial Basis in 2009 study entitled "Mapping Climate Mitigation Technologies and Associated Goods Within the Renewable Energy Supply Sector" by Paul Lako, Energy Research Centre of the Netherlands. The study also identifies technologies undergoing Research and Development (Table A2).

6 Izaak Wind is former Deputy Director (Harmonized System), World Customs Organisation.

7 Whereas the renewable energy supply and building sectors involve a number of common issues from a conceptual and methodological perspective, there are also important differences. A key objective in renewable energy supply is the installation or expansion of renewable-energy generating capacity, which in turn requires a large number of components that may be traded internationally. An important issue in this sector is the extent to which trade in multiple-use components could be expected to be to a reasonable extent driven by the deployment of renewable-energy technologies. However, the TERI list for the building sector contains very few components. In the building sector a key objective is enhancing EE. Tariff classifications normally do not allow for a differentiation of products with similar end-use on the basis of their relative EE. Also, negotiating trade liberalization on the basis of EE criteria would be very complicated.

8 Production and trade in solar panels are also analyzed in the ICTSD paper on renewable energy supply (Jha, 2009). Photovoltaics (PV) could be considered as part of the power sector if solar panels are used for large-scale centralised electricity production and as part of the building sector if used on rooftops (IEA, 2009). However, in general it is not possible to know from tariff classifications in which sector PV panels included in HS 854140 are used. The IEA considers that "most PV systems are installed in buildings rather than in central-grid power plants and this is likely to remain the case in the future" (IEA, 2009).

9 The TERI list includes HS codes for office equipment (largely automatic data processing equipment), but at the 6-digit level these codes do not give any indication of the specific technology used. These tariff lines accounted for over USD 200 billion of world trade in 2007, far more than the total of all other items on the TERI list.

10 In terms of world trade, the value of trade in selected appliances is almost three times the value of trade corresponding to all five groups together. In terms of developing country

exports, the value of trade in appliances is almost five times that of trade in all five groups (see Annex A.1, various tables).

11 Whereas in its "ACT" scenario, the IEA analyses how global CO_2 emissions can be brought back to 2005 levels by 2050, the more ambitious "BLUE" scenario targets a fifty percent reduction in CO_2 emissions by 2050 compared with 2005.

12 This scenario assumes that collective policy action is taken to limit the long-term concentration of GHG in the atmosphere to 450 parts per million (ppm) of CO_2-equivalent which may restrict the global temperature increase to two degrees Celsius (IEA, 2009).

13 In the 450 Scenario, higher energy prices (compared to the RS) are responsible for almost one-third of the total energy saving in the building sector, despite the relatively low energy-price elasticity in this sector, especially in the short term, and limited fuel-switching options (IEA, 2009).

14 According to the IEA, PV technology has the highest investment cost of all commercially-deployed renewable energy sources. In spite of the big fall in module costs in recent years and increases in the efficiency of commercial cells, PV generation remains relatively costly. Further technological advances and ultimately achieving economies of scale will depend on government subsidies. However, the IEA also notes that the PV industry expects that very large cost reductions may be achieved well before 2030 (IEA, 2008b). According to a recent study by the Lawrence Berkeley National Laboratory (Wiser, Barbose and Peterman, (2009). the installed cost of solar PV systems in the United States decreased nearly twenty-eight percent between 1998 and 2007.

15 PV markets are nevertheless growing in some developing countries such as Bangladesh, India, Kenya, Morocco, Sri Lanka and South Africa.

16 In existing buildings, the most lucrative EE projects involve renovation of energy-service systems (such as lighting; heat, HVAC and water pumping), in particular in commercial buildings. Similar system replacement projects exist in residential buildings, but are often more difficult to package attractively (Taylor et. al. 2008).

17 The Energy Conservation Building Code (ECBC) of 2007.

18 A recent survey (Janda, 2009) found that, in 2009, 61 countries (including twenty-seven developing countries and Kazakhstan) had some form of mandatory and/or voluntary energy standard for buildings, whereas eleven countries (including six developing countries) had proposed standards. In some cases, such standards covered only non-residential buildings.

19 In the European Union, for example, sales of refrigerators in Class A increased from less than five percent of total sales in 1995 to twenty-three percent in 2000 and 61 percent in 2005; in addition, nineteen percent of refrigerators sold in 2005 were in the two new more efficient classes (A+ and A++).

20 Governments may also seek the collaboration of energy suppliers to improve end-use EE in residential and commercial buildings. In the United Kingdom, the Energy Savings Trust encourages energy suppliers to help with the costs of installation of energy-saving measures. Under the Carbon Emissions Reduction Target (CERT), energy suppliers are required to achieve targets for the promotion of EE improvements in the residential buildings. Energy suppliers may choose from a range of measures, e.g. in the areas of insulation, lighting and efficient heating systems.

21 Federal tax credits are available at thirty percent of the cost of installation, with no upper limit through 2016 (for existing homes and new construction) for geothermal heat pumps, solar panels, solar water heaters, small wind-energy systems and fuel cells. In addition, tax credits are available at thirty percent of the cost, up to $1,500, in 2009 and 2010 (for existing homes only) for windows and doors, insulation, roofs, HVAC, non-solar water heaters and biomass stoves (http://www.energystar.gov/index.cfm?c=tax_credits.tx_index). A range of tax credits is also available for commercial buildings.

22 The IEA, in its World Energy Outlook 2009 (Figure 4.4), estimates that the G20 stimulus packages committed for 2009-2018, for a total of USD 2.6 trillion, had a "low-carbon" or "green energy" component (covering green energy generation and EE) of USD 242 billion, of which USD 67 billion (or twenty-eight percent) was to be invested in the building sector (IEA, 2009).

23 The programme, through the KfW, a Government-owned development bank, provides low-interest loans and non-repayable grants to improve EE and reduce CO_2 emissions.

24 In October 2009, the Government of Brazil also established a link between certain economic stimulus measures and EE when it extended tax benefits only for energy-efficient white goods (with a view to preventing adverse environmental impacts). In April 2008, Brazil had reduced the Industrial Production Tax (IPI) on a number of white goods for a period of six months to boost consumption (without applying EE criteria). These reductions were extended until 31 January 2010, but this time only for the most energy-efficient models in accordance with the EE labels of the National Electric Energy Conservation Program (Procel), i.e. Class "A" (full benefit) and B models (partial benefit), with no benefit for less-efficient modules in classes "C" through "E". For example, the reduced IPI tax was five percent for class "A" refrigerators (instead of fifteen percent for class "C"-"E" models); ten (instead of twenty) percent for class "A" washing machines; and two (instead of four) percent for class "A" stoves.

25 http://www.reuters.com/article/pressRelease/idUS101138+26-Mar-2009+BW20090326.

26 The recast of the Energy Performance of Buildings Directive (EPBD), proposed by the European Commission in November 2008, requires Member States to set targets for an increase in the number of buildings of which both CO_2 emissions and primary energy consumption are low or equal to zero. On 31 March 2009, the Industry Committee of the European Parliament adopted a report which sought to amend the Commission's proposal by attaching a requirement that all new buildings would have to produce at least as much energy as they use by 2019 (EurActiv, 2009).

27 Throughout this paper the group of developing countries includes countries in Eurasia, listed as "countries in transition in Asia" (Armenia, Azerbaijan, Georgia, Kazakhstan, Kirghizstan, Uzbekistan, Tajikistan and Turkmenistan) in the UNCTAD Handbook of Statistics 2006.

28 With regard to window or wall-type air conditioners, self-contained and "split systems", the HTSUS includes three specific 8-digit codes. Since HTSUS 8415.10.60 is for split-system air conditioners incorporating a refrigerating unit and a valve for reversal of the cooling/heat cycle (reversible heat pumps)). US imports under the provisions of this item represented only just over one percent of US imports of all air conditioners covered by HS 841510 in the period 2006-2008.

29 World trade in air conditioners more than doubled (in dollar values) between 2002 and 2008. The fastest growth was in window or wall-type air conditioners (HS 841510). With

regard to other air conditioners, those incorporating a reversible heat pump (HS 854181) grew slightly less than those that can be used only for cooling (HS 854182). However, Japanese exports of air conditioners under HS 854181 grew very quickly, in line with a fast growing share of air conditioners that can be used both for cooling and heating in Japan's production of air conditioners. In 2008, Japan took over China as the largest exporter of air conditioners that incorporate a reversible heat pump. The share of exports of air conditioners incorporating a reversible heat pump (HS 854181) in the combined exports of air conditioners under HS codes 854181 and 854182 is slightly below forty percent (in value terms). This share has been growing in the case of Japan and Thailand, but falling in the case of most other important exporters, as well as in intra-EU trade (source COMTRADE).

30 Ground-source (geothermal) heat pumps are among the most efficient cooling technologies currently available and that may also be used for heating.

31 The IEA argues that the most-efficient split-room air conditioner can be four times more efficient than the least-efficient portable air conditioner (IEA, 2008a).

32 The main suppliers to the EU, Japan and the United States are, respectively, Turkey, China and Mexico.

33 If they incorporate a refrigerating unit and a valve for reversal of the cooling-heating cycle (reversible heat pumps), then they are classified under HS 841581.

