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Addressing Energy Efficiency Products in the Environmental Goods Agreement

Issues, Challenges and the Way Forward

By Mahesh Sugathan

ICTSD
International Centre for Trade
and Sustainable Development

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

AC	Alternating current
ACEEE	American Council for an Energy-Efficient Economy
APEC	Asia Pacific Economic Community
BEVs	Pure-battery electric vehicles
CCS	Carbon-capture and storage
CEMEP	European Committee of Electric and Power Electronic Machine Builders
CFBC	Circulating fluidized bed combustion
CFC	Chlorofluorocarbon
CFL	Compact fluorescent lamp
CHP	Combined heat and power
CO_2	Carbon dioxide
CO_2eq	Carbon dioxide equivalent
DC	Direct current
DS	Degree scenario
EE	Energy efficiency
EGA	Environmental Goods Agreement
EMDS	Electric-motor driven systems
ESCO	Energy service company
ETP	Energy Technology Perspectives
EU	European Union
FCEVs	Fuel-cell electric vehicles
G8	Group of Eight
GDP	Gross domestic product
GHGs	Greenhouse gases
HCFCs	Hydrochlorofluorocarbons
HELE	High-efficiency, low-emissions
HFCs	Hydrofluorocarbons
HHV	Higher heating value
HS	Harmonized System
HVAC	Heating, ventilating, and air conditioning
ICE	Internal combustion engine
ICTSD	International Centre for Trade and Sustainable Development
IEA	International Energy Agency
IEC	International Electrotechincal Commission

IPCC	Inter-governmental Panel on Climate Change
ICT	Information and communications technology
KWh	Kilowatt hour
LED	Light-emitting diode
LHV	Lower heating value
MEPs	Minimum energy performance standards
MFN	Most-favoured nation
MW	Megawatt
Mtoe	Million tonnes oil equivalent
NTL	National tariff line
OEM	Original equipment manufacturer
PHEVs	Plug-in hybrid electric vehicles
PRI	Policy and regulatory and incentive
PV	Photovoltaic
R&D	Research and development
SBCI	UNEP Sustainable Buildings and Construction Initiative
SC	Supercritical
SPF	Standard performance factor
TNA	Technology needs assessments
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
USC	Ultra-supercritical
WBCSD	World Business Council for Sustainable Development
WCO	World Customs Organisation
WEF	World Economic Forum
WTO	World Trade Organization

FOREWORD

The recent assessment report of the Intergovernmental Panel on Climate Change (IPCC) confirms that "warming of the climate system is unequivocal … the atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased."[1] Given that fossil fuel-based energy use is the biggest contributor to anthropogenic greenhouse gas (GHG) emissions, a rapid scale up and deployment of renewable or sustainable energy sources, as well as a strengthening of energy efficiency, could contribute to reducing our dependence on polluting fossil energy and thus significantly reduce the emissions responsible for global warming.

In addition, a scale up of sustainable energy can contribute to enhancing access to energy for millions of people in the developing world and power economic growth through increasingly sustainable means, enabling developing countries to move further away from carbon-intensive growth trajectories. It will also enhance global energy security by reducing the reliance of countries on fossil-fuel imports.

Scaling up the expansion of renewable energy and improving energy efficiency will entail addressing impediments to the global diffusion of clean energy and energy-efficient (EE) goods and services. Trade policy can contribute by lowering barriers to market access for sustainable energy goods and services.

While the World Trade Organization (WTO) Doha mandate calls for a reduction, or as appropriate, elimination of tariffs and non-tariff barriers on environmental goods and services (EGS), the lack of a universally accepted definition of EGS has meant that trade delegates at the WTO have struggled over the scope of goods and services that could be taken up for liberalization. Meanwhile, the Asia-Pacific Economic Cooperation (APEC) economies have moved ahead, concluding a first-ever trade outcome on environmental goods. In September 2012, leaders of the APEC economies, meeting in Vladivostok, Russia, agreed to voluntarily reduce applied tariffs to 5 per cent or less on a list of goods contained within 54 product subcategories.

Building on the APEC initiative, 14 WTO members including the 28 members of the European Union, agreed on the sidelines of the World Economic Forum's annual meeting in Davos in January 2014 to start negotiations toward an 'Environmental Goods Agreement' (EGA). Negotiations are aimed at eliminating tariffs on environmental goods on an initially plurilateral basis, eventually extending benefits to all WTO members on a most-favoured nation basis once a 'critical mass' of members in terms of the share in the world trade of the goods agreed upon has been reached. The initiative is open to new members to join.

There is by no means a consensus on what tariff lines constitute environmental goods for the purpose of the EGA negotiations. One of the main reasons for this is that most products falling within relevant categories of the Harmonized System are often used for both environmental and non-environmental purposes. While goods in the APEC list address a number of environmental objectives, the International Centre for Trade and Sustainable Development (ICTSD) has prioritized clean energy and EE technologies in the context of the EGA, given the urgency of climate change mitigation, as expressed above.

The rationale for this paper and its proposal to consider including products relevant for energy efficiency to an EGA list of goods reflects this priority. The paper builds on existing proposals that include EE technologies submitted in the context of the WTO's Doha Round on EGS, as well as those included in the above-mentioned APEC list of 54 tariff sub-headings containing environmental goods. It also includes products based on ICTSD's technology mapping studies in the residential and commercial buildings as well as transport sectors. It further discusses broader technologies that have been proposed in non-trade research (such as the International Energy Agency's Technology Roadmaps) as well as policy contexts — such as technologies included as part of Technology Needs Assessments by members of the United Nations Framework Convention on Climate Change (UNFCCC).

The paper examines specific challenges — conceptual as well as practical — and the opportunities involved in including EE technologies in the EGA. It makes a distinction at the outset between technologies that result in overall energy savings when deployed individually or as part of a 'system,' and EE products whose energy-efficiency contribution rests on their relative performance compared with other products that have similar end uses. It puts forward concrete proposals to deal with both categories of products in the context of EGA negotiations and raises a number of considerations for trade policymakers and negotiators, including the relevance of international standard-setting initiatives and the need to reflect the 'development' dimension.

The author, Mahesh Sugathan, is a senior research fellow with ICTSD and an independent consultant, focusing on the areas of international trade, climate change, and sustainable energy, with numerous publications on these topics. He has worked as a consultant on projects with various other organizations, including the World Bank, the International Trade Centre, and the United Nations Environment Programme (UNEP), as well as with the private sector. Prior to establishing his consultancy practice, he also worked as Programme Coordinator-Economics and Trade Policy Analysis at ICTSD.

This paper was conceived by ICTSD and developed by ICTSD's Global Platform on Climate Change, Trade, and Sustainable Energy. The concept of the research originates in ICTSD's work on a Sustainable Energy Trade Agreement (SETA). In particular, it has been informed by a series of workshops held in Tokyo in April 2014 with government officials as well as with industry; by a workshop with EGA negotiators in the Japanese Permanent Mission to the WTO in June 2014; and by an ICTSD Dialogue in Geneva held in the WTO at the launch of the EGA-negotiations.

As a valuable piece of research, it has the potential to inform innovative policy responses on sustainable energy trade initiatives and will be an important reference tool for policymakers involved with energy access as well as trade negotiators. We hope that you will find the paper to be a thought-provoking, stimulating, and informative piece of reading material and that it proves useful for your work.

Ricardo Meléndez-Ortiz
Chief Executive, ICTSD

EXECUTIVE SUMMARY

This paper discusses the practical issues related to the role that an Environmental Goods Agreement (EGA) can play in advancing the diffusion of energy efficient and energy savings products through tariff liberalization, and proposes possible ways forward. For the purposes of the paper the term 'energy-efficiency' (EE) products or technologies include both energy efficient products (in a relative 'performance-based' sense) as well as energy savings products that minimise system-wide or economy-wide energy consumption (particularly fossil fuel based energy consumption) when deployed.

Energy efficiency has long been considered the 'low-hanging fruit' in terms of climate change mitigation efforts, being both cost-effective and immediately implementable. The International Energy Agency projects that until 2050, EE alone accounts for 38 per cent of cumulative emissions reductions, required to limit warming to 2C , with the rest being made up by renewables deployment (30 per cent), carbon-capture and storage (14 per cent), and fuel-switching and nuclear energy (18 per cent).

Major sectors for deployment of EE technologies include electricity supply and distribution, residential and commercial buildings, manufacturing and transport. The nature of technologies and products used in each of these sectors is diverse. Technologies may involve the use of controls and monitoring equipment, retrofits of existing plants or buildings using higher efficiency versions of already installed equipment, and entirely new technologies.

Developing countries which may have to build facilities and infrastructure from scratch often have good opportunities to deploy the latest technologies and practices, thereby enabling them to 'leapfrog' the older types of infrastructure and equipment that may need to be replaced through retrofits in the developed world.

While services such as EE audits are not within the scope of the paper, their importance should not be overlooked as a means to realize efficiency in energy use. Energy efficiency gains are often achieved through specific processes or a diverse set of multiple-use products deployed as part of a 'system'. Such products or processes may not be easily captured or identifiable for import tariff liberalization purposes by trade policy makers.

In certain cases the use of specific technologies or products can have a major impact on energy consumption and consequently greenhouse gas (GHG) emissions. For instance, motor-driven equipment accounts for about 54 per cent of electricity use in manufacturing. The use of more efficient electric motors and drives alone is estimated to save 20-30 per cent of global electric motor demand (i.e. ten per cent of all global electricity consumption). Keeping markets open for the highest efficiency classes of motors could help in their wider dissemination and reduce costs of improving industrial EE.

Domestic policies, regulations and incentives (PRIs) constitute the major driver for domestic market transformation and greater diffusion of EE products. Such PRIs span the energy supply-, buildings-, industry- and transport sectors and can be classified into: (i) Regulatory and control-based instruments (such as building codes, procurement regulations, mandatory appliance standards and labelling); (ii) Economic and market-based instruments (such as EE certificate schemes); (iii) Fiscal instruments and incentives to correct energy prices or reduce energy consumption (such as energy taxes, tax-incentives and subsidies, and import duty reductions); and (iv) Support, information and voluntary action (such as voluntary standards and labelling schemes, and education and information campaigns).

Domestic PRIs are important for enabling a market for EE technologies since EE investments may often involve high upfront costs, even if they lead to longer-term economic and energy gains. Other barriers

that PRIs are designed to overcome include lack of information, customer inertia and scepticism, as well as energy pricing that discourages EE practises or technology adoption.

Minimum energy performance standards (MEPS) and comparative labels are the two most commonly used policy instruments by governments to promote EE. Minimum energy performance standards define a minimum EE performance threshold that energy-consuming equipment should meet and are used for a wide range of traded goods, particularly household appliances, heating and cooling equipment, home entertainment equipment, information and communications technology (ICT) equipment for home or office, lighting, building materials, and electric motors. While MEPS certification and labelling create a dependable means for distinguishing between efficient and inefficient products, they also require replicable procedures for measuring and classifying products to ensure that suppliers' claims are not questionable.

Trade liberalization measures can ultimately complement domestic PRIs such as MEPS. However, if undertaken in isolation from PRIs, trade liberalization measures may not enable a long-term diffusion and uptake of EE technologies. Many EE standards and labelling requirements based on their design can also become non-tariff barriers to imports of EE goods. Greater harmonization initiatives in EE can enable economies of scale in production and benefit greater volumes of trade. Trade itself, particularly intra-regional trade, is often a driver of such harmonization efforts.

Identifying EE technologies within a trade liberalization context can often be challenging as a number of technologies and components may enable EE only when they are being deployed as part of a system. Nevertheless, in both trade and non-trade, or 'trade-policy' neutral contexts, numerous EE technologies as well as processes have been identified by various institutions. These could be usefully drawn upon or referred to by trade policy makers in terms of the contribution that trade policy could make in opening markets for EE technologies.

Trade policy can certainly make a positive contribution towards climate mitigation and EE efforts. Reducing barriers to trade in environmental goods and services (EGS), including clean energy and EE technologies can, among others, lower costs of access to these goods and reduce supply chain costs. The first formal multilateral effort to specifically reduce trade barriers on EGS was initiated with the launch of the World Trade Organization's (WTO) Doha Round in 2001. Paragraph 31 (iii) of the Doha Ministerial Declaration calls for the "[…] reduction or, as appropriate, elimination of tariffs and non-tariff barriers on environmental goods and services." However, given the absence of a universally accepted definition of environmental goods, discussions about which goods to liberalize have been contentious.

A number of WTO members have made product submissions in the context of the Doha Round of Negotiations. A large number of these products have been relevant to energy savings and have been made under various product categories such as 'Heat and Energy Management', 'Efficient Consumption of Energy', 'Environmental Monitoring Analysis and Assessment Equipment', Energy-Efficient Appliances and Lighting Equipment' and 'Renewable Energy Associated Goods'. Products classified under one category by some WTO members may also appear under other categories proposed by other members. This is the case because some members have used categories that describe the end use outcome of these goods (for example efficient consumption of energy), while others have categorized them by function (for example environmental monitoring, analysis, and assessment). Both usages are equally valid in describing the goods on the list. Furthermore, some goods can be deployed both in a 'renewable energy' as well as an 'energy savings' context.

Other active initiatives to liberalize environmental goods are regional and plurilateral undertakings outside the WTO Doha Round. These initiatives involve smaller groups of countries but comprise the major traders in EGS. In September 2012, as part of the Vladivostok Declaration, the Asia-Pacific Economic Cooperation (APEC) economies agreed to voluntarily reduce, by the end of 2015, applied tariffs to five per cent or less on a list of environmental goods contained within 54 HS codes at the 6-digit level. The list includes a number of products relevant to energy savings, for example solar water heaters and monitoring, regulating, analysis and assessment equipment such as smart sensors and heat meters. APEC member economies can choose to be as selective or as broad as they wish in implementing liberalization initiatives, reducing tariffs on goods at the broader HS 6-digit level or selectively on specific national tariff lines they may deem to be more representative of goods with an 'environmental' end use.

In January 2014, on the sidelines of the World Economic Forum (WEF) in Davos, 14 WTO members, including the EU-28, agreed to eliminate tariffs on environmental goods on a plurilateral basis and eventually bring the initiative to the WTO, extending benefits to all members on a most-favoured nation (MFN) basis once a 'critical mass' of WTO members participate. The declaration states that members would "build upon APEC Leaders' commitment to reduce tariffs on environmental goods." Renewable energy and EE as a category will be discussed. The final outcome of these discussions and the extent to which renewable energy and EE are included could ultimately determine the relevance for, as well as impact of the EGA on climate mitigation efforts.

Energy efficiency goods, as stated earlier, include both energy efficient and energy savings related goods. Liberalization of import tariffs for both categories, but particularly for energy efficient goods, throws up a number of challenges that will need to be addressed if these products are taken up in the EGA negotiations. These include: (i) the difficulties of physically distinguishing the most energy efficient products for tariff liberalization purposes; (ii) the inclusion and exclusion of many products or components that may result in energy savings when deployed as part of a 'system', but which individually cannot be identified as relevant to EE; (iii) clumping of EE as well as other unrelated products in the same basket, or more precisely under the same HS-6 digit code; (iv) whether or not to include products that may also be deployed in other applications or contexts not related to EE; and (v) dealing with technological change or rapid evolution of EE products to ensure that newer or more efficient versions of such products continue to benefit from any tariff liberalization that has been previously granted.

Many of these issues can be addressed, with varying degrees of difficulty. This would depend on how the modalities of liberalization are designed, the degree of ambition as well as practical considerations such as transaction costs compared to the benefits of selective liberalization. This is true particularly if the benefits of such selective liberalization may be eroded over time with broader multilateral or regional trade liberalization initiatives on all products (both EE as well as non-EE related).

Although it may be unwise to roll back trade liberalization or increase protection on less energy efficient goods, it must also be ensured that products with a high degree of relevance or contribution to EE and economy-wide energy savings do not suffer from any market access impediments. While tariffs as compared to non-tariff barriers may be less important barriers for many, if not most EE products, tariffs can more easily be dealt with and even eliminating very low applied 'nuisance' tariffs could help facilitate greater diffusion of EE products. Import tariff elimination could also be considered as 'low-hanging' policy measures that could come into effect fairly rapidly while domestic PRIs such as MEPS could take time to be implemented in a number of countries.

Based on the above premise, the paper proposes possible ways forward on including EE goods in the EGA for the consideration of trade negotiators. This involves categorizing possible EE product groups in various 'tiers' based on their ease of identification within the HS system as well as their relevance to energy savings in a broader economy-wide context. Most of these product tiers include products relevant to energy savings rather than performance-based energy efficient products. Most are already reflected in various Doha Round WTO member submissions on environmental goods and in the APEC list. Additional products have also been identified in the context of ICTSD Technology Mapping Studies.

A first tier of products **(Tier 1)** could be considered 'low-hanging' fruits in that they are easily identifiable at the HS-6 digit level and include products such as light-emitting diodes (LEDs) - (HS 854140) - for which import tariffs are already at zero for most WTO members, as well as others such as various types of insulation products.

A second tier of products **(Tier 2)** includes those products that are easily identifiable physically but categorised as 'ex-outs' under broader HS-6 digit sub-headings. Such products include geothermal heat pumps (an ex-out under heat pumps), solar water heaters (an ex-out of HS 841919, other Non-electric Water Heaters) and a wide range of hybrid and electric vehicles which fall as ex-outs within broader categories of HS 6-digit codes for General vehicles.

