LOW CARBON GREEN GROWTH ROADMAP FOR ASIA AND THE PACIFIC

[Background Policy Paper]

Promoting Trade and Investment in Climate-Smart Goods, Services and Technologies in Asia and the Pacific

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Acronyms and Abbreviations

ACA	Accelerated Capital Allowance
ADB	Asian Development Bank
APEC	Asia Pacific Economic Cooperation
BCA	Border Carbon Adjustment
BIPV	Building-integrated Photovoltaic
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CFT	Climate-friendly technologies
CNG	Compressed Natural Gas
COP15	Conference of Parties 15
CSGST	Climate Smart Goods, Services and Technologies
CSP	Concentrated Solar Power
CST	Climate-smart technologies
CSET	Climate-smart energy technologies
CTESS	Committee on Trade and Environment meeting in Special Session
DNA	Designated National Authority
EIA	Energy Information Association
EPP	Environmentally Preferable Products
EU	European Union
ESCO	Energy Services Company
EGS	Environmental goods and services
FEGSG	Friends of Environmental Goods and Services Group
FiT	Feed-in Tarriffs
FTA	Free Trade Agreement
GATT	General Agreement on Tariffs and Trade
GHG	Greenhouse gases
GTBR	Green Tax and Budget Reform
HS	Harmonization System
GW	Gigawatt
GWh	Gigawatt hour
ICTSD	International Center for Trade and Sustainable Development
IEA	International Energy Agency
IFT	Information Technology Agreement
ISO	International Organization for Standardization
JWPTE	the Joint Working Party on Trade and Environment
LPG	Liquefied Petroleum Gas
MDG	Millennium Development Goal
MEPS	Minimum Energy Performance Standards
$MtCO_2$	Megaton of Carbon Dioxide
MTOE	Million tons of oil equivalents
MW	Megawatt
NAMA	Nationally Appropriate Mitigation Action
NAMA	Non-agricultural Market Access Negotiating Group (NAMA)
NMEEE	National Mission for Enhanced Energy Efficiency
NTB	Non-tariff Barriers
OECD	Organization of Economic Cooperation and Development
PPA	Agreement on Public Procurement

PPM	Process and Production Methods
REF	Reference Scenario (World Bank)
REC	Renewable Energy Certificates
RES	Renewable Portfolio Standards
RoI	Return on Investment
RoK	Republic of Korea
SED	Sustainable Energy Development Path
TBoI	Thai Board of Investment
UN	United Nations
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
UNCTAD	United Nations Conference on Trade and Development
WTO	World Trade Organization
WB	World Bank
WWEA	World Wind Energy Association

1. Introduction

The recent failure of both international trade and climate change negotiations (Doha Round and COP15, respectively) to produce a meaningful and agreed-upon framework for action speaks to the level of complexities surrounding them, but not to the urgency for action. The latter is more evident from the faster-than-predicted increasing global greenhouse gas (GHG) emissions, and in parallel, worsening signs of climate change.[1]

In lieu of a legally binding global climate agreement for post-2012 action, the most that could be salvaged from the recent Conference of Parties 15 (COP15) was a "noted" Copenhagen Accord, which reaffirms the importance of restricting global temperature rise to 2.0°C, but does not necessitate sufficient action to actually accomplish this goal.[2] The Accord requires Annex I Signatories to submit quantified economy-wide emissions targets and non-Annex I Parties Nationally Appropriate Mitigation Actions (NAMA). Concerning, however, is the fact that the estimated sum of submitted targets by Annex-I countries falls markedly short of limiting CO_2e concentrations to 450ppm and the associated rise in global average temperatures of 2.0°C (Levin 2010). If the proposed mitigation targets are in fact even achieved, by some estimates, this would still set the world on a course for a rise in the range of 3-3.9°C (Project Catalyst 2010; Sustainability Institute 2009). Limiting global average temperature rise to 2°C was, ironically, one of the few numerical targets set out within the Copenhagen Accord; and yet it appears that even this is beyond reach.

While the responsibility for the buildup of GHG emission concentrations in the atmosphere lies mainly on the shoulders of developed countries, this burden is increasingly being shared by large developing countries, including, for instance, China, Brazil, India and Indonesia. By 2025, it is estimated that non-Annex I countries will account for more than 58% of global CO_2 emissions from fuel consumption, an increase of 25% from the 1990 level (World Resource Institute 2009). Against this background, successfully stabilizing CO_2e concentrations and avoiding the more severe effects of climate change will, at the very least, necessitate substantial action from developing countries. It would be to the advantage of developing countries to act quickly, as it is they who are expected to disproportionately bear the adverse impacts of climate change, many of which adaptation will not be an option.[3]

In recognizing the gravity of climate change inaction, and still in the absence of a legally binding global climate change agreement, many UNESCAP member developing countries are already working fast to foster Green Growth and transition to a climate smart development path. However, one of the major constraints of developing countries to make such a transition has been a lack of access to, and deployment of, renewable energy and other climate-smart technologies. Increased trade and investment in such technologies among developing countries is thus critical for not only mitigation, but also for expanding access and future supply of clean and reliable energy to the 1.68 billion people that still live without. The UNFCCC recognizes the existing chasm between developed and developing nations in

[1] For example, recent data indicates that the last decade and the period between January-July 2010 were the warmest on instrumental record.

[2] The Copenhagen Accord was only 'noted', not actually adopted at the conference. Thus, it is not considered to be a legally binding agreement such as the Kyoto Protocol.

[3] For many communities adaptation will not be an option. The Carteret Islanders of Papua New Guinea, for instance, were not able to adapt to climate change, but were forced to evacuate their homeland due to rapidly rising sea levels.

terms of capacity to act against and *common but differentiated responsibilities* for climate change; and Annex I countries have agreed to offer assistance in terms of financing and technology transfer (UNFCCC 1998).

Thus far, two major trade-related measures, targeted at promoting mitigation action, have emerged: 1) border carbon adjustments (BCA), also referred to as climate-related border tax adjustments; and 2) liberalization of climate-friendly environmental goods and services. The former could pose a significant trade barrier for developing countries' firms wishing to export their products to BCA levying countries, and catalyze increased trade protectionism. Various recent studies also underline the "*environmental ineffectiveness*" of BCA, stating that while they may reduce the overall cost of climate change mitigation for OECD countries, such a savings comes "*at the expense of terms of trade changes which impoverish*(es) *non-OECD countries*" (Rutherford 2010).

In an effort to promote the transfer of technologies to developing countries and diffusion globally, various proposals for liberalizing the trade of selected climate-friendly environmental goods and services have been submitted before the World Trade Organization (WTO) Committee on Trade and Environment. More recently, organizations such as the World Bank and the International Centre for Trade and Sustainable Development (ICTSD) have been at the forefront of identifying specific climate-friendly technologies categorized by Harmonized System (H.S.) 6-digit codes.[4] Their contributions have been of great value-added to the literature, as well as to furthering bilateral, regional and global trade negotiations on liberalizing climate-friendly environmental goods and services.

There already exists a number of publications and analysis pertaining to BCA. For example, the thematic background and effectiveness has been addressed by IISD (Cosbey 2009), its compatibility with WTO and GATT law by the WTO and UNEP (WTO & UNEP 2009), and even recent policies containing provisions for BCA impacts on ESCAP member countries by UNIDO (Crawford 2010). However, in terms of liberalizing CSGST, there exists a lack of recent and aggregated information on trade and investment in CFG in the Asia and Pacific. For ESCAP member policy makers are to effectively negotiate the terms of liberalization, it is critical for them to have a grasp of the recent trade and investment patterns both inter and intra-regionally. In seeking to address this shortfall within the literature, this paper focuses on analyzing the trade of and investment in climate smart goods in Asia and the Pacific, as well policy options to promote such ends in the region.

Chapter 1 begins with analysis of the nexus of trade and climate change. In an effort to grasp a clear understanding of major sources of climate change in Asia and the Pacific, chapter 1 further attempts to analyze the region's GHG emissions by sub-region, country and sector. For this task, the paper primarily employs GHG emissions data from the World Resources Institute (WRI) Climate Analysis Indicator Tool (CAIT) 7.0 database. It also highlights numerous future CO_2 emissions scenarios from leading institutions. Despite the relevance of such analysis, in order to examine the contribution to climate change from the trade sector, it is also necessary to adopt a consumption-based approach to emission accounting. By drawing on previous work in this area, the chapter concludes by painting a picture of

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[4] See, for example, World Bank, *International Trade and Climate Change: Economic, Legal, and Institutional Perspectives* (Washington D.C.: World Bank, 2008) and Izaak Wind, *H.S. Codes and the Renewable Energy Sector* (International Centre for Trade and Sustainable Development, 2009).

responsibility for climate change, not reflected within national GHG emissions inventories of parties to the United Nations Framework Convention on Climate Change (UNFCCC).

Chapter 2 seeks to assess investment in selected climate-smart energy technologies (CSET) in Asia and the Pacific. The first section illustrates the energy challenges facing the region, and the subsequent investment in CSET required to meet future energy demands while simultaneously limiting global average temperature rise to 2°C . Types of investments covered in Chapter 2 include national green stimulus programmes, foreign direct investment (FDI), public market financing, venture capital, private equity and asset financing classified by technology and country when available.

In an effort to advance the discussion on the liberalization of trade in climate-friendly environmental goods and services, Chapter 3 propounds a new list of 64 climate smart technologies, categorized by HS 6-digit codes, for future analysis and consideration. Prior to doing so, it briefly examines the history of and challenges to negotiations on liberalization. Adopting a methodology developed by the World Bank (World Bank 2008, 52), Chapter 4 seeks to paint a picture of Asia and the Pacific's trade in climate smart technologies, namely, wind, clean coal, solar photovoltaic and energy efficient lighting technologies.

While the first 4 chapters focus on analyzing the trade and investment in CSGT, Chapter 5 examines policy architectures conducive to fostering climate smart trade, investment and development in Asia and the Pacific. It underscores specific policy and programme interventions in individual UNESCAP members, which may be used by other members as a basis for formulating future climate smart policies.

2. The Nexus of Trade and Climate Change

2.1 Overview

The increased liberalization of trade has contributed significantly to rapid export-driven economic growth throughout Asia and the Pacific over the last couple of decades. It has further aided in the efforts to achieve the Millennium Development Goals (MDG) by expanding access of the Region's women, children and poor to essential basic goods and services, while also providing new opportunities for employment. Despite such achievements, however, growing levels of inequality, environmental degradation and GHG emissions have also accompanied trade liberalization and expansion. Rapidly rising GHG emissions are the source of anthropogenic (human-induced) climate change, and weakened or destroyed eco-systems enhance the vulnerability of communities and reduce their adaptive capacity and resilience to its adverse effects. Left unchecked, climate change could severely undermine global economic growth and MDG progress. Paradoxically, trade— one of the main drivers of economic development and MDG achievement in the region— could, through its contribution to climate change, indirectly be responsible for its undoing. Trade itself could also be adversely affected by future climate change. Future climate change could, for example, reduce agricultural yields and thus exports, interrupt supply chains and channels, and destroy critical trade infrastructure (e.g. from more severe climatic events such as cyclones).

This does not have to be the case. If designed and managed in a more inclusive and sustainable manner, trade liberalization and growth have the potential to be a catalyst and vehicle for delivering CSGST essential for transferring to a low-carbon economy. Such actions could also drive long-term innovation, as well as economic growth and diversification. They could also reduce the degree of climate change and its consequent impact on trade. As highlighted throughout this paper, many ESCAP members, including developing ones, are already designing policy architectures conducive to facilitating more sustainable and inclusive trade and investment patterns. Nevertheless, to maximize the effectiveness of such policy initiatives, there is a great need for supportive global agreements and frameworks that address the synergies and competing issues between trade and climate change.

Dissimilar to the Montreal Protocol, the main international climate change treaty (Kyoto Protocol), subsequent negotiations (e.g. UN Conference of Parties 15 (COP15)), and the recent Copenhagen Accord, have failed to effectively address issues for mitigation as they pertain to trade. Moreover, the Doha Round of trade negotiations, which has dealt with the topic of liberalizing the trade of climate-friendly environmental goods and services, has arrived at what some might consider an impasse.

In order for ESCAP member countries to break this deadlock and negotiate a fair and mutually supportive global agreement for trade and climate change that respects the principles of *common but differentiated responsibilities* incorporated in the United Nations Framework Convention on Climate Change (UNFCCC) and *special and differential treatment for developing countries* in numerous WTO agreements, it is first essential to have a clear understanding of their own country's and region's contribution to and future impacts from climate change. The latter will require local impact assessments within each country, and is beyond the scope of this paper. The former, however, can be analyzed through internationally available climate change and trade statistical databases. Drawing on such data and other previously conducted analysis, the following sections will attempt to assess Asia and the Pacific's contribution to climate change from both a production- and consumption-based accounting approach.

2.2 Assessing Asia and the Pacific's Carbon Footprint through Production-based Accounting

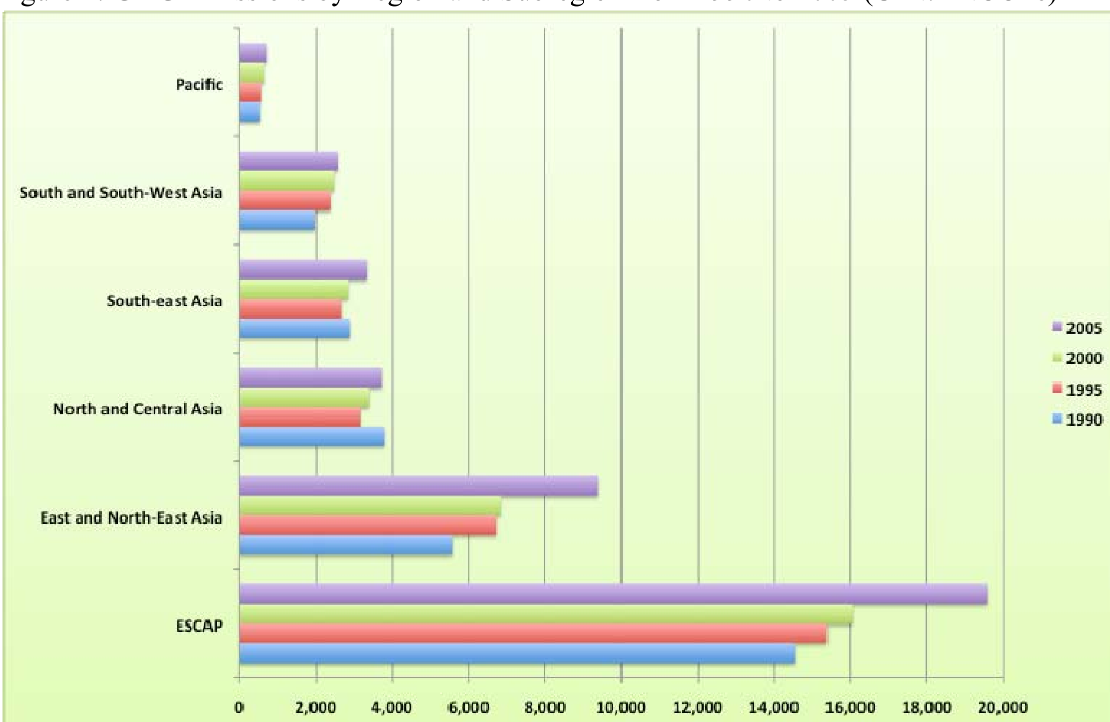
Asia and the Pacific's share of global GHG emissions has climbed from 39.6% to 44.39% between 1995 and 2005. In 2005, the ESCAP region emitted 19.59 trillion tons of CO2e, an increase of 34.4% relative to that of the 1990 level. Even though absolute increases in GHG emissions have been high over the past two decades, per capita emissions (5 tonnes of CO2e in 2005) still remains much lower than other regions: less than half of Europe's (11.2), almost one-fifth of North America's (23.7), and only 73.5% of the World's (6.8). The GHG intensity of the economy (tonnes of CO2e eq./mill. $intl. 2005) of Asia and the Pacific in 2005 was significantly higher than the World average, 979.4 compared to 763, respectively. Nevertheless, the region has been able to achieve some degree of relative decoupling of economic growth from GHG emissions, as evidenced by its improvement of GHG intensity from 1,314.4 in 1990 to 979.4 in 2005.[5]

[5] All greenhouse gas data was collected from Climate Analysis Indicators Tool (CAIT) Version 7.0. (Washington, DC: World Resources Institute, 2010). CAIT GHG data are derived from the following sources: Boden, T.A., G. Marland, and R. J. Andres. 2009. 'Global, Regional, and National Fossil Fuel CO2 Emissions.' Carbon Dioxide Information Analysis Center (CDIAC), Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. doi 10.3334/CDIAC/00001. Available online at: http://cdiac.ornl.gov/trends/emis/overview_2006.html.; Houghton, R.A. 2008. 'Carbon Flux to the Atmosphere from Land-Use Changes: 1850-2005.' In TRENDS: A Compendium of Data on Global Change. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. Available at: http://cdiac.ornl.gov/trends/landuse/houghton/houghton.html.; U.S. Energy

East and North East Asia accounted for the greatest increase in GHG emissions among all ESCAP subregions, followed by South and South-West Asia. The largest rise occurred over the period 2000-2005. North and Central Asia's GHG emissions fell dramatically from 1990 to 1995, due in large part to the collapse of the Soviet Union, and only started to rise again during the period 2000-2005.

In 2005, GHG emissions from the energy sector represented 66.2% of Asia and the Pacific's total, with electricity and heat accounting for the largest share of energy emissions at 31.1%. Agriculture (13.6%) and land-use change and forestry (10.3%) were the next two largest non-energy emitting sectors. From 1990 to 2005, emissions from electricity and heat and manufacturing and construction grew the most. Sector shares of emissions varied across subregions, with land-use change and forestry in South East Asia, for example, accounting for 52.6%. This was largely owing to rapid deforestation and forest degradation in Indonesia— globally the third largest GHG emitter in 2005.

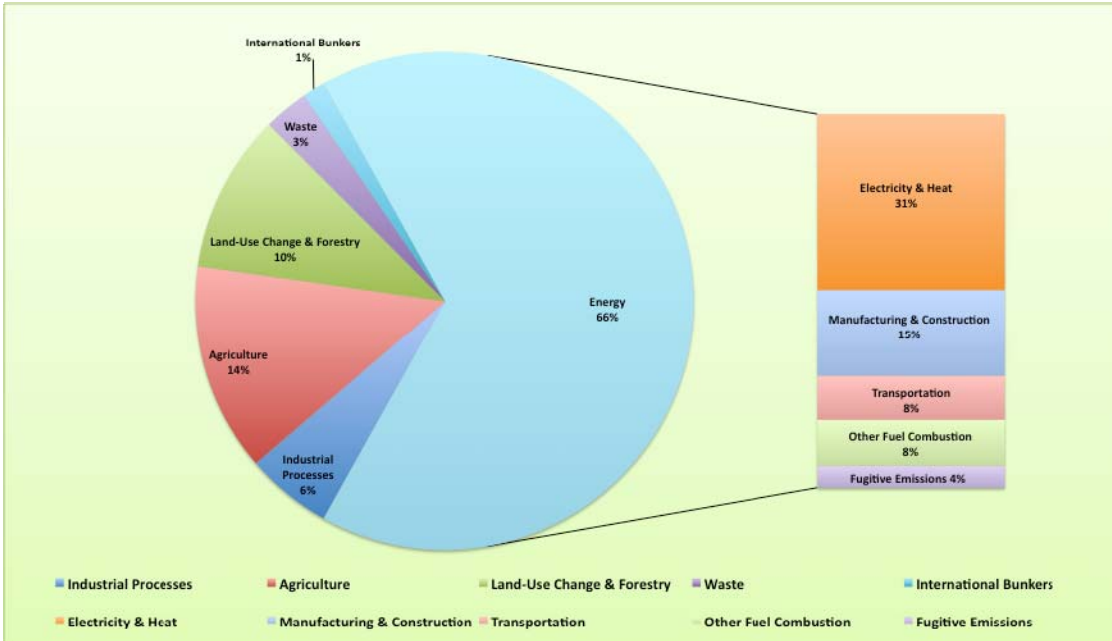
Figure 1: GHG Emissions by Region and Subregion from 1990 to 2005 (Unit: $MtCO_2e$)



Source: Data from Climate Analysis Indicators Tool (CAIT) Version 7.0. (Washington, DC: World Resources Institute, 2010).

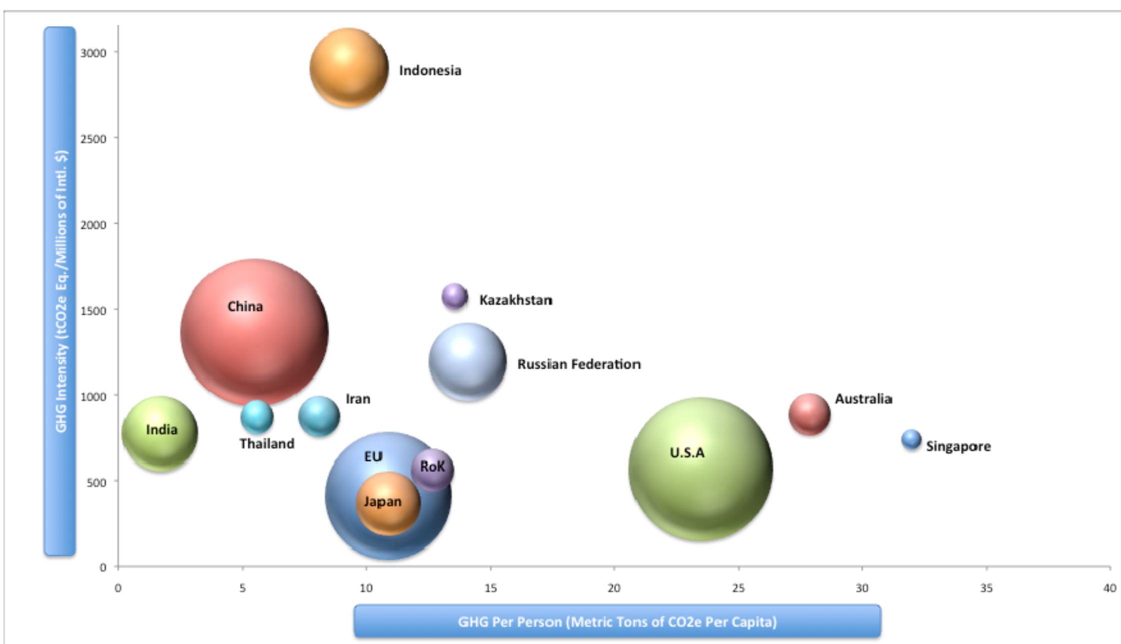
Information Administration (EIA). 2008. International Energy Annual 2006. Washington, DC: U.S. Department of Energy. Available online at: http://www.eia.doe.gov/iea/carbon.html.; U.S. Environmental Protection Agency (EPA). 2006 (revised). 'Global Anthropogenic Emissions of Non-CO2 Greenhouse Gases 1990-2020.' Washington, DC: U.S. Environmental Protection Agency. Available at: http://www.epa.gov/nonco2/econ-inv/international.html.