34 One study (McKinsey, 2009b) estimates that the size of the global market for smart home solutions (technologies that intelligently regulate a household's or company's energy use, e.g. by lowering the temperature or switching off the lights in a room that is not in use) is around 400 million Euros (USD 560 million) a year. The study argues that this market is still in its early stages because of a lack of mature products and hesitations on the part of potential customers. However, the market may grow five-fold by 2020, assuming that ten percent of households and twenty percent of companies would be equipped with smart-home packages by then.

35 This HS code also includes halide lamps.

36 In 2008, the debate on the possible extension of EU anti-dumping duties on Chinese energy-saving compact fluorescent lamps (CFL) revealed the divide of Europe's light bulb makers between those who have production plants in China and those focusing on local production in Europe. German light bulb producer Osram, which concentrates production in Europe, called for extending the anti-dumping duties, but Philips Lighting and other EU producers that have their main production facilities in Asia opposed their extension. Political pressure from a wide range of stakeholders - including environmentalist groups, retailers, consumers and business competitors - over the duties had been growing since they were imposed in 2001 (ICTSD Reporting).

37 A Feed-in Tariff (FiT) is an incentive structured to encourage the deployment of renewable-energy technologies for the generation of electricity. The system is implemented through government legislation that obliges electricity utilities to buy electricity generated from renewable sources at above-market rates set by the government. For example, a FiT may provide households with an incentive to install renewable-energy systems, such as a residential PV panel, as the electricity thus generated can be sold at an above-market price to the utility. The difference is spread over all of the customers of the utility, resulting in a small increase in the price of electricity per customer. The system normally works well as long as electricity from renewable sources accounts for only a relatively

small portion of total electricity generated by the utility. A FiT is normally phased out over time. In Germany, for example, the FiT is reduced annually by a fixed percentage as an incentive to stimulate technological progress and reduce costs. See, for example, Government of South Australia (2007) for a discussion.

38 The National Energy Efficiency Action Plan: Portugal Efficiency 2015 seeks to stimulate small-scale electricity production so as to turn 75 thousand homes into electricity producers by 2015. The Plan also includes a target to have one in every fifteen buildings equipped with solar hot-water heaters (IEA, Addressing Climate Change. Policies and Measures Database).

39 Electricity building-integrated photovoltaic panels (BiPV) may drastically reduce energy load, especially in commercial buildings (IPCC, 2007).

40 Historically, Spain has been a “20 kWp” market with small installations of less than 20 kWp connected to the grid. However, it is now developing into a “100 kWp” market. The “huertas solares” concept enables MW-scale projects by grouping a large number of “100 kWp” plants together (PV Policy Group).

41 Some of the large solar power plants provide households who have little opportunity to generate their own residential solar energy (e.g. because they live in apartment buildings and share rooftops) with an option to benefit from incentives for solar energy generation. For example, the nine and a half megawatt PV facility at Milagro has more than 750 owners - investors from across Spain, each of whom owns one or two of the panels and trackers and receives payments from the electric utility (MIT Technology Review).

42 Japan, Germany and China, among other countries, have invested heavily in renewable energy generation which explains their leading role as exporters of solar energy equipment. Examples of early programmes to stimulate residential solar-energy generation are Japan’s 70,000 Roofs Programme implemented in 1994 and which covered fifty percent of installation costs (as the cost of solar cells fell with increased production, the subsidy was later reduced to about ten percent. By 2002, the number of residential systems installed in Japan had reached 144,000) and the 100,000 Roofs Programme implemented in Germany between 2001 and 2003 (ended in 2003 when the targets were met). Such programmes have contributed to achieving economies of scale and lowering costs. Similar programmes are now under consideration in the State of Karnataka in India and Vietnam.

43 The size of the Spanish PV market, after growing by more than 2600 Megawatts (MW) of new installed solar power in 2008, shrank considerably in 2009 because installed capacity eligible for incentives provided through feed-in tariffs was capped to 500 MW in 2009. In Germany, feed-in tariffs were reduced.

44 This paragraph draws on a GEF project document.

45 This includes evacuated tube collectors (106 million m2), glazed flat-plate collectors (66 million m2) and unglazed collectors (36 million m2). Glazed flat-plate collectors are used in all countries. Evacuated tube collectors are mainly used in China, whereas unglazed collectors are used in Australia and the United States. In China, Taiwan, Europe and Japan collectors are mainly used for domestic hot-water and space heating. In the United States, swimming pool heating is the dominant application (using unglazed plastic collectors).

46 Using a conversion factor of 0.7 KWh per m2.

47 The German Federal Ministry for the Environment (BMU) is responsible for establishing the guidelines and stipulations of the MAP. Grants for solar-thermal collectors are available

through the German Federal Office of Economics and Export Control (BAFA), which is responsible for implementation. Grants provided on a €/m² collector area basis supply averaged roughly fifteen percent of investment and installation costs. The IEA argues that this subsidy was sufficient to catalyse development of the market (IEA, 2007).

48 In 2006 roughly 1.1 million m2 of collector area was produced in Austria, of which nearly 75 percent was exported (IEA, 2007).

49 Such regulations may be particularly effective in countries with booming construction.

50 Israel was the first country, in 1980, to introduce a regulation about the use of solar energy in new buildings for reasons of energy security. This legislation has made SWH a mainstream technology (Menanteau, 2006).

51 Menanteau (2006) also points out that in China the government does not offer subsidies or low interest loans to manufacturers, installers or end-users of SWH systems.

52 In Malaysia and Morocco applied tariffs are zero to thirty percent and two and a half to fifty percent respectively.

53 Wood pellets are a type of wood fuel, generally made from compacted sawdust; more recently, however, other woody feedstock has also been used. Wood pellets are usually produced as a byproduct of sawmilling and other wood-transformation activities. The pellets are quite dense and can be produced with low humidity content (below ten percent, which allows them to be burned with high combustion efficiency. Consumption is high in many EU countries and the United States. End-uses can vary widely: from small-scale residential heating systems (heating single houses), to medium-scale district heating and CHP systems to co-firing in large-scale coal power plants. Use for domestic heating is especially common in Austria, Italy, Germany and the United States (http://www.bioenergytrade.org/woodpellets.html).

54 Apart from pellet stoves, pellet boilers (fully automatic central heating systems for residential heating with bulk delivery of pellets) are also becoming more popular.

55 Tax credits for biomass stoves are included as a Residential *Energy Efficiency* Tax Credit (all of which are capped at $1,500). Residential *Renewable Energy* Tax Credits are not capped.

56 There is also no dedicated HS code for wood pellets. Wood pellets are generally traded under HS 440130 (sawdust and wood waste and scrap, whether or not agglomerated in logs, briquettes, pellets or similar forms). The largest exporters are Germany, Austria, Canada, Belgium, the Netherlands, France, Poland, the Russian Federation and the Baltic countries (Latvia, Estonia and Lithuania). Around 90 percent of world trade is between developed countries. The European Union and the Unites States are the major importers.

57 Defined as HS02 732111 or HS07 732119 (which include solar stoves) and HS02 732183 or HS07 732189 (which include wood-pellet stoves).

58 McKinsey (2009b) estimates that the world market for white goods (refrigerators, washing machines and similar appliances) generated revenues of 130 billion Euros (USD 182 billion) in 2008. In Europe the share of energy-efficient white goods in the A+ and A++ categories rose to over thirty percent in 2008. In Italy this share increased from ten percent previously to almost forty percent after the government granted twenty percent tax deductibility in 2007. McKinsey expects that the drive towards higher EE, in combination with regulatory measures and incentives, will boost global demand for highly energy-efficient modules to 75 billion Euros (USD 105 billion) in 2020.

59 HS 847160 (in the 2002 revision) includes computer monitors. It is possible to indentify relatively more (and relatively less) efficient computer monitors in the 2007 revision of the HS (which transfers monitors to HS 8528). Liquid-crystal display (LCD) computer monitors “almost invariably use less energy in the on-mode than equivalently-sized cathode ray tube (CRT) monitors” (Steenblik et. al., 2006). The HS 2007 revision separately identifies CRT monitors (HS 8528.4) and “other monitors” (HS 8528.5). The latter includes LCD monitors. Within these subheadings, goods of a kind solely or principally used in an automatic data processing system of HS 8471 are separately identified: subheadings HS 852841 for CRT computer monitors and HS 852851 for “other monitors”, which include LCD monitors. Based on data reported to COMTRADE using the HS 2007 revision, it is estimated that the (less-efficient) CRT computer monitors accounted for less than five percent of world exports in 2007 and less than three percent in 2008. CRT computer monitors accounted for two and a half and less than two percent of China’s exports of computer monitors in 2007 and 2008 respectively.