Tier 3 products include those products that are relevant to energy savings but which have also other cross-cutting applications. Such products are clearly identifiable at the HS 6-digit or ex-out level and include alternating current (AC) electric generating sets and rotary convertors (HS 850239), as well as monitoring and control equipment such as switchboards and control panels (HS 853710-20).

A fourth tier **(Tier 4)** would comprise spare parts relevant to the efficient functioning of EE goods even though such spare parts may also have other applications in non-EE contexts. Addressing import tariffs on these products could reduce supply chain costs in the manufacturing of EE products, while also providing possible export opportunities for many developing countries that may have an export interest in these low-tech parts and components.

The most challenging tier of EE products **(Tier 5)** to consider are energy efficient products that are not physically distinguishable as relevant to EE, but which perform in a more energy efficient manner than identical products with the same end use. Such products would be identifiable only on the basis of labelling or if accompanied by certification declaring that they conform to a specific energy performance standard. In principle, WTO members may be able to lower their applied tariffs on any products that meet a certain MEPS. However, such minimum thresholds could vary from country to country. One option that could be considered is to bind import tariffs at zero for the highest efficiency classes of products whenever they emerge and for which international standards exist by creating a special 'ex-out' category under the relevant HS-6 digit product sub-heading. Good candidates in this regard are energy efficient motors for which efficiency classes have already been drawn up by the International Electrotechnical Commission (IEC). Many countries apply MEPS based on these IEC standards. The advantage of keeping import tariffs at zero for the highest efficiency motors (regardless of the tariff levels for less efficient motors) is that it would lower the market price and encourage diffusion of a technology that can have a direct impact on energy consumption and thereby GHG emission levels in the manufacturing sector.

A second treatment option for Tier 5 products would be to enable zero duty for energy efficient products as long as the product meets the domestic MEPS of the importing country, even if it does not meet the requirements of an international standard or if a commonly accepted international standard does not exist. While this option provides some flexibility to include a wider range of products for import tariff liberalization, it may not particularly reward the most efficient product in a category.

An additional consideration for EGA negotiators could be to set up a process for constant review and updating of product lists so that evolving EE technologies continue to benefit from tariff liberalization as part of a 'living list'. New technologies could automatically benefit from past tariff concessions if they were already captured by existing HS-6 digit subheadings or ‘ex-out’ descriptions. In many cases, entirely new technologies could evolve that would need suitably-altered, specific product descriptions or even new HS-subheadings (codes and descriptions) at the 6 digit level. Some initiatives are already underway. Planned amendments to the HS (to be implemented in 2017) include, among other things, the creation of separate HS-6 digit sub-headings for (a) LED lamps and (b) hybrid, plug-in hybrid and all-electric vehicles. This development could be given due consideration during the EGA discussions. The review and updating process for EE goods should also draw useful lessons from a similar review process for the products liberalized under the Information Technology Agreement to enable that the process proceeds smoothly.

In any case tariff-liberalisation preferences alone may not be sustainable in terms of providing an exclusive preference for EE goods particularly as liberalization initiatives advance on manufactured products as a whole. Hence during a future ‘second-phase’ of EGA negotiations, negotiators may wish to consider addressing non-tariff measures and facilitate trade in EE products through recognition of measures that will need to be pursued outside the trade realm such as the harmonization of energy performance standards, mutual recognition initiatives and harmonization of test procedures for energy efficient products.

Finally, EGA negotiators could further give due consideration to the ‘development dimension’ by ensuring that any EE product basket agreed upon also contains items of export interest to developing countries. While many developing countries are not yet part of the EGA plurilateral initiative and even if their domestic PRI frameworks for EE are weak in many cases, they could potentially derive trade benefits from an MFN-based extension of a successful liberalization outcome. Ideally trade liberalization and subsequent diffusion of EE technologies should help all economies and sectors climb the ladder towards the use of more EE technologies even as many of these economies put in place the adequate domestic enabling frameworks to encourage greater use of such technologies. A meaningful EGA outcome that promotes trade and diffusion of EE products would serve as positive beacon from the trade policy world for climate change negotiators as they meet for the 21st session of the Conference of the Parties (COP 21) under the United Nations Framework Convention on Climate Change in in Paris in December 2015, and could represent an important trade-led contribution towards climate mitigation efforts.

1. INTRODUCTION: PURPOSE AND STRUCTURE OF THE PAPER

The objective of this paper is to discuss practical issues related to the possible role of the Environmental Goods Agreement (EGA) in supporting trade in products that contribute to enhancing energy efficiency (EE) and energy savings and propose possible ways forward.

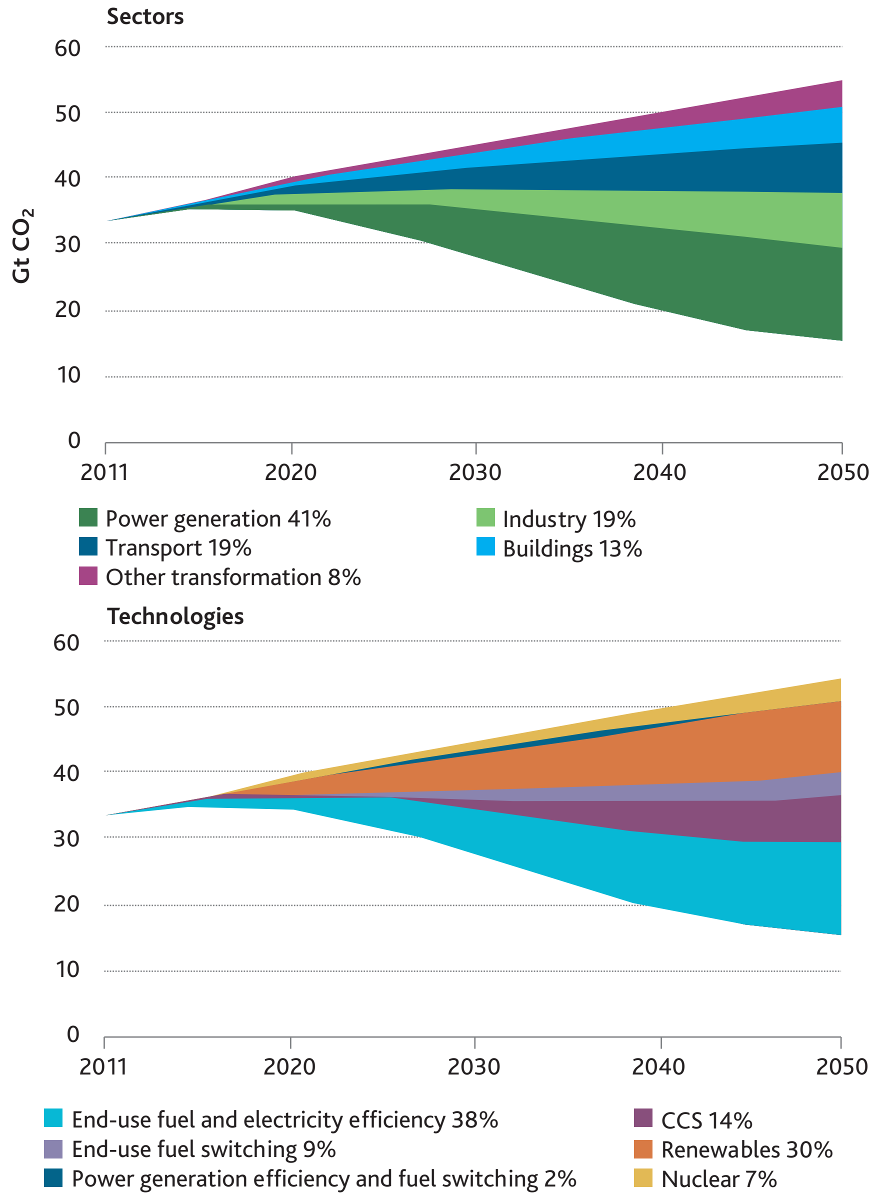
As a contextual background, the paper will begin by examining the relevance of EE to climate change mitigation and some of the key sectors relevant to the deployment of EE and energy-savings technologies and highlight the relevance of domestic policies, regulations, and incentives for advancing EE. It will then outline major developments on the trade-policy front to date, both within and outside the World Trade Organization (WTO), aimed at addressing trade barriers for environmental goods, including energy-efficient/savings products as well as other goods relevant to energy savings. It goes on to highlight specific examples of these goods in the context of these trade negotiations as well as in other institutional contexts and discusses the various issues and challenges associated with their liberalization. The paper will conclude by exploring options on the way forward to liberalize energy-efficient/savings goods within the EGA. More specifically, the paper will propose options for various tiers of energy-efficient/savings product groups, based on their relative ease of identification and their relevance to overall energy savings, that could be considered for inclusion in an EGA for duty-free treatment. In this context, it will also highlight the relevance of using international standards, such as those set by the International Electrotechincal Commission (IEC) for according permanent duty-free-treatment in certain categories of products, bearing in mind the difficulties of practical implementation in the short to medium term. For the purposes of the paper, energy-efficient products are products in the same class or category that are relatively more efficient in terms of performance. Energy-savings products could be any products (including energy-efficient ones) that when deployed lead to overall savings in consumption of either grid-based electricity or fossil-fuel based energy. The scope of the paper extends to both these categories of products. The term ‘EE goods, technologies, or products’ is used to describe both categories.

2. THE RELEVANCE OF EE IN CLIMATE CHANGE MITIGATION AND ADDITIONAL CO-BENEFITS

Energy use is more efficient when the same level of a given output or service is produced with a lower total amount of energy inputs. Alternatively, energy use becomes more efficient when more goods or services are produced with the same amount of energy inputs. Efficiency gains in end-use technologies reduce the demand for energy to provide specific energy services, such as heating and powering a range of industrial processes; conditioning (cooling/heating); lighting residential and commercial buildings; and transporting people and freight. Reductions in energy usage through EE improvements are usually associated with technological changes, but they can also result from better organization and management or improved economic conditions, as well as behavioural changes (non-technical factors).[2]

Improving EE has long been recognized as one of the most effective and low-cost ways of mitigating greenhouse gas (GHG) emissions responsible for climate change. According to the most recent Working Group III (Mitigation of Climate Change) report issued by the Intergovernmental Panel on Climate Change (IPCC), efficiency enhancements and behavioural changes aimed at reducing energy demand compared to baseline scenarios without compromising development are a key mitigation strategy in scenarios reaching 450 or 500 ppm atmospheric carbon dioxide concentrations (CO_2eq) by 2100 (robust evidence, high agreement), the level required to keep global warming to less than 2°C relative to pre-industrial levels. It further adds that 'near-term reductions in energy demand are an important element of cost-effective mitigation strategies, provide more flexibility for reducing carbon intensity in the energy supply sector, hedge against related supply side risks, avoid lock-in to carbon-intensive infrastructures, and are associated with important co-benefits.' The International Energy Agency (IEA) *Energy Technology Perspectives* (ETP) 2014 lays out three possible future scenarios attainable through policy pathways: 2°C (2 DS); 4°C (4 DS); and 6°C (6 DS).[3] According to the IEA's scenario projections until 2050, between the 6 DS and the 2 DS, EE accounts for 38 per cent of cumulative emissions reductions; renewables account for 30 per cent, and carbon capture and storage (CCS) accounts for 14 per cent with fuel switching and nuclear making up the difference. This clearly highlights the important role played by EE in emissions reduction.[4]

Figure 1. Contribution to annual emissions reductions between the 6 DS and 2 DS by sectors and technologies



Source: International Energy Agency (2014), Energy Technology Perspectives 2014, OECD/IEA, Paris.

Investments in EE can help avoid investments in completely new power plants including fossil-fuel ones. According to a new report by the American Council for an Energy-Efficient Economy (ACEEE), energy efficiency programmes aimed at reducing energy waste cost utilities only about 3 cents per kilowatt hour, while generating the same amount of electricity from sources such as fossil fuels can cost two to three times more.[5] EE investments can also mean lower air pollution levels and lower expenditures on expensive fossil-fuel imports that are responsible for a significant portion of energy imports in many countries. India, for example, is increasingly dependent on fossil-fuel imports as energy demand continues to rise and imports accounted for 38 per cent of fossil-fuel consumption in 2012. Net oil import dependency rose from 43 per cent in 1990 to an estimated 71 per cent in 2012, and net coal import dependency has risen from almost zero in 1990 to nearly 23 per cent in 2012.[6]

EE technologies can be deployed in a number of sectors. While most people usually associate energy-efficient technologies with lighting and appliances deployed in buildings, they can also be deployed in the energy supply sector (including fossil-fuel power plants) as well as in the transport sector.

3. KEY SECTORS FOR DEPLOYMENT OF EE TECHNOLOGIES

3.1 Electricity Supply and Distribution

While energy supply goes beyond the supply of electricity, this section will focus mainly on electricity supply and distribution within the energy supply sector, given the easier scope of identifying EE technologies within that definition.[7] According to a report by the World Business Council for Sustainable Development (WBCSD), there is scope for energy savings across the electricity supply chain. With regard to electric power generation, the potential for efficiency gains is twofold, using high-efficiency technologies for new power plants and maintaining or restoring the efficiency of existing plants. Such measures could achieve 25 per cent of all the potential emissions reductions identified by IEA for the electricity sector in 2050, a yearly saving of 2.15 Gt of CO_2. In emerging economies like China where, on average, a new 600 megawatt (MW) coal plant is commissioned almost daily, it is crucial to use the most efficient coal technology available. New ultra-supercritical coal plants offer a significant improvement in EE, which could reduce emissions by about 14 per cent relative to a subcritical coal plant of the same size. Aging fossil-fuel plants are subject to efficiency losses, owing to wear and tear, component failure, and deferred maintenance. Such losses can in some cases increase fuel consumption and emissions by up to 20 per cent. Power plant energy audits — a service — can help identify and minimize such losses. Retrofits using newer, more efficient versions of equipment, such as turbines and boilers as well as controls and monitoring systems, could all enable energy savings in power plants.[8]

Under the 2 DS, the coal-fired power generation sector is projected to contribute about 29 per cent of potential CO_2 emissions worldwide in 2020, and just 6 per cent in 2050. To meet this scenario, CO_2 emissions from coal-fired power generation will have to peak by 2020. In 2011, only about 50 per cent of new coal-fired power plants used high-efficiency, low-emissions (HELE) technologies, predominantly supercritical (SC) and ultra-supercritical (USC) pulverized coal combustion units. Although the share of HELE technology has almost doubled since 2000, far too many non-HELE, sub-critical units are still being constructed. About three-quarters of operating units use non-HELE technology; more than half of current capacity is more than 25 years old and comprises units of less than 300 MW.[9] USC pulverized coal combustion is currently the most efficient HELE technology: some units reach efficiency of 45 per cent — lower heating value (LHV) net,[10] reducing global average emissions to 740 grams of carbon dioxide per kilowatt hour (gCO_2/kWh). Efforts to develop advanced USC technology could lower emissions to 670 gCO_2/kWh (a 30 per cent improvement). Deployment of advanced USC is expected to begin within the next 10 to 15 years.[11] According to the IEA, realizing a 2 DS would require decommissioning all subcritical coal plants (with an average expectancy of 50 years) by 2050 with replacements as well as new capacity coming from HELE plants (SC and USC) as well as fitting the more efficient SC and USC plants with CCS technologies after 2020 (when emissions from coal-fired power plants will need to peak). The IEA Technology Roadmap also points out the important relationship between plant efficiency and the need for CCS. Compared with a subcritical plant with an efficiency of 35 per cent, a USC plant of the same size with an efficiency of 45 per cent requires about 25 per cent less CO_2 capture. Consequently, for the same net electrical output, higher-efficiency plants require CCS units with smaller capacity and hence, high-efficiency plants have lower operating costs for CCS. Therefore, deploying HELE technologies to increase plant efficiency is important to reduce the eventual cost of CO_2 abatement. On their own, HELE technologies have the potential to reduce CO_2 emissions from coal-fired generation to around 670 g/kWh, compared with the global average value for coal plants of around 1000 g/kWh – effectively delivering one-quarter of total CO_2 abatement under the 2 DS.[12]

Electricity distribution also offers opportunities for energy saving. On average, most grids around the world operate at about 90 per cent efficiency, although losses can vary significantly. In addition to transporting energy over long distances, grids also have to perform numerous other functions, such as integrating intermittent renewable energy, including from distributed generation sources and providing quality power for digital electronics. Developing countries provide a good opportunity to deploy modern grid equipment (of course, taking cost considerations into account) as power demand is growing rapidly and urban centres are being connected with new faraway sources. Such projects provide good opportunities to install new technologies, such as high-voltage direct current (DC) lines, which offer 15-40 per cent energy savings potential over long distances. In both developed and developing countries, smart-grid technologies and energy-saving solid-state devices could enable more precise control (relative to their conventional electromechanical counterparts). Monitoring and metrology devices, smart meters and other information technology-related devices can also be important components of such a ‘smart-grid’ system that could be deployed to increase efficiency.[13]