Figure 2: Share of GHG Emissions in Asia and the Pacific by Sector (2005)



Source: Data from CAIT Version 7.0. (Washington, DC: World Resources Institute, 2010)

Figure 3: GHG Absolute Emissions, Emissions per Person, and Intensity of Selected Countries and Regions (2005)



Source: CAIT Version 7.0. (Washington, DC: World Resources Institute, 2010)

Figure 3 above illustrates the GHG intensity (Y axis), GHG emissions per person (X axis) and absolute GHG emissions (size of bubble) for selected countries and regions. Ideally, countries should aim to move closer to the lower left-hand corner of the graph (indicating low GHG intensity and per capita emissions) and reduce the size of their bubble over time. Varying country and region performances are indicative of the wide spectrum of development trajectories available to developing countries. The U.S.A. and the EU maintain similar levels of human and technological development, however, the EU is more efficient (lower GHG intensity) and has a markedly lower GHG per capita emissions. China recently overtook the U.S.A. as the number one GHG emitter in the world, although its per capita emissions is comparatively mush lower. For a large, densely populated developing country, India is performing well with an emissions intensity of 767.5 and per capita emissions of only 1.7.[6] The EU, Republic of Korea (RoK) and Japan are all in the high-income bracket, have high levels of efficiency, and managed to keep GHG per capita significantly lower than the U.S.A, Australia and Singapore. The huge disparity that exists between Thailand and Indonesia— both middle-income South East Asian economies— is to some degree a product of Thailand's successful sustainable forest management practices, and a high level of tropical deforestation in Indonesia that is rapidly destroying one of the Earth's best carbon sinks.[7]

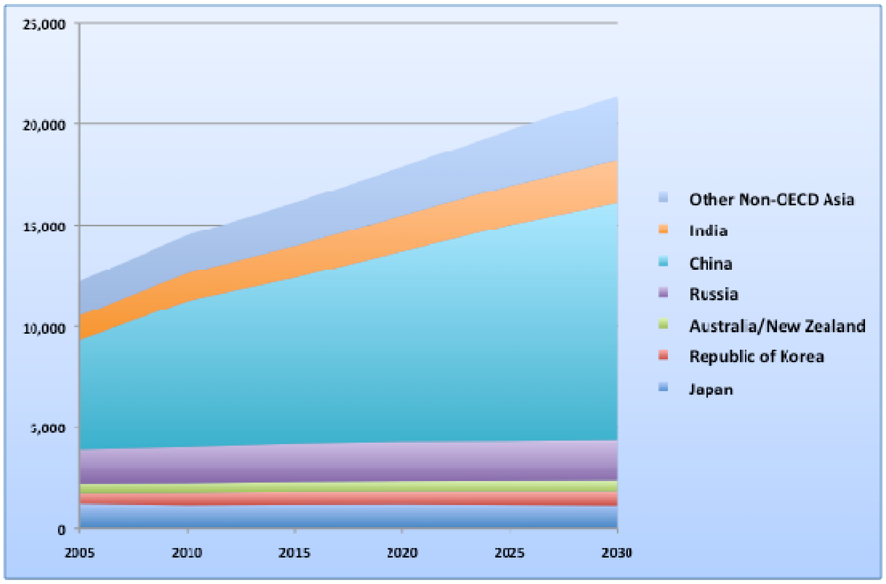
2.3 Forecasting Future Emission Scenarios

Accurately modeling future CO2 and other GHG emissions scenarios is extremely complex and difficult, and varies widely depending on assumptions of, inter alia, future population and economic growth, energy demand, as well as the carbon intensity of the energy supply. Nevertheless, it is critically important to undertake such an exercise in order for national level policy makers to have a reference point for designing and implementing policies that will assist in the global effort to successfully limit global GHG atmospheric concentrations to 450ppm. There currently exist numerous models mapping various emissions scenarios. Despite individual drawbacks, this paper draws on forecasts from the International Energy Agency (IEA), Energy Information Association (EIA), the World Bank and the Asian Development Bank (ADB), as appropriate and where data is available, to estimate future emissions of Asia and the Pacific and its subregions and member countries.

According to the IEA's World Energy Outlook 2009, if the world continues with existing policy measures (modeled in IEA WEO REF scenario), global energy-related CO2 emissions are expected to increase by 39.5% by 2030 compared to 2007 levels (2007: 28,826 Mt, 2030: 40,226 Mt), resulting in a global average temperature rise by as much as 6°C . Restricting global average temperature rise to 2°C (atmospheric concentration of 450ppm), the target set in the recent Copenhagen Accord, would require emissions to be reduced below 2007 levels by 2030. All of the forecasted growth in energy-related emissions to 2030 derives from non-OECD countries, with India and China alone accounting for 54.5%. Transferring to a low-carbon path of development is feasible, however, under the IEA's 450 scenario, such a shift would necessitate policy changes in non-OECD countries that produce major improvements in energy efficiency and deployment of renewables, biofuels, nuclear energy and carbon capture and storage (CCS) technologies (International Energy Agency 2009). Potential CO2 emissions savings from decreases in energy demand and adoption of various climate smart energy technologies for the UNESCAP member countries of Japan, China, India and the Russian Federation are listed in Annex II.

[6] This is a result of a more service-oriented economy (services account for over 60% of GDP), but still persistent high levels of poverty.
[7] Individual Asia-Pacific country GHG emissions data for 2005 is available in Annex I.

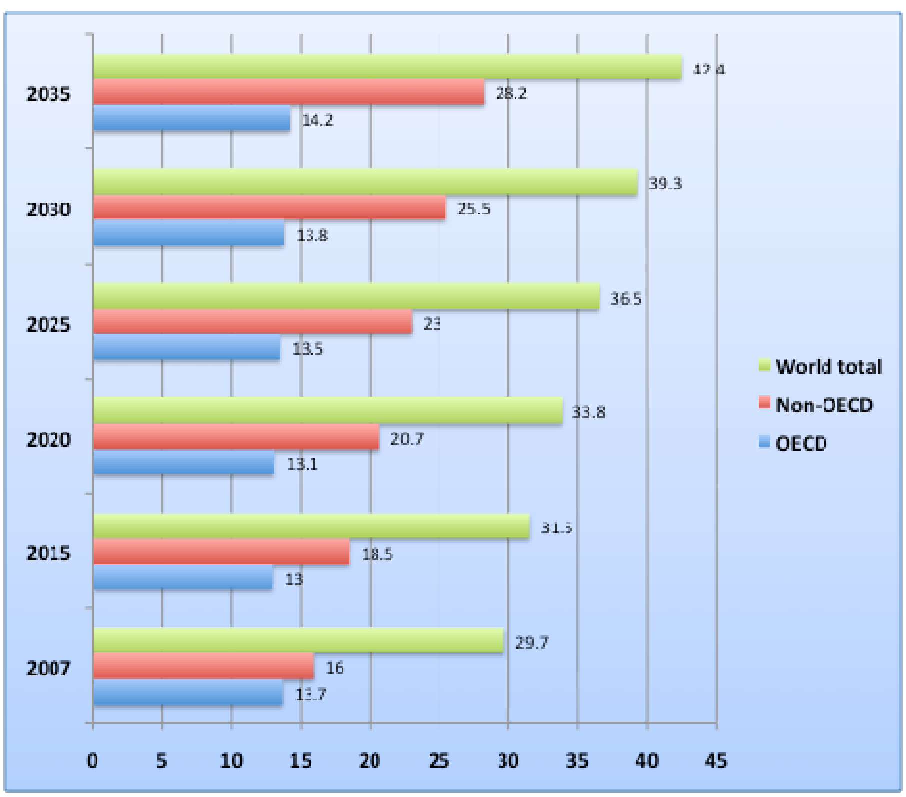
Figure 4: CO_2 Emissions Scenario for Asia (Unit: Millions of tones of CO_2), EIA Reference Case (2009)



Source: Energy Information Administration, International Energy Outlook, 2009.

A more recent report, the U.S. EIA's International Energy Outlook 2010, forecasts that World energy-related CO_2 emissions will grow by 42.7% from 2007 to 2035. It's share of growth from OECD and non-OECD is similar to that of the IEA 2009 estimates, with almost no growth in CO_2 emissions from OECD in 2030 (only 0.1 billion metric tones), but 9.5 billion metric tonnes from non-OECD, or 98.9% of total growth.

Figure 5: World Energy-Related CO_2 Emissions (Unit: Billions of metric tones)



Source: U.S. Energy Information Administration, International Energy Outlook, 2010 (forthcoming), http://www.eia.doe.gov/oiaf/ieo/index.html, accessed June 18, 2010.

2.4 A Consumption-based Approach: Assessing Emissions with Respect to Trade

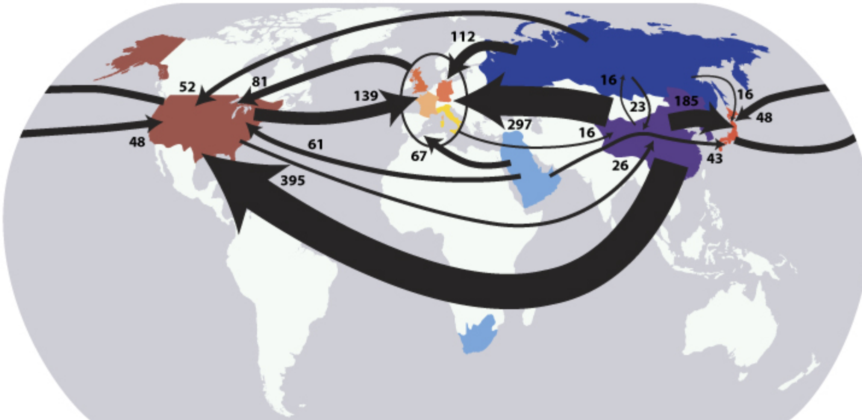
The rapid internationalization of production and services activities has severely complicated the task of divvying up responsibility for the build up of GHG emissions in the atmosphere. Traditionally, the methodology employed for inventorying GHG emissions followed a production-based approach, whereby responsibility for emissions was restricted to the geographical region in which they were produced. This is the methodology adopted within the Kyoto Protocol.

There are various inherent inadequacies and complexities surrounding this approach. For example, how should the responsibility for GHG emissions derived from international aviation and maritime transport (or, international bunker fuel emissions), which are both growing fast, be assigned? Should developing countries whose emissions were largely produced during the process of manufacturing exports to be consumed in other countries be left to fit the entire bill? These and other similar methodological obstacles were insufficiently addressed in the Kyoto Protocol.[8] However, the increasing potential for deployment of border carbon adjustments by developed countries taking on stringent climate action, coupled with proposals for future absolute emissions reduction commitments from developing countries such as China and India, has fueled the debate on integrating emissions embodied in trade (or virtual carbon) into global and regional climate policy. Operationalizing such a policy reform would first necessitate transitioning to a consumption-based accounting approach, whereby countries would also be held responsible for the virtual carbon they consume.

According to a recent study by Carnegie Institution scientists, in 2004, globally 26.9 gigatonnes of CO2 was emitted into the atmosphere. Of that amount, 6.2 gigatonnes, or 23%, was traded internationally. The majority of trade in emissions occurred in exports from developing countries (e.g. China) to mainly developed countries and markets (e.g. EU, U.S. and Japan) (Davis 2010, 5687). For a large number of Europeans, per capita consumption of imported CO2 emissions reached over 4 tons. The Americans weren't far behind with 2.5 tons per person. The two highest net importers in Asia and the Pacific were Japan and Hong Kong (China) with 284 and 64 million tones, respectively. European countries such as Sweden, the U.K., France, Switzerland and Sweden, imported over 30% of their consumption-based emissions. Major net-exporters in the region included China, Russian Federation, India, Malaysia, Thailand and Taiwan (China), among others. China topped the list, exporting almost one-fourth of its emissions abroad (Davis 2010).

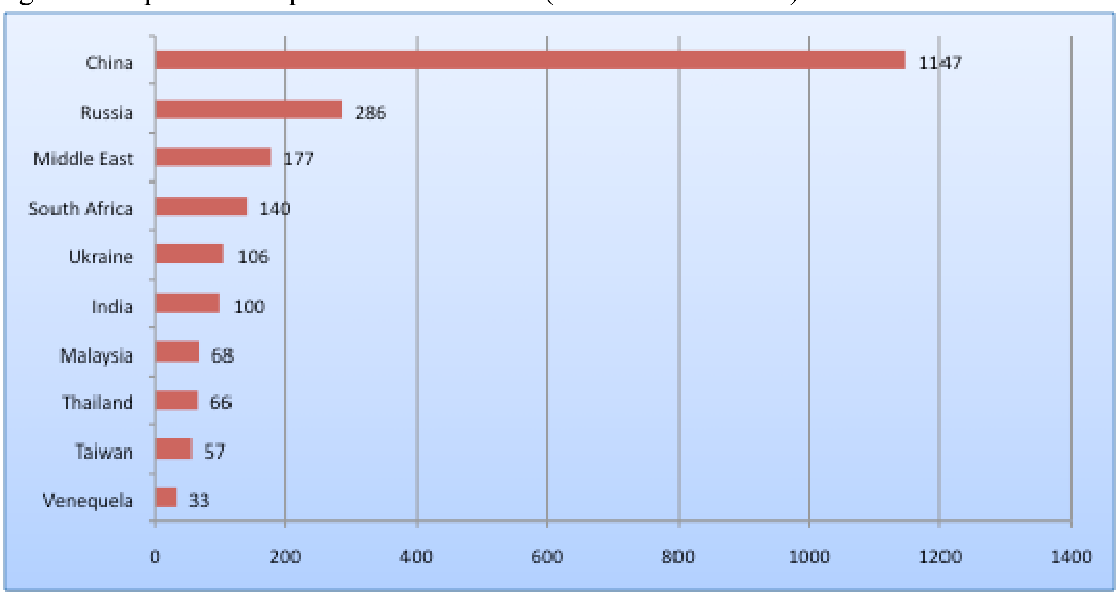
[8] For example, the UNFCCC reporting guidelines on annual GHG inventories requires signatory countries to calculate emissions derived from international bunkers, but Annex I Parties are not required to include these in national totals, which are subject to reduction commitments.

Figure 6: Largest Inter-Regional Fluxes of Emissions Embodied in Trade (Mt CO2 y−1)



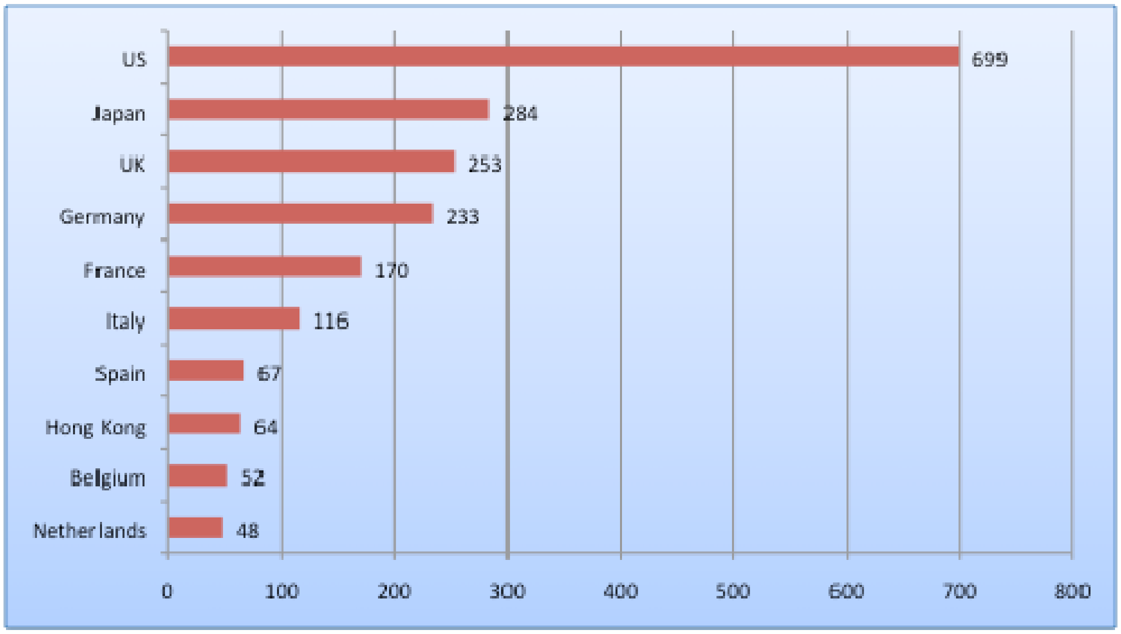
Source: Adapted from (Davis 2010, 5688)

Figure 7: Top 10 Net Exporters of Emissions (Unit: Mt CO2/Year)



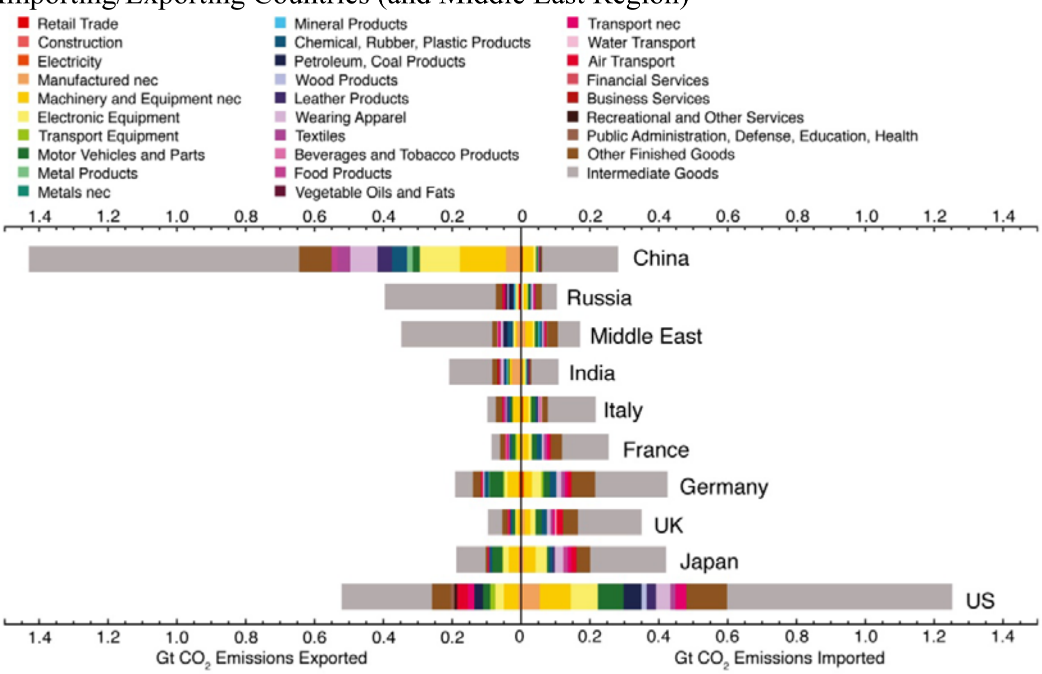
Source: Data and calculations from (Davis 2010, 5691)

Figure 8: Top 10 Net Importers of Emissions (Unit: Mt CO2/Year)



Source: Data and calculations from (Davis 2010, 5691)

Figure 9: Balance of CO2 Emissions Embodied in Imports and Exports of the Largest Net Importing/Exporting Countries (and Middle East Region)



Source: Adapted from (Davis 2010, 5689)

The disparity in the carbon intensity of trade was largely due to major developing countries use of carbon-intensive energy sources and low value of energy-intensive exports (high carbon-intensity of trade) and developed countries' cleaner supply of energy and higher value-added exports. Such dissimilarity existed between China and Japan in 2004. Japan's major imported emissions were from apparel, transport services, electronics, machinery, and chemicals. Conversely, apart from transport services, China supplied much of these products to the world with machinery, electronics, apparel and textiles accounting for a combined 368 million tones of net-exported virtual carbon dioxide (Davis 2010, 5688-5689).

As the previous data on the international trade of virtual carbon and recent climate negotiations have underscored, persuading developing countries to agree on legally binding future mitigation targets is neither fair nor easily attainable under the current production-based accounting system. Alternatively, adopting a consumption-based accounting system, which is better aligned to a polluter-pays-approach (and thus fairer), could offer an avenue for compromise in advancing a post-2012 framework for addressing climate change.

3. Investment in Climate-Smart Energy Technologies

3.1 The Energy Challenge

Globally, 1.6 billion people still lack access to energy (UN 2010). By 2030, primary energy demand in Asia and the Pacific is expected to grow by over 79% compared to 2005 if recent trends in energy development and use persist (ADB 2009).[9] This translates into an additional 7.7 trillion tons of CO2 emissions entering the atmosphere, and positions Asia and the Pacific markedly ahead of OECD in terms of aggregate emissions. Expanding access and supply to meet increasing future energy demand and support economic growth without compromising climate change mitigation efforts, thus, poses an enormous challenge to policy makers.

Primary energy mixes vary widely across the region. For example, a large percentage of China and Mongolia's energy needs are currently met with coal, whereas Indonesia, Viet Nam and Malaysia rely proportionately more on oil and gas. Many low-income countries, including Lao PDR, Cambodia, Papua New Guinea, the Pacific Island countries and Timor Leste's reliance on oil, particularly imports, is very high. This makes them exceedingly vulnerable to global oil price volatility and shocks.

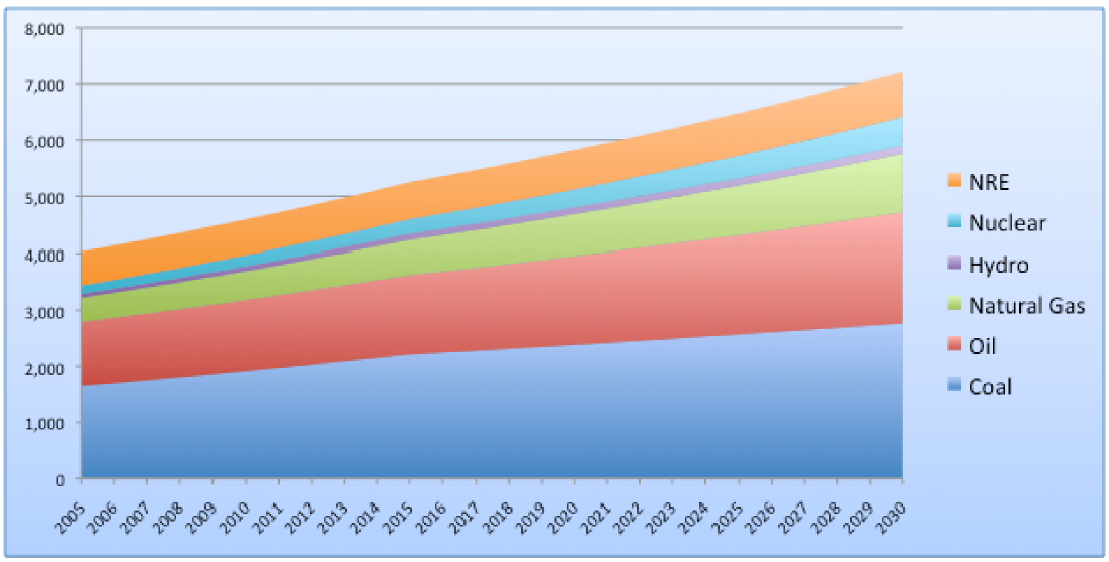
Since 2008, over half the world's population has been residing in urban areas. Urban areas currently account for an estimated 75% of global energy consumption and GHG emissions (UNEP 2009). In Asia, the trend is particularly worrying as urban populations are expected to grow by 50% from 2010 to 2030 (UN Populatation Division 2007). Instead of following smart growth guidelines (e.g. dense, diverse, pedestrian-oriented and green expansion), over the past few decades Asian cities have mostly been expanding through urban sprawl and meeting energy demand through supply-side management approaches. This unnecessarily exacerbates the burden on energy utilities by reducing the possibility for energy efficiency gains that can be achieved with district heating and shorter transmission distances and requiring the constant extension of energy infrastructure. As the extension of public

[9] The ADB's classification of countries by region and subregion varies slightly from that of ESCAP. Consequently some member countries are not included. In addition, some numbers do not reflect the entire amount due to unavailability of data. Subregional classifications are as follows: Central and West Asia: Afghanistan, Armenia, Azerbaijan, Georgia, Kazakhstan, the Kyrgyz Republic, Pakistan, Tajikistan, Turkmenistan, and Uzbekistan; East Asia: Hong Kong (China), the Republic of Korea, Mongolia, the People's Republic of China, and Taipei (China); The Pacific: the Cook Islands, Fiji Islands, Kiribati, Nauru, Palau, Papua New Guinea, Samoa, Solomon Islands, Timor-Leste, Tonga, and Vanuatu; South Asia: Bangladesh, Bhutan, India, the Maldives, Nepal, and Sri Lanka; Southeast Asia: Brunei Darussalam, Cambodia, Indonesia, the Lao People's Democratic Republic, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Viet Nam; Developed Group: Australia, Japan, and New Zealand.

transportation has lagged behind urban sprawl, commuters have been forced to use private vehicles, increasing the demand for petrol. This increased demand will have to be met in large part by imports.

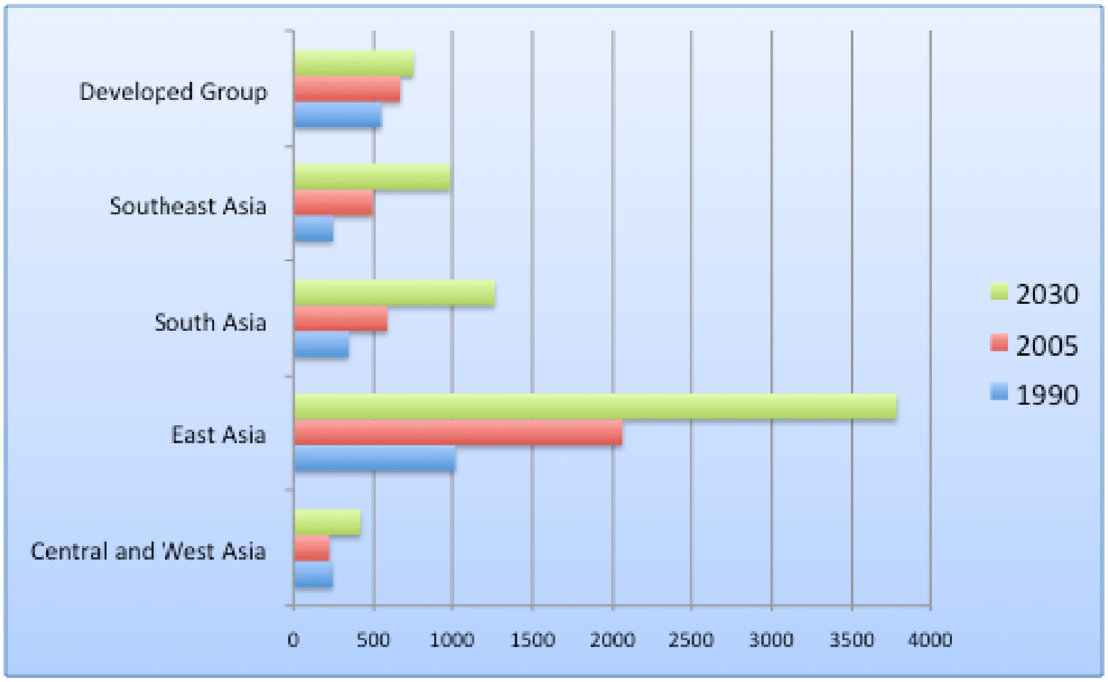
It is estimated that net imports of fossil fuels will have to double in order to meet rising energy demand in 2030. Net energy imports will continue to grow rapidly into 2030 in East, Southeast and South Asia, and decline in the Developed group, which comprises of Japan, Australia and New Zealand. East Asia's net imports are forecasted to grow annually by 4.2%, tripling by the year 2030 at 970.3 MTOE compared to the 2005 level. The Pacific is expected to become a net importer of oil, but a net exporter of gas. Central and West Asia's net exports of energy could grow substantially owing mainly to increased oil and gas production capacity in Azerbaijan, Kazakhstan, Turkmenistan, and Uzbekistan (ADB 2009, 12-13).