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ANNEX I: TOP EXPORTERS AND IMPORTERS IN SUBGROUPS

Table A1.1. Exports of Building Insulation Products in 2007

Exporter (all)	Exports ($million)	Exporter (developing countries)	Exports ($million)
All	14260.0	All developing countries*	2089.0
Germany	2488.6	China	850.9
United States	1376.4	Korea, Rep.	246.9
Belgium	1208.7	Mexico	186.1
China	850.9	Taiwan, China	133.8
Japan	772.9	Saudi Arabia	125.9
France	657.1	Brazil	118.4
Poland	549.1	Turkey	82.2
United Kingdom	540.8	Singapore	72.7
Netherlands	523.3	Thailand	51.1
Canada	521.7	Malaysia	47.4
Italy	471.5	India	35.1
Austria	454.0	Argentina	32.0
Czech Republic	301.3	South Africa	29.7
Spain	265.1	Hong Kong, China	12.2
Korea, Rep.	246.9	Colombia	11.8
Sweden	229.3	United Arab Emirates	11.1
Denmark	215.1	Chile	9.7
Russian Federation	205.7	Vietnam	5.9
Portugal	190.4	Uruguay	3.4
Slovenia	188.5	Bahrain	3.0
EU-27 total	8964.8		
Intra-EU trade	6800.3		
EU-total (excl intra-EU trade)	2164.5		

*Source: Based on COMTRADE, using WITS. * Includes countries in Eurasia*

Table A1.2. Imports of Building Insulation Products in 2007

Importer (all)	Imports ($million)	Importer (developing countries)	Imports ($million)
All countries	13657.1	All developing countries*	3439.0
United States	1065.0	China	908.6
Germany	1055.9	Mexico	373.7
France	994.7	Korea, Rep.	224.4
China	908.6	United Arab Emirates	198.5
United Kingdom	586.1	Hong Kong, China	183.6
Canada	545.0	Thailand	153.5
Belgium	533.6	Taiwan, China	132.0
Italy	518.4	Malaysia	126.7
Poland	419.3	Turkey	119.9
Spain	381.5	Kazakhstan	113.1

Table A1.2: *Continued*

Importer (all)	Imports ($million)	Importer (developing countries)	Imports ($million)
Mexico	373.7	Singapore	97.5
Netherlands	372.4	India	94.2
Russian Federation	334.9	Brazil	79.0
Czech Republic	333.4	South Africa	67.9
Switzerland	313.7	Vietnam	55.6
Austria	293.3	Saudi Arabia	51.0
Denmark	276.9	Argentina	37.9
Sweden	267.4	Colombia	37.8
Korea, Rep.	224.4	Qatar	33.6
Japan	216.8	Philippines	28.5
EU-27 total	7212.7		
Intra-EU trade	6264.1		
EU-total (excl intra-EU trade)	948.6		

*Source: Based on COMTRADE, using WITS. * Includes countries in Eurasia*

Table A1.3. HVAC-R Exports in 2007

Exporter (all)	Exports ($million)	Exporter (developing countries)	Exports ($million)
All countries	59902.3	All developing countries*	23799.8
China	9247.8	China	9247.8
Italy	6360.1	Thailand	3099.2
Germany	5847.9	Korea, Rep.	3022.0
Thailand	3099.2	Mexico	2419.3
Korea, Rep.	3022.0	Turkey	2142.8
France	2693.9	Malaysia	1041.9
United States	2515.0	Singapore	890.2
Mexico	2419.3	Brazil	417.8
Turkey	2142.8	Saudi Arabia	260.8
Japan	1731.7	Syrian Arab Republic	220.9
Sweden	1624.5	Colombia	166.0
Netherlands	1397.2	India	165.6
Poland	1329.1	Taiwan, China	117.7
Belgium	1328.2	South Africa	66.7
Austria	1265.1	Costa Rica	63.6
Czech Republic	1249.9	Chile	59.4
Malaysia	1041.9	Philippines	53.2
Hungary	943.0	Guatemala	45.7
United Kingdom	922.7	Argentina	38.5
Spain	899.4	Vietnam	36.9
EU-27 total	29945.2		
Intra-EU trade	21386.3		
EU-total (excl intra-EU trade)	8558.9		

*Source: Based on COMTRADE, using WITS. * Includes countries in Eurasia*

Table A1.4. HVAC-R Imports in 2007

Importer (all)	Imports ($million)	Importer (developing countries)	Imports ($million)
All countries	56387.6	All developing countries*	13348.1
United States	6787.5	China	1332.1
Germany	3471.6	Saudi Arabia	958.7
France	3445.6	United Arab Emirates	901.6
United Kingdom	3206.9	Turkey	822.8
Italy	2666.4	Mexico	750.0
Spain	2548.4	Hong Kong, China	625.9
Canada	2012.7	Qatar	611.2
Japan	1832.7	Singapore	569.9
Russian Federation	1780.3	Venezuela	416.7
Netherlands	1438.1	Korea, Rep.	408.0
Belgium	1392.3	Malaysia	364.4
China	1332.1	Taiwan, China	356.6
Poland	1059.1	Kazakhstan	344.8
Australia	962.0	Argentina	334.3
Saudi Arabia	958.7	India	322.8
Sweden	946.7	Vietnam	290.3
Austria	929.2	Thailand	274.5
United Arab Emirates	901.6	South Africa	265.1
Greece	858.3	Nigeria	234.1
Turkey	822.8	Algeria	191.9
EU-27 total	26965.9		
Intra-EU trade	18459.7		
EU-total (excl intra-EU trade)	8506.2		

*Source: Based on COMTRADE, using WITS. * Includes countries in Eurasia*

Table A1.5. Lighting Exports in 2007

Exporter (all)	Exports ($million)	Exporter (developing countries)	Exports ($million)
All	12845.7	All developing countries*	5255.6
China	3852.7	China	3852.7
Germany	1346.8	Mexico	767.1
Netherlands	891.5	Korea, Rep.	139.5
France	883.0	Thailand	99.0
Poland	881.6	Brazil	54.2
Belgium	802.0	Singapore	52.1
Mexico	767.1	Vietnam	49.4
Hungary	498.6	Tunisia	44.5
United States	377.9	India	38.0
Japan	374.2	Taiwan, China	36.7
Austria	296.9	Philippines	35.5
Italy	241.7	Malaysia	21.5

Table A1.5: *Continued*

Exporter (all)	Exports ($million)	Exporter (developing countries)	Exports ($million)
United Kingdom	181.2	Kyrgyz Republic	16.2
Canada	159.2	Turkey	13.9
Korea, Rep.	139.5	Colombia	10.4
Spain	138.5	Argentina	10.0
Finland	133.8	South Africa	4.4
Thailand	99.0	Hong Kong, China	2.3
Sweden	80.4	Ecuador	2.2
Slovak Republic	74.9	Azerbaijan	0.9
EU-27 total	6586.7		
Intra-EU trade	4844.5		
EU-total (excl intra-EU trade)	1742.2		

*Source: Based on COMTRADE, using WITS. * Includes countries in Eurasia*

Table A1.6. Lighting Imports in 2007

Importer (all)	Imports ($million)	Importer (developing countries)	Imports ($million)
All countries	13925.3	All developing countries*	3229.4
United States	2851.2	China	504.4
Germany	1156.0	Mexico	394.1
France	972.4	Hong Kong, China	392.7
Netherlands	778.1	Korea, Rep.	224.4
United Kingdom	653.3	Turkey	211.8
Italy	568.5	Taiwan, China	142.6
China	504.4	Brazil	129.2
Canada	418.5	South Africa	111.5
Poland	397.1	United Arab Emirates	108.0
Mexico	394.1	Saudi Arabia	90.0
Hong Kong, China	392.7	Singapore	84.2
Japan	359.7	Malaysia	74.6
Spain	354.2	India	72.9
Belgium	291.3	Argentina	69.7
Korea, Rep.	224.4	Thailand	58.8
Turkey	211.8	Venezuela	49.8
Sweden	179.7	Colombia	47.9
Austria	175.9	Chile	47.3
Russian Federation	159.1	Vietnam	41.4
Australia	152.9	Peru	28.2
EU-27 total	6389.6		
Intra-EU trade	4702.2		
EU-total (excl intra-EU trade)	1687.6		

*Source: Based on COMTRADE, using WITS. * Includes countries in Eurasia*

Table A1.7. Exports of Solar-energy Products in 2007 (Including Light-emitting Diodes)

Exporter (all)	Exports ($million)	Exporter (developing countries)	Exports ($million)
All countries	27173.7	All developing countries*	11204.1
Japan	5474.5	China	5312.6
China	5312.6	Taiwan, China	2580.9
Germany	3867.3	Malaysia	1071.3
Taiwan, China	2580.9	Korea, Rep.	565.9
United States	1674.5	Singapore	502.4
Malaysia	1071.3	Mexico	501.3
United Kingdom	783.8	India	216.3
Korea, Rep.	565.9	Thailand	214.4
Netherlands	535.0	South Africa	118.6
Belgium	525.0	Philippines	61.1
Austria	504.5	Turkey	12.7
Singapore	502.4	Hong Kong, China	12.0
Mexico	501.3	Macao	9.2
France	402.7	Saudi Arabia	7.0
Czech Republic	347.0	Vietnam	6.8
Sweden	294.7	Oman	3.1
Hungary	250.1	Brazil	2.5
India	216.3	Argentina	2.4
Thailand	214.4	Kenya	1.2
Spain	210.0	Occ. Palestinian Territory	0.9
EU-27 total	8291.2		
Intra-EU trade	6845.9		
EU-total (excl intra-EU trade)	1445.3		

*Source: Based on COMTRADE, using WITS. * Includes countries in Eurasia*

Table A1.8. Imports of Solar Energy Products in 2007 (Including Light-emitting Diodes)

Importer (all)	Imports ($million)	Importer(developing countries)	Imports ($million)
All countries	26974.2	All developing countries*	9186.9
Germany	5146.9	China	3289.8
China	3289.8	Hong Kong, China	1818.0
Spain	3266.2	Korea, Rep.	1280.0
United States	2519.8	Taiwan, China	547.6
Hong Kong, China	1818.0	Singapore	508.2
Korea, Rep.	1280.0	Mexico	462.1
Japan	1131.9	Malaysia	313.1
Italy	971.2	Thailand	183.5
United Kingdom	673.2	India	171.8
France	615.9	South Africa	142.5
Belgium	553.8	Brazil	92.8
Taiwan, China	547.6	Vietnam	59.4