3.2 Buildings

According to the WBCSD report, buildings account for at least 40 per cent of energy use in most countries, and consumption is rapidly growing in developing countries.[14] It is estimated that China alone adds the equivalent of Japan’s building area every three years.[15] According to the IEA, current trends in building energy demand alone will stimulate half of energy supply investments to 2030.[16] Consumption in China and India is set to grow rapidly, and based on current trends, China’s building energy consumption will approach that of Europe, and India’s will exceed that of Japan by 2030. Energy consumption is largely determined by regional and climatic factors (for instance, heating will be an important constituent of energy costs in Europe, the United States (US), and northern China, while cooling is more important for largely tropical and subtropical countries, like India. Energy use can also vary by sector. Food retailing, a sub-sector under commercial buildings, will entail greater refrigeration demand compared with other retailing establishments, for which lighting demand may be more important. From a life-cycle analysis perspective (which includes construction, transport to site, and operation), four-fifths of a building’s energy demand occurs in the operational phase of a building.[17] This is an important consideration from the perspective of addressing market barriers to EE technologies as those that are important from an operational perspective could be emphasized. The IPCC identifies the main sources of GHG emissions associated with buildings as space heating, space cooling, water heating, artificial lighting, and the use of appliances. In addition, buildings, with their use of insulation materials and refrigeration, are also responsible for non-CO_2 GHG emissions, including halo carbons — chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) — and hydrofluorocarbons (HFCs).[18]

Currently, space heating and cooling as well as hot-water heating are estimated to account for roughly half of global energy consumption in buildings. Energy-efficient and low/zero-carbon heating and cooling technologies for buildings have the potential to reduce CO_2 emissions by up to 2 gigatons (Gt) and save 710 million tonnes oil equivalent (Mtoe) of energy by 2050. Most of these technologies – which include solar thermal, combined heat and power (CHP), heat pumps, and thermal energy storage – are commercially available today.[19]

In general, it makes more economic sense to integrate EE measures and technologies at the early design stage of buildings, compared with retrofitting these buildings to become more energy efficient later. Nevertheless, due to the high number of existing buildings, especially in developed countries, a large amount of GHG emissions result from the inefficient operation of these buildings. In order to significantly reduce the sector’s GHG emissions in a short time frame, retrofitting existing buildings to make them more energy efficient plays an important role.[20]

3.3 Manufacturing

According to the most recent IPCC Working Group III report on climate change mitigation, industry-related GHG emissions have continued to increase and are higher than GHG emissions from other end-use sectors (high confidence). Despite the declining share of industry in global gross domestic product (GDP), global industry and waste and waste-water GHG emissions grew from 10.4 $GtCO_2eq$ in 1990 to 13.0$GtCO_2eq$ in 2005 to 15.4$GtCO_2eq$ in 2010.[21]

Energy-intensive manufacturing sectors include aluminium, steel, metal casting, cement, glass, pulp and paper, textiles, chemical and fertilizer production, and oil refining. In most of these industries, there is a wide gap between the most efficient facilities and the least efficient ones. Part of the difference is due to age and size of facilities. GHG reductions in manufacturing are often attained through a number of measures, such as fuel switching, use of new materials as feedstock, and technologies that cut down on energy and electricity use. For example, in the steel industry, electric arc furnaces enable the use of 100 per cent scrap material as a feed stock, significantly reducing energy use as compared with blast furnaces using iron ore. In the cement industry, technology developments have enabled clinker material substitutions, alternative fuels, and significant savings in electricity use.

In industry, EE opportunities are found within sector-specific processes as well as in systems, such as steam systems, process heating systems (furnaces and boilers), and electric motor systems (e.g., pumps, fans, air compressors, refrigerators, and material handling). As a technology class, electronic control systems help to optimize performance of motors, compressors, steam combustion, heating, etc. and improve plant efficiency cost-effectively with both energy savings and emissions benefits, especially for small and medium enterprises.[22]

The use of heat pump technology has also been increasing efficiencies in manufacturing. In the manufacturing sector, a 'systems approach' involving a combination of technologies and practices could make a significant difference. For example, a heat pump manufactured by Kansai Electric enabled a 70 per cent annual energy use saving as compared to a conventional heavy oil system, amounting to about 450t CO_2 of annual emission reduction. The company replaced and installed a multi-cooling and heating supply system for air conditioning and hot water for cooking, using grid electricity with heat pump technology. Further cost savings and energy savings were enabled by load shifting to the night. Heat-storage operation of the heat pump systems during the night benefitted from lower electricity prices and improved the power plants' load factor on the supply side.[23]

In terms of specific process-related equipment, motor-driven equipment accounts for about 54 per cent of electricity use in manufacturing.[24] In addition, motors and motor-systems also have applications in agriculture and the residential and commercial buildings sector as well as in the energy supply sector (including renewable energy). According to a 2011 IEA study, it is estimated that in 2006 electric-motor driven systems (EMDS) accounted for between 43 per cent and 46 per cent of all global electricity consumption, generating about 6040 Mt of CO_2 emissions. By 2030, without comprehensive and effective EE policy measures, energy consumption from electric motors is expected to rise to 13360 TWh per year and CO_2 emissions to 8570 Mt per year. The use of more efficient electric motors and drives is estimated to save 20 - 30 per cent of global electric motor demand (i.e. 10 per cent of all global electricity consumption). Savings can be achieved through a variety of routes; but, in terms of specific technologies, it involves the use of more energy-efficient motors, adjustable speed drives and variable frequency drives to match motor speed and torque to the system mechanical load requirements. Additional efficiency gains may emerge from optimization of complete systems, including correctly sized motors, pipes and ducts, efficient gears and transmissions, and efficient end-use equipment (fans, pumps, compressors, traction, and industrial handling and processing systems) to deliver the required energy service with minimal energy losses.[25] A standard electric motor (as based on IEC classifications for frame type and size, output size, and performance categories) may be manufactured by a company, advertised in catalogues and made available on short notice from stock without the eventual user and application being known. Related components to be used with the motor in the final application (such as fans, pump wheels, etc.) may be manufactured by other specialized companies without their knowing what type and size of motor will eventually be used. Similarly, the motor may be directly integrated by an original equipment manufacturer (OEM) into a larger machine or product before being sold to an end- user. In this case, the motor will no longer be separately visible from the machine as a whole and can no longer be treated or tested as such.[26]

Leading manufacturers of industrial motors around the world have now adopted an EE classification that was put in place by the IEC and has been published as a globally relevant standard IEC 60034-30.[27] The IEC standard classifies single-speed, three-phase cage and induction motors into three levels depending on how efficiently they convert electricity into mechanical energy: IE1 is the base standard for efficiency; IE2 stands for high efficiency and IE3 for premium efficiency. The standard also mentions a future level above IE3 to be called IE4 super premium efficiency.[28] These requirements apply to 2-, 4-, and 6-pole, single speed, three-phase, induction motors rated up to 1000 V and on the basis of continuous duty operation. Significantly, motors designed to operate wholly submerged in a liquid and/or motors completely integrated into a product where the motor's energy performance cannot be tested independently from the product were not included as part of the IEC standardization process. This leaves out a large number of motor integrated pumps even though pumps account for no less than 10 per cent of the world's consumption of electricity, and two-thirds of all pumps use up to 60 per cent too much electricity. The main reason an efficiency standard has not been introduced to date for wastewater pumps could be the fact that manufacturers, legislators, and standard makers see wastewater pump motors as a separate unit and not as a unit integrated in the pump. Therefore, they are having difficulties defining the motor friction losses and efficiency. This 'standards' gap is now being sought to be remedied.[29]

A number of countries are increasingly adopting minimum energy performance standards (MEPS) for low-voltage motors based on the IEC standards, and this will drive market expansion for more energy-efficient motors. The difference between the various IEC categories is huge. For example, if a typical IE1 category process industry motor (75 kW, 8 000 hours a year) is replaced by an IE4 motor, savings are 22 250 kWh, and CO_2 emission reduction is equal to seven or eight cars (130gr CO_2/km, 0, 8 kg CO_2/kWh).[30]

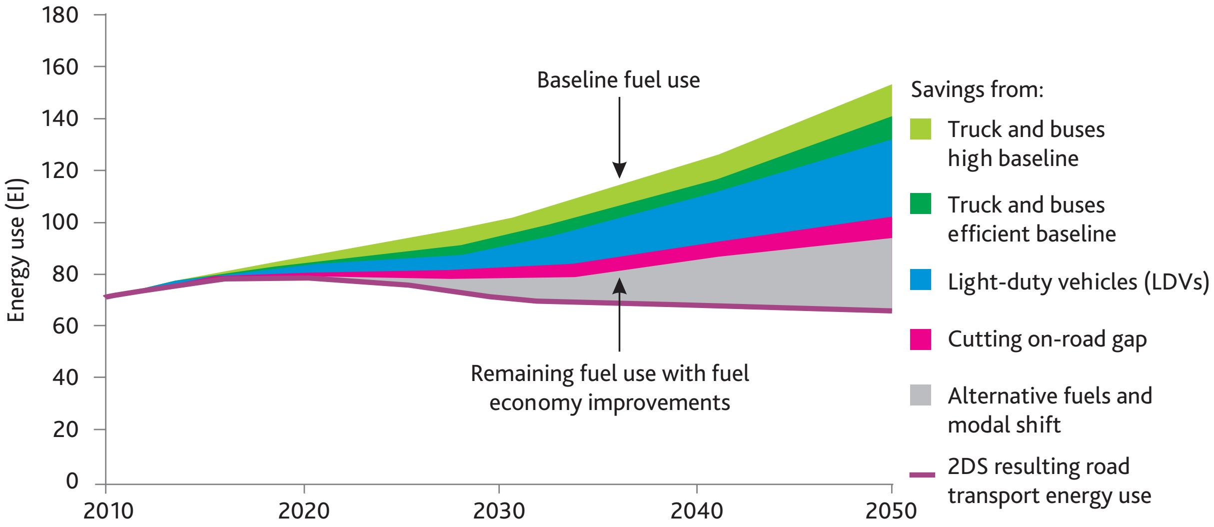
The majority of the global motor fleet is comprised of IE1 and IE2 motors. But, mandatory MEPS regulation in Australia, Brazil, the European Union (EU), Japan, Korea, and the US etc. is making IE3 category mainstream in 2016-2018 in new installations.[31] The EU, for instance, mandates the adoption of IEC-3 for all motors (or adding variable speed drives to IE2 motors for increased efficiency) from the beginning of 2015 for motors from 7.5 kw-375 kw and from 2017 onwards for motors from 0.75 kW - 375 kW.[32]

In addition, standards are set for other motor system components, such as pumps, fans, and compressors in China and the EU and are being developed in several other economies.

3.4 Transport

Fuel efficiency in the transport sector represents an important contribution to energy savings and climate mitigation. According to an IEA Study, fuel efficiency in the transport sector accounts for 4.5 gigatons of CO_2 ($GtCO_2$) reduction in the 2 DS compared with the 6 DS in 2050, representing 50 per cent of total emissions reductions in the transport sector.

Figure 2. Energy Savings from Fuel Economy Improvements



Note: two-wheelers' energy savings do not show up, as the savings are too small to be invisible.
Source: OECD/IEA (2012), IEA Technology Roadmap: Fuel Economy of Road Vehicles, http://www.iea.org/publications/freepublications/publication/Fuel_Economy_2012_WEB.pdf

Many fuel-efficient technologies are already commercially available and cost-effective over the lifetime of vehicles, but quite often various barriers restrict their uptake in many countries. Such barriers include less stringent fuel economy regulations or even a lack of regulations in the concerned country; lack of (or lower) CO_2 and emission standards as well as the prevalence of fuel subsidies; and lack of fuel taxes, resulting in cheaper fuel prices. These reduce the incentive for consumers to buy more fuel-efficient vehicles. A number of more advanced technologies would eventually increase their contribution to fuel savings in the transport sector. Some are already commercially available but relatively expensive, and others are still undergoing research and development. Such technologies include pure-battery electric vehicles (BEVs); plug-in hybrid electric vehicles (PHEVs); and fuel-cell vehicles (FCEVs). A number of internal combustion engines that run on biofuels, such as ethanol and biodiesel or blends of gasoline and ethanol have also been developed. These can also lead to savings in fossil transport fuels in the long run. These savings thus arise from the 'well to wheel' part of a vehicle's life cycle. In the IEA's ETP 2012, the 2 DS — including all technologies, such as electric vehicles (EVs); FCEVs; and PHEVs; — transport energy use and CO_2 emissions are cut dramatically by 2050, with more than half of these reductions coming from fuel economy improvements to conventional internal combustion engine (ICE) vehicles and the rest from adoption of new vehicle propulsion technologies and fuels.[33]

The challenge is that improvements to existing combustion engine efficiencies are harder to capture in terms of specific products to provide tariff incentives. Most energy losses from the engine are from the power train, especially waste-heat from the engine exhaust, coolant, and brake pads. Turbo chargers can recover some of the waste heat, leading to a more efficient combustion cycle. In addition, for light-duty vehicles, improvements to engine, transmission, and overall vehicle improvements such as weight, aerodynamics, tyres, and auxiliary power systems, (lights, heating, air conditioning, etc.) can also enable energy savings.

4. RELEVANCE OF DOMESTIC POLICIES, REGULATIONS AND INCENTIVES FOR EE

A number of barriers prevent greater uptake of EE technologies. These include:

(i) Lack of information among consumers on opportunities to purchase energy-efficient/ savings goods as well as benefits (such as energy and cost savings) arising from use.

(ii) Lack of confidence or scepticism about the benefits of new technologies.

(iii) Financial barriers that may discourage people, particularly in developing countries, to invest in EE retrofits and dispose of large household products.

(iv) Consumer inertia, particularly when energy prices are low and/or stable.

(v) Separation of capital expenditure and operating expenditure, particularly in rental markets where people investing and owning capital assets are not the same as those who pay for energy use.

(vi) Costly Incremental capital expenses as energy-efficient appliances are often (but not always) more expensive at the point of purchase compared with their less-expensive counterparts. Import tariffs on appliances/equipment in general can add to these costs.

(vii) Energy subsidies: Many countries subsidize energy producers and consumers, resulting in lower than normal electricity prices, which also discourages the purchase of energy-saving products.

(viii) Lack of effective policy, regulatory and incentive (PRI) measures, such as MEPS for appliances, and energy-efficient standards and labelling requirements also constrain markets for domestic producers as well as imports of energy-efficient products.[34]

Against this background, domestic PRIs are a major driver for market transformation and greater diffusion of EE technologies. Trade liberalization efforts may complement these PRIs to ensure a meaningful uptake of EE technologies.[35] PRIs could span energy supply, industry, building, and transport sectors and include standards, labelling requirements, building codes, procurement-related requirements, taxes, and fiscal incentives. These PRIs (or 'policy instruments') could be broadly classified into the following categories:[36]

(i) Regulatory and control based instruments refer to laws and implementation regulations that require certain devices, practices, or system designs to improve energy efficiency. This category includes (a) normative instruments, like standards and (b) informative instruments, such as labelling where the end-user is informed but not obliged to follow the EE advice.

(ii) Economic or market-based instruments are usually based on market mechanisms and contain elements of voluntary action or participation. They are often initiated or promoted by regulatory incentives.

(iii) Fiscal instruments and incentives that usually correct energy prices either by a Pigouvian tax aimed at reducing energy consumption or by financial support if first-cost related barriers are to be addressed.

(iv) Support, information and voluntary action: These instruments are aimed at persuading users to change behaviour by providing information and examples of successful implementation.

The table below shows a classification of policy instruments used to promote EE.

Table 1: Classification of Policy Instruments for EE

Regulatory and Control Instruments		Economic and market-based Instruments	Fiscal Instruments and Incentives	Support, Information and Voluntary Action
Normative -Appliance standards -Building Codes -Procurement Regulations -Energy Efficiency Obligations and Quotas	**Informative** – Mandatory audits – Utility demand-side management programs – Mandatory labelling and certification programs	Energy performance contracting – Cooperative procurement – Energy efficiency certificate schemes – Kyoto flexibility mechanisms	-Energy Taxation –Tax exemptions/ reductions -Import duty reductions on energy-efficiency technologies –Public benefit charges –Capital subsidies, grants, subsidized loans	– Voluntary certification and labelling – Voluntary and negotiated agreements – Public leadership programs – Awareness raising, education, information campaigns – Detailed billing and disclosure programs

Source: Adapted from United Nations Environment Programme and Central European University (2007), Assessment of Policy Instruments for Reducing Greenhouse Gas Emissions from Buildings.

Research for the United Nations Environment Programme (UNEP) Sustainable Buildings and Construction Initiative (SBCI) found that the most effective way to achieve energy savings for society was combining different elements of various successful instruments as part of a package. The study identified policies that were both cost-effective and successful in reducing emissions in the buildings sector. The table below illustrates the most successful instruments in each policy category.

Table 2. Effective Policy Instruments for EE in the Building Sector

	Effectiveness for emissions reductions	Cost-effectiveness
Control and regulatory instruments		
Appliance standards	High	High
Mandatory labeling & celebration programs	High	High
Energy efficiency obligations & quotas	High	High
Utility demand-side management programs	High	High
Economic and market-based instruments		
Energy performance contracting	High	Medium High
Fiscal instruments and incentives		
Tax exemptions and reductions	High	High
Support, information and voluntary action		
Voluntary certification and labeling	Medium High	High
Public leadership program	Medium High	High

Source: WBCSD, Energy Efficiency in Buildings: Business Realities and Opportunities, World Business Council for Sustainable Development.

In the area of standards and labelling it also matters whether requirements are voluntary or mandatory. The latter provide more of an incentive for deployment of EE goods than the former. Even voluntary programmes require test procedures that are themselves mandatory.