Figure 10: Primary Energy Demand in Asia and the Pacific 2005–2030 (Unit MTOE)



Source: (ADB 2009); Note: NRE refers to New and Renewable Energy

Figure 11: Primary energy demand by subregion (Unit MTOE)



Source: (ADB 2009); Note: The Pacific Region's primary energy demand was 1.7 (1990), 3 (2005) and 9 (2030).

The largest increase in primary energy demand will come by far from East Asia, whose growth is estimated to increase by over three fold in the next 20 years (ADB 2009). Under the World Bank's reference (REF) scenario for East Asia, Malaysia and Viet Nam, historically net energy exporters, are expected to become net importers (World Bank 2010). The Philippines and Thailand will meet 70% and 60% of their energy demands from imports in 2030. China is estimated to become the number one oil importer in the world, importing 75% of its demand (World Bank 2010). Against this background, success of global climate change action, thus, rests largely on the energy strategy undertaken by this subregion. As a recent World Bank report pointed out, it is "*within the reach of East Asia's governments to maintain economic growth, mitigate climate change, and improve energy security*" by transferring to a sustainable energy path (World Bank 2010). Realizing this goal will necessitate immediate actions on behalf of governments to implement policy and institutional reforms that promote markedly higher levels of energy efficiency and deployment of climate smart technologies. Delayed action could have profound adverse effects as continued investment in fossil fuel-based energy production has the potential to lock countries into carbon-intensive trajectories of development for decades (World Bank 2010). Against this background, rapidly scaling up investment in and the trade of climate smart technologies will be critical for success.

3.2 Investment in Climate Smart Energy Technologies

The IEA estimates that limiting global average temperature rise to 2°C (450 Scenario) would necessitate very sizable investments in various climate-smart energy technologies, including energy efficiency, renewables, biofuels, nuclear and carbon capture and storage. The global estimates for the periods 2010-2020 and 2021-2030 are $2.734 and $9.361 quadrillion, respectively. The two largest technologies for investment are efficiency (especially end-use), which accounts for 59%, and renewables, 24%, over the period 2021-2030.

Table 1: Required investment for IEA 450 Scenario for various climate smart technologies (Unit $2008 billions)

	2010-2020	2021-2030
Efficiency	1999	5586
End-use	1933	5551
Power plants	66	35
Renewables	527	2260
Biofuels	27	378
Nuclear	125	491
CCS	56	646
Total	2734	9361

Source: IEA, World Energy Outlook 2009, http://www.iea.org/country/graphs/weo_2009/fig9-2.jpg

The estimated required annual investment for achieving the World Bank's Sustainable Energy Development Path (SED) in East Asian middle-income countries is $120 billion: $85 billion for energy efficiency in the power, transport and industry sectors; and $35 billion for low carbon technologies (i.e. climate smart technologies), including $25 billion for renewables and $10 billion for nuclear (World Bank 2010, 9). Such investments could reduce environmental damage costs from US$ 127 billion (under the reference (REF) scenario) to US$ 66 billion (under the SED scenario) and drastically improve energy security by reducing reliance of foreign energy imports by US$ 1.106 trillion in 2030 (World Bank 2010, 6).

In addition to rapidly growing energy demand, GHG emissions and scarcity of fossil fuel resources, increasing financial and criminal liability of the fossil fuel industry for environmental degradation and GHG emissions is becoming a driving force in re-prioritizing investments towards cleaner and safer forms of energy production such as climate smart energy technologies. For example, in June 2010, investors jettisoned stocks of major fossil fuel industry players in the U.S. after the Attorney General announced that they were launching a criminal investigation into the still ongoing, oil gushing disaster caused by British Petroleum (BP) and Halliburton that is now considered the worst environmental disaster in U.S. history (Kraemer 2010). A forthcoming UNEP report notes that the largest 3,000 global enterprises could be liable for over 30% of their profits ($2.2 trillion) if required to reimburse the world for their damage to the climate stemming from carbon emissions (Morris 2010).

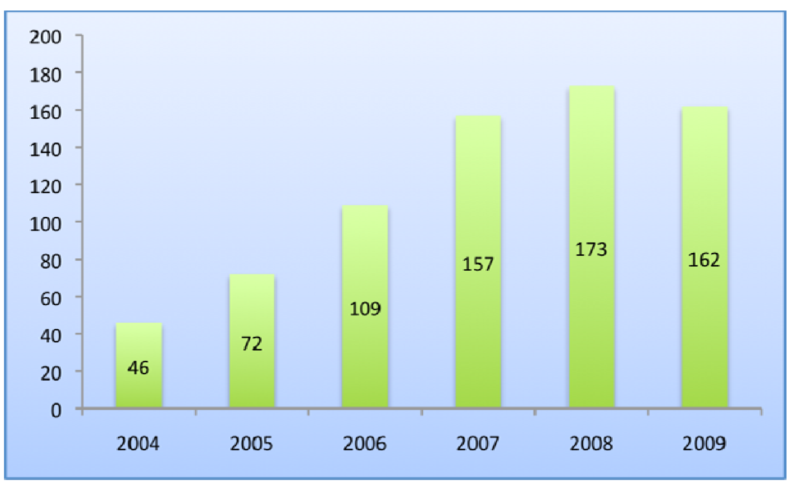
Globally, individual cases seeking financial compensation for damages incurred are on the rise, and expected to increase in frequency in the near future (Hays 2009). The Inupiat community of Kivalina, Alaska, for instance, filed a lawsuit against 19 U.S. utility and oil companies claiming that their emissions, in part, are the core cause for the melting ice that underpins the village. Costs for relocation are estimated to be $400 million. Such cases are not only limited to domestic legal action either. One of UNESCAP's most vulnerable members to sea level rise— the Federated States of Micronesia— officially filed a legal challenge in January 2010 to the government approved 25-year license to operate awarded to the Prunerov power plant in the Czech Republic, which emits over 11 million tons of carbon dioxide annually. Other countries adversely impacted by oceanic changes (e.g. acidification, death of coral reefs, sea-level rise) could also take legal action under the Convention on the Law of the Sea (Morris 2010). Cases related to the depletion of scarce natural resources that are forecasted to be impacted by climate change (e.g. water) are also becoming more frequent. In India, the State Government of Kerala held a Coca Cola subsidiary liable for US

$47 million for over-extracting scarce water resources and polluting the environment (Reuters 2010). Incorporating such future financial risks into investment decision-making greatly improves the attractiveness of companies producing climate smart goods, such as solar powered slow-drip irrigation systems, compared to oil and coal energy producers. The benefits of doing so are epitomized in the actions of Swiss RE, a major global insurer, which is already "*includ*(ing) *climate change-related litigation in its emerging risks framework in order to systematically monitor developments, quantify risks and define mitigation measures* (Hays 2009)." Investment figures from 2009 demonstrate that not only individual companies such as Swiss RE, but also the industry as a whole, are starting to shift a larger portion of its investments towards climate-smart technologies.

3.2.1 Climate Smart Portfolio Investment

Global overall portfolio investments in climate-smart energy reached $162 billion in 2009, an increase of 230% since 2005 (figure 2.1).[10] G-20 member countries represented over 90% of climate-smart energy investment and finance worldwide. Research and development (R&D) investments by public and private sectors totaled approximately $25 billion in G-20 countries. Even under the pressure of an economic downturn, climate-smart energy faired far better than oil and gas, with investments decreasing only by 6.6% compared to 19%, respectively, from 2008 levels. This decline is expected to reverse in 2010 with forecasts for global investment growth in climate-smart energy reaching as high as 25%, approximately US$200 billion. Consistent high levels of investments in the renewables sector have been driving capacity expansion, which rose to 250 GW in 2009, representing approximately 6% of the world total (The Pew Charitable Trusts 2010) and (International Energy Agency 2009).

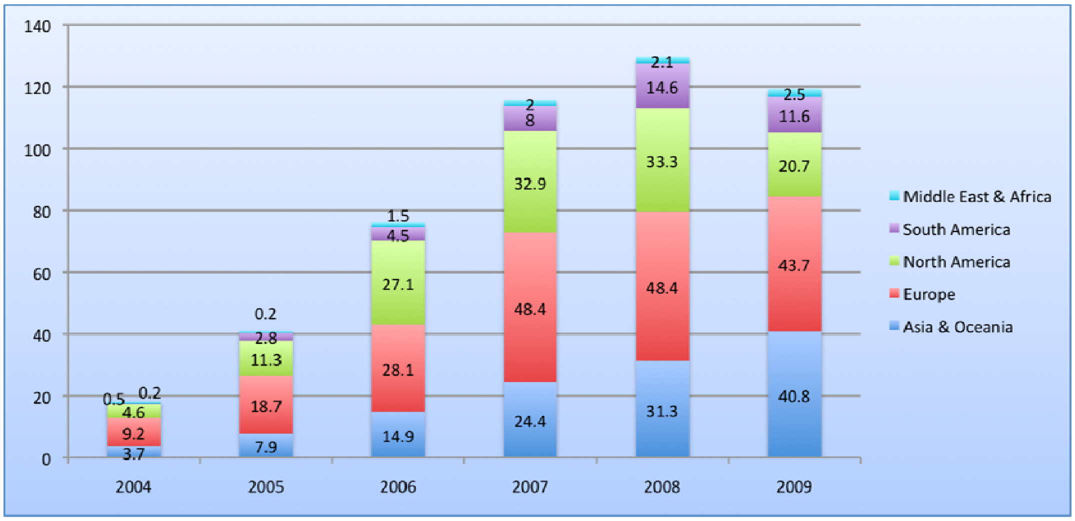
Figure 12: Global New Investment in Climate-smart Energy (Unit: Billions of US$)



Source: Bloomberg New Energy Finance, 2010

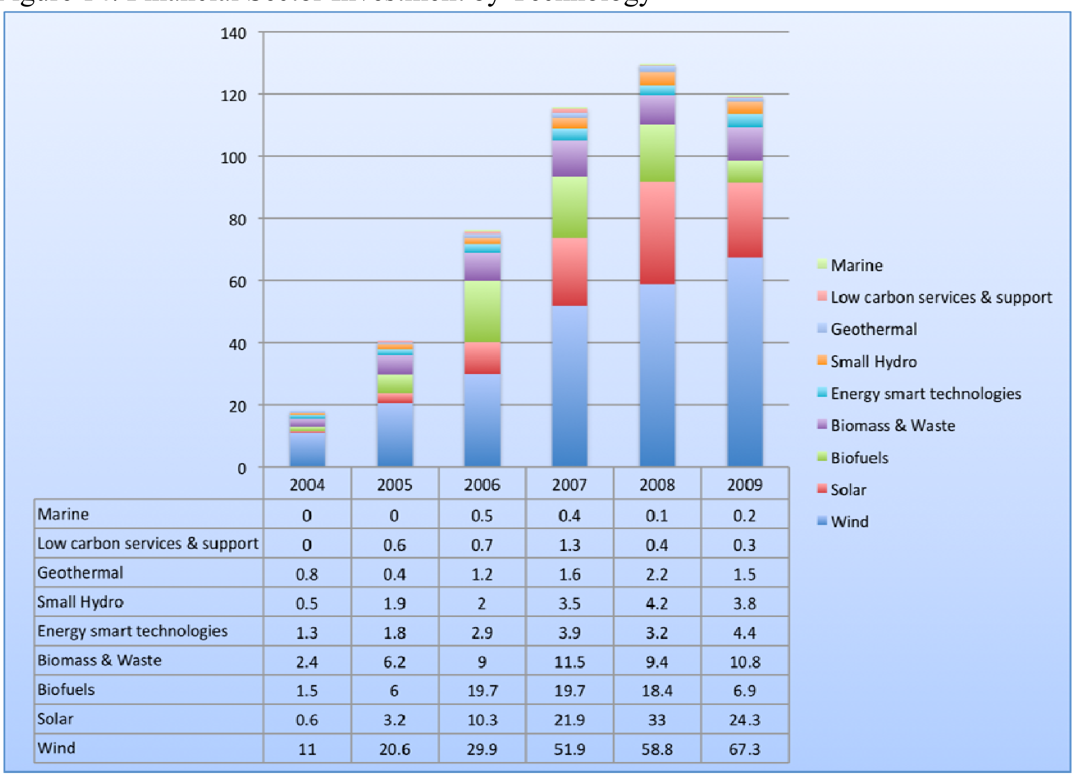
[10] Unless otherwise noted, data on investments is largely derived from Bloomberg New Energy Finance which was published in two primary sources: 1) Global Trends in Sustainable Energy Investment 2010: Analysis of Trends and Issues in the Financing of Renewable Energy and Energy Efficiency; and 2) The Pew Charitable Trusts, "Who's Winning the Clean Energy Race?: Growth, Competition and Opportunity in the World's Largest Economies," G-20 Clean Energy Factbook, The Pew Charitable Trusts (Washington D.C., 2010). Figures for G-20 countries do not include R&D investments (approximately 25 billion in 2009) or data for Russian Federation (ESCAP Member) and Saudi Arabia due to very small levels of investment. For more detailed information on the data sources and methodology employed, please see the appendix of the previously mentioned publication from The Pew Charitable Trusts.

Figure 13: Financial New Investment by Region, 2004-2009 (Unit: Billions of US$)



Source: Bloomberg New Energy Finance and UNEP SEFI
New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals

Figure 14: Financial Sector Investment by Technology



	2004	2005	2006	2007	2008	2009
Marine	0	0	0.5	0.4	0.1	0.2
Low carbon services & support	0	0.6	0.7	1.3	0.4	0.3
Geothermal	0.8	0.4	1.2	1.6	2.2	1.5
Small Hydro	0.5	1.9	2	3.5	4.2	3.8
Energy smart technologies	1.3	1.8	2.9	3.9	3.2	4.4
Biomass & Waste	2.4	6.2	9	11.5	9.4	10.8
Biofuels	1.5	6	19.7	19.7	18.4	6.9
Solar	0.6	3.2	10.3	21.9	33	24.3
Wind	11	20.6	29.9	51.9	58.8	67.3

Source: Global Trends in Sustainable Energy Investment 2010: Analysis of Trends and Issues in the Financing of Renewable Energy and Energy Efficiency, Bloomburg New Energy Finance, 2010, pg. 13

Asia faired much better than the Americas and Europe, with 37% growth in investment compared to drops of 33% and 16%, respectively. As illustrated in Table 2, numerous UNESCAP member countries performed in the G-20 Top Ten across multiple indices. In the category of *5-year Growth Installed Capacity*, UNESCAP members held 5 of the 10 spots.

The best performer overall was China, a developing member, who topped the list in *Investment* ($34.6 billion), placed second in *Energy Capacity* (52.5 GW) and *Growth in Installed Capacity* (79%), and third in *Five-Year Growth in Investment* (148%) and *Investment Intensity* (0.39%). Other top ten performers included Australia, India, Indonesia, Japan, the Republic of Korea (#1 in *5-year Growth Installed Capacity*), and Turkey (#1 in *5-year Growth in Investment*) (The Pew Charitable Trusts 2010).

Table 2: G-20 Top 10 Performers

Investment (Billions of US$)		Investment Intensity (%)		5-year Growth in Investment (%)		Renewables Capacity (GW)		5-year Growth Installed Capacity (%)	
China	**34.6**	Spain	0.74	**Turkey**	**178**	U.S.	53.4	**RoK**	**249**
U.S.A.	18.6	U.K.	0.51	Brazil	148	**China**	**52.5**	**China**	**79**
U.K.	11.2	**China**	**0.39**	**China**	**148**	Germany	36.2	**Australia**	**40**
RoEU-27	10.8	Brazil	0.37	U.K.	127	Spain	22.4	France	31
Spain	10.4	RoEU-27	0.26	Italy	111	**India**	**16.5**	**India**	**31**
Brazil	7.4	Canada	0.25	U.S.	103	**Japan**	**12.9**	U.K.	30
Germany	4.3	**Turkey**	**0.19**	France	98	RoEU-27	12.3	**Turkey**	**30**
Canada	3.3	Germany	0.15	**Indonesia**	**95**	Italy	9.8	U.S.	24
Italy	2.6	Italy	0.14	Mexico	92	France	9.4	Canada	18
India	**2.3**	Mexico	0.14	RoEU-27	87	Brazil	9.1	RoEU-27	17

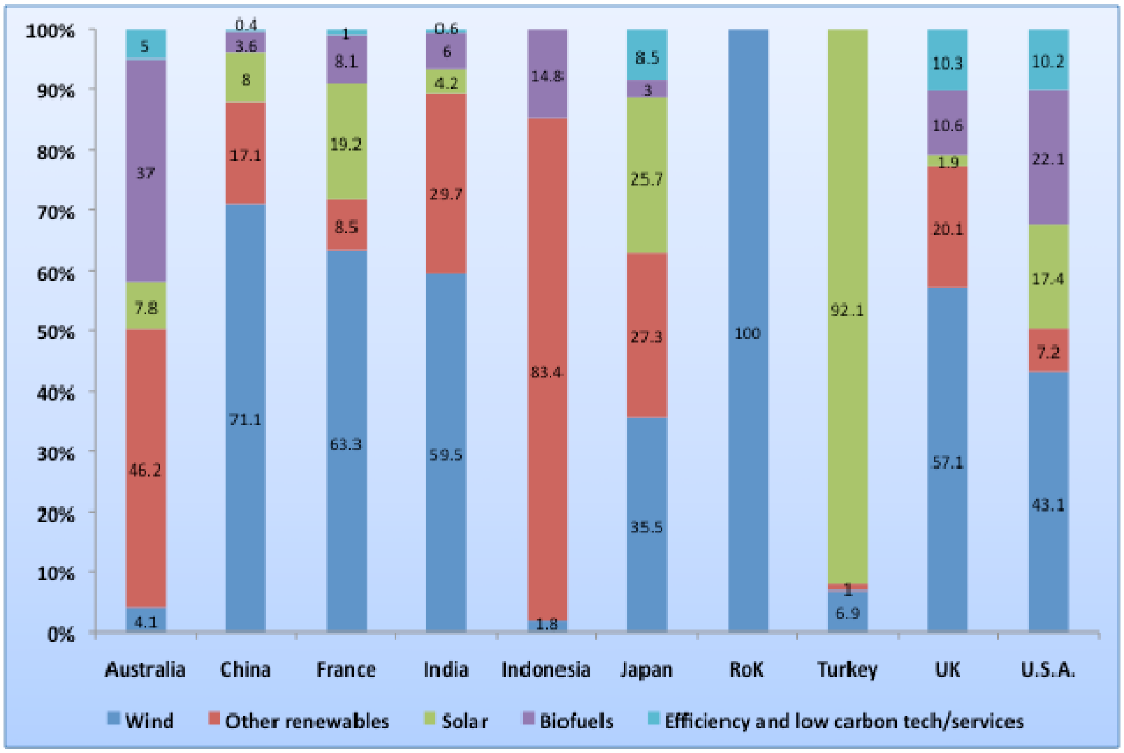
Source: Adapted from (The Pew Charitable Trusts 2010, 6-10)

Note: RoK refers to the Republic of Korea; RoEU-27 refers to the Rest of the European Union 27

Investments of other selected UNESCAP member countries not in the top ten were $1.6 (Turkey), $1 billion (Australia), $800 million (Japan), 354 million (Indonesia) and $20 million (Republic of Korea).

Among all climate smart energy technologies, wind and solar dominated the most in 2009. Attracting over 50% of global CSET investment and nearly half of installed capacity, Wind was the clear winner. However, with increasing technological advancements of market disruptive proportions and economies of scale, coupled with falling prices and an increasing number of solar feed-in tariff policies, the solar energy sector is poised for rapid growth. First generation biofuels witnessed a significant reduction in investment, however, second generation biofuels such as algae have been growing (The Pew Charitable Trusts 2010). This is probably due to the recent criticism that first generation biofuels such as ethanol drive food prices up and can, in some cases, be more carbon intensive than fossil fuels, in part from the land use change incurred from plantation expansion. Still yet, most investment in second generation tends to rely heavily on government spending.

Figure 15: Distribution of investment by sector in selected countries (as a percentage of total climate smart energy investment)

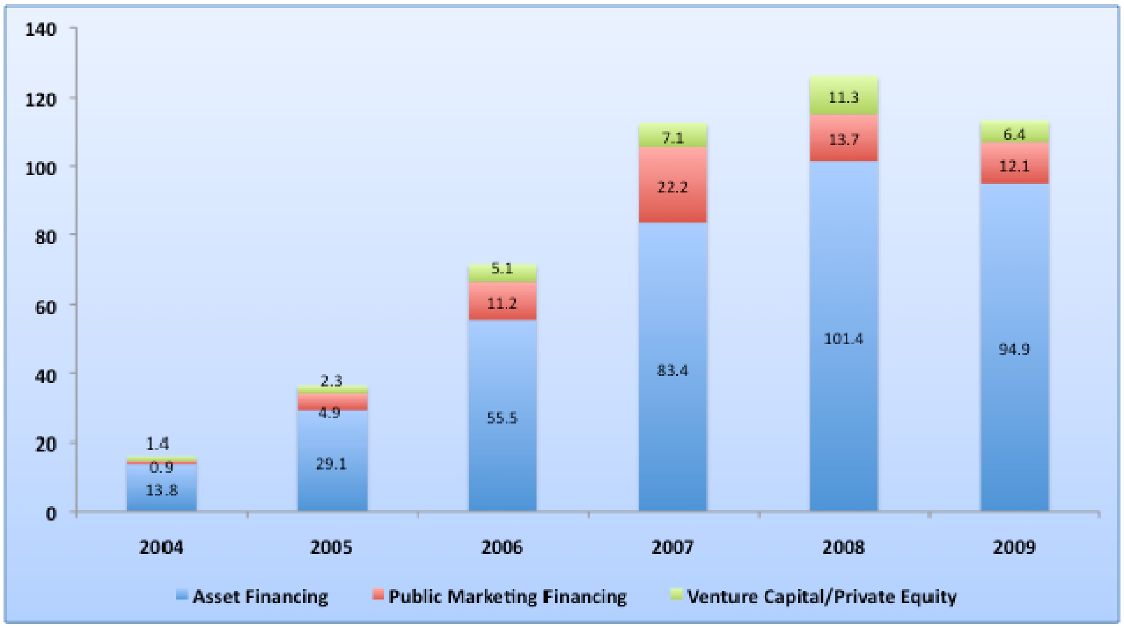


Source: Data from (The Pew Charitable Trusts 2010)

National distribution of investments over the period 2005-2009 by sector varied considerably between countries. Wind attracted the most investment (as a percentage of total investment in CSET) in China, France, India, Japan, RoK, U.K. and the U.S.A. Solar garnered the vast majority in Turkey (91%) and a substantial portion in Japan (25.7%). Australia, Indonesia and the U.S.A. invested in biofuels the most among surveyed member countries. The majority of Indonesia's investment in "other renewables" went to geothermal, in which it has an installed capacity of 880 MW. Investments in efficiency and low-carbon technology services were mainly only visible in developed countries: U.K. 10.3%, U.S.A. 10.2%, Japan 8.5%, Australia 5% and France 1%; India and China's investments were both below 1%.

Investments in global venture capital/private equity, public marketing financing and asset financing fell by 44%, 13% and 6%, respectively, in 2009 relative to 2008 levels. Asset financing— which mainly relates to adding/developing capacity— accounted for 83.4% of investments and declined the least in 2009. Onshore wind was the most attractive destination for asset financing, followed by biofuels, solar and other renewables, respectively. China topped the charts in terms of asset financing at $29.8 billon, or 86% of its total. In response to many firms postponing their initial public offerings (IPOs) in the hopes of more stabilized markets in the near future, public market financing only totaled 12.1 billion in 2009, a 45% decline from its 2007 all time high. However, late 2009 showed promise in at least the Chinese market with higher IPO activity. At 44%, venture capital/private equity financing fell the most in 2009 compared to its 2008 level of $11.3 billion. Venture capitalists withdrew from nascent firms and re-focused their investments on more prominent market players and sectors such as next generation biofuels (e.g. algae), smart grids and other budding energy efficiency technologies (The Pew Charitable Trusts 2010).