Table A1.8: *Continued*

Importer (all)	Imports ($million)	Importer(developing countries)	Imports ($million)
Singapore	508.2	Saudi Arabia	51.9
Mexico	462.1	Turkey	34.2
Hungary	363.3	United Arab Emirates	27.4
Austria	352.2	Philippines	24.3
Czech Republic	336.3	Qatar	18.9
Netherlands	325.4	Bangladesh	17.1
Malaysia	313.1	Morocco	12.4
Sweden	274.9	Kenya	11.1
EU-27 total	13438.1		
Intra-EU trade	4942.0		
EU-total (excl intra-EU trade)	8496.1		

*Source: Based on COMTRADE, using WITS. * Includes countries in Eurasia*

Table A1.9. Exports of Certain Stoves in 2007

Exporter (all)	Exports ($million)	Exporter (developing countries)	Exports ($million)
All countries	4646.7	All developing countries*	1640.9
China	1001.1	China	1001.1
Italy	833.6	Turkey	208.2
Poland	264.8	Brazil	124.9
United States	224.1	Ecuador	84.5
Turkey	208.2	Mexico	62.3
Germany	177.0	Colombia	25.2
France	140.9	Syrian Arab Republic	24.9
Brazil	124.9	Costa Rica	23.4
Hungary	123.6	Korea, Rep.	18.3
Spain	123.4	India	9.4
Canada	118.3	Vietnam	9.3
Belarus	113.0	Chile	8.6
Czech Republic	109.1	Malaysia	8.5
Belgium	92.7	Taiwan, China	7.1
Austria	87.4	Jordan	6.2
Ecuador	84.5	Singapore	4.2
Denmark	83.4	South Africa	2.7
Slovak Republic	70.3	Thailand	2.2
United Kingdom	68.6	Trinidad and Tobago	1.9
Slovenia	63.5	Namibia	1.6
EU-27 total	2435.1		
Intra-EU trade	1628.6		
EU-total (excl intra-EU trade)	806.4		

*Source: Based on COMTRADE, using WITS. * Includes countries in Eurasia*

Table A1.10. Imports of Certain Stoves in 2007

Importer (all)	Imports ($million)	Importer (developing countries)	Imports ($million)
All countries	5288.3	All developing countries*	710.7
United States	1883.5	Venezuela	81.5
Germany	287.8	Saudi Arabia	38.4
Canada	276.4	Kazakhstan	30.8
France	265.8	United Arab Emirates	28.3
United Kingdom	258.5	Hong Kong, China	28.0
Russian Federation	200.1	Kuwait	27.5
Australia	158.4	Peru	26.6
Poland	111.6	Argentina	25.7
Italy	98.1	Algeria	24.8
Netherlands	88.0	Morocco	22.0
Belgium	84.6	Colombia	21.5
Venezuela	81.5	South Africa	20.6
Norway	73.4	Turkey	19.8
Spain	72.1	Mexico	19.4
Austria	66.3	Lebanon	19.2
Switzerland	60.4	Guatemala	18.8
Ireland	53.4	Chile	14.7
Romania	50.2	Korea, Rep.	13.0
Denmark	44.9	Panama	12.8
Hungary	43.1	El Salvador	11.6
EU-27 total	1781.5		
Intra-EU trade	1317.6		
EU-total (excl intra-EU trade)	463.9		

*Source: Based on COMTRADE, using WITS. * Includes countries in Eurasia*

Table A1.11. Exports of Office Equipment in 2007

Exporter (all)	Exports ($million)	Exporter (developing countries*)	Exports ($million)
All countries	203838	All developing countries*	128928
China	86000	China	86000
Germany	13456	Malaysia	10507
Netherlands	12169	Thailand	10004
United States	11107	Singapore	8345
Ireland	10754	Mexico	5495
Malaysia	10507	Philippines	3469
Thailand	10004	Korea, Rep.	2941
Singapore	8345	Taiwan, China	1646
Czech Republic	6053	India	144
Mexico	5495	Brazil	106
United Kingdom	4434	Turkey	69
Hungary	3640	South Africa	53

Table A1.11: *Continued*

Exporter (all)	Exports ($million)	Exporter (developing countries*)	Exports ($million)
Philippines	3469	Vietnam	48
Japan	3374	Chile	25
France	3067	Hong Kong, China	19
Korea, Rep.	2941	Argentina	17
Taiwan, China	1646	Costa Rica	5
Belgium	1231	Colombia	4
Sweden	1147	Saudi Arabia	4
Canada	721	Kenya	3
EU-27 total	58867		
Intra-EU trade	45896		
EU-total (excl intra-EU trade)	12971		

*Source: Based on COMTRADE, using WITS. * Includes countries in Eurasia*
Note: Tables A.11 and A.12 include printers (HS 844351); computers (847130; 847141, 847149 and 847150); fax machines (851721) and photocopiers (HS 9009). These products also figure on the TERI list

Table A1.12. Imports of Office Equipment in 2007

Importer (all)	Imports ($million)	Importer (developing countries)	Imports ($million)
All countries	218040	All developing countries*	52171
United States	51429	China	13404
Germany	17934	Hong Kong, China	7332
China	13404	Mexico	4429
United Kingdom	12913	Singapore	4124
Netherlands	11785	Korea, Rep.	3218
Japan	11548	India	2348
France	9590	Malaysia	2112
Hong Kong, China	7332	Taiwan, China	2043
Canada	6417	Turkey	1514
Italy	4851	Thailand	1163
Mexico	4429	Brazil	1095
Spain	4181	South Africa	1015
Australia	4134	Saudi Arabia	874
Singapore	4124	Colombia	801
Korea, Rep.	3218	United Arab Emirates	682
Sweden	3088	Chile	638
Belgium	3065	Argentina	577
Ireland	2817	Paraguay	503
Czech Republic	2673	Venezuela	490
India	2348	Vietnam	450
EU-27 total	84314		
Intra-EU trade	45014		
EU-total (excl intra-EU trade)	39299		

*Source: Based on COMTRADE, using WITS. * Includes countries in Eurasia*

Table A1.13. Exports of Selected Energy-using Consumer Products in 2007

Exporter (all)	Exports ($million)	Exporter (developing countries)	Exports ($million)
All countries	130600	All developing countries*	77441
China	36674	China	36674
Mexico	23125	Mexico	23125
Slovak Republic	6577	Malaysia	4047
Netherlands	5799	Thailand	3132
Germany	5050	Korea, Rep.	2883
Poland	4437	Taiwan, China	2709
Hungary	4228	Turkey	2525
Malaysia	4047	Singapore	1351
Czech Republic	3576	Vietnam	212
Spain	3242	South Africa	195
Thailand	3132	Brazil	143
United States	2982	India	111
Korea, Rep.	2883	Philippines	95
Taiwan, China	2709	Argentina	75
Japan	2698	Tunisia	71
United Kingdom	2671	Jordan	21
Belgium	2588	Hong Kong, China	12
Turkey	2525	Ecuador	9
France	2230	Namibia	6
Sweden	1392	Zimbabwe	6
EU-27 total	46574		
Intra-EU trade	40424		
EU-total (excl intra-EU trade)	6150		

*Source: Based on COMTRADE, using WITS. * Includes countries in Eurasia*
Note: Tables A.13 and A.14 are based on a sample of energy-using products, including microwave ovens (HS 851650); audio equipment (HS 851810-851850, 852110, 852190 and 852712-852732); and colour TV sets (HS 852812 and 852821). The TERI list does not include such appliances.

Table A1.14. Imports of Selected Energy-using Consumer Products in 2007

Importer (all)	Imports ($million)	Importer (developing countries)	Imports ($million)
All countries	144983	All developing countries*	23766
United States	43957	Hong Kong, China	5734
Germany	9850	Mexico	2365
United Kingdom	8896	Singapore	1592
France	6597	Korea, Rep.	1265
Netherlands	6337	Venezuela	1038
Hong Kong, China	5734	United Arab Emirates	854
Japan	5037	China	840
Canada	4738	India	806
Spain	4362	Turkey	800
Italy	3989	Malaysia	707

Table A1.14: *Continued*

Importer (all)	Imports ($million)	Importer (developing countries)	Imports ($million)
Belgium	3011	Brazil	693
Australia	2847	South Africa	652
Russian Federation	2831	Colombia	569
Sweden	2461	Chile	538
Mexico	2365	Argentina	503
Singapore	1592	Taiwan, China	493
Denmark	1569	Thailand	442
Poland	1286	Peru	304
Austria	1276	Nigeria	284
Czech Republic	1274	Saudi Arabia	249
EU-27 total	58063		
Intra-EU trade	34337		
EU-total (excl intra-EU trade)	23726		

*Source: Based on COMTRADE, using WITS. * Includes countries in Eurasia*

ANNEX II: IMPORTS OF SELECTED PRODUCTS

Table A2.1. Top Twenty Importers of Slag Wool, Rock Wool and Other Minerals in 2007