MEPs and comparative labels are the two most common policy instruments used by national governments to promote EE. They are employed for a wide range of traded goods, such as household appliances; heating and cooling equipment; home entertainment equipment; information and communications technology (ICT) equipment for home or office; lighting; building materials; and electric motors. MEPS and labels create dependable means for distinguishing between efficient and inefficient products. However, they require replicable procedures for measuring and classifying products to ensure that suppliers' claims are not questionable.[37]

MEPS define an EE performance threshold that energy-consuming equipment should meet. Mandatory and voluntary MEPS can coexist in the same market, and mandatory standards can be set for one efficiency level and voluntary standards for another for the same product. MEPS are usually reviewed periodically to keep pace with technological progress. More than 60 countries already have MEPS, focussing mainly on appliances but increasingly covering industrial equipment, such as motors.[38] Existing and already planned MEPS in IEA countries cover 50-70 per cent of household electricity consumption. Among the major developing countries, China covers nearly 70 per cent of its electricity consumption. Demand created by new appliances and offset some of this coverage and MEP standard-setting will need to keep up.[39]

While important for uptake, a number of EE standards and labelling requirements based on their design can also act as non-tariff barriers to imports of EE goods. Greater harmonization initiatives in EE can enable economies of scale in production and benefit greater volumes of trade. Trade itself (particularly intra-regional trade) is often a driver of such harmonization efforts. Harmonization can occur either at government or non-governmental levels. Harmonization of testing procedures is also often equally important but is not accorded high priority in many countries. Test procedures, often through international standards bodies, form the foundation for future MEPS and labelling.[40] Given the focus of this paper on tariffs, the implications of these measures for international trade in EE products will not be discussed, but their relevance in the EGA negotiations for certain types of EE products will certainly be highlighted in the recommendations. According to Janssen, effective policy commitment and awareness of EE standards is still lacking in many developing countries. The bilateral and international support increasingly being made available though many initiatives is still in the early stages.[41]

In addition to various PRIs, energy pricing policies are also important. Higher electricity prices, including higher unit pricing beyond certain threshold consumption levels, provide more of an incentive for consumers to save on their electricity bills by investing in energy-saving measures and technologies. In addition, measures such as decoupling utilities revenues from the amount of energy supplied and providing incentives for providing and managing grid infrastructure can also lead to energy savings on the supply side. Trading in EE certificates that provide monetary incentives for energy savings could also be part of an energy-pricing scheme designed to boost EE investments.[42]

Policy is ineffective unless performance is measured, verified, and enforced. For example, buyers basing a decision on an energy label need to know that the label is credible. The existence of different labels (sometimes using different methods) can undermine comparability of labels and their credibility, therefore, reducing the influence of labels on consumer decisions. Hence, harmonization initiatives in labelling can help. Similarly, energy savings need to be reliably measured if they are to be given value in the form of white certificates or as part of a commercial arrangement, possibly involving an energy service company (ESCO).[43]

5. A REVIEW OF EE TECHNOLOGIES SUBMITTED IN THE CONTEXT OF NON-TRADE FORUMS

A good overview of various types of EE technologies can also be obtained from the International Centre for Trade and Sustainable Development (ICTSD) mapping studies of climate mitigation technologies and associated goods in the buildings and transport sectors.[44] ICTSD has also matched these in separate papers with specific Harmonized System (HS) codes widely used in international trade.[45] A number of the products listed in the papers are already included in members' WTO submissions. In many cases, distinguishing and differentiating products on the basis of actual physical characteristics may be difficult. This would be the case, for instance, with heating, ventilating, and air conditioning (HVAC) equipment in the buildings sector and more efficient tyres and lightweight materials (that would lead to fuel savings) in the transport sector. In certain other cases (for example, triple-glazed glass falling under HS 700800-multiple wall insulating units of glass and vehicles with direct-injection diesel engines), ex-out specifications could lead to their possible inclusion on a list of EE technologies.

One aspect to consider would be the trajectory that technology development may take in the future and what new types of integrated technologies mean for trade negotiations to liberalize products. For example, a review of the list of buildings technologies identified by ICTSD mapping studies as undergoing research and development (R&D) with a prospect of commercialization includes technologies like electrohromic windows with sensors embedded to control lighting. New building integrated solar photovoltaic (PV) technologies, such as window panes may require new HS codes to be developed to avoid confusion at customs.

The IEA at the request of the Group of Eight (G8) has been developing a series of roadmaps for some of the most important technologies needed for achieving a global energy-related CO_2 target in 2050 of 50 percent below current levels. Each roadmap develops a growth path for the technologies covered from today to 2050 and identifies technology, financing, policy, and public engagement milestones that need to be achieved to realize the technology's full potential. The roadmaps cover a number of important EE sectors, such as energy-efficient heating and cooling for buildings, energy-efficient building envelopes, fuel-economy of road vehicles, high-efficiency, low emissions coal-fired power generation, smart-grids, and solar heating and cooling. Each roadmap also includes a current status of technologies and a vision for deployment. The studies provide specific examples of technologies under each category; however, they do not get into a detailed breakdown of the technology components.

The table below provides an overview of some of the technology categories included in a select number of IEA roadmaps that are relevant to EE. It also provides specific examples of technologies listed under each category. The technology examples listed are a mix of commercially available and cost-effective technologies as well as those that are only just emerging and will need further cost-reductions to enable scale-up.

Table 3: An Overview of IEA technology roadmap categories and specific technologies relevant to EE

A. High-efficiency Low Emissions Coal-fired Power Generation	
Technology Category (Primary difference is operating temperature and pressure)	**Specific Technology Examples**
Supercritical pulverized coal combustion	
Ultra-supercritical pulverized coal combustion	1 Boilers 2. Steam-turbines
Advanced ultra-supercritical pulverized coal combustion	1. Boilers 2. Steam-turbines 3. Super-alloys (non-ferrous materials based on nickel) for plant components
Circulating fluidized bed combustion	1. Combustor 2. Cyclone 3. Steam-turbine
Integrated gasification combined cycle	1. Air-separation unit 2 .Coal gasifier 3. Coal-gas cleaner 4. Gas-turbine generator 5. Heat-recovery steam generator 6. Steam-turbine
B. Energy-Savings-Buildings Heating and Cooling	
Technology Category	**Specific Technology Examples**
Heat-pumps (electric, gas or other sources)	1. Air to air, split and room air conditioners 2. Air to water heat pumps (also called Air-source heat pumps-ASHP) for water and space heating. 3. Water to water and water to air heat pumps (uses water source as heat source or sink and typically more efficient than AHSPs). 4. Ground source heat pumps (uses brine to water or brine to air or direct exchange with heat sink/source. Also uses heat-exchanger loop buried under ground.
Combined heat and power (CHP)	1. Micro-turbines 2. Fuel-cells (molten carbonate fuel cells (MCFC), solid oxide fuel cells (SOFC), phosphoric acid, fuel cells (PAFC) and polymer electrolyte membrane fuel cells (PEMFC) 3. Reciprocating engines (Otto cycle or spark-ignited and Diesel cycle or compression-ignited internal combustion engines) 4. Stirling or external combustion engines 5. Gas-turbines

Table 3: *Continued*

Solar-thermal	1. Solar water-heating systems 2. Solar thermal collectors (Evacuated tube, unglazed, flat-plate) 3. Solar concentrator systems (with and without trackers) 4. Thermally driven chillers 5. Dessicant Evaporating Cooling systems (Open-cycle chillers).
Chillers	1. Water or air-cooled (to produce chilled water to cool air in buildings) 2. Thermally driven absorption chillers (can use fossil-fuels, waste energy, solar-thermal and biomass) 3. Dessicant de-humidification (materials and solutions that attract and hold moisture and enable air conditioning systems to deal primarily with dry air).
C. Building Envelope	
Technology Category	**Specific Technology Examples**
Insulation (High to moderate thermal conductivity)	1. Vacuum Insulated Panel (VIP) 2. Aerogel 3. Polyeurthane Boards and Spray 4. Extruded polystyrene 5. Glass fibre 6. Stone fibre
Windows	1. Double glazed low e-coated windows 2. Triple glazed low or double-low e-coated windows 3. Electrochromic glazing/smart windows (Higher cost/ Not yet commercially widespread) 4. Advanced solar-controlled glazing including dynamic solar glazing (Higher cost/Not yet commercially widespread) 5. Automatic exterior shades
Reflective surfaces	1. Cool roofs
Building Integrated PV/Advanced Roofs	1. BIPV roofs (solar tiles, slates, shingles and single-ply membranes) 2. BIPV facades (cladding and curtain walls) 3. BIPV windows (glazing, skylights and sunshades)
D. Transportation	
Technology Category	**Specific Technology Examples**
Electric and Plug-in Hybrid Electric Vehicles	Electric and Plug-in Hybrid Electric Vehicles of various classes
Smart Grid Technologies (Examples of Hardware)	
Technology Category	**Specific Technology Examples**
Wide-area monitoring and control	Phasor measurement units (PMU) and other sensor equipment

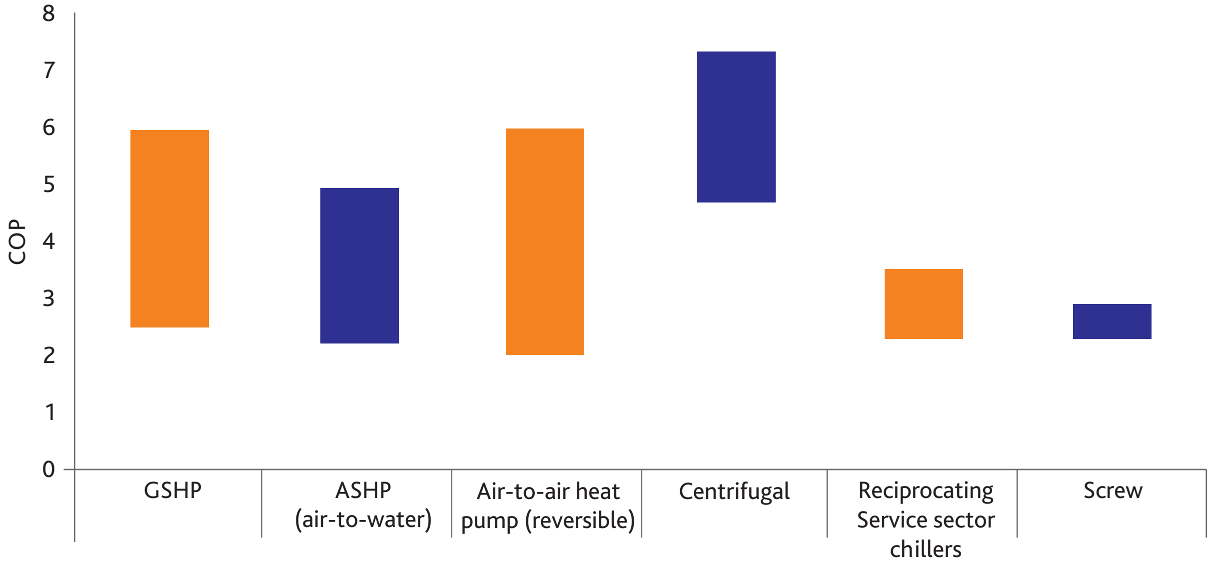
Table 3: *Continued*

Information and communication technology integration	1. Communication equipment (Power line carrier, WIMAX, Long-term Evolution (LTE), RF mesh network, cellular) 2. Routers 3. Relays 4. Switches 5. Gateway 6. Computers (servers)
Renewable and distributed generation integration	1. Power conditioning equipment for bulk power and grid support 2. Communication and control hardware for generation and enabling storage technology
Transmission enhancement	1. Superconductors 2. Flexible Alternating Current Transmission Systems(FACTS) 3. High Voltage Direct Current (HVDC) systems
Distribution grid management	1. Automated re-closers 2. Switches 3. Capacitors 4. Remote controlled distributed generation and storage, 5. Transformer sensors 6. Wire and cable sensors
Advanced metering infrastructure	1. Smart meter 2. In-home displays 3. Servers 4. Relays
Electric vehicle charging infrastructure	1. Charging infrastructure 2. Batteries 3. Inverters
Customer-side systems	1. Smart appliances 2. Routers 3. In-home display 4. Building automation systems 5. Thermal accumulators 6. Smart thermostat

Source: (i) IEA Technology Roadmaps, http://www.iea.org/roadmaps/ and (ii) Building Integrated Photovoltaics: An emerging market, Solar Server, http://www.solarserver.com/solar-magazine/solar-report/solar-report/building-integrated-photovoltaics-an-emerging-market.html

The WBCSD report also provides a characterization of some of the key technologies used in improving EE in the buildings sector.[46] All of these studies show that the commercial and residential buildings sector can benefit from a diversity of technologies ranging from insulation material to lighting equipment and HVAC equipment. All of these technologies may involve diverse types of equipment with varying degrees of EE and resulting in varying degrees of energy savings. Electric heat pumps for industrial water heating offer much greater energy savings relative to oil or gas-fired units.[47] Different heat pump types also vary in terms of efficiency ranges, as the figure below for standard performance factors (SPFs) for heat pumps used in space and water heating as well as cooling shows.[48]

Figure 3. Typical Current Efficiency Ranges for Heat Pumps in Heating and Cooling Modes by Technology*

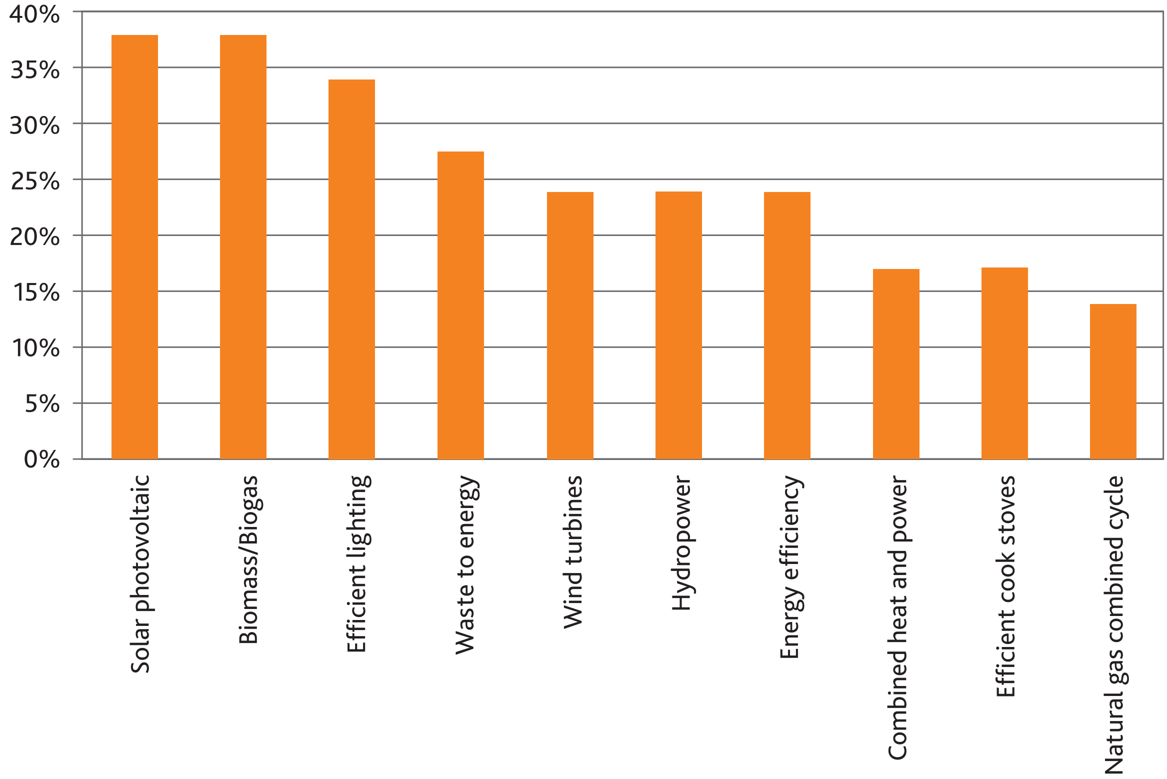


**COP-stands for Co-efficient of Performance. Higher numbers indicate greater energy efficiency*
Source: IEA, 2011.Technology Roadmap: Energy-efficient Buildings-Heating and Cooling Equipment, http://www.iea.org/publications/freepublications/publication/buildings_roadmap.pdf

The United Nations Framework Convention on Climate Change (UNFCCC) TT:CLEAR (a technology information clearing house) includes an inventory of environmentally friendly technologies and technology development and transfer projects, as well as information on financing technology development and transfer. TT:CLEAR also provides access to information on technology needs identified by developing countries and supports a pilot network of national and regional technology information centres. The objective is to improve the flow of, access to and quality of information related to the development and transfer of environmentally sound technologies that help improve access to energy globally.[49] The platform also contains a technology portal, which includes a database of over 700 technology briefs, technology roadmaps on climate technologies, and over 290 technology needs assessment (TNA) project ideas compiled from TNA reports. The portal also includes a web page providing links to other relevant organizations, initiatives, and databases.[50]