Figure 16: Trends in Investment by Category 2004-2009 (Unit: Billions of US$)



Source: Data collected from (The Pew Charitable Trusts 2010)

Robust CST investment figures throughout Asia and the Pacific during the recent economic downturn was largely a product of effective and targeted national level climate change policies. Facing growing fiscal deficits and unemployment, many UNESCAP member governments reduced financially and environmentally unsustainable subsidies to fossil fuels and redirected scarce revenue towards investments in cleaner, more job-intensive and cost-saving areas such as energy efficiency improvements and renewables development, among others. Such a fiscal reform that promotes environmental sustainability, climate change action, technological innovation, green job creation, poverty reduction and economic growth is often referred to in the literature as Green Tax and Budget Reform (GTBR).

3.2.2 Climate Smart Stimulus Packages

Many of these GTBR policies were ushered in under the umbrella of green stimulus packages. The UNEP's proposal for a global *Green New Deal* appealed for governments to invest $750 billion towards:

- Raising the energy efficiency of old and new buildings;
- Transitioning to renewable energies including wind, solar, geothermal and biomass;
- Increasing reliance on sustainable transport including hybrid vehicles, high speed rail and bus rapid transit systems;
- Bolstering the planet's ecological infrastructure, including freshwaters, forests, soils and coral reefs;
- Supporting sustainable agriculture, including organic production (UNEP n.d.).

According to (Strand and Toman 2010), 15% of the total $2.8 trillion allocated within stimulus packages went to green areas of investment. The Republic of Korea and China's stimulus packages ranked first and third (second in Asia), respectively, in the world in terms of percentage of "greenness." China took first place for having the largest green investments within their program estimated at over $221 billion, followed by the U.S. at $112.3 billion. Globally, a large majority of the investments were targeted at infrastructure such as rail, power grids (e.g. smart grids) and water and sanitation. In Asia and the Pacific, of the $1.153 trillion invested, $266.9 billion was considered "green." In line with global trends, the three largest destinations for investment in the region were also rail ($105.7 billion), grid ($70 billion, but only in China) and water and sanitation ($65.04 billion) (Strand and Toman 2010). The Republic of Korea, aiming to vamp-up its exports to meet the sustainable consumption demand of foreign markets, targeted stimulus funds at of a number of CSTs including, inter alia, solar photovoltaic (PV), hybrid cars and LED lighting products. By late 2009, roughly only $16.6 billion globally, or 9%, had actually been invested in green areas, with the Republic of Korea and the U.S. leading in terms of speed of implementation. Over 60% of the stimulus funds are projected to be spent between 2010 and 2011 (The Pew Charitable Trusts 2010).

Table 3: Summary of Direct Stimulus Programs and their "Green" Components in Selected Countries and Regions (As of March 2009)

Country	Total Stimulus (US$Bil)	Green Stimulus (US$Bil)	Green Stimulus (%)	Renewable	CCS/ Other	Building Efficiency	Low Carbon Vehicle	Rail	Grid	Water/ Waste
Australia	26.7	2.5	9.3	-	-	2.48	-	-	-	-
China	586.1	221.3	37.8	-	-	-	1.5	98.65	70	51.15
India	13.7	0	0	-	-	-	-	-	-	-
Japan	485.9	12.4	2.6	-	-	12.43	-	-	-	-
RoK	38.1	30.7	80.5	-	-	6.19	-	7.01	-	13.89
Thailand	3.3	0	0	-	-	-	1.8	-	-	-
A-P Total	1153.8	266.9	21.7 avg	0	0	21.1	3.3	105.7	70	65.04
EU	38.8	22.8	58.7	0.65	12.49	2.85	1.94	-	4.86	-
France	33.7	7.1	21.2	0.87	-	0.83	-	1.31	4.13	-
U.K.	30.4	2.1	6.9	-	-	0.29	1.38	0.41	-	-
U.S.A.	972	112.3	11.6	32.78	6.55	30.74	4.76	9.92	11.92	15.58

Source: Adapted from (Strand and Toman 2010)

3.2.3 Climate Smart Foreign Direct Investment

Global FDI flows constitute approximately 15% of fixed capital formulation. Transnational corporations have been playing a critical role in assisting developing countries achieve climate smart development. UNCTAD estimates that in 2009 alone, FDI by transnational corporations in climate smart energy, recycling and environmental technology manufacturing reached $90 billion. Among UNESCAP members, China, India and Turkey have been absorbing the greatest share of CSE crossborder M&A. Apart from losses during the recent financial crisis, greenfield investments in climate smart energy production have been growing since 2003, with China, India, Indonesia, Pakistan, Philippines, Turkey, and Viet Nam attracting the most in Asia and the Pacific. Japan's Kyocea and Sanyo Electric, as well as Singapore's Hyflux, were some of the top greenfield investors in environmental technologies manufacturing over the period 2003-2009. Green field investments in recycling have been much less, however, Singapore's Semb- corp and Taiwan's (province of China) Chuang Tieh have emerged as industry leaders (UNCTAD 2010).

3.3 Solar Energy

Advances in solar technology have rapidly increased over the past few years and the solar PV industry continues to be one of the fastest growing industries in the world. There are now a wide variety of products and technologies available to harness the power of the sun to generate renewable energy. Companies involved in the solar power industry typically include PV equipment producers, cell manufacturers, panel manufacturers, system installers and energy service companies. Over recent years the market for solar PV technologies has witnessed growth trends in three main areas; thin-film solar PV technologies, building-integrated PV (BIPV) and utility-scale solar PV power plants (defined as larger than 200 kW). By the end of 2008 there were 1,800 utility-scale solar PV power plants in the world with hundreds more under consideration or construction. Efficiency levels for solar PV cells also continue to improve, in fact researchers at the University of Minnesota in the U.S. have recently discovered an alternative process to make PV cells that use tiny nanoscale crystals called quantum dots. These crystals capture more of the available energy in sunlight increasing efficiency from the present rate of about 31% for conventional solar cells up to around 66%, making solar even more cost competitive in relation to fossil fuels (Casey 2010). Increased solar PV efficiency coupled with next generation flywheels that store energy mechanically as well as other energy storage devices could make solar power just as stable and reliable as oil, gas or coal. Concentrated solar power (CSP) systems have also seen tremendous growth in recent years because they are a lot cheaper than conventional solar PV systems. CSP uses mirrors to focus a large area of sunlight onto a small area, similar to a magnifying glass. Sunlight is then captured by PV panels or a transfer fluid, and then heated and used to generate electricity; systems such as these have a great potential in developing countries.

Global installed capacity for solar PV increased six fold from 2004-2008 to more than 16 GW (REN21 2009), and by year-end 2009, had reached 21 GW worldwide. With almost 10 GW of installed capacity, Germany remains the largest PV market in the world, largely as a consequence of their generous feed-in-tariff legislation. Germany is followed by Japan and the U.S.; these three countries represent nearly 89% of the total worldwide solar PV installed capacity. Global installed solar heating capacity reached an estimated 145 Gigawatts-thermal (GWth) in 2008 (REN21 2009).

Table 4: Portfolio Investment in Solar Energy in Selected Asia-Pacific Countries in 2009 US$

Country	Investment
China	2.77 billion
Turkey	1.47 billion
Japan	206 million
India	97 million
Australia	78 million

Source: Calculations by author, data from (The Pew Charitable Trusts 2010)

Both China and India have announced plans to increase their national capacity for solar power to 20 GW by 2020 (SEIA 2010), while Japan and Republic of Korea have also begun to invest in utility-scale plants. Japan has set ambitious targets for their solar PV capacity at 28 GW by 2020 and 53 GW by 2030 (EPIA 2010). Much of this growth in installed capacity has been attributed to the drop in price for solar technologies. For example, solar photovoltaic (PV) modules and systems experienced a significant decrease in price in 2009 for the second year running from $3.50-$4.00 per watt in mid 2008 to $1.85-$2.25 per watt in 2009, a drop of around 40% (SEIA 2010). In 2009, the top ten solar PV manufacturers globally were First Solar (U.S.A.), Suntech (China), Sharp (Japan), Q-Cells (Germany), Yingli (China), JA Solar (China), Kyocera (Japan), Trina Solar (China), SunPower (U.S.A.) and Gintech (Taiwan, Province of China)(Hirshman 2010).

3.4 Wind Energy

Wind power and turbine production has experienced stupendous growth over recent years and is now one of the most widespread forms of climate smart technologies. There are many different types and styles of wind turbines available on the market such as small-scale units (under 3 kW) used for direct use, pumping water or charging batteries; medium sized units (up to 50 kW) used in grid-intertie environments to generate power and to feed in to the utility grid and large-scale units (megawatts) generally suited to large scale utilities and power co-operatives and increasingly located at both on and offshore sites.

In 2009, there were 82 countries worldwide using wind energy with a total installed capacity of 159,213 MW (about 2% of global electricity demand), compounding the recent trend which has seen installed wind capacity double every three years (WWEA 2009). In the Asia and Pacific region, installed wind capacity reached 40 GW and accounted for 25.1% of the global capacity (WWEA 2009).[11] The combined turnover of the world wind energy market reached US$ 70 billion in 2009 and seemed to be unaffected by the global financial and economic crisis. At present the wind sector employs 550,000 people worldwide— more than double the figure in 2005— and this is expected to reach over 1 million jobs by 2012. These new green jobs are often high-skilled well-paid positions providing decent work to local people living in the vicinity of the wind farms.

According to estimates from the World Wind Energy Association (WWEA), wind power has the potential to generate 1,900,000 MW per year by 2020 if turbine development and deployment is accelerated and supported by improved government policies. In 2008, the top ten wind turbine manufacturers globally were Vestas (Denmark), GE Wind (USA), Gamesa (Spain), Enercon (Germany), Suzlon (India), Siemens (Denmark), Sinovel (China), Acciona (Spain), Goldwind (China) and Nordex (Germany). These companies produced 85% of global wind related manufacturing worldwide in 2009 (REN21 2009).

Table 5: Portfolio Investment in Wind Power in Selected Asia-Pacific countries in 2009 US$

Country	Investment
China	24.6 billion
India	1.37 billion
Japan	284 million
Turkey	110 million
Australia	41 million
Indonesia	6.4 million
RoK	2 million

Source: Calculation by author, data from (The Pew Charitable Trusts 2010)

In the Asia and Pacific region China leads the pack with around 20 GW of wind power capacity operational in 2009 becoming the world's biggest market for new turbines and the world's third largest wind energy provider (behind USA and Germany). This outstanding growth in capacity is a direct result of government policies aimed at developing a sustainable domestic energy supply to improve the country's energy security. This has been supported by new legislation which requires Chinese energy companies to purchase all the electricity produced by renewable sources coupled with the introduction of new feed-in-tariff legislation in 2009. There are around 15 main Chinese companies manufacturing wind turbines at present and dozens more making components, however, they have focused predominantly on

[11] This figure was based on data from countries available in the World Wind Energy Report.

supplying the Chinese domestic market. Developments are also underway in China to start producing the new maglev wind turbines which use magnetic levitation rather than traditional bearings in the turbine design, significantly increasing its efficiency in areas with low wind speeds. The second largest Asian market for wind turbines and related parts is India which saw a 14% increase in installed capacity in 2009, reaching 11 GW (WWEA 2009). Other major Asian players in the wind market were Japan (2 GW), Republic of Korea (364 MW) and Taiwan, Province of China (436 MW). There still exist major potentials across the Asia and Pacific region for other countries to develop their own wind energy capabilities predominantly in Iran, Pakistan, Philippines, Mongolia and Viet Nam.

3.5 Ocean Power

The use of both wave and tidal forces to create renewable energy has gained in popularity over recent years. As of writing the UK, Australia, New Zealand, Canada and United States are the primary countries conducting research in ways to harness the power of the oceans. Generating energy from water can be achieved by tapping the energy found in waves, tides, ocean currents, varying salinity gradients and varying thermal gradients. Wave energy devices are designed to capture the energy from the surface of the seas and are usually designated into five main categories; *buoys, surface followings, oscillating water columns, terminators* and *overtoppings*. Tidal energy devices are designed to harness the energy found in tidal stream flows and usually employ three main methods; cross-flow or vertical axis turbines, axial or horizontal axis turbines and reciprocating hydrofoils. It has been estimated that deriving renewable energy from the oceans has the potential to generate up to 200 GW by 2025 (Pike 2009). However, installed capacity still lacks well behind other renewable sources with only 4 MW to date worldwide, primarily as engineering prototypes (Bedard and others 2010). Many projects are still in the infancy stage and are solely funded by government research grants. In the Asia and Pacific region, Australia, Japan, New Zealand and Taiwan (Province of China) were the major governments undertaking research and development projects in wave and tidal power.

3.6 Geothermal

Geothermal energy production is derived by harnessing the natural heat generated by the earth's crust. There are three main types of geothermal power plants: *dry steam, flash steam* and *binary cycle*. Dry steam plants generate power by tapping underground sources of steam directly. Flash steam plants are the most common and utilize water spouted to the surface from underground reservoirs (geysers) - the steam is separated from the water and used to power a turbine, the condensed steam is then injected back into the reservoir, making the operation a sustainable resource. Binary cycle power plants use the heat from the hot water to boil a working fluid, usually an organic compound with a low boiling point. The working fluid is then vaporized in a heat exchanger and used to power a turbine (National Renewable Energy Laboratory n.d.).

In 2010, there was 10,715 MW of installed geothermal capacity worldwide with 70 countries either currently using geothermal power or having projects under development or active consideration (Holm and others 2010). This installed capacity is expected to almost double to 18,500 MW by 2015. According to the International Geothermal Association the countries in the Asia and Pacific region with the greatest increase in geothermal energy production since 2005 are Indonesia, New Zealand, Papua-New Guinea, the Philippines and Australia. The Philippines is now the second highest producer of geothermal power in the world with 1,904 MW of installed capacity. Indonesia's National Energy Blueprint is aiming for 9,500 MW to be generated from geothermal over the coming years, an 800% increase from the current level (Holm and others 2010).

The use of geothermal energy for district heating and direct use geothermal application is increasingly being supported by government policies under broader climate initiatives (e.g. feed-in-tariffs) in many countries, consequently making their financial viability more attractive to investors.

3.7 Clean Coal

The most common adjective used to describe the technology that reduces the environmental impacts (including GHG emissions) from the burning of coal is "*clean*". This description is slightly misleading, however. Even when applying clean coal technology, the product life cycle of coal is not entirely clean, nor safe. Coalmines often destroy mountaintops and pollute local aquifers, reducing scarce potable water supplies that are already being threatened by climate change. In recent years, despite improvements in safety technology and regulation, deaths from accidents in coalmines still remain high, with over 3,000 fatalities last year and hundreds of thousands suffering from pneumoconiosis in China alone (Branigan 2009) and (Xueli 2004). In light of the above, it is the view of the author that improving energy efficiency/conservation and increasing capacity in renewable energy production such as solar, wind, ocean and/or geothermal (depending on which is more appropriate for local geographic conditions and cost-effective) should be pursued over bringing online new coal power plants, even if they are equipped with clean coal technology. Nevertheless, according to the IEA, coal will still account for a significant portion of the energy supply in the coming years. Consequently, mandating the use of clean coal technology for current online coal power plants has the potential to significantly reduce the energy sector's carbon footprint.

Clean coal technologies are used to reduce the environmental impacts incurred by using coal to generate electricity. There are a range of techniques which can be used to minimize or even eliminate pollutants and GHG emissions from being released into the atmosphere. Techniques include using chemicals to wash the impurities from the coal, gasification, treating emissions with steam to remove sulfur dioxide, as well as more recent carbon capture and storage technologies, which work to stop GHGs from being released. Scrubbers attached to the flumes can also reduce emissions of sulphur dioxide. The U.S. is leading the research into clean coal technology by developing integrated gasification combined cycle (IGCC) plants which convert the coal into a gas and separate the carbon dioxide, which can then be captured and stored underground. The German government has actively supported the research and development of a number of clean coal projects, and in 2008, opened the world's first clean coal power plant in Spremberg, Germany.

There are a significant number of companies currently engaged in research on clean coal technologies including, for instance, Sino Clean Energy (China), Arch Coal (U.S.A.), Consol Energy (U.S.A.) and Foundation Coal Holdings (U.S.A.). Major corporations involved with building IGCC plants comprise of, inter alia, General Electric (U.S.A.), Bechtel (U.S.A.), Duke Energy (U.S.A.), Royal Dutch Shell (U.K.), Siemens (Germany), ConocoPhillips (U.S.A.) and Mitsubishi (Japan).

3.8 Biofuels

Biofuels are derived from organic materials such as plant and animal matter known as biomass, commonly referred to as first generation (1G) biofuels. Bioethanol and biodiesel are used in substitution of petrol and diesel, respectively. Bioethanol is a form of alcohol made from fermented sugar found in plants primarily from sugar beat, corn, wheat and starch crops (e.g. potatoes or fruit waste), but more recently also with trees and grasses. Biodiesel can be made from vegetable oils (e.g. sunflower seeds, palms, soy, rapeseed, jatropha), animal fats or recycled greases and is usually used as a diesel additive rather than a fuel in itself to reduce levels of particulates, carbon monoxide, and hydrocarbons generated by diesel-powered vehicles. Due to the controversies created by first generation biofuels, second generation (2G) fuels are gaining in popularity because they do not compete with existing food stocks. They are made of materials from waste biomass, such as the stalks of wheat, corn, wood, and special-energy-or-biomass crops like miscanthus. More recent research has focused on third generation (3G) biofuels made from oil derived from algae known as oilgae or green crude. Using Co_2 as a catalyst to grow algae using water and sunlight offers a viable alternative to simply capturing and storing the Co_2 underground. Producing fuel from algae offers great potentials as studies have shown algae produces up to 30 times more energy per acre than current land crops used for biofuels.

Table 6: Portfolio Investment in Biofuels in Selected Asia-Pacific Countries in 2009 US$

Country	Investment
China	1.25 billion
Australia	370 million
India	138 million
Indonesia	52 million
Japan	24 million

Source: Calculations by author, data from (The Pew Charitable Trusts 2010)

Bioethanol global production reached 67 billion liters a year in 2008 (REN21 2009). The U.S. remains the world leader in bioethanol production, producing 34 billion liters in 2008. Brazil, the second largest producer, attained a production capacity of 27 billion liters in the same year. The major countries in Asia also involved in bioethanol production include, China, India and Thailand.

Global growth rates in biodiesel production are also reaching record levels with an increase from 2 billion liters a year in 2004 to 12 billion liters in 2008. The EU is currently the world leader in biodiesel production accounting for about two thirds of the global capacity in 2008 at 16 billion liters a year with Germany, France, Italy and Spain being the top producers.

In the Asia and Pacific region, Indonesia and Malaysia are leading exporters of palm oil, which is used in the production of biodiesel. In 2009 Malaysia produced 17,564,937 tonnes of palm oil (MPOB 2010). From January to April 2010, Indonesian exports of palm oil to the EU were valued at $930 million, with a significant percentage imported for the purpose of producing biodiesel.

Companies leading the global growth in biofuel production include Royal Nedalco (Netherlands), Ecocern (Netherlands), Logen (Canada), Diversa/Celunol (U.S.A.), Abengoa (Spain) and the Broin & Dupont consortium (U.S.A.).

4. Liberalizing Trade in Climate-Smart Goods and Services

Illustrated in the previous chapters is the pressing urgency to increase access to, and deployment of, climate smart technologies to satisfy rapidly growing energy demands in an environmentally sustainable manner. Tariff and non-tariff barriers (NTBs) to the trade of climate smart goods and services pose significant obstacles to achieving such an end. Fast-tracking the liberalization of environmental goods and services that are "climate-smart" by eliminating tariff and NTBs could accelerate their diffusion and reduce the cost of climate change mitigation. Even though Paragraph 31(iii) of the Doha Ministerial Declaration called for the elimination or reduction of tariffs and NTBs to environmental goods and services— which was agreed to by all WTO members in 2001— nine years later an agreed-upon list or schedule for such liberalization has yet to crystallize. This speaks to the inherent complexities surrounding the negotiations.

Chapter Three continues in section 3.1 by briefly examining the history of WTO negotiations on liberalizing environmental goods and services (specifically climate-friendly goods), as well as the challenges that have thus far hindered a successful agreement. It focuses more on goods rather than services, and within the context of climate-smart goods, those that are more relevant for climate change mitigation than adaptation. The major reason for this emphasis is that adaptation can often best be achieved by employing low-tech goods and materials that already exist locally. In an effort to advance the negotiations, Section 3.3 proposes a new list of 64 climate smart goods for consideration and examines recent trade patterns of such goods both intra- and inter-regionally.

4.1 Background on a Global Agreement for Liberalization

The genesis of WTO work on liberalizing the trade of CSGS lies within the 1994 Ministerial Decision on Trade and Environment that established the WTO Committee on Trade and Environment, wherein issues relevant to expediting the trade of environmental and climate-friendly goods are still currently being debated. Issues pertaining to environmental services have been dealt with separately in the WTO Council for Trade in Services.

On 14 November 2001, the Doha WTO Ministerial Declaration was adopted. Under its Trade and Environment section, paragraph 31, an agreement was made to negotiate "*the reduction or, as appropriate, elimination of tariff and non-tariff barriers to environmental goods and services*" (WTO 2001). In September of 2002, the Non-agricultural Market Access Negotiating Group (NAMA), and then soon after, the Committee on Trade and Environment meeting in Special Session (CTESS), received two lists identifying specific environmental goods. The Organization for Economic Cooperation and Development (OECD) and the Asia Pacific Economic Cooperation (APEC) had developed these lists separately— although some coordination occurred between developers— for different purposes during the 1990s.

The OECD list was created by the OECD/Eurostat Informal Working Group and the Joint Working Party on Trade and Environment (JWPTE) in an effort to analytically identify the "*scope of the environmental industry*" (Steenblik 2005, 3). Work on the list was finished in 1998 and published in 1999 in the JWPTE working paper and the final report of the OECD/Eurostat Informal Working Group. The first agreed-upon definition of the environmental industry was:

> The environmental goods and services industry consists of activities which produce goods and services to measure, prevent, limit, minimise or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco-systems. This includes cleaner technologies, products and services that reduce environmental risk and minimise pollution and resource use.

Due to a lack of a consensus on a methodology for measuring the environmental contribution of cleaner technologies, products and services at the time, the list did not comprise of goods defined with regards to energy efficiency. It did, however, classify goods according to 6-digit Harmonization System (HS) trade nomenclature product codes, which could be used for developing an architecture for trade liberalization. There were three main groups: i) Pollution Management (air pollution control; wastewater management; solid waste management; remediation and cleanup; noise and vibration abatement; environmental monitoring, analysis and assessment); ii) Cleaner Technologies and Products (cleaner/resource efficient technologies and processes; cleaner/resource efficient products); and iii) Resources Management Group (indoor air pollution control; water supply; recycled materials; renewable energy plant; heat/energy savings and management; sustainable agriculture and fisheries; sustainable forestry; natural risk management; eco-tourism; other). In total, the OECD list contained 164 HS sub-headings, of which 132 of those were unique.

Utilizing a methodology similar to request-offer procedures conducted in international trade negotiations, the APEC list initially called for nominations for specific environmental goods that would eventually be entered into an agreed-upon classification system. The aim of this exercise was to achieve more favorable tariff treatment for the goods contained within the list. As such, the APEC list was inherently more politically palatable and relevant to trade liberalization than the OECD list. Despite its lack of political origins, the OECD list still probably provided a more comprehensive survey of the environmental industry and has often been used as a point of reference in the creation of more recent proposed lists.

Specifically citing the need to address climate change with references to UNFCCC and IEA findings, in January of 2003 the State of Qatar submitted a list for discussion within the WTO that contained natural gas fuel cell technologies, chemical gas to liquid fuels and gas turbines combined cycle power generation.

As an alternative to the list approach to liberalization, in June of 2005 India proposed a project-based method whereby projects would have to be reviewed and individually approved by a designated national authority (DNA) to ensure that they met specified criteria set by the WTO Committee on Trade and Environment. Later in the same year, Argentina put forth an integrated approach, which was similar in nature to the project-based approach, but also required the identification the goods to be utilized in each project.

In April of 2007, the *Friends of Environmental Goods and Services Group (FEGSG)*— which includes the Republic of Korea, the United States, Japan, European Union, Canada, New Zealand, Taipei (China), Norway and Switzerland— submitted a list of 153 environmental goods for examination in the WTO. This list included items relevant to climate change mitigation such as heat/energy management and renewable energy products. Within the same year, two members of the FEGSG (the U.S. and EU) proposed the elimination of tariffs for 43 products by 2013 that had been identified by the World Bank as climate-friendly (relevant to climate change mitigation) and had been derived from the previously submitted FEGSG 153 product list. The rational for such a list was that "*a narrower choice of climate-friendly products … would be* … (more)… *acceptable to a broader range of countries, rather than a broader range of goods that would be acceptable to only a few countries*" (World Bank 2008, 79). In line with the principle of *special and differential treatment*, under this proposal developing countries would be allowed longer phase-in periods, and least developed countries, the possibility to opt out. The list covered an extensive array of products that could contribute to climate change mitigation, for instance, towers for wind turbines, solar driven stoves and hydraulic turbines. Subsequent to this submission, the EU and the U.S. also advocated an Environmental Goods and Services Agreement, similar in framework to the Information Technology Agreement (ITA). It encompassed a large array of both climate change and non-climate change related goods and services.