Importer (all countries)	Imports ($million)	Importer (developing countries*)	Imports ($million)
All countries	1731.8	All developing countries	245.3
Belgium	141.4	Kazakhstan	46.9
France	120.9	South Africa	20.6
Russian Federation	112.0	China	19.6
Italy	108.7	Korea, Rep.	17.6
Germany	88.4	Turkey	16.8
United States	79.5	Saudi Arabia	13.6
United Kingdom	69.4	Mexico	12.4
Austria	62.3	Taiwan, China	11.0
Sweden	56.0	Singapore	10.6
Kazakhstan	46.9	Thailand	7.3
Czech Republic	46.4	Qatar	6.2
Netherlands	46.0	United Arab Emirates	6.1
Norway	43.2	Morocco	5.4
Romania	38.3	Brazil	4.7
Latvia	32.9	India	3.6
Poland	31.3	Hong Kong, China	3.5
Denmark	30.4	Nigeria	3.4
Spain	29.8	Vietnam	3.4
Estonia	29.0	Malaysia	3.2
Japan	28.4	Algeria	3.0
EU-27	1114.3		
Intra-EU	974.4		
EU (excl intra-EU trade)	139.9		

*Source: Based on COMTRADE, using WITS. * Includes countries in Eurasia*

Table A2.2. Top Twenty Importers of Mineral Insulating Materials and Articles in 2007

Importer (all countries)	Imports ($million)	Importer (developing countries*)	Imports ($million)
All countries	1309.3	All developing countries	296.3
Germany	129.3	Mexico	40.5
United States	85.9	Korea, Rep.	39.5
France	83.7	Turkey	24.2
Canada	78.7	South Africa	22.9
United Kingdom	76.7	United Arab Emirates	17.8
Spain	74.2	Taiwan, China	16.1
Italy	74.0	China	12.5
Netherlands	66.0	India	11.2
Russian Federation	48.6	Saudi Arabia	10.7
Mexico	40.5	Brazil	10.6

Table A2.2: *Continued*

Importer (all countries)	Imports ($million)	Importer (developing countries*)	Imports ($million)
Korea, Rep.	39.5	Hong Kong, China	8.8
Belgium	28.2	Chile	7.9
Poland	26.7	Kazakhstan	7.1
Australia	25.5	Thailand	6.6
Switzerland	24.2	Malaysia	5.4
Turkey	24.2	Argentina	4.8
Japan	23.4	Singapore	4.0
South Africa	22.9	Algeria	3.4
Czech Republic	22.8	Colombia	3.4
Austria	21.7	Vietnam	3.4
EU-27	690.4		
Intra-EU	599.3		
EU (excl intra-EU trade)	91.1		

*Source: Based on COMTRADE, using WITS. * Includes countries in Eurasia*

Table A2.3. Top Twenty Importers of Multiple-walled Insulating Units of Glass in 2007

Importer (all countries)	Imports ($million)	Importer (developing countries*)	Imports ($million)
All countries	1083.3	All developing countries	99.4
United States	214.7	Qatar	14.5
Denmark	101.7	Kazakhstan	10.8
Netherlands	74.8	United Arab Emirates	9.5
Switzerland	67.9	Hong Kong, China	9.1
Canada	65.3	Mexico	8.0
France	58.3	India	7.1
Sweden	55.6	Singapore	6.0
Poland	41.4	Saudi Arabia	3.5
United Kingdom	39.4	Turkey	3.0
Belgium	34.0	Bahamas, The	2.8
Austria	33.0	Bahrain	2.2
Germany	22.4	Azerbaijan	2.0
Norway	21.3	Algeria	2.0
Czech Republic	18.1	Georgia	1.8
Luxembourg	14.5	Argentina	1.7
Qatar	14.5	Trinidad and Tobago	1.6
Italy	12.1	Jordan	1.5
Russian Federation	11.7	Lebanon	1.4
Kazakhstan	10.8	Chile	1.3
Slovak Republic	10.4	China	1.1
EU-27	581.9		
Intra-EU	544.1		
EU (excl intra-EU trade)	37.8		

*Source: Based on COMTRADE, using WITS. * Includes countries in Eurasia*

Table A2.4. Top Twenty Importers of Glass-fibre Insulation Products in 2007

Importer (all countries)	Imports ($million)	Importer (developing countries*)	Imports ($million)
All countries	1383.6	All developing countries	226.8
France	209.2	Hong Kong, China	31.9
United States	149.7	China	31.1
Canada	95.9	Mexico	26.3
Germany	94.0	Kazakhstan	22.9
Poland	65.9	Korea, Rep.	13.9
United Kingdom	49.8	Malaysia	10.4
Russian Federation	47.2	India	9.7
Belgium	41.6	Saudi Arabia	6.8
Sweden	39.7	Vietnam	6.5
Czech Republic	34.6	Turkey	6.1
Italy	33.0	Brazil	5.5
Hong Kong, China	31.9	United Arab Emirates	5.5
China	31.1	Chile	4.6
Netherlands	27.9	Singapore	4.4
Mexico	26.3	Morocco	4.0
Norway	25.8	Taiwan, China	3.8
Estonia	23.7	Thailand	3.7
Kazakhstan	22.9	Argentina	2.7
Denmark	20.2	Algeria	2.6
Spain	19.8	Pakistan	2.0
EU-27	765.7		
Intra-EU	649.9		
EU (excl intra-EU trade)	115.8		

*Source: Based on COMTRADE, using WITS. * Includes countries in Eurasia*

Table A2.5. Top Twenty Importers of Heat Exchange Units in 2007

Importer (all countries)	Imports ($million)	Importer (developing countries*)	Imports ($million)
All countries	7615.9	All developing countries	2788.2
Germany	709.4	China	602.5
China	602.5	Qatar	329.9
Russian Federation	526.6	Saudi Arabia	319.1
United States	494.5	United Arab Emirates	176.9
France	363.6	Singapore	143.7
Qatar	329.9	Korea, Rep.	124.0
Saudi Arabia	319.1	Mexico	123.5
Italy	312.9	Thailand	100.7
Canada	311.0	Taiwan, China	85.1
Japan	223.0	Malaysia	83.5
Belgium	206.3	Brazil	82.5
Austria	188.8	India	80.5

Table A2.5: *Continued*

Importer (all countries)	Imports ($million)	Importer (developing countries*)	Imports ($million)
United Arab Emirates	176.9	Turkey	75.3
United Kingdom	168.6	Vietnam	40.9
Spain	152.1	Kazakhstan	40.5
Singapore	143.7	Argentina	40.0
Netherlands	128.5	Oman	32.8
Korea, Rep.	124.0	Syrian Arab Republic	31.7
Mexico	123.5	Algeria	31.1
Australia	118.6	Chile	28.4
EU-27	2850.3		
Intra-EU	2278.8		
EU (excl intra-EU trade)	571.5		

*Source: Based on COMTRADE, using WITS. * Includes countries in Eurasia*

Table A2.6. Top Twenty Importers of Heat Pumps in 2007

Importer (all countries)	Imports ($million)	Importer (developing countries*)	Imports ($million)
All countries	3021.7	All developing countries	875.6
China	334.6	China	334.6
Germany	285.3	Mexico	90.2
Netherlands	283.6	Saudi Arabia	71.3
Canada	216.2	South Africa	64.6
France	184.7	Thailand	32.3
United Kingdom	177.6	Turkey	31.1
Japan	135.9	United Arab Emirates	27.8
Switzerland	105.4	Vietnam	18.5
Spain	91.2	Kazakhstan	17.1
Mexico	90.2	Hong Kong, China	16.9
Italy	82.0	Singapore	15.7
Poland	76.9	India	15.3
Saudi Arabia	71.3	Korea, Rep.	13.9
South Africa	64.6	Venezuela	12.9
Belgium	62.7	Nigeria	11.9
Czech Republic	46.2	Malaysia	9.2
Austria	45.7	Taiwan, China	7.9
Norway	42.1	Costa Rica	7.1
Finland	37.7	Qatar	5.5
Greece	35.2	Guatemala	5.3
EU-27	1562.3		
Intra-EU	1414.9		
EU (excl intra-EU trade)	147.4		

*Source: Based on COMTRADE, using WITS. *Includes countries in Eurasia*

Table A2.7. Top Twenty Importers of Thermostats in 2007

Importer (all countries)	Imports ($million)	Importer (developing countries*)	Imports ($million)
All countries	2984.5	All developing countries	741.0
United States	510.4	China	141.6
Germany	256.6	Hong Kong, China	138.3
Italy	167.3	Mexico	126.7
France	144.8	Turkey	60.9
China	141.6	Korea, Rep.	34.0
United Kingdom	139.0	Thailand	20.3
Hong Kong, China	138.3	Brazil	18.5
Mexico	126.7	Saudi Arabia	17.4
Canada	106.1	Malaysia	17.4
Spain	84.0	South Africa	17.0
Netherlands	83.0	United Arab Emirates	15.7
Czech Republic	82.7	Taiwan, China	13.5
Poland	80.9	Argentina	12.4
Turkey	60.9	Tunisia	12.0
Austria	57.5	India	11.3
Sweden	48.8	Singapore	10.6
Japan	47.2	Colombia	9.5
Hungary	39.4	Algeria	7.4
Belgium	39.3	Chile	5.7
Switzerland	37.8	Pakistan	5.3
EU-27	1429.3		
Intra-EU	1072.7		
EU (excl intra-EU trade)	356.6		