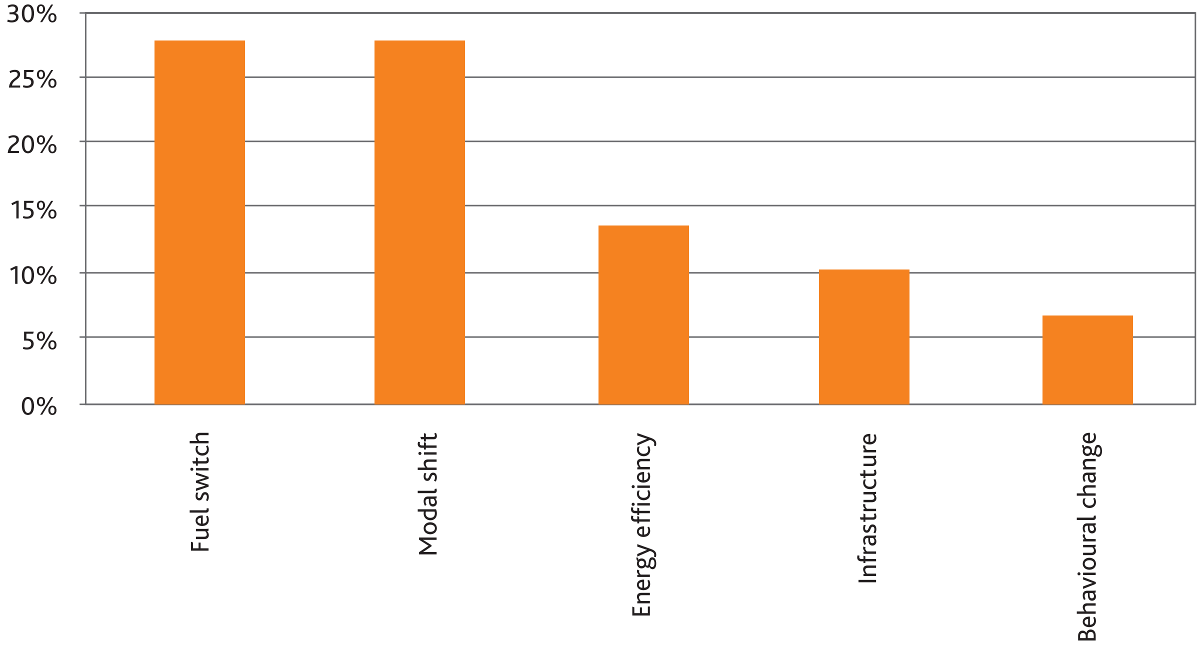
The third synthesis report of the TNAs indicates that for mitigation, almost all of the submitting parties prioritized the energy sector. The most prioritized sub-sectors of the energy sector were energy industries and transport. The majority of the technologies prioritized for the energy industries sub-sector as shown in Figure 4 below were related to electricity generation. Energy-efficient lighting also appears as a priority technology after solar PV and biomass/biogas electricity generation. EE, combined heat and power, and efficient cook stoves also figured among the priority technology groups. For the transport sub-sector of the energy sector, as shown in Figure 5, more than 25 per cent of the parties prioritized technologies relating to fuel switching, such as electric or liquefied natural gas vehicles and modal shifts, such as mass rapid transit road or rail systems. EE within the transport sector is also included.[51]

Figure 4. Prioritized Technologies for the Energy Industries Sub-sector as reported in UNFCCC Parties' TNAs (Percentage of the Parties that Undertook Mitigation TNAs).



Source: UNFCCC (2013), Third synthesis report on technology needs identified by Parties not included in Annex I to the Convention: Note by the Secretariat, http://unfccc.int/resource/docs/2013/sbsta/eng/inf07.pdf

Figure 5. Prioritized Technologies for the Transport Sub-sector as reported in UNFCCC Parties' TNAs (Percentage of the Parties that Undertook Mitigation TNAs)



Source: UNFCCC (2013), Third synthesis report on technology needs identified by Parties not included in Annex I to the Convention: Note by the Secretariat, http://unfccc.int/resource/docs/2013/sbsta/eng/inf07.pdf

Not all UNFCCC developing country members have submitted TNAs. The major developing country that has is China, and its TNA submissions date back to 1998. Interestingly, among the priority GHG mitigation technologies identified by China for technology co-operation, are a number of EE and energy-savings relevant products, such as high-efficiency motors and boilers (particularly advanced industrial boilers); high-efficiency power generation technologies — particularly those relevant to circulating fluidized bed combustion (CFBC) — green-lighting; and energy-efficient buildings.[52]

EE systems frequently involve a number of general products, such as pipes and tubes or metal sheets that may also have other applications. An important observation after a review of the ICTSD mapping studies, the IEA technology roadmaps, as well as the WBCSD reports is that practices and engineering designs also play a major role in EE. All of these aspects are not readily captured by HS classifications.

A true understanding of the overall cost of import tariffs and other non-tariff measures can be ascertained only by the firms involved in installing these systems, as they are responsible for bringing the various equipment and components together. Many technologies within the same category, such as insulation material, often differ In terms of EE performance. A number of more efficient technologies are not yet fully commercialized or are more expensive than their counterparts. Hence, removing import tariffs on these technologies may be only one step among a whole array of policies required to bring down their costs.

6. NEGOTIATIONS ON ENVIRONMENTAL GOODS: THE WTO DOHA MINISTERIAL DECLARATION AND DEVELOPMENTS OUTSIDE THE WTO

Reducing barriers to trade in environmental goods and services, including clean energy technologies and EE goods can lower costs of access to these goods as well as supply chain costs, facilitating faster scale-up of clean energy and energy access for poorer communities not connected to the electricity grid.

Para 31 (iii) of the WTO Doha Ministerial Declaration calls for the "…reduction or, as appropriate, elimination of tariffs and non-tariff barriers on environmental goods and services." However, given the absence of a universally accepted definition of environmental goods, discussion on which goods to liberalize has been contentious. One of the greatest challenges with respect to the Doha environmental goods negotiations at the WTO has been to define the precise scope of 'environmental goods.'

The HS is commonly used by customs officials to administer import tariffs at the border as well as trade negotiators to identify specific products and product groups for liberalization. Products are identified on the basis of physical characteristics. This means that if certain products are physically indistinguishable, customs officials are unable to treat them as separate products for the purposes of tariff liberalization. Customs classification under the HS often groups many environmental goods at the 6-digit level with other goods, which may not have an environmental or renewable energy end use.

A large number of HS subheadings as well as specific products (or 'ex-outs') under these subheadings proposed by WTO members have also been 'dual-use' products, i.e. those with both environmental and non-environmental end uses. There has also been debate on the right approach to liberalization, i.e. whether it should be based on permanent liberalization of 'lists' of specific goods (the 'list' approach) or temporary liberalization of 'all goods and services used in specific environmental projects' (the 'project' approach). Further, the lack of progress in other critical areas of WTO negotiations, such as agriculture, services and manufactured goods has stalled progress in discussions on environmental goods. This has led to renewed interest among proponents of environmental goods liberalization in other initiatives outside the WTO.

The Asia Pacific Economic Community (APEC) 2012 Honolulu Declaration provides, on a voluntary and non-binding basis, for liberalization — of both tariffs and non-tariff barriers — of environmental goods. In September 2012 as part of the Vladivostok Declaration, APEC economies also agreed to voluntarily reduce, by the end of 2015, applied tariffs to 5 per cent or less on environmental goods contained within 54 HS codes at the 6-digit level. This also includes a number of intensively traded sustainable energy goods. While the APEC initiative will extend benefits of liberalization to all WTO members on an MFN basis, the voluntary nature of the initiative means that APEC economies are not penalized for non-compliance with the declaration. Moreover, the obligation is to lower applied and not bound tariffs, and APEC member economies can also choose to be as selective or as broad as they wish to be in implementing liberalization initiatives, reducing tariffs on goods at the broader HS 6-digit level or selectively on specific national tariff lines they may deem to be more representative of goods with an 'environmental' end use. Many APEC economies are already in compliance with APEC's mandate, since their applied tariffs are at or lower than 5 per cent.[53]

In January 2014, 14 WTO members (including the EU-28) agreed on the sidelines of the World Economic Forum (WEF) in Davos to eliminate tariffs on environmental goods on a plurilateral basis and eventually bring it to the WTO, extending benefits to all members on a most-favoured nation (MFN) basis once a 'critical mass' of WTO members participate. The G14 declaration stated that members would 'build upon APEC Leaders' commitment to reduce tariffs on environmental goods classified under the APEC List of 54 HS subheadings.[54] Furthermore, it is likely that new HS subheadings (or 'ex-outs' under them) may be added to any final outcome, depending on how negotiations progress. The implications of these initiatives for climate change mitigation will depend on the extent to which goods relevant to both sustainable energy generation and EE are included in any final basket of environmental goods. ICTSD research has identified at least 15 HS subcategories in the APEC list that would be relevant for renewable energy generation, including solar panels and wind-powered generating sets as well as a number of additional products based on its previous research.[55] However, identifying and promoting trade in EE products through tariff liberalization may pose more of a challenge. Before discussing this in further detail, it is worth reviewing the extent to which EE goods have been put forward in earlier negotiations on environmental goods under the WTO and included within the APEC's list of 54 subheadings. As clarified earlier, EE goods, technologies or products include, in the context of the paper, both energy-efficient goods (in terms of relative performance) as well as products whose deployment or application can lead to overall energy savings. The sections below reveal that the overwhelming majority of products submitted or discussed in the context of trade-liberalization negotiations under the WTO Doha Round as well as in APEC comprise energy-savings rather than energy-efficient goods.

7. EE GOODS PROPOSED DURING WTO DOHA ROUND NEGOTIATIONS ON ENVIRONMENTAL GOODS AND SERVICES AND WITHIN APEC

During negotiations under the WTO on environmental goods and services, a number of members have proposed goods, citing the rationale of EE application, energy savings, and more efficient resource use. Products classified under one category by some WTO members also appear under other categories proposed by other members. This is because some members have used categories that describe the end-use outcome of using those goods (for example, efficient consumption of energy) while others have categorized them by function (for example, environmental monitoring, analysis, and assessment), and both usages are equally valid in describing the goods on the list.

EE technologies (comprising mainly energy-savings goods) have been proposed within the WTO Doha Round under various categories, and energy-savings goods have also been included in the APEC list of environmental goods. These Doha Round categories are outlined in greater detail below and included in the Annex Table (which also lists the members that have proposed them).

7.1 Heat and Energy Management

Products under this category have been proposed by the so-called Friends of Environmental Goods, comprising Canada, Chinese Taipei, the European Communities, Japan, Korea, New Zealand, Norway, Switzerland, and the US. These have been listed informally in JOB (09)/132. They include six HS subcategories, two of which appear to be clearly identifiable based on their customs description, namely, HS-701931 (mats made of glass fibre, including glass wool) and HS-841950 (heat exchange units — whether or not electrically heated). The other four HS subheadings primarily include measuring equipment, such as liquid meters (HS 902820) and electricity meters (HS 902830). These two subheadings may include integral components of EE systems, although they do not directly contribute to EE. Some products, such as geothermal heat pumps (under HS 841861) have been proposed by the EU as part of the Friends' submission under the category of 'Renewable Energy,' but the use of such pumps can also lead to energy savings in residential buildings.

7.2 Efficient Consumption of Energy

All if not the vast majority of products listed under the 'Efficient Consumption of Energy' category proposed by Saudi Arabia span a wide range of industrial products, components such as pipes and tubes, machinery, equipment and petroleum-based derivatives, and chemical products that may have applications in systems to improve EE. Their end uses in most cases are not identifiable easily by customs on the basis of subheading descriptions. Those that can be so identified (usually at the 'ex-out' level) overlap to a great degree with HS subheadings proposed by the 'Friends' as revealed in the Annex Table.

7.3 Environmental Monitoring, Analysis and Assessment Equipment

A number of products have also been put forward by WTO members whose primary function appears to be related to monitoring, analysis, and assessment. They have also been classified under other product categories, such as 'Renewable Energy' as well as 'Efficient Consumption of Energy.' Based on the HS code description as well as remarks on environmental benefits indicated by the submitting members, products relevant to EE and savings include heat meters ('ex-out' under other instruments and apparatus—HS 902680) used to monitor and measure the distribution of heat from geothermal or biomass district heating systems, thermostats (HS 903210) as well as parts for liquid flow meters and pressure meters (HS

902690). Products, such as liquid meters (HS 902820); electricity meters (HS 902830); and gas meters (HS 902810) relevant to environmental monitoring have also been proposed under the category of 'Heat and Energy Management' by the 'Friends' and under 'Efficient Consumption of Energy' by Saudi Arabia.

Monitoring equipment also features prominently in the APEC list and among these products are heat meters (HS 902680) and automatic current and voltage regulators (classified under HS 903289) as well as their various parts and accessories.

7.4 Renewable Energy Associated Goods

Some products relevant to energy savings in buildings have also been proposed under the category of 'Renewable Energy' and/or 'Air-Pollution Control' in various WTO submissions (some of these are also listed under the APEC's 54 HS subheadings). Products proposed under this category include a large number of environmentally friendly vehicles submitted by Japan (see Annex 1); geothermal heat-pump systems (listed under HS 841861); and solar water heaters (listed under HS 841919). In the APEC list, the main products under this category appear to be certain parts and auxiliary plants for use with boilers (HS 840490) and solar water heaters (HS 841919) that use solar energy (but can also help cut down on energy use in households.)

7.5 Clean and Cleaner Transportation—Environmentally Friendly Vehicles

A large number of products proposed during the Doha Round by Japan include environmentally friendly vehicles, such as hybrid and electric vehicles as well as hydrogen-fuelled, natural gas, and cleaner diesel vehicles as well as hybrid motorcycles with electric motors. (See Annex 1). These products do not have their own specific HS 6-digit codes but are classified under the broader HS 6-digit subheadings for motor cars and other motor vehicles as well as motor cycles, fire-fighting vehicles, concrete mixer lorries, and mobile drilling derricks. It could be argued that pure electric and hydrogen vehicles may not be EE technologies per se, but uptake in their use could under certain circumstances (such as being charged from renewable electricity sources in the case of electric and plug-in hybrid vehicles) certainly contribute to overall savings in energy consumption as well as fossil-fuel imports. Similarly, natural gas-powered or cleaner diesel vehicles are not completely clean, but they may emit relatively less GHGs and other suspended particulate matter.

7.6 Energy-Efficient Appliances and Lighting Equipment

The last major group of products submitted during the Doha Round include various appliances deployed in commercial and residential buildings. Primarily proposed by Japan, they include products like refrigerators, freezers, television sets, printers, copiers and scanners, and other appliances that would conform to the EE standard and are so certified by the authority in the destination country.

A review of Japan's submission in the various categories relevant to EE and energy savings reveals that most goods are electrical consumer goods and appliances, where energy-efficient versions cannot be physically distinguished from their less energy-efficient counterparts on the basis of HS descriptions alone. In its submission, Japan has stated that the goods could be those that conform to the EE standard and are so certified by the authorities in the destination country. This would then entail their identification by customs authorities on the basis of an EE label or performance description of the product. The only products in Japan's list in which some sort of physical identification (absent a label) seems possible are for electric lamps and lighting equipment using light-emitting diode (LED) lamps and bulbs as well hybrid vehicles and motor cycles, which use a different technology from internal combustion engines. Such products could be easier to identify on the basis of technical descriptions by customs at the border. As shown by the examples in Japan's submission (See Annex 1), these goods may still require an ex-out to identify them within a broader HS subheading but even so the very fact a hybrid or electric motor is present could be sufficient to qualify for zero tariffs. Of course, if minimum performance standards are set for the hybrid engines, similar to energy-efficient appliances, it will be more challenging to provide selective tariff concessions. Interestingly, Japan's submission also includes products such as fuel-cell batteries, nickel-iron electric accumulators, and other accumulators that appear to be more related to energy-storage than EE per se.

7.7 Issues with Liberalizing EE Goods

While using trade-policy tools to advance EE is desirable, there are a number of issues and challenges that negotiators will need to tackle, particularly with respect to providing tariff incentives for EE technologies and primarily with regard to energy-efficient goods. Some of these issues are laid out in detail below:

Physically distinguishing EE Products for tariff liberalization purposes

A review of technologies from ICTSD mapping studies as well as other literature reveals that energy-efficient technologies are usually not immediately identifiable based on visual inspection. Some, such as building integrated solar PV technologies could be, but others, such as a state of the art air conditioning unit may look identical to a less energy-efficient version. Further, achieving energy savings may also depend more on the adoption of a 'systems approach,' under which several technologies are used in combination in an integrated manner—such as, for instance, when 'smart lighting technologies' are integrated with movement sensors.

As highlighted previously, the HS classification systems used by customs to distinguish products based on their physical characteristics often make it difficult to capture energy-efficient products for tariff liberalization purposes. This is more of a challenge for energy-efficient goods (based on performance) than for other types of energy-saving products. For example, in the case of buildings-related technologies, particularly electrical appliances, very few products can be physically distinguished. Products that can be so distinguished include LEDs; compact fluorescent lamps (CFLs); and solar water heaters.