As there has been little progress in fortifying an agreement in the Doha Round on liberalizing environmental or climate-friendly goods and services, various discussions on bilateral and/or multilateral proposals for liberalization have been gaining momentum, most notably between the U.S. and EU. If WTO negotiations are unable to surmount this stalemate, bilateral and multilateral liberalization may be the second best option. Nevertheless, the myriad of submissions at the WTO Special Session of the Committee on Trade and Environment from member countries such as Argentina, Brazil, Singapore and Qatar in early July 2010 speaks to the desire to salvage the Doha round and push forward with liberalization (ICTSD 2010).
Spearheading the thematic research on issues pertaining to liberalizing climate-friendly environmental goods and services has been the International Centre for Trade and Sustainable Development (ICTSD). Their work— in close coordination with the WTO, World Customs Organization (WCO) and UNFCCC— has sought to map technologies by HS code for specific climate relevant sectors, including renewable energy, buildings, and most recently transport. Regardless of the outcome of WTO negotiations, this work provides policy makers with a reference point for identifying CSG.[12]

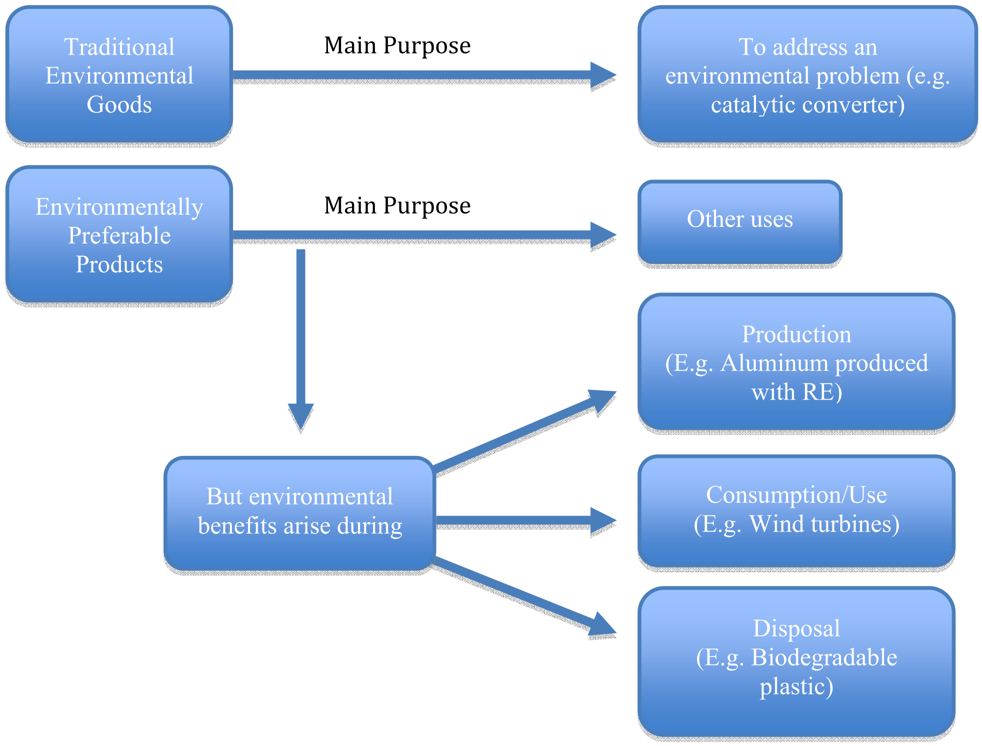
4.2 Challenges Impeding an Agreement for Liberalization

The two most salient complications for solidifying an agreement on liberalization have been identifying which goods and services to liberalize and how to go about it. Overcoming the former rests on achieving a consensus on how to define environmental goods, and more specifically, climate smart goods. Environmental goods are generally classified into two types: 1) traditional environmental or climate smart goods, which seek to address an environmental problem such as climate change (e.g. diesel particulate filters for reducing emissions of black carbon); and 2) environmentally preferable products (EPP) that have a relatively greater benefit to, or lower impact on, the environment over the product's life cycle (e.g. in its production, consumption or disposal) compared to a *like* or *substitute* good. Examples of EPPs include aluminum that was produced with renewable energy (benefit arises during the production stage), wind turbines that produce energy without emitting GHG (benefit arises during consumption/use stage) and biodegradable plastics that decompose quicker and in a less environmentally harmful manner (benefit arises during disposal stage). In these instances, aluminum produced with renewable energy would be preferred over aluminum produced with energy from fossil fuels, wind turbines would be preferred over turbines used in non-clean coal power production, and biodegradable plastics would be preferred over conventional plastics. Despite the obvious benefits of incentivizing the trade of EPPs over non-EPPs, WTO members have been hesitant to table such goods for liberalization based on their process and production methods (PPM). This is due to a number of factors. First, without internationally accepted standards for certification and labeling, how could a customs agent accurately identify the difference between steel that was produced using renewable energy from that which was produced with energy from fossil fuels? Second, as technology evolves, products that were traditionally considered to be relatively climate-friendly (e.g. natural gas compared to oil) may be later viewed as climate-

[12] For example, see Rene and Veena Jha Vossenaar, *Technology Mapping of the Renewable Energy, Buildings, and Transport Sectors: Policy Drivers and International Trade Aspects*, Environmental Goods and Services Series: Synthesis Paper, International Centre for Trade and Sustainable Development (ICTSD, 2010).

"un"friendly. This might be the case with natural gas that has a relatively much higher carbon footprint than newer, more technically advanced second and third generation biofuels such as oilgae.

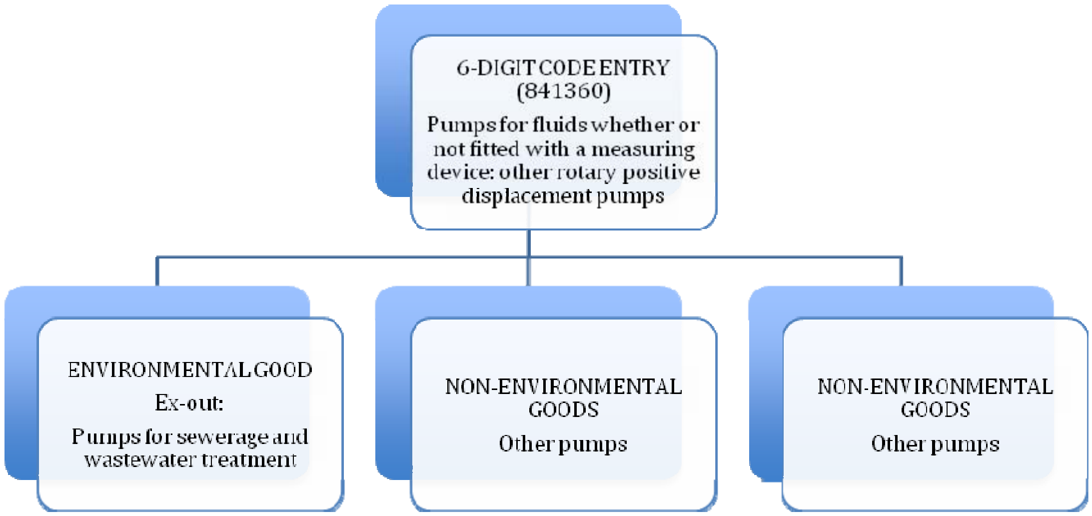
Figure 17: Traditional Environmental Goods vs Environmentally Preferable Products



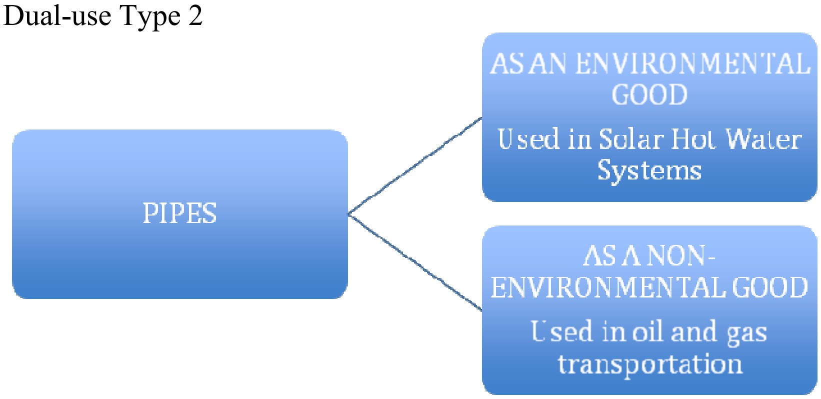
Source: Adapted from (Claro and others 2007)

In order for all WTO members to liberalize these goods, it is essential to have a common method for classification and identification. The approach adopted in previously submitted lists classifies goods according to a specific H.S code at the 6-digit level. Other countries may use up to ten digits; however, within the WTO, consistency between countries only applies as far as the 6-digit level. ASEAN member countries, for instance, have common HS codes up to the 8-digit level and are allowed to further disaggregate classifications individually up to the 10-digit level. With such a system, liberalization may be suitable for single-use goods such as fluorescent light bulbs (HS code 853931), however, it poses some difficulties in cases where there is potential for dual use. At the 6-digit level, sometimes environmental goods may be amalgamated together with non-environmental goods (dual use type 1). This is the case with HS 841360 (*pumps for fluids whether or not fitted with a measuring device: other rotary positive displacement pumps*), which contains *pumps for sewerage and wastewater treatment* (an environmental purpose), as well as *other pumps for non-environmental purposes*. This issue of dual use has been dealt with by submitting proposals for goods with "ex-outs".

Figure 18: Types of Dual-use Products
Dual-use: Type 1



Dual-use Type 2



Source: Adapted from (ICTSD 2009)

An additional dual-use problem is that some products, such as *pipes*, can be used for environmental purposes (e.g. in solar hot water systems) or for non-environmental purposes (e.g. to transport oil). This is illustrated as dual-use type 2 in the figure above. Against this background, efforts have been increasing within the WTO to identify single-use climate-friendly goods.

4.3 Trade of Climate-Smart Goods

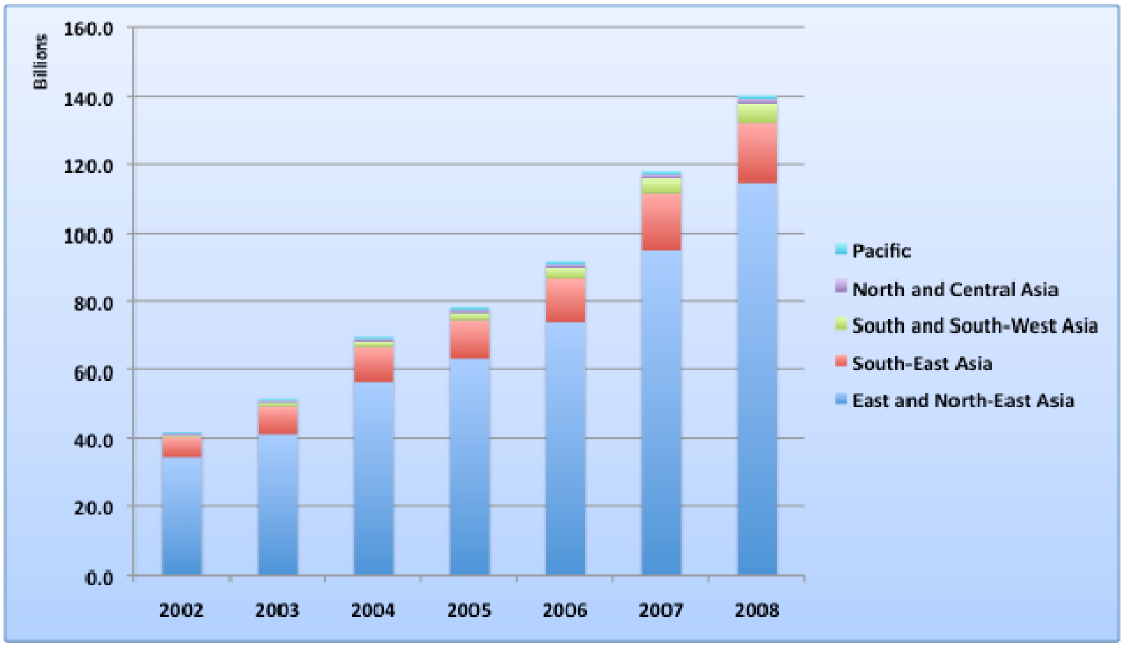
In an effort to resuscitate the negotiations on liberalizing the trade of climate-friendly environmental goods and services, a new list of climate smart goods is proposed for consideration. This list, from here on out referred to as the *UNESCAP list*, builds on the 43-product list amalgamated by the World Bank, which was tabled as only an initial starting point for discussions. The UNESCAP list proposes an additional 21 products that appeared on one of the recent ICTSD lists (Renewables and Buildings) and also on either the APEC, OECD or WTO list. In total, the list comprises of 64 climate smart goods classified by H.S. 2007 codes at the 6-digit level. Annex III provides a detailed description of each good and its corresponding HS code. Each code's appearance in previous lists is illustrated in Annex IV. These specific goods were seen as particularly relevant for the Asia and Pacific as 57 of the

64 HS codes are currently tabled for negotiations at APTA's fourth round of liberalization. The specific number various across countries and does not include recommendations from China, leaving room for additional goods to be added. Furthermore, APTA, China, Japan and nearly the Philippines already have a relative competitive advantage in the trade of these 64 climate smart goods.

The term "climate smart" was chosen over the previously used classification of "climate friendly" owing mainly to the fact that many goods/technologies contained within the UNESCAP list are not only "friendly" to the climate (i.e. assist in mitigation efforts by reducing GHG emissions), but also contribute to fostering "climate-smart" development by improving adaptive capacity such as by conserving water (e.g. HS 732490 water saving shower) or by improving access to energy. Based on data from UN Comtrade, the following briefly discusses recent trends in the trade of goods contained within the UNESCAP list both inter and intra-regionally. HS 2002 nomenclature is employed for time-series analysis between the years 2002 and 2008. In consideration that a number of the codes are "ex-outs" and the problem of dual-use still exists, it is important to note that there is potential for the estimation of the trade of actual climate smart goods to be overstated.

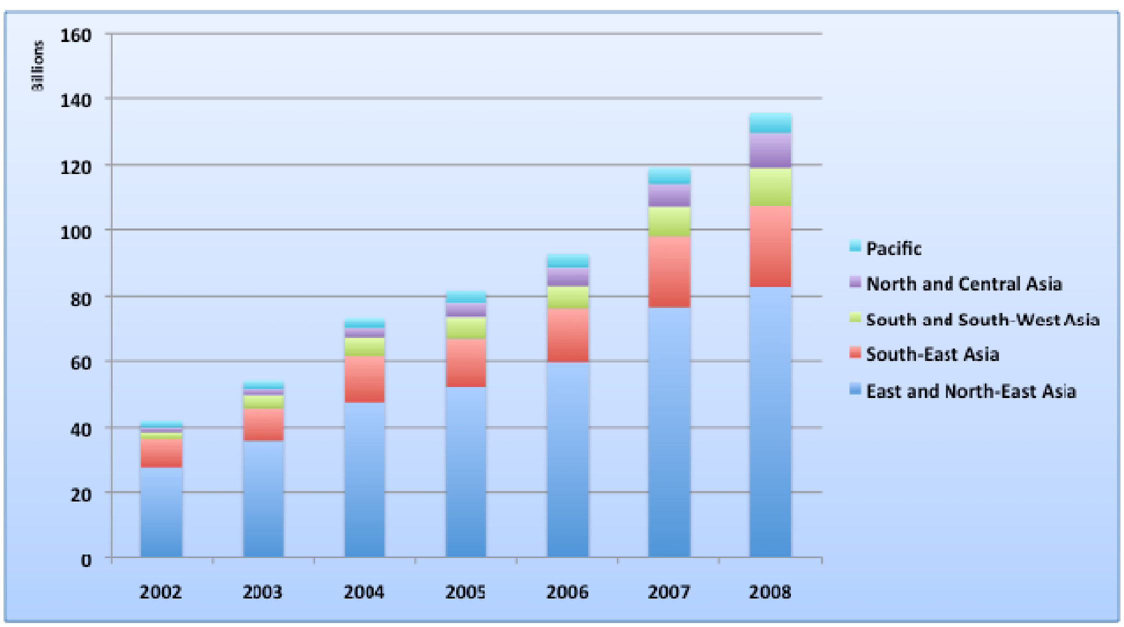
During the period 2002-2008, Asia and the Pacific's exports of climate smart goods increased from $41 to $140 billion, or 235%, growing on average by 22.5% per annum. This outpaced the growth of total Asia and the Pacific exports by 41%. Over the same period imports also witnessed significant growth of 222%, although slightly less than exports. Exports' consistent outperformance over imports has allowed UNESCAP to reposition itself as a net exporter of CSG. Total UNESCAP figures, however, are not fully representative of all subregional performances. While all subregions have experienced significant levels of growth in both imports and exports during the period 2002-2008, only East and North Asia has transferred from a net importer to a net exporter. The fact that this subregion's share of UNESCAP CSG exports is over 80% is telling of its influence over the region's total performance. All other subregions' imports of CSG have increased in greater proportion to their exports. It should be noted, however, that in terms of total trade of all goods, UNESCAP is also still a net exporter. South and Southwest Asia took, by far, the number one spot for total growth of exports from 2002 to 2008 at 1,211%. North and Central Asia had the lowest growth in exports, but the highest growth in imports at 626%. Despite the fact that many subregions' imports have been rising in greater proportion than exports, there is considerable potential for this trend to soon reverse. As numerous countries in the region continue to construct policy architectures more conducive to fostering climate smart development, their domestic capacity to supply the increased domestic demand for climate smart goods and services, and then foreign through exports, is likely to increase.

Figure 19: UNESCAP Total CSG Exports by Subregion 2002-2008



Source: WITS Database

Figure 20: UNESCAP Total CSG Imports by Subregion 2002-2008



Source: WITS Database

Asia and the Pacific's exports of CSG represented 2.4% of total exports and 2.6% of total imports, respectively, in 2008. UNESCAP member countries' CSG exports (as a % of their total exports) ranged from 0.00027% in Bhutan to 5.5% in Japan, just slightly lower than the global leader Denmark at 6.99%. For countries where data was available, only nine

UNESCAP members had higher than 2%. In terms of CSG imports (as a % of their total imports), the spectrum spanned from 0.93% in DPR Korea to 14.92% in Tajikistan.

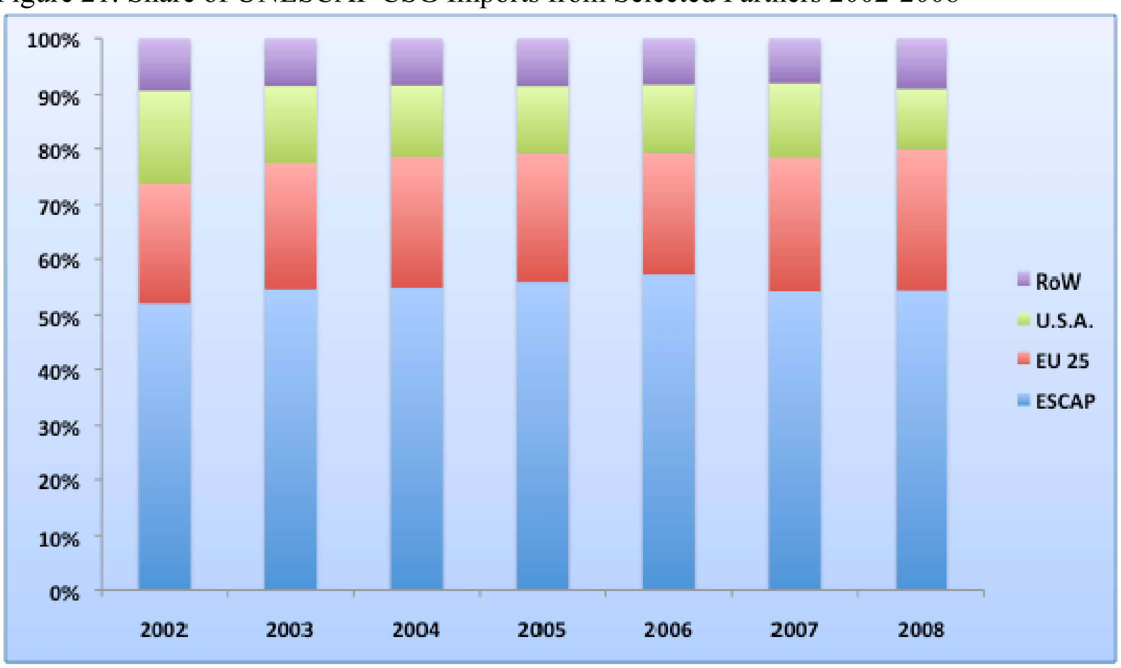
Table 7: Top 10 Traders of CSG in 2008 (Measured as a Percentage of UNESCAP CSG Exports or Imports)

Country	Exports	Country	Imports
China	36.1	China	30.0
Japan	30.9	Republic of Korea	13.2
Republic of Korea	7.4	Japan	10.2
Hong Kong, China	7.2	Hong Kong, China	7.5
Singapore	4.2	Russian Federation	5.7
Malaysia	3.1	Singapore	5.1
India	2.6	Thailand	4.3
Thailand	2.5	India	4.1
Turkey	1.4	Australia	3.8
Indonesia	1.2	Turkey	3.5

Source: WITS Database

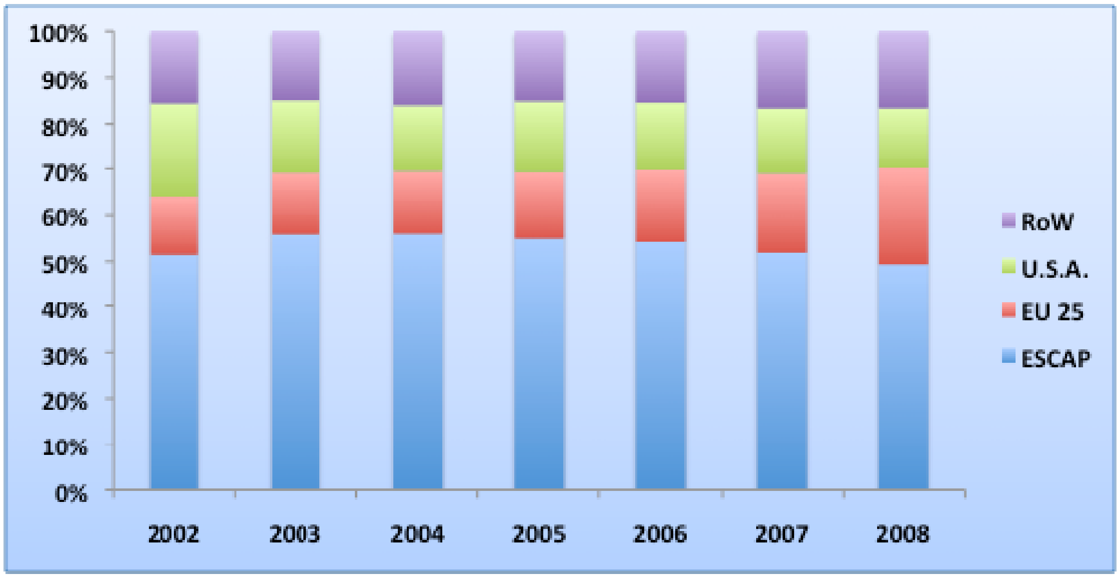
In 2008, China was the largest exporter and importer of CSG (as a % of UNESCAP CSG exports and imports) in Asia and the Pacific. Japan and the Republic of Korea took second place in exports and imports, respectively. Surprisingly, the top ten exporters of CSG accounted for 96.6% of all UNESCAP CSG exports, with China and Japan alone representing 67%. Imports of the top ten members represented 87.4% of total imports.

Figure 21: Share of UNESCAP CSG Imports from Selected Partners 2002-2008



Source: WITS Database

Figure 22: Share of UNESCAP CSG Exports to Selected Partners 2002-2008



Source: WITS Database

UNESCAP's share of intra-regional trade of CSG (as a % of total CSG trade) in 2008 has demonstrated little change from its 2002 figure. Inter-regional trade of CSG (as a % of total CSG trade), however, has changed markedly. Since 2002, UNESCAP's trade with the EU 25 has been steadily increasing, while in parallel, decreasing with the U.S.A. This is probably a result of EU countries rapidly adopting climate smart development policies such as Feed-in tariffs, while the U.S.A. has still failed to pass a climate change bill or put a price on carbon.