*Source: Based on COMTRADE, using WITS. * Includes countries in Eurasia*

Table A2.8. Top Twenty Importers of Compact Fluorescent Lamps in 2007

Importer (all countries)	Imports ($million)	Importer (developing countries*)	Imports ($million)
All countries	4548.1	All developing countries	1068.6
United States	1105.6	China	163.6
France	299.3	Hong Kong, China	107.5
Germany	278.8	Brazil	85.2
United Kingdom	224.3	Turkey	83.1
Italy	212.4	Korea, Rep.	74.0
China	163.6	Taiwan, China	51.2
Canada	158.6	Mexico	45.4
Netherlands	150.8	Malaysia	44.8
Poland	129.1	United Arab Emirates	44.2
Japan	126.2	Singapore	34.0
Spain	125.1	Saudi Arabia	31.1
Hong Kong, China	107.5	South Africa	30.8

Table A2.8: *Continued*

Importer (all countries)	Imports ($million)	Importer (developing countries*)	Imports ($million)
Brazil	85.2	Argentina	29.2
Turkey	83.1	India	28.7
Sweden	75.2	Venezuela	18.0
Korea, Rep.	74.0	Colombia	16.5
Belgium	72.9	Thailand	15.6
Russian Federation	68.1	Chile	14.1
Australia	65.7	Ghana	11.6
Taiwan, China	51.2	Peru	11.4
EU-27	1833.5		
Intra-EU	1123.8		
EU (excl intra-EU trade)	709.7		

*Source: Based on COMTRADE, using WITS. * Includes countries in Eurasia*

Table A2.9. Top Twenty Importers of Solar Panels and Light Emitting Diodes in 2007

Importer (all countries)	Imports ($million)	Importer (developing countries)	Imports ($million)
All countries	25417.0	All developing countries	8968.4
Germany	4865.3	China	3288.6
China	3288.6	Hong Kong, China	1817.5
Spain	3208.3	Korea, Rep.	1276.8
United States	2155.7	Taiwan, China	544.4
Hong Kong, China	1817.5	Singapore	503.6
Korea, Rep.	1276.8	Mexico	442.5
Japan	1131.3	Malaysia	306.9
Italy	897.6	India	168.9
United Kingdom	619.1	Thailand	167.1
Taiwan, China	544.4	South Africa	141.1
France	528.8	Brazil	91.7
Belgium	520.6	Vietnam	33.9
Singapore	503.6	Turkey	29.2
Mexico	442.5	Philippines	23.3
Hungary	354.5	Bangladesh	16.6
Czech Republic	319.6	Kenya	10.3
Netherlands	310.2	Algeria	8.0
Malaysia	306.9	Morocco	7.5
Austria	281.4	Argentina	7.0
Sweden	262.3	United Arab Emirates	5.6
EU-27	12627.4		
Intra-EU	4235.3		
EU (excl intra-EU trade)	8392.1		

*Source: Based on COMTRADE, using WITS. * Includes countries in Eurasia*

Table A2.10. Top Twenty Importers of Solar Water Heaters in 2007

Importer (all countries)	Imports ($million)	Importer (developing countries)	Imports ($million)
All countries	1557.3	All developing countries	218.5
United States	364.1	Saudi Arabia	46.6
Germany	281.6	Vietnam	25.5
France	87.1	United Arab Emirates	21.8
Italy	73.5	Mexico	19.5
Austria	70.8	Qatar	18.9
Canada	65.6	Thailand	16.4
Spain	57.9	Malaysia	6.1
United Kingdom	54.0	Turkey	5.0
Saudi Arabia	46.6	Morocco	4.9
Switzerland	42.7	Singapore	4.6
Russian Federation	34.6	Nigeria	3.3
Belgium	33.2	Korea, Rep.	3.2
Vietnam	25.5	Taiwan, China	3.2
Poland	23.1	India	2.9
United Arab Emirates	21.8	Algeria	2.5
Mexico	19.5	Lebanon	2.5
Qatar	18.9	Ghana	2.3
Czech Republic	16.7	Tunisia	2.1
Thailand	16.4	Chile	1.9
Netherlands	15.2	Kazakhstan	1.7
EU-27	810.7		
Intra-EU	706.7		
EU (excl intra-EU trade)	104.0		

Source: Based on COMTRADE, using WITS. Includes countries in Eurasia*

Table A2.11. Top Twenty Importers of Products with Predominantly Environmental End-use in 2007

Importer (all countries)	Imports ($million)	Importer (developing countries)	Imports ($million)
All countries	50842	All developing countries	15718
Germany	7011	China	4597
United States	5176	Hong Kong, China	2142
China	4597	Korea, Rep.	1598
Spain	3849	Mexico	935
Hong Kong, China	2142	Singapore	737
France	2080	Taiwan, China	737
Italy	1974	Saudi Arabia	525
Japan	1732	Malaysia	487
United Kingdom	1618	Qatar	402
Korea, Rep.	1598	Thailand	371
Canada	1328	India	339

Table A2.11: *Continued*

Importer (all countries)	Imports ($million)	Importer (developing countries)	Imports ($million)
Netherlands	1186	Turkey	335
Belgium	1180	United Arab Emirates	331
Mexico	935	South Africa	325
Russian Federation	920	Brazil	302
Austria	804	Kuwait	168
Singapore	737	Kazakhstan	158
Taiwan, China	737	Vietnam	141
Sweden	704	Argentina	99
Czech Republic	685	Chile	72
EU-27	24266		
Intra-EU	13600		
EU (excl intra-EU trade)	10666		

*Based on COMTRADE, using WITS. * Includes countries in EurasiaSource.*

ANNEX III: APPLIED AND BOUND TARIFFS FOR SELECTED PRODUCTS

Table A3.1. Applied and Bound Tariffs - HS 680610 (Slag Wool, Rock Wool)

Reporter	Imports ($m)	Applied tariffs				Bound tariffs		
		Year	Average	Min	Max	Average	Min	Max
EU-27	139.9	2008	0.0	0	0	0.0	0	0
Russian Federation	112.0	2001	15.0	15	15	-	-	-
United States	79.5	2008	3.9	3.9	3.9	3.9	3.9	3.9
Kazakhstan	46.9	n/a	n/a	n/a	n/a	-	-	-
Norway	43.2	2008	0.0	0	0	0.0	0	0
Japan	28.4	2008	0.0	0	0	0.0	0	0
Canada	27.9	2008	0.0	0	0	6.1	4.3	7.4
Belarus	25.4	2001	15.0	15	15	-	-	-
South Africa	20.6	2007	15.0	15	15	15.0	15	15
China	19.6	2006	10.5	10.5	10.5	10.5	10.5	10.5
Switzerland	19.4	2008	-	-	-	-	-	-
Korea, Rep.	17.6	2007	8.0	8	8	13.0	13	13
Turkey	16.8	2006	0.0	0	0	15.8	15.8	15.8
Saudi Arabia	13.6	2007	5.0	5	5	15.0	15	15
Mexico	12.4	2007	10.0	10	10	35.0	35	35
Taiwan, China	11.0	2008	5.0	5	5	5.0	5	5
Singapore	10.6	2008	0.0	0	0	0.0	0	0
Tariff average								
- Simple			5.8	5.8	5.8	9.2	9.0	9.3
- Trade-weighted			5.7	5.7	5.7	4.9	4.8	5.0

Source: COMTRADE, using WITS and WTO, using the WTO Tariff Download Facility.

Table A3.2. Applied and Bound Tariffs - HS 680690 (Mineral Insulating Materials)

Reporter	Imports ($m)	Applied tariffs				Bound tariffs		
		Year	Average	Min	Max	Average	Min	Max
EU-27	91.1	2008	0.0	0	0	0.0	0	0
United States	85.9	2008	0.0	0	0	0.0	0	0
Canada	78.7	2008	3.0	0	6	5.8	4.3	6.7
Russian Federation	48.6	2006	15.0	15	15	-	-	-
Mexico	40.5	2007	18.0	18	18	35.0	35	35
Korea, Rep.	39.5	2007	8.0	8	8	-	-	-
Australia	25.5	2008	5.0	5	5	10.0	10	10
Switzerland	24.2	2008	-	-	-	-	-	-
Turkey	24.2	2006	0.0	0	0	0.0	0	0
Japan	23.4	2008	0	0	0	0.0	0	0
South Africa	22.9	2007	7.5	0	15	15.0	15	15

Table A3.2: *Continued*

Reporter	Imports ($m)	Applied tariffs				Bound tariffs		
		Year	Average	Min	Max	Average	Min	Max
United Arab Emirates	17.8	2007	5.0	5	5	15.0	15	15
Taiwan, China	16.1	2008	2.5	2.5	2.5	2.5	2.5	2.5
China	12.5	2006	10.0	10	10	10.0	10	10
Norway	11.5	2008	0	0	0	0.0	0	0
India	11.2	2008	10.0	10	10	40.0	40	40
Saudi Arabia	10.7	2007	5.0	5	5	15.0	15	15
Brazil	10.6	2008	8.0	8	8	35.0	35	35
Tariff average								
- Simple			5.7	5.1	6.3	12.2	12.1	12.3

Source: COMTRADE, using WITS and WTO, using the WTO Tariff Download Facility.