Also in the case of technologies relevant to the manufacturing sector, such as energy-efficient motors, it appears difficult to give a tariff preference to certain types of motors (at least at the HS 6-digit level) based on their energy performance. From a survey of HS codes used for electric motors, it is clear that they are classified under Chapter 85 (Electrical Machinery and Equipment and Parts Thereof) and within Chapter 85 under the 4-digit HS Code 'Electric Motors and Generators' (excluding Electric Generating Sets). The HS-6 digit codes for which there is a uniform tariff nomenclature among all WTO members only provide for a differentiation based on output (in terms of kilowatts) and not in terms of physically identifiable technology.[56] In the transport sector, however, many technologies such as pure-electric vehicles (as well as fuels, such as ethanol) may be more readily identifiable and captured by HS classifications whether at the HS 6 digit level[57] or at a more detailed level as part of national tariff lines (NTLs).[58] Planned amendments to the HS (to be implemented in 2017) include, among other things, (a) LED lamps and (b) hybrid, plug-in hybrid and all-electric vehicles. This may facilitate the identification of renewable energy and EE products to be included in the EGA.[59]

For energy-efficient products, their efficiency can only be measured through testing procedures. For some products under this visually non-identifiable group, according to Steenblik[60], where energy-test procedures, product categorization, efficiency metrics, and the required efficiency thresholds are sufficiently similar, it would be feasible to devise a common set of requirements determining their entitlement to a liberalized tariff. For a second group of products, many aspects of energy-test procedures, product categorization, and efficiency metrics might be similar or could be expressed in a comparable manner across regions, but for which efficiency thresholds might be set differently for different markets. Such differences in efficiency requirements reflect significant differences in energy prices and the way the product is used from one region to another. These requirements determine the efficiency level at which the product is most cost-effective for the consumer. For this second group, Steenblik considers that it would be inappropriate to aim at harmonized efficiency requirements as an entitlement for low or zero tariffs but suggests that a common approach to devising economy-specific efficiency thresholds above which liberalized tariffs would be applied might be a common way forward. However, as his paper cautions, the transaction costs of developing such approaches for non-easily identifiable EE products vis-à-vis the benefits of selective liberalization will also need to be considered. Such benefits might include the mitigation potential of market expansion and subsequent reduced energy consumption made possible through lower tariffs selectively applied for these products (even if such preferential benefits are only available for a limited period).

HS 6-digit categories that lump EE and non-EE products in the same basket

An important observation of many EE products in a number of WTO member submissions is that they are often physically distinguishable but appear only as 'ex-outs' under broader HS 6-digit subheadings that also include other goods unrelated or not relevant to EE. Such products include solar water-heaters for which WTO members do not have a distinct HS 6-digit code. Rather, they are one 'ex-out' item under HS 841919 (non-electric water heaters). There are also no stand-alone HS codes for products, such as electric and hybrid-vehicles. They often appear as 'ex-outs' under the relevant HS codes for broader vehicle categories. Japan's submission in the WTO, for instance, proposes environmentally friendly vehicles as an ex-out or additional product specification under a number of broader HS subheadings that include different types of vehicles ranging from motor cycles to light motor vehicles and concrete mixer lorries. Other examples include lighting fittings, such as chandeliers which use LEDs that fall under broader categories of lighting and light sensors that have been proposed in the APEC list as an ex-out under automatic regulating or controlling instruments (HS 903289. (See Annex 1).

Products that can be deployed in multiple contexts

Certain other products that are relevant to EE can also be used in multiple contexts. For instance, APEC economies have included AC electric generating sets and rotary convertors (HS 850239) as part of the list of 54 HS subheadings that contain environmental goods. These generating sets may be used to generate electricity from fossil fuel as well as renewable energy power plants. At the same time, they can also be used as part of combined heat and power systems and heat recovery systems. When applied within distributed electricity and heat generation systems, they can also minimize transmission losses through electricity grids and avoid the need to create centralized electric generating capacity and transmission networks. Other examples of these types of products include switchboards and control panels (HS 853710-20) that could be used in a wide variety of applications, such as coal and solar power plants as well as smart grids that improve EE.

Dealing with technological change

A major challenge with respect to preferential tariff liberalization for energy-efficient products is the issue of technological change and how to ensure that newer, more efficient appliances that emerge continue to benefit from tariff liberalization initiatives. This can raise some challenges. For example, if the most acceptable energy-efficient version of a refrigerator (based on energy-efficiency thresholds and other parameters agreed by all countries) is selected to benefit from zero tariffs, there is the issue of whether newer or more energy-efficient versions of the same refrigerator, once developed, would continue to benefit from zero tariffs. This is possible if the tariff liberalization is selectively applied to a specific NTL (ex-out) or at the level of the HS 6-digit subheading, such that newer technologies are automatically captured. This would happen whenever such technologies fall under the same HS subheading or tariff line. In cases where the HS subheading or tariff line cannot be used to distinguish between energy-efficient products and their less/non-energy-efficient counterparts, both energy as well as non-energy-efficient versions would benefit from zero or low tariffs. Even if newer, more efficient products are automatically captured under a zero tariff HS subheading or ex-out, older, less energy-efficient versions of the same product would continue to benefit from zero tariffs. This is because there is no way to raise bound tariffs once they are lowered or eliminated. In such cases, zero import tariffs by themselves cannot be used to provide any kind of market advantage for energy-efficient products.

8. INCLUDING EE GOODS IN THE EGA NEGOTIATIONS: WAYS FORWARD

This paper has reviewed some issues and challenges associated with identifying EE products, particularly energy-efficient goods, for preferential tariff liberalization purposes under the EGA. It has highlighted the importance of EE technologies in mitigating climate change, given that global energy dependence on fossil fuels is likely to continue for many more years if not decades. Domestic policy, regulatory and incentive measures, particularly minimum mandatory energy performance standards, will be required to promote effective diffusion of these technologies. Trade policy can play an important role in keeping markets open for such products, but a number of challenges will need to be addressed with respect to providing tariff preferences through trade negotiations. These challenges often have to do with the difficulty of clearly distinguishing energy-saving technologies in general and many energy-efficient products from their less energy-efficient counterparts. Moreover, products deployed to increase EE or savings are often used in the context of a 'system' and can have other industrial applications. The lack of internationally accepted MEPS and the rapid emergence of new energy-efficient technologies and products can also pose challenges for trade negotiators.

Despite these challenges, the plurilateral EGA negotiations offer a good opportunity to address tariff and eventually non-tariff barriers (which may be more important) for these goods.

Given the significant potential of EE to contribute to climate mitigation, liberalizing the international flow of EE goods, thereby contributing to their dissemination and up-take, can be a major contribution that trade negotiators can make for climate mitigation, ideally to be shown in time for 21st UNFCCC conference of parties meeting (COP 21) in Dec 2015 in Paris.

Trade negotiators will need to address the various challenges outlined earlier and move forward in a manner that strikes a balance between 'environmental credibility' and 'practicality' as has been previously emphasized by trade delegates in the APEC context. This section outlines some possible options for a way forward in terms of including EE products (both energy-savings as well as performance-based energy-efficient products) as part of the EGA negotiations categorizing possible product groups in various 'tiers' based on their ease of identification within the HS system as well as their relevance to energy-savings in a broader economy-wide context.

Picking low-hanging fruit: Selecting EE goods clearly identifiable at the HS 6-digit level (Tier 1 Products): One option for negotiators could be to select and include clearly identifiable goods at the HS 6-digit level that are energy efficient or contribute to energy savings. Certain products, such as LEDs (HS 854140), are already included in the APEC list, and most members have bound tariffs at zero. Other candidate products identified by ICTSD research include rock wool used for insulation in buildings (HS 680610); insulating materials and articles (HS 680690); multiple walled insulating units of glass (HS 700800); and other glass fibre insulation products (HS 701939). Another related product, namely mats made of glass fibre used for thermal insulation of buildings (HS 701931), has already been proposed by the EU as part of the 'Friends' submission' in the WTO (See Annex Table).

Selecting easily identifiable products at the 'ex-out' level (Tier 2 Products): A number of goods can be readily identified physically. These would include products that have been proposed in the context of the Doha Round environmental goods negotiations and identified in the context of ICTSD mapping studies and research. They are, however, hidden under HS 6-digit subheadings. Such products include geothermal heat pumps (an ex-out under heat pumps) identified by both ICTSD research and proposed in the 'Friends'

WTO submission. Other products include solar water heaters (ex-out of HS 841919 other Non-electric Water Heaters) and a wide range of hybrid and electric vehicles that have been proposed in Japan's submission to the WTO, but which fall as ex-outs within a wide range of HS codes for general vehicles. (See Annex 1). Other relevant examples have already been proposed by certain APEC members in the APEC list. These include (i) solar water heaters (an ex-out under HS 841919) and non-electric water heaters (other than instantaneous gas water heaters); (ii) combined heat and power and heat recovery systems, an ex-out under HS 850239 (electric and rotary generating sets); and (iii) light sensors, automatic voltage and current regulators, which have smart grid and other EE applications. These fall as an ex-out under HS 903289 (Automatic Regulating or Controlling Instruments).

Selecting products that have cross-cutting applications but are also relevant to EE (Tier 3 Products): A third-tier of products could be those that have cross-cutting applications, including within renewable energy systems as well as EE. These products are clearly identifiable at the HS 6-digit level or ex-out level but may also have applications outside of EE, including as part of fossil-fuel plants. Examples of products already included in the APEC list, as highlighted previously, include AC electric generating sets and rotary convertors (HS 850239) and monitoring and control equipment, such as switchboards and control panels (HS 853710-20). These two have already been included in the APEC list, but members may also wish to draw on other examples previously submitted in the WTO (see Annex Table) by the 'Friends' as well as Saudi Arabia, such as electricity meters (HS 902830) and gas meters (HS 902810) as well as thermostats (HS 903210). Delegates with the assistance of technical experts may also wish to review the broader list of goods, particularly those submitted by Saudi Arabia during the Doha Round to ascertain if other cross-cutting products important from an EE perspective could be identified.

Spare-parts (Tier 4 products): These products are important for the functioning of EE products. Examples include parts of solar water-heaters or parts for electricity and gas meters. Many of these spare parts have been included in prior submissions by various WTO members in the Doha Round and are also included in the APEC list (See Annex Table). Addressing tariffs on these products could not only reduce supply chain costs in the manufacture of EE products, but also possibly provide export opportunities for many developing countries that may have an export interest in these low-tech parts and components (even if they do not participate in the EGA negotiations).

The most challenging tier of EE products to consider are *energy-efficient products that are not physically distinguishable but perform in a more energy-efficient manner relative to identical products with the same end use (Tier 5 products):* Such products would be identifiable only on the basis of labelling or certification, declaring that they conform to a specific energy performance standard. In principle, WTO members may be able to lower their applied tariffs on any products that meet a certain MEPS. However, such minimum thresholds could vary from country to country. It may also be problematic to provide a zero duty benefit to certain classes of energy-efficient products relative to their less-efficient counterparts if countries undertake ambitious liberalization across the board for all industrial products in the WTO or through regional trade agreements.

One treatment option, based on feedback from industry representatives, that could be considered is to at least maintain import tariffs at zero for the highest efficiency classes of products. Given the divergent set of performance standards that exist, one option may be to create a specific ex-out category for highest efficiency products, such as low-voltage motors and pumps for which international standards such as those developed by the IEC exist. This 'ex-out' category could then benefit from a permanent tariff waiver implemented by all members regardless of what the tariff levels are for less energy-efficient products under the same HS 6-digit category. To give a specific example of low-voltage motors where IEC efficiency categories are accepted globally, the EGA negotiations could reserve a 'zero duty' status under a special 'ex-out' category within members' customs schedules for motors meeting IEC 3 standards and upwards.[61] Customs authorities could apply zero duties if the importer produces documentation at the border that the product meets the IEC 3 performance standard. This does not imply that countries should continue to maintain or increase their import duties on the less-efficient motors, but only that the highest efficiency class is not penalized by import tariffs. Such zero duties could provide an incentive for the most efficient motors until most or all countries raise their MEPS to allow only the most efficient motors to be sold in their domestic markets. Raising MEPS is a process that may take some time, while the 'duty-free' ex-out category could be created relatively quickly. An internationally accepted standard whether set by the IEC or any other body could be less contentious as a basis for providing such treatment.

A second treatment option for Tier 5 products, as also reflected in Japan's submission, would be to enable zero duty as long as the product meets the domestic MEPS of the importing country even if it does not meet the requirements of an international standard or if a commonly accepted international standard does not exist. This would provide greater flexibility to catch a 'wider range' of products but may not particularly reward the most-efficient product in a category.

A quick examination of applied MFN tariff levels for various motors reveals that they are generally zero for some EGA members (Canada, Costa Rica, Hong Kong, Japan, Norway, Singapore) low for the EU (2.7 per cent for most categories), Australia and New Zealand (5 per cent) but rather higher for developing economies, such as Korea (mostly 8 per cent). Others show a wide range for various motor types, such as Russia (0-15 per cent); China (5-14.2 per cent); Chinese Taipei (5-9.6 per cent); and the US (1.2-4.6 per cent).[62] Additional products that could be included under the Tier 5 category include advanced energy-efficient lighting ballasts and premium-efficiency electric transformers based on standards acceptable to all EGA members. (See Annex Table).

In addition to reflecting products based on the various tiers discussed above, EGA members could also consider setting up a process for constant review and updating of product lists. Technologies, including energy-efficient technologies, will continue to evolve, and it is important to ensure they benefit from the EGA liberalization effort, even if they were not part of an initial basket of products agreed. In case newly emerging technologies are so distinct as to be physically distinguishable, WTO members may wish to consider creating new HS subheadings and proposing these within the World Customs Organization (WCO). This review process could be ongoing to enable the addition of new products as part of a 'living list' to ensure they continue to benefit from the EGA outcome or can be addressed through future trade liberalization initiatives on environmental goods. A notable feature of the JOB (07)/54 submission by the *Friends of Environmental Goods* group was the proposal for a review mechanism for any set of products agreed for liberalization to ensure that it does not remain static over time. Here, there is a lesson from the implementation of the Information Technology Agreement. The Ministerial Declaration and Implementation Document for the ITA2 provides for a review of product coverage every three years, and no new products have been added since 1996. Despite additional products being submitted for inclusion by a few countries, the review process has faced difficulties, because members are not able to agree on classifications for a number of existing products without HS codes (contained in Annex B of the ITA Agreement). Inconsistent product descriptions and encoding of 'ex-heading' goods at the national level have contributed to disagreements that have slowed down the inclusion of new products.[63] The lesson for environmental goods negotiators, therefore, is to assign clear HS codes and ensure harmonized product descriptions (in case of 'ex-outs') so that any review process to consider inclusion of new products can proceed smoothly. The WCO considers amendments to the HS only once every five years with implementation taking place from one to two years following notifications to members.[64] The most recent one happened in 2012 when a new HS code was created for biodiesel among others.[65]

In any case, the increasing stringency of domestic MEPS will ultimately be a key in enabling market transformation, but zero duties can facilitate broader market diffusion by keeping markets open for such products. International trade offers opportunities to enhance the effectiveness of MEPS and other product-related EE measures by increasing scale and facilitating market transformation. China, for example, is a key exporter of energy-using products to OECD markets and has been improving EE standards similar to those in export markets. Chinese exporters also supply such products to other developing countries. To the extent that these products meet similar energy performance standards as the models that are shipped to OECD markets (or sold in domestic markets of developing countries with stringent MEPS), there may be further progress in market transformation. For example, in its World Energy Outlook 2007, the IEA observed that "China's efforts to improve the efficiency of vehicles and electrical appliances contribute to improved efficiency in the rest of the world, as the country is a net exporter of these products."[66]

Given the challenging nature of providing preferential tariff treatment for products based on energy performance standards, a feasible alternative would be for the EGA as well as other WTO members to explore opportunities for tariff liberalization on such products wherever feasible as discussed in this paper. In addition, however, they should continue efforts aimed at the harmonization of energy performance standards, mutual recognition initiatives, and harmonization of test procedures for energy-efficient products. Such measures would also constitute an advance in terms of addressing non-tariff barriers, and they could be reflected as part of concluding a second phase of the EGA once an outcome on tariffs is reached under the first phase.

Last, but not least, the 'development-dimension' in any trade liberalization initiative should be given importance. Standards for energy efficiency vary among countries and sectors within countries (especially developing countries) and ideally trade liberalization should help different economies and sectors climb the ladder toward using more EE technologies. While the EGA initiative does not presently include a large number of developing countries, including energy-efficient and energy-savings products (including relevant spare parts that may be of export interest to developing countries could benefit exports from these countries as well, particularly as the benefits are extended to all WTO members on an MFN basis.

ENDNOTES

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2 René Vossenaar. 2009. “Energy Efficiency: Turning Challenges into Opportunities for Developing Countries.” *Trade and Environment Review 2009-10: Promoting Poles of Green Growth to Foster the Transition to a More Sustainable Economy.* UNCTAD.

3 The 6°C scenario (6 DS) is largely an extension of current trends. By 2050, energy use grows by more than two-thirds (compared with 2011), and total GHG emissions rise even more. In the absence of efforts to stabilize atmospheric concentrations of GHGs, the average global temperature rise is projected to be at least 6°C in the long term.

The 4°C scenario (4 DS) takes into account recent pledges made by countries to limit emissions and step up efforts to improve EE. It serves as the primary benchmark in ETP 2014 where comparisons are made among scenarios, and it projects a long-term temperature rise of 4°C. In many respects, this is already an ambitious scenario that requires significant changes in policy and technologies compared with the 6 DS. Capping the temperature increase at 4°C requires significant additional cuts in emissions in the period after 2050, yet still potentially brings forth drastic climate impacts.

The 2 DS is the main focus of *ETP 2014*. It describes an energy system consistent with an emissions trajectory that recent climate science research indicates would give at least a 50 per cent chance of limiting the average global temperature increase to 2°C. The 2 DS also identifies changes that help ensure a secure and affordable energy system in the long run.