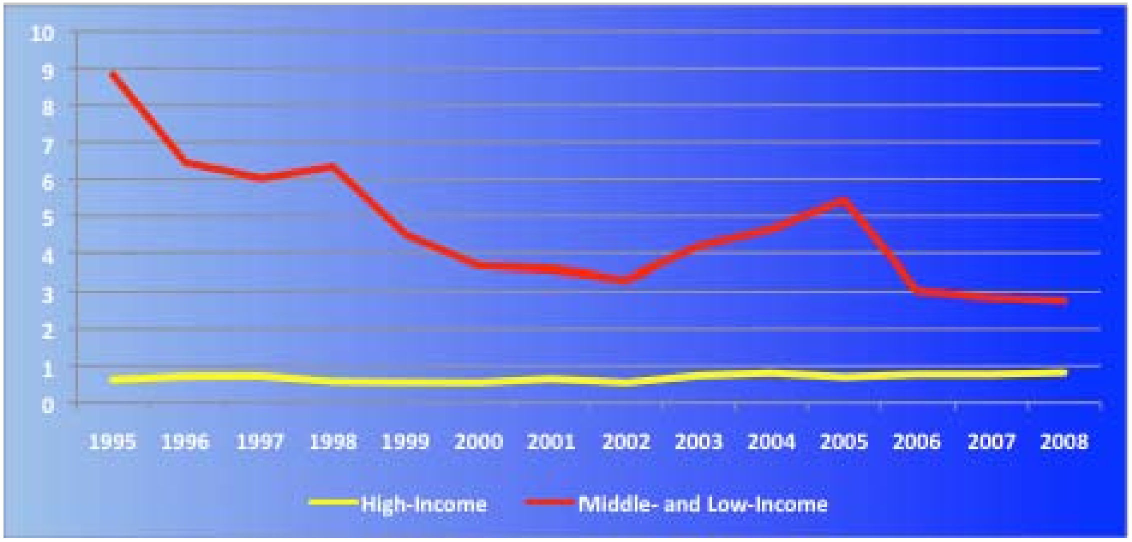
5. Trade in Selected Climate Smart Energy Technologies

Following an approach utilized in (World Bank 2008), the subsequent sections attempt to briefly analyze the trade of four climate smart energy technologies. The Harmonized Commodity Description and Coding System (HS), developed by the World Customs Organization, is commonly used to follow and analyze trade. This section uses HS nomenclature 1992 Codes at the 6-digit level for comparison between countries and income groups. The Goods contained within each classification consist of components critical for the installation or adoption of climate smart technologies. The 1992 nomenclature is utilized in order to track the change in trading patterns from as early back as 1995. As the classification of goods at the 6-digit level may include some non-climate smart energy technologies as well (especially in the section on clean coal), it should be noted that there is potential for over estimation. While a comparison at a more disaggregated level, for instance, at an 8 or 10-digit level, would be better for isolating specific technologies, it is not feasible as codes are only aligned, and thus comparable, globally at the 6-digit level.

5.1 Wind Power Technology

The HS codes employed in this section to measure and analyze the trade in wind energy include: HS 848340, HS 848360 and HS 850230.

Figure 23: Wind Power Generation Import-Export Ratio in UNESCAP High-Income versus Low- and Middle-Income Economies[13]



Source: WITS Database

In 1995, there was a major disparity between high and middle/low-income countries in terms of trading patterns. As illustrated through import-export ratios, high-income countries were net exporters of wind power (indicated by a ratio of less than 1), and conversely, middle and low-income countries were by far net importers (ratio of almost 9). Over the past 13 years, their roles have remained the same, however, now to a much lesser degree. There is clear convergence between the two sets of countries; nevertheless, middle and low-income countries still remain net importers of wind power generation, illustrated by an import-export ratio of 2.9 in 2008.

Even though China ranks number 2 in exports (see table 4.1), most of China's production of wind turbines has supplied the domestic market. However, as China's manufacturers recently entered the top ranks of global wind producers, and as the global wind market continues to expand rapidly, China's producers may choose to soon export their products abroad. These products may not need to go as far as Europe either, other Asia-Pacific markets such as India— whose installed capacity was the 4th largest in the world in 2009— are growing rapidly.

Table 8: Top 10 UNESCAP Trading Countries in the Wind Energy in 2008

Rank	Importers	Exporters
1	China	Japan
2	Russian Federation	China
3	RoK	India
4	Turkey	RoK
5	Australia	Singapore
6	Japan	Vietnam
7	Viet Nam	Turkey

[13] The classification by income group follows the definition of the World Bank: Economies are divided according to 2007 GNI per capita, calculated using the World Bank Atlas method. The groups are: low-income: $935 or less; middle-income: $936 - $11,455; and high-income: $11,456 or more.

8	Thailand	Russian Federation
9	India	Hong Kong, China
10	Indonesia	Australia

Source: WITS Database

With the exception of India and Turkey, all top 10 trading countries of wind energy technologies resided in East Asia. Surprisingly, Australia— one of the few Asia-Pacific OECD members— only scored tenth on the list of top ten exporters. This may be due in part to its relatively high import tariff: almost double its industry average, and 12% higher than the sector average. Japan, traditionally a top leader in the region in the exportation of environmental and climate-friendly technologies, maintained first place. This, however, might not remain the case in the near future. The next three contenders— China, India and RoK— have been moving up the charts rapidly, largely owing to favorable domestic investment climates and progressive policies such as feed-in tariffs and reduced import tariffs for wind energy technology. These three member countries are continually fine tuning both market and regulatory incentives to further stimulate development of and trade in wind energy.

Table 9: Average Applied Tariffs on Wind Technology in Top 20 UNESCAP GHG Emitting Countries

Rank	Country	Tariff	Industrial Goods Average	Year
1	China	7.65	8.57	2008
2	Indonesia	4.81	5.84	2007
3	Russian Fed.	4.14	8.19	2008
4	India	7.28	9.74	2008
5	Japan	0.00	2.61	2008
6	RoK	5.50	8.29	2007
7	Australia	6.88	3.93	2008
8	Iran	5.78	24.78	2008
9	Turkey	0.47	2.41	2008
10	Thailand	6.59	10.97	2006
11	Malaysia	4.39	5.91	2007
12	Myanmar	1.00	4.12	2007
13	Pakistan	31.80	14.04	2008
14	Philippines	0.84	5.00	2007
15	Kazakhstan	4.60	3.91	2008
16	Viet Nam	11.80	11.68	2007
17	Bangladesh	5.00	14.52	2007
18	Singapore	0.00	0.00	2008
19	Cambodia*	12.65	12.45	2007
20	Turkmenistan	0.00	5.43	2002
	Mean	**6.06**	**8.12**	

Note: Ranking of countries by GHG emissions is based on 2005 data from Climate Analysis Indicators Tool (CAIT) Version 7.0. (Washington, DC: World Resources Institute, 2010)
* Cambodia and Turkmenistan are actually ranked 20th and 21st, respectively, with North Korea taking 19th place. However due the lack of tariff data for North Korea, Cambodia and Turkmenistan were both moved up a rank.
Source: WITS

Examined at the HS code 6-digit level, India's applied average tariff is 7.28 for the wind technologies examined in this section. While this tariff is lower than India's industrial goods average of 9.74, indicating a positive incentive for wind technology, it doesn't quite tell the whole story. Like many other countries, India further disaggregates its classification of imports and their applied custom duties. In the case of wind energy equipment, it offers even lower duties for many goods, as low as 5% in most instances (see Table 4.3 below).

Table 10: Customs duty for wind energy equipment and components in India, 2009

Description of Goods	Rate (%)
(1) Wind operated electricity generators up to 30 kW and wind operated battery chargers up to 30 kW	5
(2) Parts of wind operated electricity generators for manufacturer/maintenance of wind operated electricity generators, namely:	
a) Special bearing	5
b) Gear Box	5
c) Yaw components	5
d) Wind turbine controllers	5
e) Parts of the goods specified at (a) to (d) above	5
(3) Blades for rotor of wind operated electricity generators for the manufacturer or the maintenance of wind operated electricity generators	5
(4) Parts for the manufactur or the maintenance of blades for rotor of wind operated electricity generators	5
(5) Raw materials for manufacture of blades for rotor of wind operated electricity generators	5
(6) Permanent Magnets for manufacture of PM Synchronous Generators above 500 kW for use in wind operated Electricity Generators	5

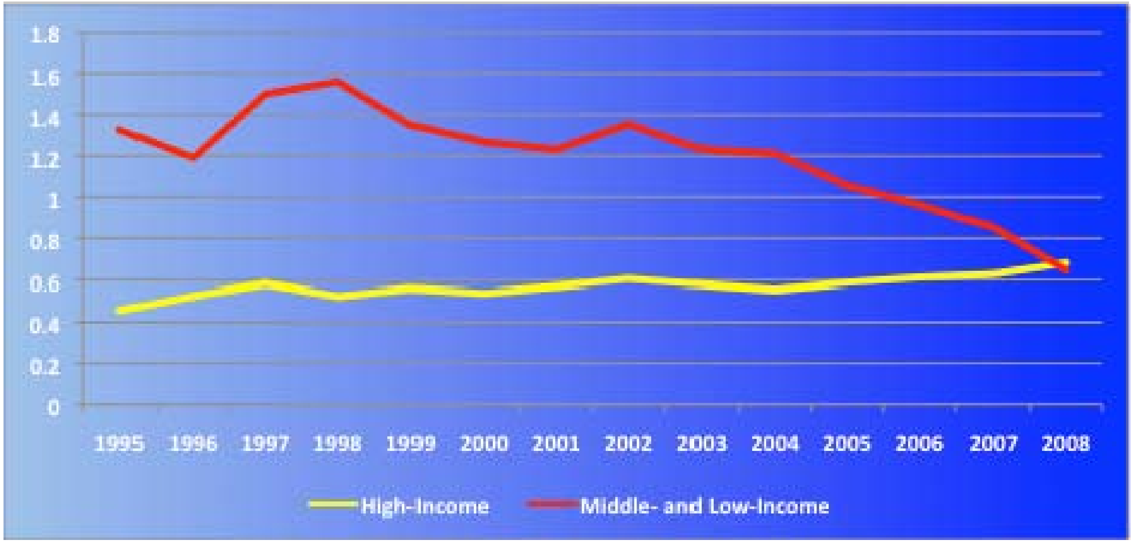
(Notification No.21/2002 – Customs dated 01.03.2002, as amended by Notification No.26/2003 dated 01.03.2003 & No.77/2009 – Customs dated 07.07.2009)
Source: (Consolidated Energy Consultants 2010)

5.2 Solar Photovoltaics Technology

This section uses the following HS codes to analyze trade in solar PV systems:

- HS 850720
- HS 853710
- HS 854140

Figure 24: Solar Power Generation Import-Export Ratio in UNESCAP High-Income versus Low- and Middle-Income Countries



Source: WITS Database

As illustrated in Figure 4.2 above, there has been a complete convergence of high and middle/low-income countries trade patterns of solar power technologies. In 1995, middle and low-income countries were net importers (indicated by an import-export ratio of more than 1) and high-income countries were net exporters (indicated by an import-export ratio of less than 1). However, with the rise of numerous developing countries (e.g. China) successfully competing on the international solar PV market, this relationship has changed markedly. As of 2008, both high and middle/low-income countries in Asia and the Pacific have been net exporters. There are probably at least two significant reasons for this. One, as very generous feed-in tariffs in EU countries such as Spain and Germany drastically increased global demand for solar PV panels, China, and a handful of other developing countries, were able to quickly step up production to meet the increase in demand by providing significantly cheaper versions than traditional exporting countries such as Germany. The second reason has to do with the expansion of domestic markets for solar PV in developing countries, in which large portions of these markets are also being supplied by developing countries in the region.

Table 11: Top 10 UNESCAP Trading Countries in Solar Photovoltaics in 2008

Rank	Importers	Exporters
1	China	China
2	RoK	Japan
3	Hong Kong, China	Malaysia
4	Japan	Hong Kong, China
5	Thailand	Singapore
6	Russian Federation	RoK
7	Singapore	Thailand
8	Malaysia	India
9	India	Australia
10	Australia	Russian Federation

Source: WITS Database

Malaysia rose to the number three spot in Solar PV exports in 2008. Most of the Solar PV technology in Malaysia has been deployed in rural areas such as Sabah and Sarawak where on-grid electrification is not cost effective. A number of Solar PV companies emerged over the last decade, but unfortunately, due to high subsidies to fossil fuels, and at the time of writing, no feed-in tariff in place, solar PV has been less financially competitive in urban settings, and thus, most of their production has been targeted at rural off-grid areas or for export. Although, this may change very soon, as the current government is keen on rapidly diversifying the economy by developing Malaysia's green technology sector. In an aim to further this goal, a new Green Technology Policy was recently passed and more climate-friendly legislation (e.g. feed-in tariff) is currently under development.

Dissimilar to wind energy production, a large percentage of China's solar PV production has been aimed at supplying international markets, largely owing to feed-in tariffs and other financial incentives for solar power in major foreign solar markets. China's solar industry, however, did not solidify on its own. Vamped-up financial and policy support for the Solar PV sector have been the key foundations and catalysts for its sustained growth in international trade, and its subsequent rise to the to top of the list. Nevertheless, such support has not come without repercussions. One of the biggest recent proponents of "free trade" and the "liberalization of climate-friendly goods and services," the United States, has actually retaliated against China's financial support to its domestic solar industry by increasing its import tariffs on solar PV panels (Palmer 2009). Such an act is completely at odds with the goals of climate change mitigation and support for developing countries inscribed in the Copenhagen Accord, of which it is a signatory, and the nature of the Doha Round of trade negotiations that as been deemed the "development" round. This conflict underscores the essentiality of forging a global climate change agreement that has specific provisions for trade which are both fair and respect principles of responsibility and capacity.

Table 12: Average Applied Tariffs on Solar Photovoltaics Technology in Top 20 UNESCAP GHG Emitting Countries

Rank	Country	Tariff	Industrial Goods Average	Year
1	China	4.16	8.57	2008
2	Indonesia	5.93	5.84	2007
3	Russian Fed.	4.33	8.19	2008
4	India	5.41	9.74	2008
5	Japan	0.00	2.61	2008
6	RoK	4.64	8.29	2007
7	Australia	1.91	3.93	2008
8	Iran	33.19	24.78	2008
9	Turkey	0.47	2.41	2008
10	Thailand	6.82	10.97	2006
11	Malaysia	7.51	5.91	2007
12	Myanmar	2.69	4.12	2007
13	Pakistan	19.39	14.04	2008
14	Philippines	4.97	5.00	2007
15	Kazakhstan	1.27	3.91	2008
16	Viet Nam	14.91	11.68	2007
17	Bangladesh	11.13	14.52	2007
18	Singapore	0.00	0.00	2008
19	Cambodia*	18.59	12.45	2007

20	Turkmenistan	3.62	5.43	2002
	Mean	**7.55**	**8.12**	

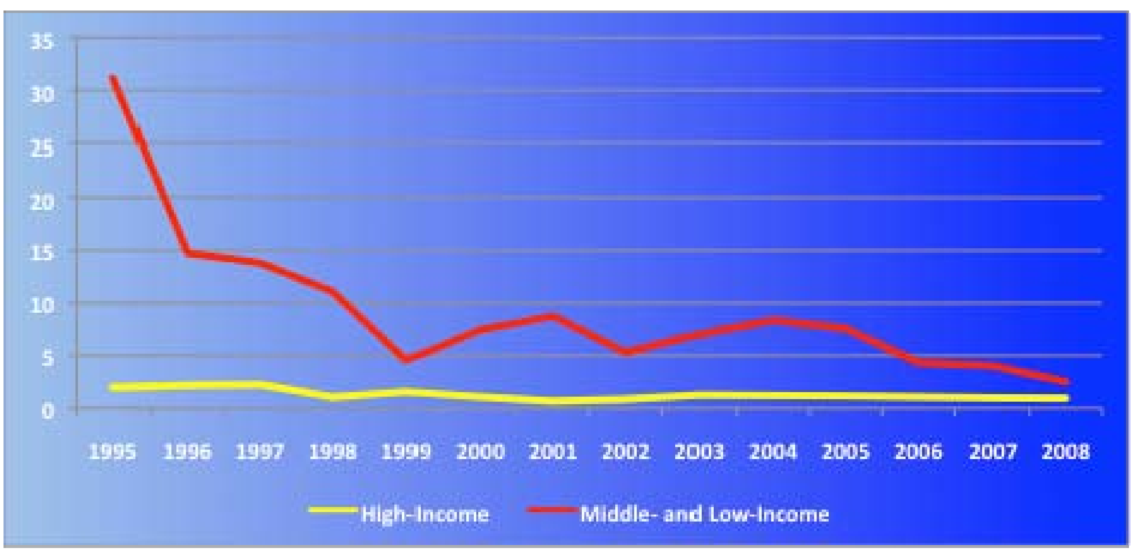
Note: Ranking of countries by GHG emissions is based on 2005 data from Climate Analysis Indicators Tool (CAIT) Version 7.0. (Washington, DC: World Resources Institute, 2010)
* Cambodia and Turkmenistan are actually ranked 20th and 21st, respectively, with North Korea taking 19th place. However due the lack of tariff data for North Korea, Cambodia and Turkmenistan were both moved up a rank.
Source: WITS

Fourteen of the top 20 GHG emitting countries' import tariffs on solar PV were less than the industrial goods average. This speaks to the increased importance given to incentivizing the trade of solar PV and climate change mitigation. Nonetheless, tariffs on Solar PV in Iran (33.19), Pakistan (19.39), Viet Nam (14.91), and Cambodia (18.59) were especially high in both nominal terms and relative to their corresponding industrial goods average. Considering that these countries are high GHG emitters, and that they do not have developed domestic solar industries, high tariffs could pose a serious impediment to, or at least raise the cost of, mitigation and the provision of energy.

5.3 Clean Coal Technology

This section uses the following integrated coal gasification combined cycle (IGCC) technologies as proxies for examining the trade of clean coal technologies: 1) parts of gas turbines, 2) as turbines exceeding 5,000 kW; 3) gas turbines not exceeding 5,000 kW; 4) steam and vapor turbines not exceeding 40 MW; and 5) producer gas generators.

Figure 25: Clean Coal Technology Import-Export Ratio in UNESCAP High-Income versus Low- and Middle-Income Countries



Source: WITS Database

As demonstrated in Figure 4.3 above, there is clear convergence between high and middle/low-income countries over the time period 1995-2008. Middle and low-income countries level of exports as compared to imports has significantly increased. As of 2008, however, they still remain net importers of clean coal technology.

Table 13: Top 10 UNESCAP Trading Countries in Clean Coal Technology Components in 2008

Rank	Importers	Exporters
1	Singapore	Japan
2	Japan	Singapore
3	RoK	China
4	Indonesia	India
5	China	Thailand
6	Australia	Russian Federation
7	India	Turkey
8	Malaysia	Hong Kong, China
9	Thailand	RoK
10	Russian Federation	Australia

Source: WITS Database

The same two developing countries, Japan and Singapore, took the top two spots in 2008 for both exports and imports of clean coal technology components. These countries are not only highly trading in these technologies, but are also starting to deploy them domestically. China and India scored higher in exports (third and fourth, respectively) than in imports (fifth and seventh, respectively). Even though both are adding an enormous amount coal generated electricity capacity each year, more of their technology demands appear to be being met by domestic production. As it is difficult to distinguish between traditional coal and "clean" coal technologies at the HS 6-digit level, a fair amount of the trade analyzed may in fact still be traditional "dirty" coal technologies. Further examination at a higher digit HS code level and of regional industry trading trends is needed for a more accurate evaluation.

Table 14: Average Applied Tariffs on Clean Coal Technology in Top 20 UNESCAP GHG Emitting Countries

Rank	Country	Tariff	Industrial Goods Average	Year
1	China	8.03	8.57	2008
2	Indonesia	0.00	5.84	2007
3	Russian Fed.	8.85	8.19	2008
4	India	7.25	9.74	2008
5	Japan	0.00	2.61	2008
6	RoK	5.35	8.29	2007
7	Australia	0.69	3.93	2008
8	Iran	6.38	24.78	2008
9	Turkey	0.46	2.41	2008
10	Thailand	0.89	10.97	2006
11	Malaysia	0.00	5.91	2007
12	Myanmar	1.00	4.12	2007
13	Pakistan	4.63	14.04	2008
14	Philippines	2.07	5.00	2007
15	Kazakhstan	0.00	3.91	2008
16	Viet Nam	0.00	11.68	2007
17	Bangladesh	5.00	14.52	2007
18	Singapore	0.00	0.00	2008

19	Cambodia*	7.00	12.45	2007
20	Turkmenistan	0.00	5.43	2002
	Mean	**2.88**	**8.12**	

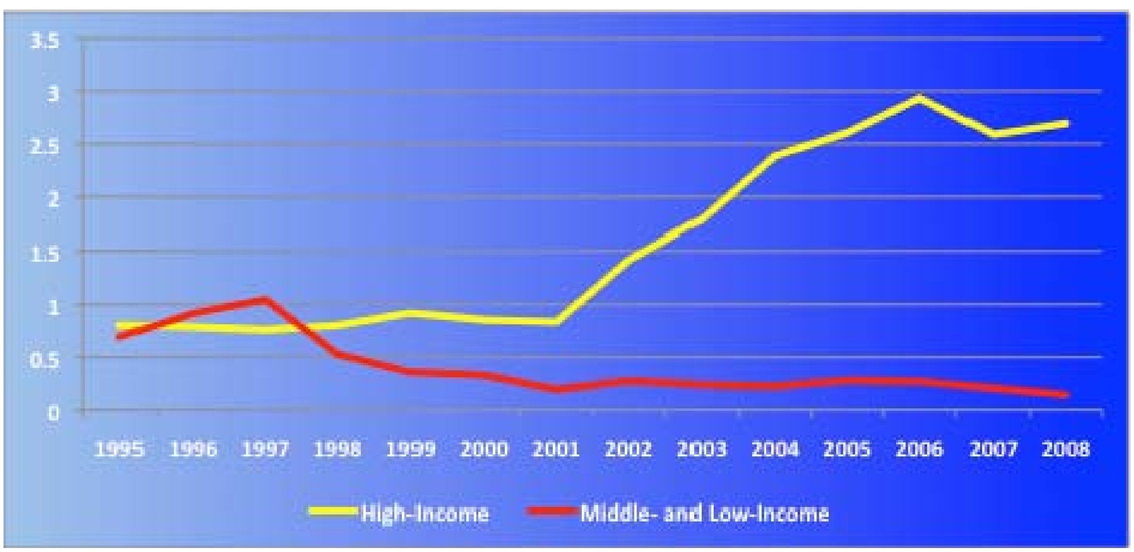
Note: Ranking of countries by GHG emissions is based on 2005 data from Climate Analysis Indicators Tool (CAIT) Version 7.0. (Washington, DC: World Resources Institute, 2010)
* Cambodia and Turkmenistan are actually ranked 20th and 21st, respectively, with North Korea taking 19th place. However due the lack of tariff data for North Korea, Cambodia and Turkmenistan were both moved up a rank.
Source: WITS

Applied average tariffs for clean coal were by far the lowest among the top 20 GHG emitters in the region, averaging only 2.88, compared to solar PV at 8.85, wind energy at 6.06, and energy efficient lighting at 9.8. The highest levied rate (8.85), by the Russian Federation, was the same as the average for solar PV (also 8.85), and actually less than the average for energy efficient lighting (9.8). From this initial analysis, one might expect significant GHG emission reductions to be occurring from the coal energy sector. However, as stated earlier, there is not much differentiation between "dirty" and "clean" coal technologies at the HS 6-digit level, and thus, the low level of tariffs may not actually be incentivizing trade and investment in clean coal technologies over dirty ones.

5.4 Energy Efficient Lighting

Under the current international trading framework and available data, it is very difficult to accurately measure the trade of energy efficient technologies. In an attempt to circumvent such measurement obstacles, the trade of fluorescent light bulbs (HS code 853931) is used as a proxy.

Figure 26: Import-Export Ratio of Energy Efficient Lighting in UNESCAP High-Income versus Low- and Middle-Income Countries



Source: WITS Database

Dissimilar to the trade patterns of other previously examined climate smart technologies, the import-export ratios of high and middle/low-income countries illustrate significant divergence between 1995 and 2008. Since 1998, middle and low-income countries overtook high-income countries in terms of import-export ratios, and the trend has accelerated significantly since 2001. This is largely due to developing countries such as India and China dominating the market in fluorescent lighting. Australia's imports of fluorescent lights may rise dramatically over the coming years due to its 2007 law, which came into effect in 2009, mandates the phasing-out of inefficient light bulbs (IEA n.d.). This could further drive exports of compact fluorescent lamps (CFL) from other regional members.