Table A3.3. Applied and Bound Tariffs - HS 700080 (Multiple-walled Insulating Units of Glass)

Reporter	Imports ($m)	Applied tariffs				Bound tariffs		
		Year	Average	Min	Max	Average	Min	Max
United States	214.7	2008	3.9	3.9	3.9	3.9	3.9	3.9
Switzerland	67.9	2008	-	-	-	-	-	-
Canada	65.3	2008	0.0	0	0	0.0	0	0
EU-27	37.8	2008	3.0	3	3	3.0	3	3
Norway	21.3	2008	0.0	0	0	3.0	3	3
Qatar	14.5	2007	5.0	5	5	20.0	20	20
Russian Federation	11.7	2001	15.0	15	15	-	-	-
Kazakhstan	10.8	n/a	n/a	n/a	n/a	n/a	n/a	n/a
United Arab Emirates	9.5	2007	0.0	0	0	15.0	15	15
Hong Kong, China	9.1	2008	0.0	0	0	0.0	0	0
Mexico	8.0	2007	23.0	23	23	35.0	35	35
Tariff average								
- Simple			5.5	5.5	5.5	10.0	10.0	10.0
- Trade-weighted			3.5	3.5	3.5	4.5	4.5	4.5

Source: COMTRADE, using WITS and WTO, using the WTO Tariff Download Facility.

Table A3.4. Applied and Bound Tariffs - HS 701939 (Glass-fibre Insulation Products)

Reporter	Imports ($m)	Applied tariffs				Bound tariffs		
		Year	Average	Min	Max	Average	Min	Max
United States	149.7	2008	4.9	4.9	4.9	4.9	4.9	4.9
EU-27	115.8	2008	5.0	5	5	5.0	5	5
Canada	95.9	2008	2.2	0	6.5	6.7	6.7	6.7
Russian Federation	47.2	2001	11.7	5	15	-	-	-
Hong Kong, China	31.9	2007	0.0	0	0	0.0	0	0
China	31.1	2006	10.5	10.5	10.5	10.5	10.5	10.5
Mexico	26.3	2007	7.0	7	7	35.0	35	35
Norway	25.8	2008	0.0	0	0	3.0	3	3
Kazakhstan	22.9	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Korea, Rep.	13.9	2008	8.0	8	8	-	-	-
Israel	12.1	2006	5.3	0	8	5.0	5	5
Belarus	11.3	2001	11.7	5	15	-	-	-
Malaysia	10.4	2001	25.0	25	25	-	-	-
Switzerland	10.3	2008	-	-	-	-	-	-
Tariff average								
- Simple			7.6	5.9	8.7	8.8	8.8	8.8
- Trade-weighted			5.5	4.4	6.6	7.3	7.3	7.3

Source: COMTRADE, using WITS and WTO, using the WTO Tariff Download Facility.

Table A3.5. Applied and Bound Tariffs - HS 841861 (Heat Pumps)

Reporter	Imports	Applied tariffs				Bound tariffs		
		Year	Average	Min	Max	Average	Min	Max
China	334.6	2006	10.0	10	10	10.0	10	10
Canada	216.2	2008	3.3	0	7	4.5	0	7.4
EU27	147.4	2008	2.2	2.2	2.2	1.1	0	2.2
Japan	135.9	2008	0.0	0	0	0.0	0	0
Switzerland	105.4	2008	-	-	-	-	-	-
Mexico	90.2	2007	15.7	7	20	36.7	35	40
Saudi Arabia	71.3	2007	5.0	5	5	7.5	0	15
South Africa	64.6	2007	12.5	0	25	30.0	30	30
Norway	42.1	2008	0.0	0	0	4.0	4	4
Thailand	32.3	2007	10.0	10	10	30.0	30	30
Turkey	31.1	2007	1.1	0	2.2	-	-	-
United Arab Emirates	27.8	2007	5.0	5	5	15.0	15	15
Belarus	20.5	2001	20.0	20	20	-	-	-
Vietnam	18.5	n/a	n/a	n/a	n/a	10.0	10	10
Kazakhstan	17.1	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hong Kong, China	16.9	2007	0.0	0	0	-	-	-

Table A3.5: *Continued*

Reporter	Imports	Applied tariffs				Bound tariffs		
		Year	Average	Min	Max	Average	Min	Max
United States	16.4	2008	0.0	0	0	0.0	0	0
Singapore	15.7	2008	0.0	0	0	10.0	10	10
India	15.3	2008	7.5	7.5	7.5	25.0	25	25
Korea, Rep.	13.9	2008	8.0	8	8	13.0	13	13
Venezuela	12.9	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Russian Federation	12.2	2001	20.0	20	20	-	-	-
Nigeria	11.9	2003	45.0	45	45	-	-	-
Tariff average								
- Simple			8.7	7.4	9.8	13.3	12.3	14.4
- Trade-weighted			6.7	5.0	8.3	10.2	8.8	11.6

Source: COMTRADE, using WITS and WTO, using the WTO Tariff Download Facility.

Table A3.6. Applied and Bound Tariffs - HS 841919 (Solar Water Heaters)

Reporter	Imports	Applied tariffs				Bound tariffs		
		Year	Average	Min	Max	Average	Min	Max
United States	364.1	2008	0.0	0	0	0.0	0	0
EU-27	104.0	2008	2.6	2.6	2.6	2.6	2.6	2.6
Canada	65.6	2008	0.0	0	0	0.0	0	0
Saudi Arabia	46.6	2007	5.0	5	5	15.0	15	15
Switzerland	42.7	2008	-	-	-	-	-	-
Russian Federation	34.6	2001	10.0	10	10	-	-	-
Vietnam	25.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a
United Arab Emirates	21.8	2007	5.0	5	5	15.0	15	15
Mexico	19.5	2007	12.5	10	15	35.0	35	35
Qatar	18.9	2007	5.0	5	5	15.0	15	15
Thailand	16.4	2007	10.0	10	10	30.0	30	30
Malaysia	6.1	2001	20.0	0	30	28.3	5	40
Croatia	5.7	2007	10.0	10	10	10.0	10	10
Turkey	5.0	2006	10.0	10	10			
Morocco	4.9	2002	26.3	2.5	50	40.0	40	40
Singapore	4.6	2008	0.0	0	0	10.0	10	10
Nigeria	3.3	2003	15.0	15	15			
Korea, Rep.	3.2	2008	8.0	8	8	13.0	13	13
Taiwan, China	3.2	2008	2.5	2.5	2.5	2.5	2.5	2.5
New Zealand	3.1	2008	5.0	5	5	25.0	25	25
Australia	2.9	2008	5.0	5	5	15.0	15	15
India	2.9	2008	8.8	7.5	10	40.0	40	40
Ghana	2.3	2007	15.0	10	20			
Norway	2.1	2008	0.0	0	0	3.0	3	3

Table A3.6: *Continued*

Reporter	Imports	Applied tariffs				Bound tariffs		
		Year	Average	Min	Max	Average	Min	Max
Tunisia	2.1	2008	43.0	43	43			
Chile	1.9	2008	6.0	6	6	25.0	25	25
Jamaica	1.6	2004	20.0	20	20	50.0	50	50
Peru	1.5	2008	9.0	9	9	30.0	30	30
Belarus	1.4	2001	10.0	10	10			
South Africa	1.4	2007	7.5	0	15	12.5	10	15
Colombia	1.3	2007	20.0	20	20	35.0	35	35
China	1.3	2006	35.0	35	35	35.0	35	35
Brazil	1.1	2008	20.0	20	20	35.0	35	35
Yugoslavia	1.1	2005	7.0	7	7			
Philippines	1.1	2008	1.0	1	1	20.0	20	20
Pakistan	0.8	2007	25.0	25	25	50.0	50	50
Kenya	0.8	2005	0.0	0	0	50.0	50	50
Japan	0.6	2008	0.0	0	0	0.0	0	0
Argentina	0.5	2004	20.0	20	20	35.0	35	35
Hong Kong, China	0.5	2007	0.0	0	0			
Tariff average								
- Simple			10.5	9.0	11.9	22.4	21.5	22.9
- Trade-weighted			3.4	3.0	3.8	6.4	6.1	6.6

Source: COMTRADE, using WITS and WTO, using the WTO Tariff Download Facility.

Table A3.7. Applied and Bound Tariffs - HS 841950 (Heat Exchange Units)

Reporter	Imports ($m)	Applied tariffs				Bound tariffs		
		Year	Average	Min	Max	Average	Min	Max
China	602.5	2006	10.0	10	10	10.0	10	10
EU-27	571.5	2008	1.7	1.7	1.7	0.9	0	1.7
Russian Federation	526.6	2001	10.0	10	10	-	-	-
United States	494.5	2008	1.4	0	4.2	1.1	0	4.2
Qatar	329.9	2007	5.0	5	5	15.0	15	15
Saudi Arabia	319.1	2007	5.0	5	5	15.0	15	15
Canada	311.0	2008	0.0	0	0	6.3	6.1	6.7
Japan	223.0	2008	0.0	0	0	0.0	0	0
United Arab Emirates	176.9	2007	5.0	5	5	15.0	15	15
Singapore	143.7	2008	5.0	5	5	10.0	10	10
Korea, Rep.	124.0	2008	8.0	8	8	13.0	13	13
Mexico	123.5	2007	6.3	0	10	35.0	35	35
Australia	118.6	2008	7.5	5	10	10.0	10	10
Switzerland	117.9	2008	-	-	-	-	-	-