It sets the target of cutting energy- and process-related CO emissions by more than half in 2050 (compared with 2011) and ensuring that they continue to fall thereafter. Notably, the 2 DS acknowledges that transforming the energy sector is vital, but not the sole solution: the goal can be achieved only if CO and GHG emissions in non-energy sectors are also reduced.

For more information, see IEA. 2014. “ETP 2014 Data Visualisation.” IEA. http://www.iea.org/etp/explore/ (Last accessed 15 January 2015).

4 The 2 DS shows substantial efficiency gains in all end-use sectors. In transport, fuel economy of the whole vehicle fleet doubles over the projection period, keeping sectoral energy use flat while travel activity almost doubles. Industry, through adoption of best available technologies and greater penetration of less-energy-intensive process routes related in some cases to the use of recycled materials, cuts energy use by 25 per cent. Despite the global floor area increasing by more than 70 per cent, energy demand in buildings grows just 11 per cent, without changing the comfort levels of buildings or requiring households and businesses to reduce their purchases of appliances and electronics equipment.

5 Maggie Molina. 2014. “The Best Value for America’s Energy Dollar: A National Review of the Cost of Utility Energy Efficiency Programs.” *American Council for an Energy-Efficient Economy.* Report Number U1402.

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9 IEA. 2012. "Technology Roadmap: High-Efficiency, Low-Emissions Coal-Fired Power generation." OECD/IEA. http://www.iea.org/publications/freepublications/publication/HELE_Foldout_A3_2ndProofs.pdf (Last accessed 15 January 2015).

10 Higher heating value (HHV) is the heating value directly determined by calorimetric measurement in the laboratory. In this measurement, the fuel is combusted in a closed vessel, and the heat of combustion is transferred to water that surrounds the calorimeter. The combustion products are cooled to 60°F (15°C) and hence, the heat of condensation of the water vapour originating from the combustion of hydrogen and from the evaporation of the coal moisture is included in the measured heating value. For determining the lower heating value, LHV, calculation is needed to deduct the heat of condensation from the HHV. In US engineering practice, HHV is generally used for steam plants, while in the European practice, efficiency calculations are based on LHV. For Gas turbine cycles, LHV is used both in the US and Europe. Source: János Beér. 2009. "Higher Efficiency Power generation Reduces Emissions." National Coal Council Issue Paper. https://mitei.mit.edu/system/files/beer-emissions.pdf. (Last accessed 15 January 2015).

11 Ibid. above n.9.

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17 Ibid. above n.14.

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21 IPCC. 2014. "Climate Change 2014: Mitigation of Climate Change." IPCC. http://www.ipcc.ch/report/ar5/wg3/. (Last accessed 15 January 2015).

22 Ibid. above n.21.

23 Ibid. above n.13.

24 US Office of Energy Efficiency & Renewable Energy. “Motor Systems.” http://www.energy.gov/eere/amo/motor-systems. (Last accessed 15 January 2015)

25 Conrad U. Brunner and Paul Waide. 2011. “Energy-Efficiency Policy Opportunities for Electric Motor-Driven Systems.” IEA Working Paper. http://www.energiestiftung.ch/files/downloads/energiethemen-energieeffizienz-industriegewerbe/ee_for_electricsystems-2-.pdf. (Last accessed 15 January 2015).

26 Ibid. above n.25.

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42 Ibid. above n.14.

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58 Ethanol, for instance, has its own HS 6-digit tariff headings-HS 2201710 and HS 220720 (but only a small part is used for fuel purposes) as does Biodiesel (HS 271020 and HS 382600). The EU, for instance, has a separate NTL heading (CN 8703.9010) for electric vehicles.

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For example, HS 870390 would be replaced by:

8703.40 - Other vehicles, with both spark-ignition internal combustion reciprocating piston engine and electric motor as motors for propulsion, other than those capable of being charged by plugging to external source of electric power.

8703.50 - Other vehicles, with both compression-ignition internal combustion piston engine (diesel or semi-diesel) and electric motor as motors for propulsion, other than those capable of being charged by plugging to external source of electric power.

8703.60 - Other vehicles, with both spark-ignition internal combustion reciprocating piston engine and electric motor as motors for propulsion, capable of being charged by plugging to external source of electric power.

8703.70 - Other vehicles, with both compression-ignition internal combustion piston engine (diesel or semi-diesel) and electric motor as motors for propulsion, capable of being charged by plugging to external source of electric power.

8703.80 - Other vehicles, with only electric motor for propulsion

60 Ronald Steenblik et al. 2006. "Can Energy-Efficient Electrical Appliances be Considered 'Environmental Goods'?." OECD Trade and Environment Working Papers No. 2006-04. http://www.iea.org/publications/freepublications/publication/efficient_appliances.pdf. (Last accessed 15 January 2015).

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ANNEX TABLE: TIERS OF ENERGY–EFFICIENT/ SAVINGS PRODUCT CATEGORIES AND HS CODES FOR CONSIDERATION IN AN EGA

The table below shows a depiction of the various energy-efficient/ savings product tiers explained in Chapter8 that could be explored by negotiators for an Environmental Goods Agreement (EGA). **Column 1** indicates the relevant HS subheading at the 6 digit level using HS (2012) classifications. **Column 2** shows the HS description at the 6-digit level. **Column 3** indicates a further ex-out description wherever this becomes necessary or based on earlier submissions put forward by WTO members. **Column 4** indicates the relevance of either the HS 6-digit or ex-out (where indicated) to energy-efficiency (EE) or overall energy savings. **Column 5** indicates whether or not a particular HS subheading (and ex-out in many cases) has been reflected in previous WTO submissions during the Doha round of negotiations on environmental goods. A tick mark indicates that it has been submitted previously. **Column 6** provides details on any product submissions that have been made including the name of the WTO submitting member, the submission reference number as well as the particular product category under which the HS sub-heading/ex-out was mentioned. It is notable that many products of relevance to energy savings have also been included under categories such as 'Renewable Energy' or 'Air-Pollution Control'. This shows that the same product could be deployed in more than one sector or can have multiple environmental benefits. **Column 7** reveals whether the HS-subheading/ex-out has also been included within the APEC list of 54-subheadings containing environmental goods that forms the basis for negotiations on environmental goods under the EGA. Finally **Column 8** also indicates whether the HS subheading/ex-out has been included or not in the original mapping studies in the buildings and transport sector conducted by the ICTSD. Certain additional products (that could more or less be clearly identified at the HS-6 digit/ex-out level) that are not found in WTO submissions and the APEC list but found in the ICTSD mapping studies have been included. These are products relevant to sound-proofing and thermal insulation of buildings. The original ICTSD mapping studies also contain a large number of technologies and product groups relevant to EE (for example, light-weight materials used in automobiles and aircraft), but these have been difficult to capture precisely at the HS 6-digit or ex-out levels and hence are not included in the Annex Table.

TIER 1: Clearly Identifiable Energy Efficiency Goods at the HS-6 Digit Level

HS Code / [No: of HS-6 lines]	HS Descrip-tion	Ex-out/ description	Energy-efficiency relevance	Included In WTO Submissions	WTO Submitting Member(s)/ Submission Reference/[Category]	Included in APEC-54 List	Included in ICTSD Mapping Studies List
HS 854140 [1]	Light-emitting diodes (grouped with solar PV cells and other photosensitive semi-conductor devices)		Most energy-efficient lighting technology	√	1.Canada, European Communities, Japan, New Zealand, United States, JOB(09)/132, **[Renewable Energy]** 2.Philippines, TN/TE/2, **[Renewable Energy]**	√	√
HS 680610 [1]	Slag wool and Rock wool		Soundproofing and thermal insulation of buildings.				√
HS 680690 [1]	Other insulating materials and articles		Soundproofing and thermal insulation of buildings.				√
HS 700800 [1]	Multiple-walled insulating units of glass		Soundproofing and thermal insulation of buildings.				√
HS 701939 [1]	Other glass fibres		Soundproofing and thermal insulation of buildings.				√
HS 701931 [1]	Glass fibre mats		Soundproofing and thermal insulation of buildings.	√	European Communities, JOB(09)/132, **[Heat and Energy Management]**		

TIER 2: Clearly Identifiable Energy Efficiency Goods at the 'Ex-Out' Level

HS Code / [No: of HS-6 lines]	HS Descrip-tion	Ex-out/ description	Energy-efficiency relevance	In-cluded In WTO Submis-sions	WTO Submitting Member(s)/Submission Reference/[Category]	Included in APEC-54 List	Included in ICTSD Mapping Studies List
HS 841861 [1]	Heat pumps other than air conditioning machines of heading 84.15	Geothermal or ground source heat pump system	Such systems transfer ("pump") the heat available in land and water masses to either heat or cool buildings. Saves on fossil energy/ grid-power use.	✓	European Communities, JOB(09)/132, **[Renewable Energy]**		✓
HS 841919 [1]	Instantaneous or storage water heaters, non-electric (other than instantaneous gas water heaters).	Solar water heaters	Uses solar thermal energy to heat water, producing no pollution. Use of solar water heating displaces the burning of other, pollution-creating fuels and saves on grid-electricity.	✓	1.Canada, European Communities, Japan, New Zealand, United States, JOB(09)/132, **[Renewable Energy]** 2.Philippines, TN/TE/2, **[Renewable Energy]**	✓	✓
HS 841950 [1]	Heat Exchange Units	1.Heat Exchange Units for use in renewable energy systems 2.Heat Exchange Units for use with geothermal/ ground-source heat pumps 3. Other electrically operated cooling towers	1.Some heat exchangers are specifically designed for use in relation to renewable energy sources such as geothermal energy 2. Provides cooling effect to heat exchangers in solar collector or solar system controllers to avoid overheating.	✓	1.Canada, European Communities, Japan, United States, JOB(09)/132, **[Heat and Energy Management]** 2.Philippines, TN/TE/2, **[Renewable Energy]** 3.Saudi Arabia, , JOB (09/169), **[Efficient Consumption of Energy] [Gas-Flaring Emission Reduction Technologies]**		✓

TIER 2: *Continued*

HS Code / [No: of HS-6 lines]	HS Descrip-tion	Ex-out/ description	Energy-efficiency relevance	Included In WTO Submis-sions	WTO Submitting Member(s)/Submission Reference/[Category]	Included in APEC-54 List	Included in ICTSD Mapping Studies List
HS 850239 [1]	Other Electric generating sets and rotary convertors	Combined heat and power using biomass/ biogas and heat recovery systems	Combined heat and power systems produce usable power (usually electricity) and heat at the same time. Micro combined heat and power systems are very efficient for domestic use, particularly in places where reticulated natural gas and hot water central heating are the norm. ‘Distributed generation’ also minimizes transmission losses through national grids, reducing the need to increase centralized generating capacity and transmission networks.	√	New Zealand, European Communities, United States, JOB(09)/132, **[Renewable Energy]**	√	
HS 853650 [1]	Other switches (for voltage not exceeding 1000 volts)	Dimmer Switches	Adjusts the lighting load within a building based on the availability of natural light. This thereby reduces the loading requirements for lighting within a building. LEDs, fluorescent lamps provide light for a longer time period reducing the energy consumption.				√

TIER 2: *Continued*

HS Code / [No: of HS-6 lines]	HS Descrip-tion	Ex-out/ description	Energy-efficiency relevance	Included In WTO Sub-missions	WTO Submitting Member(s)/ Submission Reference/ [Category]	Included in APEC-54 List	Included in ICTSD Mapping Studies List
HS 903289 [1]	Other automatic regulating or controlling instruments	1.Light sensors 2.Automatic voltage and current regulators 3. Elevator and escalator sensors 4. Temperature sensor for solar boiler/water heater 5.Differential temperature controller for solar boiler/ water heater	Process control instruments can have applications in smart-grids and other energy-efficiency applications (e.g.: Grid distribution efficiency, building space heating and hot-water, efficient electricity end-use).	√	1.Canada, Japan, Korea, New Zealand, United States, JOB(09)/132, **[Renewable Energy]** 2.Saudi Arabia, JOB (09/169), **[Efficient Consumption of Energy] [Gas-Flaring Emission Reduction Technologies]**	√	

TIER 2: *Continued*

HS Code / [No: of HS-6 lines]	HS Descrip-tion	Ex-out/ description	Energy-efficiency relevance	Included In WTO Sub-missions	WTO Submitting Member(s)/ Submission Reference/ [Category]	Included in APEC-54 List	Included in ICTSD Mapping Studies List
HS 940510 [1]	Chandeliers and other electric ceiling or wall lighting fittings, excluding those of a kind used for lighting public open spaces or thoroughfares	Lighting fittings using LED lamp	Compared with the conventional fluorescent or incandescent lamps, it is long life, low power consumption, energy saving and no toxic substance (mercury free).	√	Japan, TN/TE/W/75/ Add.1. **[Energy Efficiency]**		
HS 940520 [1]	Electric table, desk, bedside or floor-standing lamps	Lighting fittings using LED lamp	Compared with the conventional fluorescent or incandescent lamps, it is long life, low power consumption, energy saving and no toxic substance (mercury free).	√	Japan, TN/TE/W/75/ Add.1. **[Energy Efficiency]**		
HS 940540 [1]	Electric lamps and lighting fittings other than those of 9405.10-9405.30	Lighting fittings using LED lamp	Compared with the conventional fluorescent or incandescent lamps, it is long life, low power consumption, energy saving and no toxic substance (mercury free).	√	Japan, TN/TE/W/75/ Add.1. **[Energy Efficiency]**		

TIER 2: *Continued*

HS Code / [No: of HS-6 lines]	HS Descrip-tion	Ex-out/ description	Energy-efficiency relevance	Included In WTO Sub-missions	WTO Submitting Member(s)/ Submission Reference/ [Category]	Included in APEC-54 List	Included in ICTSD Mapping Studies List
HS 870210 870290 870321 870322 870323 870324 870331 870332 870333 870390 [10]	Motor cars and other motor vehicles of various specifications principally designed for the transport of persons	1.Clean diesel vehicles with a diesel-engine and a device that eliminate the suspended particulate matter, oxide of nitrogen, etc. 2.Hybrid vehicles with electric motor 3.Hydrogen-fuelled vehicle 4.Electric vehicles with a secondary battery and an electric motor 5. Fuel cell vehicles with a fuel cell, electric motor and hydrogen tank 6.Natural gas vehicles with a natural gas tank	Low gas consumption, fuel economy, zero or lower CO_2 emissions and pollutants such as NOx and SOx emission	√	Japan, TN/TE/W/75/Add.1.**[Air Pollution Control] [Renewable Energy]**		√

TIER 2: *Continued*

HS Code / [No: of HS-6 lines]	HS Descrip-tion	Ex-out/ description	Energy-efficiency relevance	Included In WTO Sub-missions	WTO Submitting Member(s)/ Submission Reference/ [Category]	Included in APEC-54 List	Included in ICTSD Mapping Studies List
HS 870410 [1]	Dumpers designed for off-highway use	1.Clean diesel vehicles with a diesel-engine and a device that eliminate the suspended particulate matter, oxide of nitrogen etc. 2.Hybrid vehicles with electric motor 3.Electric vehicles with a secondary battery and an electric motor 4.Fuel cell vehicles with a fuel cell, electric motor and hydrogen tank 5.Natural gas vehicles with a natural gas tank 6.Hydrogen-fuelled vehicle	Low gas consumption, fuel economy, zero or lower CO_2 emissions and pollutants such as NOx and SOx emission	√	Japan, TN/ TE/W/75/Add.1. **[Air Pollution Control] [Renewable Energy]**		

TIER 2: *Continued*

HS Code / [No: of HS-6 lines]	**HS Descrip-tion**	**Ex-out/ description**	**Energy-efficiency relevance**	**Included In WTO Sub-missions**	**WTO Submitting Member(s)/ Submission Reference/ [Category]**	**Included in APEC-54 List**	**Included in ICTSD Mapping Studies List**
HS 870421 870422 870423 870431 870432 870490 [6]	Motor Vehicles for transport of goods with various specifications	1.Clean diesel vehicles with a diesel-engine and a device that eliminate the suspended particulate matter, oxide of nitrogen, etc. 2.Hybrid vehicles with electric motor 3.Hydrogen-fuelled vehicle 4.Electric vehicles with a secondary battery and an electric motor 5. Fuel cell vehicles with a fuel cell, electric motor and hydrogen tank 6.Natural gas vehicles with a natural gas tank	Low gas consumption, fuel economy, zero or lower CO_2 emissions and pollutants such as NOx and SOx emission	✓	Japan, TN/ TE/W/75/ Add.1. **[Air Pollution Control] [Renewable Energy]**		✓

TIER 2: *Continued*

HS Code / [No: of HS-6 lines]	**HS Descrip-tion**	**Ex-out/ description**	**Energy-efficiency relevance**	**Included In WTO Sub-missions**	**WTO Submitting Member(s)/ Submission Reference/ [Category]**	**Included in APEC-54 List**	**Included in ICTSD Mapping Studies List**
HS 870510 [1]	Crane lorries	1.Clean diesel vehicles with a diesel-engine and a device that eliminates the suspended particulate matter, oxide of nitrogen etc. 2.Hybrid vehicles with electric motor 3.Electric vehicles with a secondary battery and an electric motor 4.Fuel Cell Vehicles with a fuel cell, electric motor and hydrogen tank 5.Natural Gas Vehicles with a natural gas tank 6.Hydrogen-fuelled vehicle	Low gas consumption, fuel economy, zero or lower CO_2 emissions and pollutants such as NOx and SOx emission	√	Japan, TN/TE/W/75/Add.1. **[Air Pollution Control] [Renewable Energy]**		