Table 15: Top 10 UNESCAP Trading Countries in Energy Efficient Lighting in 2008

Rank	Importers	Exporters
1	Japan	China
2	Hong Kong, China	Indonesia
3	Turkey	Hong Kong, China
4	Indonesia	Thailand
5	Russian Federation	Japan
6	RoK	India
7	Australia	RoK
8	China	Singapore
9	India	Russian Federation
10	Singapore	Malaysia

Source: WITS Database

Table 16: Average Applied Tariffs on Energy Efficient Lighting in Top 20 UNESCAP GHG Emitting Countries

Rank	Country	Tariff	Industrial Goods Average	Year
1	China	8.03	8.57	2008
2	Indonesia	7.63	5.84	2007
3	Russian Fed.	0.00	8.19	2008
4	India	9.39	9.74	2008
5	Japan	0.00	2.61	2008
6	RoK	6.98	8.29	2007
7	Australia	3.97	3.93	2008
8	Iran	29.80	24.78	2008
9	Turkey	0.52	2.41	2008
10	Thailand	17.00	10.97	2006
11	Malaysia	25.11	5.91	2007
12	Myanmar	1.00	4.12	2007
13	Pakistan	19.97	14.04	2008
14	Philippines	9.88	5.00	2007
15	Kazakhstan	0.00	3.91	2008
16	Viet Nam	32.22	11.68	2007
17	Bangladesh	18.24	14.52	2007
18	Singapore	0.00	0.00	2008
19	Cambodia*	6.27	12.45	2007
20	Turkmenistan	0.00	5.43	2002
	Mean	**9.80**	**8.12**	

Note: Ranking of countries by GHG emissions is based on 2005 data from Climate Analysis Indicators Tool (CAIT) Version 7.0. (Washington, DC: World Resources Institute, 2010)

* Cambodia and Turkmenistan are actually ranked 20th and 21st, respectively, with North Korea taking 19th place. However due the lack of tariff data for North Korea, Cambodia and Turkmenistan were both moved up a rank.
Source: WITS

Applied average tariffs to energy efficient lighting for the top 20 GHG emitters in Asia and the Pacific ranged from a low of zero in Turkmenistan, Singapore, Kazakhstan, Japan and the Russian Federation, to a high of 32.22 in Viet Nam. The sector average for tariffs applied to energy efficient lighting (9.80) among the top ten GHG emitters in the region was higher than the industrial goods average (8.12). Improving energy efficiency is one of the most cost-effective means for enhancing energy security and climate change mitigation. Such high import tariffs undermine the cost savings that could be accrued from adopting energy efficient lighting and represent significant barriers to trade and deployment of this technology.

6. Engineering a Policy Architecture Conducive to CSGST Deployment, Trade and Investment

Climate change poses a serious and urgent threat to inclusive development and environmental sustainability. Surmounting this threat will necessitate a paradigm shift towards climate smart development and a low carbon economy. Shoring up increased investment in and expanding the trade of climate smart goods, services and technologies can work to such an end. Experience has demonstrated, however, that the market alone has been unable to incentivize enough CSGST investment and trade to achieve a level of deployment that would limit global average temperature rise to 2°C . Realizing climate smart development will thus necessitate the engineering of a policy architecture that promotes energy efficiency and the deployment of climate smart technologies over that of inefficiency and fossil fuels-based technologies. As individual country circumstances will be uniquely defined and not all policy makers will be dealt equal options for intervention, there will be no single panacea appropriate for fostering such a change. It is thus essential for countries to develop nationally appropriate, comprehensive policy mixes that consist of mutually re-enforcing and non-counterproductive interventions and incentive structures.

For example, simultaneously subsidizing fossil fuels and renewable energy is not only counterproductive, but it also is a wasteful and inefficient use of scarce fiscal revenue. Ensuring appropriate timing of policies— for instance, the gradual phasing-out of subsidies to petroleum and expansion of public transport prior to the levying of fuel taxes— as well as long-term price certainty is critical for reducing negative impacts on the poor and maximizing policy effectiveness. Finally, even though climate change mitigation is a global good, developed countries should carefully design their domestic policies so that climate change actions do not come at the expense of developing countries' human development goals.

Despite the fact that there is no single-best solution (i.e. no one-size-fits-all solution), there are a number of interventions that may be appropriate for various levels of development and common constraints. Generally, when firms compare countries in which to invest in or trade with their decision may take into account macroeconomic stability, level of infrastructure development, quality of workforce and level of education, location, political and social stability, potential for conflict, and degree of good governance, among others. In addition, and specifically for CSGST, it is countries where— 1) barriers to CST investment and fossil fuel subsidies are low; 2) the purchase of climate smart energy is promoted at a level that covers the cost to produce it; 3) standards for carbon/energy efficiency are high; and 4) the public is aware of the threats of climate change and the benefits of purchasing CSGS— that CST are being invested in and deployed widely.

6.1 Removing Barriers

6.1.1 Tariffs and Non-Tariff Barriers

Import tariffs and non-tariff barriers on CSGST can seriously hamper their ability to compete cost-effectively with traditional carbon-intensive technologies, and thus their rate of diffusion. There has been significant recent progress among numerous Asia-Pacific countries in reducing both tariff and NTBs to CSGST, though many other UNESCAP member countries still maintain relatively high barriers. In India, customs duties on biodiesel were recently reduced from 7.5% to 2.5%, and permanent magnets for PM synchronous generator above 500 kW that are utilized in wind power generators from 7.5% to 5%. Between June and September of 2009, the Republic of Korea cut import duties by 50% on hybrid cars, recycling facilities, as well as 31 other components used in renewable energy generation: 2 for geothermal, 1 for hydrogen fuel cells, 21 for solar energy, and 7 for wind power. It is estimated that these reductions will result in over $10 million in savings for climate smart technology importing companies (Chan 2009).

This paper has promulgated the option of liberalizing the trade of CSGS in order to enhance access and diffusion. For small developing countries with very low market demand and lack of fiscal revenue to subsidize CSGS, as well as limited potential to quickly scale up domestic production capacity of CSTs, liberalization across the board may be the best option for transferring technology, building long-term capacity and fostering climate smart development. This should be undertaken gradually and with due diligence not to unnecessarily harm local industries.

However, for larger middle-income economies that want to develop their domestic industries' capacity to produce and then export higher value-added finished climate smart technologies such as Solar PV panels and wind turbines, a different approach might be more effective. These countries can rapidly increase their domestic demand for climate smart technologies by adopting many of the policies described in greater detail later in this chapter such as the elimination of fossil fuel subsidies, renewable portfolio standards, feed-in tariffs, energy-efficiency standards, etc. Adopting and implementing such policy measures, while also reducing import duties on CSGST components and maintaining higher duties on finished CSGST, allows domestic climate smart technology producing companies access to cheaper components, but also shields them from competition from foreign imports where more value-added CSGTs are concerned. This situation can incentivize greater foreign direct investment in the country, as it will be more cost-effective for foreign companies to set up production to supply the increased domestic market demand than to have their products face high import duties at the border. Increased FDI in CSGT production has the potential to increase domestic green jobs and transfer climate smart technology and service-related skills. Adopting green public procurement and grants for CSGT R&D that prioritizes domestic producers can better support domestic industry growth in CSGT production and innovation. This particular measure will only be possible for countries that are not yet signature to the Agreement on Government Procurement, which prohibits such discrimination. Over time, as the domestic capacity to produce CSGT increases, the countries exports will be better positioned to compete on the global market.

Variants of the above strategy have been intermittently visible in China, Brazil and Thailand. Thailand, for example, reduced petroleum subsidies, increased incentives for compressed natural gas (CNG) and liquefied petroleum gas (LPG), offered tax incentives for producers of eco-friendly automobiles, as well as adopted higher fuel-economy standards and feed-in tariffs for renewables such as solar energy. The Government of Thailand also reduced import tariffs on various climate smart energy and green car components (by as much as 90% for approved importers) but kept import duties on finished CSG with more value-added such as solar PV panels and hybrid cars relatively high. As a result, FDI in CST and domestic capacity to produce solar PV panels and hybrid cars has increased significantly, and in turn, exports. Shortly after announcing the high reductions in import duties for green car components, foreign automakers including Tata Motors, Nissan, Toyota, Mitsubishi, Honda and Suzuki pledged to invest US$1.24 billion in the production of green cars in Thailand (Chan, 2009). In June of 2010, in a demonstration of a continuation along this strategy, the Government also announced it would further reduce import tariffs on accessories for gas-electric hybrid automobiles, but gave no reference to doing the same for entire hybrid automobiles. Some other UNESCAP members such as the Philippines have been adopting a similar strategy (Electric and Hybrid Vehicles Today 2006), however, others like India have not only reduced import duties on green car components, but also appear to be moving towards similar reductions for entire hybrid automobiles (The Times of India 2009).

6.1.2 Investment Barriers

Despite the recent increased investment in CST and capital market and energy sector reforms that have been undertaken in Asia and the Pacific over the past 30 years, there still exists a variety of barriers that are impeding investment in CST, particularly in developing markets.

- **Weak environmental regulation:** Weak environmental and climate regulation, monitoring and enforcement favors polluting carbon-intensive energy technologies over CST.
- **High policy risk**: Policy makers should avoid policy and regulatory changes that could adversely affect the profitability of climate smart investments. As climate smart energy projects often require front loading investment and generally have a long return on investment (ROI) period, it is critical to ensure that prices and quotas (e.g. feed-in tariffs, renewable portfolio standards, and mandatory fuel mixing requirements) are locked-in for a set period of time to reduce risk and improve long-term certainty for investors.
- **Low level of competition**: Fostering a more competitive energy market through privatization and regulatory reform can greatly improve efficiency and allow for desperately needed private sector participation and commercial investment. Establishing an independent regulatory authority can safeguard tariff rates favorable to CSET from competing short-lived political interests.
- **Limited foreign ownership permitted**: Permitting greater foreign ownership can greatly incentivize foreign direct investment in CST. India, for example, has recently allowed for 100% FDI in the renewable energy sector. Whether a lender can legally take ownership of a renewable energy plant and generate revenue if that plant defaults on a loan is also very important.
- **Poor transmission and grid interconnection**: Guaranteeing access of independent producers of CSE to the grid in order to feed in surplus energy is an essential component of a renewable energy policy. As CSE projects are often in remote

locations, and the cost of interconnection high, subsidizing a portion of this cost can have a major impact.

- **Limited access to local financing**: Improving access to local currency financing, particularly micro-financing, can drastically increase the diffusion of CSET, especially in remote rural areas where off-grid energy solutions such as wind and solar are already more cost-effective than the cost of extending the grid.
- **Few exit options**: In some markets, investors wishing to exit their venture may have limited options. Permission may be required to transfer shares or capital markets undeveloped reducing the potential for success of an initial public offering (IPO).

6.1.3 Trade Related Aspects of Intellectual Property Rights

Failing to fast track the transfer of critical CSTs to developing countries, such as drought-resistant crops and solar-powered slow-drip irrigation systems and small-scale desalination plants, could have huge health-related ramifications for the poor and delay climate change action. One of the most critical impediments is the North-South stalemated negotiation over Trade Related Aspects of Intellectual Property Rights (TRIPS) as they pertain to climate smart technologies. The advancement of TRIPS has been largely spearheaded by developed nations. However, many have noted that it is not fulfilling objectives: "the promotion of technological innovation and transfer and dissemination of technology "*to the mutual advantage of producers and users of technological knowledge and in a manner conducive to social and economic welfare, and to a balance of rights and obligations*. (Roffe 2010)."

The key question now is: how to foster climate smart technology transfer to developing countries at affordable prices without undermining entrepreneurship and investor confidence, and consequently, innovation and economic welfare? Studies indicate that it takes an average of 24 years for energy sector inventions to reach a level of wide-scale use in the market, and as much as 3 years simply to register a patent. Achieving the mitigation targets set within the Copenhagen Accord will necessitate reducing this timeframe for the diffusion of CST by at least half (Lee, Iliev and Preston 2009). It is against this background that some form of compromise and revision must be made. There have been a number of proposals by UNESCAP members seeking to remedy this problem. India's 2008 *CleanNet* proposal at Poznan, for instance, which garnered support from numerous G77 nations, calls for the establishment of climate technology development and diffusion centres in developing and least developed nations. It references the World Bank and UN jointly established Consultative Group on International Agricultural Research (CGIAR) as a paragon (Mathor 2008). In the Bangkok negotiations, Pakistan and India were especially vocal regarding relaxing IPR. Saudi Arabia pressed for countries to be allowed to issue compulsory licenses for climate smart technologies, and China emphasized a balanced approach (ICTSD 2008). This line of thought was further supported at the more recent COP 15 in Copenhagen, when China, India and Brazil also proposed "*new green technologies be made subject to compulsory licensing*." Another option promulgated by India's climate change envoy was to establish a "*global fund that could buy out IPRs of green technologies, and then distribute these technologies free, in a way that is similar to what is done for HIV/AIDS drugs"* (Kogan 2010).

6.2 Leveling the Playing Field: Correcting for Government and Market Failures

Climate change is a direct result of the "*greatest market failure the world has ever seen*": the failure to effectively incorporate the cost to society and the environment of GHG emissions into market prices. Many governments have not only failed to correct for this catastrophic market failure, but have, and are still, exacerbating it by heavily subsidizing fossil fuels.

Despite pledges to reduce GHG emissions, the IEA estimates that subsidies to fossil fuels were still as high as $557 billion in 2008. 2009 subsidies to renewable energy and biofuel technologies accounted for only 8%, or approximately $46 billion, of those to fossil fuels, according to Bloomberg New Energy Finance (EON 2010).[14] Subsidizing fossil fuels make them artificially cheap, and CST less cost-competitive. These perverse subsidies are also not only counterproductive to the goal of mitigating climate change, but are also huge drains on scarce revenue resources and usually benefit the middle and upper-income groups more than the poor. Subsidies to fossil fuels in Iran, for example, account for approximately one-third ($101 billion) of its entire budget.

In seeking to correct these market and government failures, many countries have started to undertake green subsidy reform, which "*consists of gradually eliminating counterproductive subsidies (e.g. those to fossil fuels) that favor unsustainable development and redirecting fiscal funds towards areas that support*" climate smart development and poverty reduction (Crawford 2009). The G20 pledged in September of 2009 to assume such a reform by phasing out subsidies to fossil fuels and maintaining targeted support to lower income groups. A number of UNESCAP members are already spearheading the effort. China, for instance, has been eliminating subsidies to petroleum and is estimated to have spent $2 billion on subsidies to renewable energy and biofuels in 2009 (EON 2010). Indonesia is seeking to eliminate subsidies to electricity and fuel by 2015 and redirecting revenue towards more pro-poor development programmes.

6.3 Promoting the Purchase of Climate Smart Goods and Services

Until the market cost of fossil fuel-based energy and the emission of GHGs are priced appropriately (i.e. subsidies are removed and externalities are internalized), many nascent climate smart technologies (e.g. wave energy) and even more mature ones (e.g. solar PV) need government policies to support future R&D and the purchase of CSGS, especially the energy produced from climate smart energy technologies. Four measures which have proven successful globally and in Asia and the Pacific are: 1) renewable energy targets and portfolio standards; 2) renewable energy certificates; 3) Feed-in Tariffs (FiTs); and 4) green public procurement.

6.3.1 Renewable Energy Targets and Portfolio Standards

Setting national level renewable energy targets and mandating utilities to purchase a certain percentage of their energy from renewable sources (also known as renewable portfolio standards (RPS)) can rapidly vamp up investment in and deployment of climate smart energy technologies. Whether produced domestically or imported, these technologies will require the accompaniments of climate smart services such as installation, maintenance and even carbon asset management. The increased demand for such services can drive local green job and skill creation. Other benefits of RPS are greater competition between energy suppliers, increased innovation and improved efficiency. Countries in Asia-Pacific with renewable energy targets include China (20% by 2020); Republic of Korea (4% by 2015 and 10% by 2022), Indonesia (15% by 2025) and Japan (5,000 MW from wind and 28,000 MW from solar by 2020).

[14] This number is inclusive of the cost of renewable energy certificates, feed-in tariffs, tax credits, cash grants, as well as other direct subsidies. Upstream support, such as the cost benefit received from cap-and-trade schemes is not included.

6.3.2 Renewable Energy Certificates

Renewable energy certificates (REC) are tradable commodities that are used as means to verify that a certain amount of electricity, generally 1 megawatt, was generated by a renewable source. Electric utilities can use these certificates to satisfy compliance requirements in areas where renewable portfolio standards are enforced. UNESCAP members presently using or planning to use renewable energy certificates programmes include the U.S., India, Australia, New Zealand, China, Japan and the Philippines.

6.3.3 Feed-in Tariffs

Feed-in Tarriffs (FiT) are the most widely used policy instrument to procure energy generated from climate smart energy technologies worldwide. Approximately 75% of global solar PV and 45% of global wind deployment were the result of FiT (Deutsche Bank Group 2010). Within the Asian and Pacific region, numerous countries have implemented, or are planning to adopt, FiT to incentivize the deployment of CSET, including Australia, China, India, Japan, Malaysia, New Zealand, the Philippines, Thailand, and Turkey.

6.3.4 Climate Smart Public Procurement

Public procurement can amount to as much as 40% of GDP in some developing countries (EURODAD 2009). Consequently, setting guidelines for government agencies to prioritize the procurement of CSGST can act as a major driver for investment and deployment. Thailand's Green Purchasing Policy, the Philippines Green Procurement Programme and Japan's Green Public Procurement Law are selected examples of the progressive initiatives being undertaken by UNESCAP members.

6.4 Improving Standards and Raising Awareness

6.4.1 Energy Efficiency Standards

Governments can set standards aimed at enhancing energy efficiency and conservation that can result in increased economic productivity, financial savings, and international competitiveness for companies dealing with climate smart goods and services. Numerous countries in the region have already set national level targets. India, for example, aims to save about 10,000 MW by 2012 as indicated in its National Mission for Enhanced Energy Efficiency (NMEEE). China's enthusiastic goal of reducing its intensity by 20% from 2005 levels by 2010 appears to be in reach. This would be testimony to the effectiveness of its recent policy initiatives targeted improving energy efficiency.

6.4.2 Fuel Efficiency Standards

Adopting robust fuel efficiency standards for automobiles has the potential to spur demand in energy efficient technologies used in the automobile industry and to mitigate green house gas emissions from the transport sector. Many developing countries have recently been announcing plans to increase their fuel efficiency standards. China, for example is planning on raising its fleet-wide fuel economy average standard to 42.2 miles per gallon by 2015. According to its National Strategy on Climate Change, Thailand is also planning on improving the fuel economy standards of new vehicles. India, under its twelfth five-year plan, is intending on making fuel efficiency standards mandatory for all vehicles by December 2011.

6.4.3 Minimum Energy Performance Standards

Minimum Energy Performance Standards (MEPS) refer to energy performance criteria for devices that use electricity such as air conditioners, refrigerators or lights, which must be legally adhered to in order to enter the market. These standards apply to imports as well, and can thus be viewed as a market barrier to less energy-efficient products that do not comply. As such, adopting MEPS promotes the investment in and trade of CSG, especially energy-efficient ones. MEPS throughout Asia and the Pacific have been growing both in their application by countries (including developed and developing members) and level of performance required. Australia and New Zealand have closely aligned their MEPS— which includes electric motors, lamps, air conditioners, televisions, and distribution transformers, among others— so as to ease regulatory compliance for producers and importers that operate in both markets. The Republic of Korea adopted its Energy Efficiency Label and Standard Programme as early as 1992. Thailand and China recently passed legislation for establishing MEPS for appliances and equipment. The government of Indonesia has also promoted energy efficiency standards for lighting products and many appliances. Even though a complementary labeling programme supported these standards in Indonesia, they have still been viewed as ineffective and have yet to gain traction owing to insufficient public awareness (UNESCAP 2010, 115).

6.4.4 Greener Building Codes

Numerous countries in Asia and the Pacific are developing their own institutions and standards for assessing the energy, water and waste efficiency performance of buildings. Examples include Australia's Green Star, China's Green Building Assessment Method and Green Building Network, Honk Kong's Building Environmental Assessment Method, India's Indian Green Building Council, Malaysia's Green Building Index, New Zealand's Green Star, and Singapore's Green Mark. The Republic of Korea adopted mandatory building energy standards in 2004. These codes were not as descriptive in detail as in Germany and the U.S. and more closely resembled those in Japan and the U.K. In RoK's effort to foster low-carbon green growth, the new action plan for emissions reductions seeks to further improve its buildings' energy performance by requiring building owners to significantly reduce energy consumption and encourage the replacement of conventional buildings with "zero energy" buildings that produce their own energy from renewable sources such as wind, solar and geothermal from 2025 (Lee 2009). In India, the states of Delhi, Haryana, Uttarakhand and Gujarat are among the first moving towards mandating building codes that encourage energy conservation and efficiency (Gombar 2009). Japan has recently indicated that it will finally be moving away from voluntary targets to mandatory energy-saving standards for new buildings that will apply to windows, thermal insulation and outer walls (Kyodo News 2010).

6.4.5 Green Labelling

The labeling of product's environmental and climate impacts is critical for raising awareness, fostering sustainable consumption and assisting climate-friendly conscientious consumers (both business and individual) accurately and easily identify climate smart goods and services. Historically, mainly green European consumers and multi-national corporations (MNCs) seeking to improve their corporate social responsibility (CSR) and green their global supply chains that spanned to Asia were the driving force behind the development of energy efficient, eco- and carbon labels and supportive legislation. Recently, however, environmentally related labels targeted at Asia-Pacific domestic consumers, including those in developing countries, have been steadily growing in number (e.g. Japan's Eco Mark, Taiwan's Green Mark, RoK's Eco-labeling Program, Singapore's Green Label and

Thailand's Green Label. Since as early as 1992, RoK has required imported and domestically manufactured products to indicate their energy performance on a label ranging from 1 to 5, with 1 being the highest level of performance. Products that do not meet the necessary minimum performance standard are banned (IEA n.d.). Turkey has been mandating energy labels for many household appliances from 2002 (IEA n.d.). In line with their MEPS, New Zealand and Australia have also mandated the use of energy performance labels. Energy labeling in India became mandatory for various electrical appliances from 2007.

Particularly in regards to carbon disclosure through labeling, countries such as the Republic of Korea, Thailand and Japan have all adopted carbon footprinting programmes on a trial, voluntary or mandatory basis (Asian Productivity Organization 2010). Pioneering one of the most progressive policies, the Republic of Korea requires all new appliances and vehicles produced for the domestic market to display their CO2 emitted per hour of use and kilometer driven, respectively (IEA n.d.). Another good example is Japan's Carbon Footprint Pilot Program, which was brought into force at the national level in 2009. For firms seeking to display the Carbon Footprint Label on their marketed products, the CO2e of GHGs emitted over the entire product's life cycle must be calculated verified, and the methodology for doing so, approved by the specified government institution (Ministry of Economy Trade and Industry 2009). Calculating a product's carbon footprint over its entire life cycle has been made easier in Japan by the establishment of a national Life Cycle Index database that, as of early 2010, housed over 900 individual indexes (Asian Productivity Organization 2010). Other countries, for instance, Malaysia are also working diligently to build their national life cycle index databases. According to SIRIM, as of May 2010 Malaysia's database contained slightly over 40 individual indices.

Standardizing life cycle analysis, labeling, GHG management and carbon footprinting methodology across countries and international markets is a key factor for promoting international trade of and investment in CSGST, as well as for reducing the costs of suppliers for meeting numerous and often differing criteria. Such costs can be relatively higher for small green exporters from developing countries that lack economies of scale and seek to enter multiple international markets. The International Organization for Standardization (ISO) is working towards such an end with its 14025, 14040/44, 14064/65, and 14067 (under development) standards. ISO 14025 "*establishes the principles and specifies the procedures for developing Type III environmental declaration programmes and Type III environmental declarations*," which are "*primarily intended for business to business use, but their use in business-to-consumer communication under certain conditions is not precluded* (ISO n.d.)." Examples of ISO 14025 Type III certified labels in Asia and the Pacific include, for instance, Japan's Eco Leaf and the Republic of Korea's EDP. ISO 14040/44 explains the principles of and framework for LCA. The ISO 14067, which is still under development, builds on the LCA framework of 14040/44 by providing a uniform quantification methodology for calculating GHG emissions for carbon footprinting of goods and services. Various governments throughout the region have already started providing financial incentives for companies to gain accreditation. Singapore, for example, through SPRING Singapore provides grants to local companies participating in the SIP pilot project for as high as 70% of the qualifying costs for adopting ISO 14064 greenhouse gas management standards (Green Business Times 2010). One option for increasing intra-regional trade would be to agree on a common definition of climate smart goods, methodology for calculating a products carbon footprint, and green label.

6.5 Selected International Financing Options

High domestic savings rates in Asia have resulted in significant reserves of domestic capital, which can be tapped as a local source of investment for CST. Compared to developed country markets, however, entrepreneurs in developing countries can often not act upon foreign investment and export opportunities if they are unable to secure additional financing at a reasonable cost. Interest rates in developing countries are usually higher and capital markets less mature, rendering access to favorable financing poor at best in most cases. Adopting various measures that can increase access to and reduce the cost of financing should be an essential component of any policy package aimed at scaling up investment and trade in CSGST.