Table A3.7: *Continued*

Reporter	Imports ($m)	Applied tariffs				Bound tariffs		
		Year	Average	Min	Max	Average	Min	Max
Thailand	100.7	2007	0.0	0	0	20.0	20	20
Taiwan, China	85.1	2008	3.0	3	3	5.0	5	5
Malaysia	83.5	2001	12.5	0	25	12.5	5	20
Brazil	82.5	2008	14.0	14	14	34.2	30	35
India	80.5	2008	8.8	7.5	10	40.0	40	40
Turkey	75.3	2006	0.9	0	1.7	-	-	-
Norway	73.4	2008	0.0	0	0	4.0	4	4
Vietnam	40.9	n/a	n/a	n/a	n/a	5.8	3	10
Kazakhstan	40.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Argentina	40.0	2004	0.0	0	0	35.0	35	35
Belarus	35.1	2001	10.0	10	10	-	-	-
Oman	32.8	2002	5.0	5	5	15.0	15	15
Syrian Arab Republic	31.7	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Algeria	31.1	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Chile	28.4	2008	6.0	6	6	25.0	25	25
South Africa	25.3	2007	0.0	0	0	15.0	15	15
Venezuela	22.6	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Israel	22.4	2006	8.9	0	12	5.3	0	10.5
Trinidad and Tobago	21.2	2007	0.0	0	0	50.0	50	50
Croatia	19.1	2007	8.0	8	8	4.8	0	8
Morocco	17.6	2002	2.5	2.5	2.5	40.0	40	40
Peru	17.5	2008	0.0	0	0	30.0	30	30
Philippines	12.3	2008	1.8	1	5	20.0	20	20
Iceland	12.3	2006	0.0	0	0	3.0	0	6
Colombia	10.2	2007	15.0	15	15	35.0	35	35
Tariff average								
- Simple			4.6	3.5	5.5	16.8	15.8	17.7
- Trade-weighted			5.1	4.4	5.7	9.3	8.8	9.9

Source: COMTRADE, using WITS and WTO, using the WTO Tariff Download Facility.

Table A3.8. Applied and Bound Tariffs - HS 853931 (Compact Fluorescent Lamps - CFL)

Reporter	Imports	Applied tariffs				Bound tariffs		
		Year	Average	Min	Max	Average	Min	Max
United States	1105.6	2008	2.4	2.4	2.4	2.4	2.4	2.4
EU-27	709.7	2008	2.7	2.7	2.7	2.7	2.7	2.7
China	163.6	2006	8.0	8	8	8.0	8	8
Canada	158.6	2008	7.0	7	7	7.4	7.4	7.4
Japan	126.2	2008	0.0	0	0	0.0	0	0
Hong Kong, China	107.5	2007	0.0	0	0	-	-	-
Brazil	85.2	2008	18.0	18	18	35.0	35	35
Turkey	83.1	2006	2.7	2.7	2.7	17.0	17	17
Korea, Rep.	74.0	2008	8.0	8	8	-	-	-
Russian Federation	68.1	2001	15.0	15	15	-	-	-
Australia	65.7	2008	5.0	5	5	10.0	10	10
Taiwan, China	51.2	2008	5.0	5	5	5.0	5	5
Mexico	45.4	2006	15.0	15	15	35.0	35	35
Malaysia	44.8	2001	30.0	30	30	30.0	30	30
United Arab Emirates	44.2	2007	5.0	5	5	15.0	15	15
Switzerland	44.0	2008	-	-	-	-	-	-
Singapore	34.0	2008	0.0	0	0	10.0	10	10
Saudi Arabia	31.1	2007	5.0	5	5	5.0	5	5
South Africa	30.8	2007	17.5	15	20	20.0	20	20
Argentina	29.2	2004	18.0	18	18	35.0	35	35
Norway	28.7	2008	0.0	0	0	0.0	0	0
India	28.7	2008	10.0	10	10	40.0	40	40
Israel	18.7	2006	8.0	8	8	25.0	25	25
Venezuela	18.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Colombia	16.5	2007	20.0	20	20	35.0	35	35
Thailand	15.6	2007	10.0	10	10	-	-	-
Chile	14.1	2008	6.0	6	6	25.0	25	25
Ghana	11.6	2007	5.0	0	10	-	-	-
Peru	11.4	2008	9.0	9	9	30.0	30	30
Philippines	10.3	2008	11.0	3	15	-	-	-
Tariff average								
- Simple			8.7	8.1	9.1	17.8	17.8	17.8
- Trade-weighted			4.9	4.8	4.9	7.5	7.5	7.5

Source: COMTRADE, using WITS and WTO, using the WTO Tariff Download Facility.

Table A3.9. Applied and Bound Tariffs - HS 854140 (Solar Panels and Light Emitting Diodes)

Reporter	Imports	Applied tariffs				Bound tariffs		
		Year	Average	Min	Max	Average	Min	Max
EU-27	8496.1	2008	0.0	0	0	0.0	0	0
China	3288.6	2006	0.0	0	0	0.0	0	0
United States	2155.7	2008	0.0	0	0	0.0	0	0
Hong Kong, China	1817.5	2007	0.0	0	0	0.0	0	0
Korea, Rep.	1276.8	2007	0.0	0	0	0.0	0	0
Taiwan, China	544.4	2007	0.0	0	0	0.0	0	0
Singapore	503.6	2008	0.0	0	0	0.0	0	0
Mexico	442.5	2007	0.0	0	0	35.0	35	35
Malaysia	306.9	2001	0.0	0	0	0.0	0	0
Canada	202.5	2008	0.0	0	0	0.0	0	0
India	168.9	2008	0.0	0	0	0.0	0	0
Thailand	167.1	2007	0.0	0	0	0.0	0	0
South Africa	141.1	2007	0.0	0	0	10.0	10	10
Switzerland	115.7	2008	-	-	-	0.0	0	0
Brazil	91.7	2008	4.4	0	12	20.6	0	35
Australia	83.7	2008	0.0	0	0	0.0	0	0
Israel	44.3	2006	0.0	0	0	0.0	0	0
Turkey	29.2	2006	0.0	0	0	0.0	0	0
Russian Federation	27.6	2001	20.0	20	20	-	-	-
Philippines	23.3	2008	0.0	0	0	0.0	0	0
Croatia	17.7	2006	0.0	0	0	0.0	0	0
Norway	17.6	2008	0.0	0	0	0.0	0	0
Bangladesh	16.6	2005	13.0	13	13	-	-	-
New Zealand	10.5	2008	0.0	0	0	0.0	0	0
Kenya	10.3	2005	0.0	0	0	-	-	-
Tariff average								
- Simple			1.5	1.3	1.8	3.1	2.1	3.8
- Trade-weighted			0.02	0.00	0.06	0.95	0.85	1.01

Source: COMTRADE, using WITS and WTO, using the WTO Tariff Download Facility.

Table A3.10. Applied and Bound Tariffs - HS 903210 (Thermostats)

Reporter	Imports ($m)	Applied tariffs				Bound tariffs		
		Year	Average	Min	Max	Average	Min	Max
United States	510.4	2008	0.9	0	1.7	0.9	0	1.7
EU27	356.6	2008	2.3	2.1	2.8	1.8	0	2.8
China	141.6	2006	7.0	7	7	7.0	7	7
Hong Kong, China	138.3	2007	0.0	0	0	0.0	0	0
Mexico	126.7	2007	12.0	10	20	35.0	35	35
Canada	106.1	2008	2.5	0	5	4.8	4.5	5
Turkey	60.9	2006	1.2	0	2.8	7.7	6	8.9
Japan	47.2	2008	0.0	0	0	0.0	0	0
Switzerland	37.8	2008	-	-	-	-	-	-
Korea, Rep.	34.0	2008	7.3	5	8	8.0	8	8
Russian Federation	31.9	2001	5.0	5	5	-	-	-
Thailand	20.3	2007	10.0	10	10	-	--	-
Brazil	18.5	2008	18.0	18	18	35.0	35	35
Saudi Arabia	17.4	2007	5.0	5	5	4.0	0	8
Malaysia	17.4	2001	0.0	0	0	10.0	0	20
South Africa	17.0	2007	5.0	0	10	30.0	30	30
United Arab Emirates	15.7	2007	5.0	5	5	15.0	15	15
Australia	13.9	2008	0.0	0	0	7.5	0	15
Taiwan, China	13.5	2008	3.0	3	3	3.0	3	3
Argentina	12.4	2004	18.0	18	18	35.0	35	35
Tunisia	12.0	2008	10.0	10	10	-	-	-
India	11.3	2008	7.5	7.5	7.5	40.0	40	40
Singapore	10.6	2008	0.0	0	0	10.0	10	10
Tariff average								
- Simple			5.4	4.8	6.3	13.4	12.0	14.7
- Trade-weighted			3.3	2.6	4.5	6.3	5.4	7.0

Source: COMTRADE, using WITS and WTO, using the WTO Tariff Download Facility.

Basic Data Used in this Annex

Trade data are based on COMTRADE, using WITS. Trade data are presented in descending order of 2007 import values and expressed in USD millions. In this annex, data for the EU-27 excludes intra-EU trade.

Tariff data are extracted from WTO databases, using the WTO Tariff Download Facility (http://tariffdata.wto.org/default.aspx). Data on applied tariffs come from the WTO Integrated Data Base (IDB), whereas bound rates come from the Consolidated Tariff Schedules (CTS) database covering all WTO members. Applied rates are shown for the most recent year available (as indicated). In some cases, national or regional tariff schedules include more than one tariff line for a particular 6-digit HS code. In this case the minimum and maximum tariffs are listed under the “Min” (minimum) and “Max” (maximum) columns respectively. Bound rates correspond to the 1996 HS schedules.

The country names are those appearing in COMTRADE (except for “EU-27” which aggregates imports into the 27 EU Member States).

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