TIER 2: *Continued*

HS Code / [No: of HS-6 lines]	HS Descrip-tion	Ex-out/ description	Energy-efficiency relevance	Included In WTO Sub-missions	WTO Submitting Member(s)/ Submission Reference/ [Category]	Included in APEC-54 List	Included in ICTSD Mapping Studies List
HS 870530 [1]	Fire-fighting Vehicles	1.Clean diesel vehicles with a diesel-engine and a device that eliminates the suspended particulate matter, oxide of nitrogen, etc. 2.Hybrid vehicles with electric motor 3.Electric vehicles with a secondary battery and an electric motor 4.Fuel Cell Vehicles with a fuel cell, electric motor and hydrogen tank 5.Natural Gas Vehicles with a natural gas tank	Low gas consumption, fuel economy, zero or lower CO_2 emissions and pollutants such as NOx and SOx emission	√	Japan, TN/ TE/W/75/ Add.1. **[Air Pollution Control] [Renewable Energy]**		

TIER 2: *Continued*

HS Code / [No: of HS-6 lines]	**HS Descrip-tion**	**Ex-out/ description**	**Energy-efficiency relevance**	**Included In WTO Sub-missions**	**WTO Submitting Member(s)/ Submission Reference/ [Category]**	**Included in APEC-54 List**	**Included in ICTSD Mapping Studies List**
HS 870540 [1]	Concrete Mixer Lorries	1.Clean diesel vehicles with a diesel-engine and a device that eliminates the suspended particulate matter, oxide of nitrogen, etc. 2.Hybrid vehicles with electric motor 3.Electric vehicles with a secondary battery and an electric motor 4.Fuel Cell Vehicles with a fuel cell, electric motor and hydrogen tank 5.Natural Gas Vehicles with a natural gas tank	Low gas consumption, fuel economy, zero or lower CO_2 emissions and pollutants such as NOx and SOx emission	√	Japan, TN/ TE/W/75/ Add.1. **[Air Pollution Control] [Renewable Energy]**		

TIER 2: *Continued*

HS Code / [No: of HS-6 lines]	HS Descrip-tion	Ex-out/ description	Energy-efficiency relevance	Included In WTO Sub-missions	WTO Submitting Member(s)/ Submission Reference/ [Category]	Included in APEC-54 List	Included in ICTSD Mapping Studies List
HS 870590 [1]	Special purpose motor vehicles other than crane lorries, mobile drilling derricks, fire fighting vehicles and concrete-mixer lorries	1.Clean diesel vehicles with a diesel-engine and a device that eliminates the suspended particulate matter, oxide of nitrogen etc. 2.Hybrid vehicles with electric motor 3.Electric vehicles with a secondary battery and an electric motor 4.Fuel Cell Vehicles with a fuel cell, electric motor and hydrogen tank 5.Natural Gas Vehicles with a natural gas tank 6.Hydrogen-fuelled vehicle	Low gas consumption, fuel economy, zero or lower CO_2 emissions and pollutants such as NOx and SOx emission	✓	Japan, TN/ TE/W/75/ Add.1. **[Air Pollution Control] [Renewable Energy]**		

TIER 3: Products (including ex-out categories) with Cross-Cutting Applications but also relevant to Energy Efficiency

HS Code / [No: of HS-6 lines]	HS Descrip-tion	Ex-out/ description	Energy-efficiency relevance	Included In WTO Sub-missions	WTO Submitting Member(s)/ Submission Reference/ [Category]	Included in APEC-54 List	Included in ICTSD Mapping Studies List
HS 871110 871120 871130 871140 871150 871190 [6]	Motorcycles (including mopeds) and cycles fitted with an auxiliary motor(with or without sidecars) of various specifications	1.Hybrid motorcycle with electric motor 2. Electric motorcycles with a secondary battery and an electric motor 3.Fuel cell motorcycles with a fuel cell, electric motor and hydrogen tank.	Low gas consumption, fuel economy, zero or lower CO_2 emissions and pollutants such as NOx and SOx emission	√	Japan, TN/ TE/W/75/Add.2. **[Air Pollution Control] [Renewable Energy]**		

TIER 3: *Continued*

HS Code / [No: of HS-6 lines]	**HS Descrip-tion**	**Ex-out/ description**	**Energy-efficiency relevance**	**Included In WTO Submis-sions**	**WTO Submitting Member(s)/Submission Reference/[Category]**	**Included in APEC-54 List**	**Included in ICTSD Mapping Studies List**
HS 850239 [1]	Other electric generating sets and rotary convertors: other	Optional ex-outs (from energy savings in buildings and for small communities and townships) may include: 1.Combined heat and power systems using biomass and/or biogas 2.Portable solar power generation equipment 3.Solar power electric generating sets 3.Gas turbine sets for biomass plants	Combined heat and power systems produce usable power (usually electricity) and heat at the same time. Micro combined heat and power systems are very efficient for domestic use, particularly in places where reticulated natural gas and hot water central heating are the norm. 'Distributed generation' also minimizes transmission losses through national grids, reducing the need to increase centralized generating capacity and transmission networks.	√	New Zealand, European Communities, United States, JOB(09)/132, **[Renewable Energy]**	√	

TIER 3: *Continued*

HS Code / [No: of HS-6 lines]	HS Descrip-tion	Ex-out/ description	Energy-efficiency relevance	Included In WTO Submis-sions	WTO Submitting Member(s)/Submission Reference/[Category]	Included in APEC-54 List	Included in ICTSD Mapping Studies List
HS 902680 [1]	Other Instruments and apparatus for measuring or checking other variables of liquids or gases.	1. Heat meters	1. Heat meters can be used to monitor and measure the distribution of heat from geothermal or biomass district heating systems.	√	1.Japan, Korea, New Zealand, United States, Canada, JOB(09)/132, **[Environmental Monitoring, Analysis and Assessment Equipment]** 2.Saudi Arabia, JOB (09/169), **[Efficient Consumption of Energy] [Gas-Flaring Emission Reduction Technologies]**	√	
HS 902810 [1]	Gas meters -including calibrating meters thereof		Meters are necessary to measure and regulate use and hence enable more efficient use of the resource. In particular, these gas meters are generally designed for use with natural gas and propane, but may include those designed for other gases such as helium.	√	1.Canada, European Communities, Japan, New Zealand, United States, JOB(09)/132, **[Heat and Energy Management]** 2. Saudi Arabia, JOB (09/169), **[Efficient Consumption of Energy] [Gas-Flaring Emission Reduction Technologies]**		

TIER 3: *Continued*

HS Code / [No: of HS-6 lines]	**HS Descrip-tion**	**Ex-out/ description**	**Energy-efficiency relevance**	**Included In WTO Submis-sions**	**WTO Submitting Member(s)/Submission Reference/[Category]**	**Included in APEC-54 List**	**Included in ICTSD Mapping Studies List**
HS 902830 [1]	Electricity meters		These products include those designed to measure electricity flow in residential, commercial, and industrial consumption of electricity. They could assist in demand-side energy consumption management.	✓	1.Canada, Japan, New Zealand, United States, JOB(09)/132, **[Heat and Energy Management]** 2. Saudi Arabia, JOB (09/169), **[Efficient Consumption of Energy] [Gas-Flaring Emission Reduction Technologies]**		
HS 903210 [1]	Thermostats		Products include thermostats that control the efficiency of air conditioning, refrigeration or heating systems.	✓	1.Canada, Japan, New Zealand, United States, JOB(09)/132, **[Environmental Monitoring, Analysis and Assessment Equipment]** 2. Saudi Arabia, JOB (09/169), **[Efficient Consumption of Energy] [Gas-Flaring Emission Reduction Technologies]**		✓

TIER 4: Spare Parts important for the Functioning of Energy- Efficiency Products

HS Code / [No: of HS-6 lines]	HS Descrip-tion	Ex-out/ description	Energy-efficiency relevance	Included In WTO Sub-missions	WTO Submitting Member(s)/ Submission Reference/ [Category]	Included in APEC-54 List	Included in ICTSD Mapping Studies List
HS 841990 [1]	Parts of machinery, plant and equipment of heading No 84.19	1.Parts for 841919x(solar water heaters) including insulation, temperature sensor for solar boiler/water heater; Differential temperature controller for solar boiler/water heater; Evacuated glass tubes for solar boiler/water heater; Heat pipes for solar boiler/water heater 2.Parts for 841950x (heat exchange units)		√	1.Canada, Japan JOB(09)/132, **[Renewable Energy]** 2. Saudi Arabia, JOB (09/169), **[Efficient Consumption of Energy] [Gas-Flaring Emission Reduction Technologies]**	√	
HS 850300 [1]	Parts suitable for use solely or principally with the machines of heading 85.01 or 85.02.	1.Parts for 850239x (Combined heat and power/heat recovery systems) 2. Parts for 850239x (Parts, of Motors, of Generators, of Generating Sets, of Rotary Converters).		√	1.European Communities, Switzerland, United States, JOB(09)/132, **[Renewable Energy]** 2. Saudi Arabia, JOB (09/169), **[Efficient Consumption of Energy] [Gas-Flaring Emission Reduction Technologies]**	√	

TIER 4: *Continued*

HS Code / [No: of HS-6 lines]	HS Description	Ex-out/ description	Energy-efficiency relevance	Included In WTO Sub-missions	WTO Submitting Member(s)/ Submission Reference/ [Category]	Included in APEC-54 List	Included in ICTSD Mapping Studies List
HS 902690 [1]	Parts and accessories for articles of subheading 9026	Parts for 90268x (Other Instruments and apparatus for measuring or checking other variables of liquids or gases including heat meters)		√	1.Canada, Japan, Korea, New Zealand, United States, JOB(09)/132, **[Environmental Monitoring, Analysis and Assessment Equipment]** 2. Saudi Arabia, JOB (09/169), **[Efficient Consumption of Energy] [Gas-Flaring Emission Reduction Technologies]**	√	
HS 902890 [1]	Parts and accessories for articles of subheading 9028	Optional ex-out may include: 1.Parts for 902810 (Gas meters) 2. Parts for 902830 (Electricity meters)		√	1.Japan, Korea, New Zealand, United States, Canada, European Communities, **[Heat and Energy Management]** 2. Saudi Arabia, JOB (09/169), **[Efficient Consumption of Energy] [Gas-Flaring Emission Reduction Technologies]**		

TIER 4: *Continued*

HS Code / [No: of HS-6 lines]	**HS Description**	**Ex-out/ description**	**Energy-efficiency relevance**	**Included In WTO Submissions**	**WTO Submitting Member(s)/ Submission Reference/ [Category]**	**Included in APEC-54 List**	**Included in ICTSD Mapping Studies List**
HS 903290 [1]	Parts and accessories for nominated articles of subheading 9032 (Automatic regulating or controlling instruments and apparatus)	Optional ex-out may include: 1.Parts for 903210x (thermostats) 2.Parts for 903289x (other automatic regulating or controlling instruments and apparatus including (a)Light sensors (b) Automatic voltage and current regulators (c) Elevator and escalator sensors (d) Temperature sensor for solar boiler/water heater (e) Differential temperature controller for solar boiler/water heater			1.Canada, Japan, New Zealand, United States, Korea, JOB(09)/132, **[Environmental Monitoring, Analysis and Assessment Equipment]** 2. Saudi Arabia, JOB (09/169), **[Efficient Consumption of Energy] [Gas-Flaring Emission Reduction Technologies]**	√	

TIER 4: *Continued*

HS Code / [No: of HS-6 lines]	**HS Description**	**Ex-out/ description**	**Energy-efficiency relevance**	**Included In WTO Submissions**	**WTO Submitting Member(s)/ Submission Reference/[Category]**	**Included in APEC-54 List**	**Included in ICTSD Mapping Studies List**
HS 903300 [1]	Parts and accessories (not specified or included elsewhere in this Chapter) for machines, appliances, instruments or apparatus of Chapter 90 (Optical, Photographic, Cinematographic, Measuring, Checking, Precision, Medical or Surgical Instruments and Apparatus; Parts and Accessories Thereof).		All parts and accessories of the products described above.	√	1.Canada, European Communities, Japan, Korea, New Zealand, United States, JOB(09)/132, **[Environmental Monitoring, Analysis and Assessment Equipment]** 2.Saudi Arabia, JOB (09/169), **[Efficient Consumption of Energy] [Gas-Flaring Emission Reduction Technologies]**	√	

TIER 5: Energy-efficient products (based on relative performance among identical end-use products)

HS Code / [No: of HS-6 lines]	HS Description	Ex-out/ description	Energy-efficiency relevance	Included In WTO Submissions	WTO Submitting Member(s)/ Submission Reference/ [Category]	Included in APEC-54 List	Included in ICTSD Mapping Studies List
HS 850110 850120 850131 850132 850133 850134 850151 850152 850153 850161 850162 850163 850164 [13]	Electric motors and generators f various specifications (0.12KW-1000KW) excluding generating sets	All motors conforming to IEC 3 and IEC 4 efficiency classes designated though an appropriate ex-out heading in Members' schedules. Note: This 'ex-out' designation may be revised as new efficiency classes emerge but always retaining a zero duty treatment.	IEC3 and IEC4 classes represent the highest energy efficiency classes. IEC standards are international and recognized globally by all WTO members	√			

TIER 5: *Continued*

HS Code / [No: of HS-6 lines]	HS Description	Ex-out/ description	Energy-efficiency relevance	Included in WTO Submis-sions	WTO Submitting Member(s)/ Submission Reference/ [Category]	Included in APEC-54 List	Included in ICTSD Mapping Studies List
HS 850410	Ballasts for discharge lamps or tubes	Advanced lighting ballasts for discharge lamps or tubes to increase energy-efficiency commonly known as Digitally Addressable Lighting Interface (“DALI”) ballasts. DALI is a worldwide open standard for digital lighting control that allows compliant components from different manufacturers to be mixed and matched into complete systems. The DALI standard is known as Annex E of IEC standard 60929	DALI ballasts offer not only efficient conversion of electrical current for optimal use by the light source but also offer two-way communication between the ballast installed in a lighting fixture and a control unit that can be linked from the lighting system to a building’s central systems management capabilities. This type of communication and control allows for optimal energy performance of a lighting system.	✓	Saudi Arabia, JOB (09/169), [Efficient Consumption of Energy] [Gas-Flaring Emission Reduction Technologies]		
HS 850421 850422 850423 850431 850432 850433 850434	Electrical transformers, static converters (for example, rectifiers) and inductors of various capacities	Energy-efficient electric transformers based on standards acceptable to all EGA members.	Premium efficiency electric transformers saves energy by significantly reducing power losses that occur during the voltage step-up and step-down processes in electricity transmission.	✓	Saudi Arabia, JOB (09/169), [Efficient Consumption of Energy] [Gas-Flaring Emission Reduction Technologies]		

TIER 5: *Continued*

HS Code / [No: of HS-6 lines]	**HS Description**	**Ex-out/ description**	**Energy-efficiency relevance**	**Included in WTO Submis-sions**	**WTO Submitting Member(s)/ Submission Reference/ [Category]**	**Included in APEC-54 List**	**Included in ICTSD Mapping Studies List**
Other HS headings as designated by EGA participants							

Sources: Wind,I (2009), Wind,I (2010), WTO (2010), NEMA (2014) and APEC (2012).

Proposed Treatment Options-

* *Permanent duty-waiver on 'Highest Efficiency Class/Classes' of Energy-Efficient Products by EGA Members based on an International Standard as documented by importer and/or (if EGA Members agree):*

* *Permanent duty waiver applied by importing country to energy-efficient products that conforms to highest domestic MEPS as documented by importer*

Other Publications from the Environment theme include:

- The APEC List of Environmental Goods: An Analysis of the Outcome & Expected Impact. Issue Paper No. 18 by Rene Vosenaar, 2013.
- Market Access Opportunities for ACP Countries in Environmental Goods. Issue Paper No. 17 by D. Laborde and C. Lakatos, 2012.
- Facilitating Trade in Services Complementary to Climate-friendly Technologies. Issue Paper No. 16 by Joy Aeree Kim, 2011.
- Deploying Climate-Related Technologies in the Transport Sector: Exploring Trade Links. Issue Paper No. 15 by Rene Vosenaar, 2010.
- Harmonising Energy Efficiency Requirements. Issue Paper No.14 by Rod Janssen, 2010.
- Climate-related single-use environmental goods. Issue Paper No.13 by Rene Vossenaar, 2010.
- Technology Mapping of the Renewable Energy, Buildings, and Transport Sectors: Policy Drivers and International Trade Aspects. An ICTSD Synthesis Paper. Issue Paper No.12 by Rene Vossenaar, 2010.
- Deploying Energy-Efficiency and Renewable-Energy Technologies in Residential and Commercial Buildings. Issue Paper No.11 by Rene Vossenaar and Veena Jha, 2010.

For further information, visit www.ictsd.org

ABOUT ICTSD

Founded in 1996, the International Centre for Trade and Sustainable Development (ICTSD) is an independent think-and-do-tank based in Geneva, Switzerland and with operations throughout the world, including out-posted staff in Brazil, Mexico, Chile, Senegal, Canada, Russia, and China. By enabling stakeholders in trade policy through information, networking, dialogue, well-targeted research and capacity-building, ICTSD aims to influence the international trade system so that it advances the goal of sustainable development. ICTSD co-implements all of its programme through partners and a global network of hundreds of scholars, researchers, NGOs, policymakers and think-tanks around the world.