The Clean Development Mechanism (CDM) has been the main international instrument under the Kyoto Protocol for financing technology transfer to developing countries. History has, unfortunately, demonstrated the utter ineffectiveness of project-level CDM in most Asia-Pacific developing countries. Among ASEAN members, only 17, or 3.2%, of the 526 projects were actually issued carbon credits (Puhl 2010).

Under the Copenhagen Accord, developed countries agreed to pledge $30 billion over the period 2010-2012 as ‘fast start’ financing for adaptation and mitigation actions, and then $100 billion per year from 2020 to developing countries to assist with GHG mitigation measures (UNFCCC 2009). While progress has been made on the establishment of the Copenhagen Green Fund, it is still unclear as to which organization will manage it. There have been motions for both the World Bank and UNFCCC (ICTSD 2010). As of September 12, 2010, only six developed countries/regions— including Denmark, the EU, France, Germany, the Netherlands and Norway— had actually contributed funding to developing countries. UNESCAP developing country recipients of such funding consist of Bangladesh, India, Indonesia, Maldives, Nepal and the Philippines (UNFCCC and others n.d.).

Table 18: Countries Contributing ‘Fast Start’ Financing (under the Copenhagen Accord) to Developed Countries

Contributor	Total Pledged (Millions)	Total Committed (Millions)	Programmes
Denmark	DKK 1,200	DKK 308	0
European Union	EUR 150	EUR 50	0
France	EUR 1,260	EUR 1,260	0
Germany	EUR 1,260		7
Netherlands	EUR 310	EUR 310	7
Norway		USD 357	11

Source: Adapted from (UNFCCC and others n.d.)

6.6 Potential Conflicts with WTO and GATT

Various UNESCAP Member States have raised concerns as to whether certain types of policy interventions aimed at mitigating climate change and the provision of subsidies to develop CSGST fall into conflict with WTO/GATT law and/or unfairly act as barriers to developing country exports. High emissions and renewable energy standards, as well as carbon labeling schemes have at times been deemed as non-tarriff barriers, as they could exclude lower level automobile technologies and/or impose higher costs on developing country exports. The Government of Malaysia complained that under the initial EU Renewable Energy Directive, its palm oil exports would be disqualified as an ingredient in biodiesel as they were found to be more carbon intensive than the set ceiling.

Local content provisions in green public procurement policies— which give preference to domestic enterprises over that of foreign— could be considered incompatible with the WTO for countries that are signatory to the Agreement on Public Procurement (APP). This point of incompatibility has been raised regarding the U.S., China and India's recent public procurement of and subsidies to CST. Despite the fact that China has indicated that it plans on becoming a member to the WTO APP, it has still yet to officially sign the APP, and as such, its public procurement local content requirements appear to not conflict with the WTO. This may not be the case for the other 41 APP signatories.

Some countries that have or are planning to tax the emission of GHG have also explored the option of border carbon adjustments as a means to prevent carbon leakage and 'level the playing field' between domestic producers that would face this tax and imports from abroad that would be exempt without such a mechanism. UNESCAP member countries, such as India and China have vehemently opposed the use of BCAs claiming that it would act as a tariff barrier to developing country exports. The U.S.'s recent Waxman and Markey Bill contained a provision for the creation of an *international reserve allowance programme* that represented one form of BCA. As the Senate did not pass the bill, the BCA provision was never implemented and its compatibility with the WTO never formally challenged or examined. BCA could possibly be interpreted as falling under GATT Articles II and III that allow for the imposition of "charges on imported products equivalent to internal taxes and other charges." However, even if BCA are found to conflict with certain WTO principles, GATT XX could be employed which allows for such policy interventions if they are deemed as "*necessary to protect plant or human life*," or if they relate to the "*conservation of exhaustible natural resources*."

6.7 Recent Policy Initiatives in Malaysia and Thailand

6.7.1 Malaysia

In April 2009, the Malaysian Prime Minister announced his vision of a Green Malaysia and demonstrated his commitment to climate change mitigation and energy security by escalating green technology to the mainstream cabinet portfolio, creating the Ministry of Energy, Green Technology and Water. The PM further enunciated his vision by stating his goal to develop Putrajaya and Cyberjaya as pioneer townships in Green Technology, as a showcase for the development of other townships across the country. In Malaysia green technology has been recognised as a key driver for future economic growth, energy security, climate change mitigation and the development of a knowledge based society. The National Green Technology Policy was developed with the cooperation of all relevant stakeholders in the country to strengthen institutional frameworks and policy coherence based around four main pillars; energy, environment, economy and social. Progress will be monitored by a variety of National Key Indicators to measure the success of new green technology policies and initiatives. New green technologies will be developed in four core sectors; energy, buildings, water and waste management and transport while work is under way to develop a new Green Technology Roadmap for Malaysia.

Policies to enhance and strengthen institutional frameworks include: the formation of the Green Technology Council and a Cabinet Committee on Green Technology chaired by the Prime Minister for high level policy coordination among ministries; the establishment of the

Malaysia Green Technology Agency to coordinate and implement initiatives and programmes; a review of existing legal mechanisms and the establishment of new legislation in line with national objectives and goals as well as enhancing institutional clarity so all agencies are aware of their respective roles and responsibilities.

Policies to facilitate the growth of green technology sectors include support for networks of innovation including the expansion of local research institutions and institutions of higher learning to support research and development, increased foreign and domestic investment (FDIs and DDIs), Green Technology Fund, feed-in-tariff (FiT) legislation to support renewable energy in power generation; recognition of green products through standards, rating and labelling programmes supported by green public procurement and widespread public awareness programmes. In addition to the Green Technology Fund and forthcoming FiT, other fiscal incentives for renewable energy include Pioneer Status which provides exemption from income tax (25% from 2009 onwards) on 100% of statutory income for 10 years and Investment Tax Allowances on qualifying capital expenditure incurred within 5 years of the first expenditure (KETTHA 2009). Import duty and sales tax exemptions for 1 year on imported machinery, equipment, materials, spare parts and consumables used for renewable energy are also available both for importers and third party distributors. An incentive to improve the power quality of renewables is an Accelerated Capital Allowance (ACA) available to support projects implemented before December 2010. Various industry enhancement programmes also exist to strengthen and inform SMEs about new green technologies and funding mechanisms as well as the establishment of strategic green technology hubs throughout the country.

To improve human resource capacity for green technology, a number of policies for training and education programmes will be used, such as financial and fiscal incentives for students perusing studies in green technology related disciplines at both undergraduate and post graduate levels; retraining and apprenticeship schemes for new green jobs; formulation of new grading and certification mechanisms for technology-related skills and take advantage of brain gain programmes to strengthen local expertise.

6.7.2 Thailand

Thailand has enormous potential for generating electricity from renewables (see Table 19). As part of its 2009 Energy Policy goal of generating 20% of their energy requirements from renewable sources by 2020, the Ministry of Energy directed the Department of Alternative Energy Development and Efficiency to set the policy on alternative energy as part of the National Agenda. The plan aims to generate 40,000 new jobs and reduce migration from rural areas, reduce green house gas emissions, save baht 460 billion a year of foreign currency reserves spent on importing fossil fuels and generate up to baht 14 billion a year revenue from international carbon markets.

The Alternative Energy Development Plan features provisions for the production and use of alternative energy to enhance energy security particularly by using biofuels and biomass. The Government of Thailand will use a mix of market-based instruments as well as the oil fund to maintain energy prices at appropriate, stable and affordable levels. Policies included in the Alternative Energy Development Plan, include, inter allia, support for research and development into renewable energy particularly in biofuels and co-generation from biomass and biogas; energy efficiency standards for electrical appliances and buildings and renewable energy technology standards; the revision of existing obstructive legislation; and feed-in-tariffs for energy derived from alternative sources (e.g. 8 baht/kwh adder cost for solar, which may be reduced to 6.5 due to the reduction in the cost of solar technology). Import duties on equipment for renewable energy will be waivered as well as exemption from corporate income tax for new investments and start-ups. A country-wide network for workshops, seminars and knowledge sharing activities will also be established to inform stakeholders about renewable energy well as publishing an academic booklet for students and nation-wide public awareness campaigns.

Table 19: Renewable Energy Potentials for Electricity Generation in Thailand

Renewable Energy Source	Potentials (MW)	From
Solar	50,000	Urban areas, solar homes, Majestic projects
Hydro	700	Micro-hydro and mini-hydro
Wind	1,600	Wind farms in southern Thailand
Biomass	4,400	Sugarcane & palm industries, biomass power plants and community power plants
Biogas	190	Livestock farms, agro- industry

Source: Department of Alternative Energy Development and Efficiency, Ministry of Energy, Thailand, 2009

Funding for new commercial alternative energy technologies will be encouraged by tax incentives and investments from a revolving fund (4% interest over 7 years), the Thai Board of Investment (BOI), the energy services company (ESCO) fund and the Clean Development Mechanism under the Kyoto Protocol.

Over the long term the alternative energy policy aims to enhance the utilization of available new green technologies such as hydrogen and bio hydrogenated (BHD) diesel from palm oil; extend green city models throughout communities in the country and encourage the exportation of biofuels and indigenous green technologies to the ASEAN region.

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8. Annexes

Annex I: Total GHG Emissions of UNESCAP Members Countries (2005)

Country	MtCO2e	UNESCAP Rank	World Rank	% of World Total	MtCO2e Per Person	UNESCAP Rank	World Rank
China	7,217.70	1	1	16.36%	5.5	23	93
Indonesia	2,045.30	2	5	4.63%	9.3	13	57
Russian Federation	2,020.70	3	6	4.58%	14.1	7	26
India [1]	1,876.60	4	7	4.25%	1.7	34	154
Japan [1]	1,397.40	5	8	3.17%	10.9	12	45
Korea (South) [1]	609.2	6	13	1.38%	12.7	9	34
Australia [1]	569.9	7	16	1.29%	27.9	3	9
Iran [1]	560.3	8	17	1.27%	8.1	16	69
Turkey	431.1	9	23	0.98%	6.1	19	84
Thailand [1]	366.5	10	26	0.83%	5.6	22	92
Malaysia [2]	364.6	11	27	0.83%	14.2	6	25
Pakistan [1]	243.1	12	33	0.55%	1.6	35	156
Philippines	211.7	13	35	0.48%	2.5	28	134
Kazakhstan [1]	206.2	14	36	0.47%	13.6	8	28
Uzbekistan [1]	180.9	15	39	0.41%	6.9	18	79
Vietnam [1]	178.5	16	41	0.40%	2.1	31	141
Bangladesh [1]	143.2	17	45	0.32%	0.9	39	172
Singapore [1]	136.7	18	49	0.31%	32	2	5
Korea (North) [1,3]	118.4	19	55	0.27%	5	24	101
Cambodia	106.8	20	58	0.24%	7.7	17	73
Turkmenistan [1,3]	91.4	21	61	0.21%	18.9	5	15
New Zealand [1]	82.5	22	68	0.19%	20	4	13
Papua New Guinea [2,3]	52.6	23	85	0.12%	8.7	15	64
Azerbaijan [1]	48.4	24	88	0.11%	5.8	21	88
Nepal [1]	40.6	25	92	0.09%	1.5	36	158
Mongolia [1]	30.3	26	99	0.07%	11.9	10	40

Sri Lanka [1,2]	26.1	27	103	0.06%	1.3	38	163
Laos [1,3]	17.3	28	118	0.04%	3	27	126
Afghanistan [1,2,3]	14	29	121	0.03%	0.5	40	183
Brunei* [1,2]	12.5	30	126	0.03%	33.4		4
Tajikistan [1]	9.8	31	136	0.02%	1.5		157
Kyrgyzstan [1]	9.7	32	137	0.02%	1.9		150
Armenia [1]	7.5	33	142	0.02%	2.5		136
Solomon Islands [1,2,3]	4.2	34	149	0.01%	8.9		61
Fiji [1,2,3]	2.7	35	156	0.01%	3.3		117
Vanuatu [1,2,3]	0.5	36	172	0.00%	2.1		142
Nauru [1,2,3]	0.1	37	181	0.00%	11.2		44
Palau [1,2,3]	0.1	38	183	0.00%	6.1		83
Cook Islands [1,2,3]	0.1	39	184	0.00%	3.2		120
Kiribati [1,2,3]	0	40	185	0.00%	0.5		184

Note: Includes land use change & international bunkers. (CO_2, CH_4, N_2O, PFCs, HFCs, SF_6)
Countries for which data was not available are not included.
[1] Data from Land Use Change & Forestry not available. [2] PFC HFC & SF_6 data not available. [3] Data from Int'l Bunkers not available.
Source: Climate Analysis Indicators Tool (CAIT) Version 7.0. (Washington, DC: World Resources Institute, 2010)

Annex II: Power Generation in the 450 Scenario— Potential Carbon Dioxide (CO2) Savings and Abatement Costs in the IEA World Energy Outlook 2009 for Selected Countries

	Russia		China		India		Japan	
	CO_2 Savings $MtCO_2$	Abatement Cost \$ per tonne CO_2	CO_2 Savings $MtCO_2$	Abatement Cost \$ per tonne CO_2	CO_2 Savings $MtCO_2$	Abatement Cost \$ per tonne CO_2	CO_2 Savings $MtCO_2$	Abatement Cost \$ per tonne CO_2
Changes in demand	**163.6**		**1 696.4**		**267.7**		**64.5**	
Savings from lower emitting technologies	**282.9**	**41.7**	**1 542.8**	**41.6**	**608.4**	**37.2**	**191.1**	**33.1**
more efficient coal plant (excl. CCS)	*4.1*	*4.6*	*310.6*	*- 14.7*	*42.3*	*- 5.6*	*9.5*	*16.5*
more efficient gas plant (excl. CCS)	-	-	-	-	*0.8*	*84.2*	-	-
utilising spare gas capacity over coal	-	-	-	-	*14.2*	*94.6*	-	-
through use of CCS	*51.3*	*52.8*	*210.1*	*38.2*	*23.0*	*37.2*	*12.8*	*59.8*
- CCS Coal (Oxyfuel)	*19.8*	*48.9*	*82.6*	*42.2*	*9.3*	*35.3*	*3.1*	*42.5*
- CCS Coal (IGCC)	*22.7*	*55.3*	*124.6*	*34.0*	*13.7*	*38.6*	*4.2*	*48.0*
- CCS Gas	*8.8*	*55.0*	*2.9*	*106.8*	-	-	*5.5*	*78.6*
Nuclear	*33.8*	*11.7*	*353.7*	*23.5*	*130.9*	*17.1*	*104.6*	*15.9*
Renewables	*193.6*	*44.8*	*668.5*	*71.5*	*397.2*	*45.7*	*64.2*	*58.2*
- Hydro Conventional	*97.9*	*34.5*	*140.7*	*46.5*	*246.1*	*33.6*	*7.6*	*12.8*
- Bioenergy	*39.1*	*63.9*	*148.1*	*70.4*	*62.5*	*54.9*	*14.1*	*35.8*
- Wind Onshore	*42.1*	*50.4*	*179.0*	*59.4*	*40.5*	*45.1*	*8.7*	*25.2*
- Wind Offshore	*2.0*	*68.6*	*125.9*	*74.2*	*27.9*	*58.2*	*16.2*	*39.4*
- Geothermal	*11.2*	*23.3*	*5.8*	*37.3*	*1.3*	*25.5*	*2.9*	*4.0*
- Solar PV	*1.3*	*229.2*	*40.2*	*205.1*	*16.0*	*174.6*	*13.4*	*165.0*
- Concentrating Solar Power	-	-	*28.5*	*82.0*	*2.8*	*65.2*	*0.0*	*46.9*
- Tide/Wave	*0.1*	*65.8*	*0.1*	*72.0*	*0.1*	*56.3*	*1.3*	*37.3*
Total Savings	**446.481**		**3239.26**		**876.136**		**255.619**	

Source: IEA, World Energy Outlook 2009, http://www.worldenergyoutlook.org/investments.asp, accessed June 18, 2010.

Annex III: UNESCAP Proposed List of 64 Climate Smart Technologies

H.S. Code	H.S. Code Description 2007
380210	Activated carbon
392010	Name: Plates, sheets, film, foil & strip, of polymers of ethylene, non-cellular reinforced, laminated, supported/similarly combined with other materials (excl. self-adhesive) Description: - Of polymers of ethylene
392690	Name: Articles of plastics & articles of other materials of headings 39.01 to 39.14, n.e.s. in Ch 39 Description: - Other
560314	Name: Nonwovens, whether/not impregnated/coated/covered/laminated, of man-made filaments, weighing >150 g/m2 Description: -- Weighing more than 150 g/m²
700800	Multiple-walled insulating units of glass
701931	Name: Mats of glass fibres Description: -- Mats
730431	Name: Tubes, pipes & hollow profiles (excl. of 7304.10-7304.29), seamless, of circular cross-section, of cold-drawn/cold-rolled (cold-reduced) steel Description: -- Cold-drawn or cold-rolled (cold-reduced)
730441	Name: Tubes, pipes & hollow profiles (excl. of 7304.10-7304.39), seamless, of circular cross-section, of stainless steel, cold-drawn/cold-rolled (cold-reduced) Description: -- Cold-drawn or cold-rolled (cold-reduced)
730451	Name: Tubes, pipes & hollow profiles (excl. of 7304.10-7304.49), seamless, of circular cross-section, of alloy steel other than stainless steel, cold-drawn/cold-rolled (cold-reduced) Description: -- Cold-drawn or cold-rolled (cold-reduced)
730820	Name: Towers & lattice masts of iron/steel Description: - Towers and lattice masts
730900	Reservoirs, tanks, vats and similar containers for any material (other than compressed or liquefied gas), of iron or steel, of a capacity exceeding 300 l, whether or not lined or heat-insulated, but not fitted with mechanical or thermal equipment.
732111	Name: Cooking appliances & plate warmers, for gas fuel/for both gas & other fuels. Description: -- For gas fuel or for both gas and other fuels. (HS 732119) Name: Other cooking appliances & plate warmers incl. appliances for solid fuel, other than for gas fuel/for both gas & other fuels/liquid fuel. Description: -- Other, including appliances for solid fuel
732190	Name: Parts of the non-electric domestic appliances of 7321.11-7321.83, of iron/steel Description: - Parts
732490	Name: Sanitary ware & parts thereof , of iron/steel (excl. of 7324.10-7324.29) Description: - Other, including parts

761100	Aluminium reservoirs, tanks, vats and similar containers, for any material (other than compressed or liquefied gas), of a capacity exceeding 300 l, whether or not lined or heat-insulated, but not fitted with mechanical or thermal equipment.
761290	Name: Aluminum casks, drums, cans, boxes & similar containers, incl. rigid tubular containers but excl. collapsible tubular containers for any material (other than compressed/liquefied gas), of a capacity not >300 l, whether/not line/heat-insulated, but not fitted Description: - Other
840219	Name: Vapour generating boilers, incl. hybrid boilers (excl. of 8402.11 & 8402.12; excl. central heating hot water boilers capable also of producing low pressure steam) Description: -- Other vapour generating boilers, including hybrid boilers
840290	Name: Parts of the boilers of 8402.11-8402.20 Description: - Parts
840410	Name: Auxiliary plant for use with boilers of 84.02/84.03 (e.g., economisers, super-heaters, soot removers, gas recoverers) Description: - Auxiliary plant for use with boilers of heading 84.02 or 84.03
840490	Name: Parts of the auxiliary plant of 8404.10 & 8404.20 Description: - Parts
840510	Producer gas or water gas generators, with or without their purifiers; acetylene gas generators and similar water process gas generators, with or without their purifiers
840681	Name: Steam turbines & other vapour turbines (excl. for marine propulsion), of an output >40 MW Description: -- Of an output exceeding 40 MW
840682	Name: Steam turbines & other vapour turbines (excl. for marine propulsion), of an output not >40 MW Description: -- Of an output not exceeding 40 MW
841011	Name: Hydraulic turbines & water wheels, of a power not >1000 kW Description: -- Of a power not exceeding 1,000 kW
841012	Name: Hydraulic turbines & water wheels, of a power >1,000 kW but not >10,000 kW Description: -- Of a power exceeding 1,000 kW but not exceeding 10,000 kW
841013	Name: Hydraulic turbines & water wheels, of a power >10,000 kW Description: -- Of a power exceeding 10,000 kW
841090	Name: Parts (incl. regulators) of the hydraulic turbines & water wheels of 8410.11-8410.13 Description: - Parts, including regulators
841181	Name: Gas turbines other than turbo-jets/turbo-propellers, of a power not >5,000 kW Description: -- Of a power not exceeding 5,000 kW
841182	Name: Gas turbines other than turbo-jets/turbo-propellers, of a power >5,000 kW Description: -- Of a power exceeding 5,000 kW
841581	Name: Air-conditioning machines incorporating a refrigerating unit & a valve for reversal of the cooling/heat cycle (reversible heat pumps) Description: -- Incorporating a refrigerating unit and a valve for reversal of the cooling/heat cycle (reversible heat pumps)
841861	Name: Compression-type refrigerating/freezing equip. whose condensers are heat exchangers Description: -- Heat pumps other than air conditioning machines of heading 84.15

841869	Name: Refrigerating/freezing equip. n.e.s. in 84.18; heat pumps Description: -- Other
841919	Name: Instantaneous/storage water heaters, non-electric (excl. of 8419.11) Description: -- Other
841940	Name: Distilling/rectifying plant, whether/not electrically heated Description: - Distilling or rectifying plant
841950	Name: Heat exchange units, whether/not electrically heated Description: - Heat exchange units
841989	Name: Machinery, plant & equip., n.e.s. in Ch.84, other than for making hot drinks/for cooking/heating food, whether/not electrically heated Description: -- Other
841990	Name: Parts of machinery, plant/laboratory equipment, whether/not electrically heated (excl. furnaces, ovens & other equipment of heading 85.14), for the treatment of materials by a process involving a change of temperature such as heating, cooking, roasting Description: - Parts
842129	Filtering/purifying mach. & app. for liquids (excl. of 8421.21-8421.23)
842139	Name: Filtering/purifying machinery & apparatus for gases, other than intake air filters for internal combustion engines Description: -- Other
847989	Name: Other machines & mechanical appliances, other than Machines & mechanical appliances for treating metal, incl. electric wire coil-winders/Mixing/kneading/crushing/grinding/screening/sifting/homogenising/emulsifying/stirring machines Description: -- Other
848340	Gears and gearing, other than toothed wheels, chain sprockets and other transmission elements presented separately; ball or roller screws; gear boxes and other speed changers, including torque converters
848360	Clutches and shaft couplings (including universal joints)
850161	Name: AC generators (alternators), of an output not >75kVA Description: -- Of an output not exceeding 75 kVA
850162	Name: AC generators (alternators), of an output >75kVA but not >375kVA Description: -- Of an output exceeding 75 kVA but not exceeding 375 kVA
850163	Name: AC generators (alternators), of an output >375kVA but not >750kVA Description: -- Of an output exceeding 375 kVA but not exceeding 750 kVA
850164	Name: AC generators (alternators), of an output >750kVA Description: -- Of an output exceeding 750 kVA
850231	Name: Wind-powered electric generating sets Description: -- Wind-powered
850239	Name: Electric generating sets n.e.s. in 85.02 Description: -- Other
850300	Parts suitable for use solely or principally with the machines of heading 85.01 or 85.02.
850440	Static converters

850680	Name: Primary cells & primary batteries n.e.s. in 85.06 Description: - Other primary cells and primary batteries
850720	Name: Electric accumulators, incl. separators therefore, whether/not rectangular (incl. square), lead-acid (excl. of 8507.10) Description: - Other lead-acid accumulators
853710	Description: Boards, panels, consoles, desks, cabinets and other bases, equipped with two or more apparatus of heading 85.35 or 85.36, for electric control or the distribution of electricity, including those incorporating instruments or apparatus of Chapter 90, and numerical control apparatus, other than switching apparatus of heading 85.17. Description: - For a voltage not exceeding 1,000 V
853931	Name: Electric discharge lamps (excl. ultra-violet lamps), fluorescent, hot cathode Description: -- Fluorescent, hot cathode
854140	Photosensitive semiconductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light emitting diodes
890790	Name: Floating structures other than inflatable rafts (e.g., rafts (excl. inflatable), tanks, coffer-dams, landing-stages, buoys & beacons) Description: - Other
900190	Name: Lenses (excl. of 9001.30-9001.50), prisms, mirrors & other optical elements, of any material, unmounted, other than such elements of glass not optically worked Description: - Other
900290	Name: Lenses, prisms, mirrors & otheroptical elements, of any material, mounted, being parts of/fittings for instr./apparatus (excl.such elements of glass not optically worked), n.e.s. in 90.02 Description: - Other
902830	Name: Electricity meters, incl. calibrating meters therefore Description: - Electricity meters
903020	Oscilloscopes and oscillographs
903031	Name: Multimeters Description: -- Multimeters without a recording device
903039	Name: Instruments & apparatus for measuring/checking voltage/current/resistance/power (excl. of 9030.31), without a recording device Description: -- Other, with a recording device
903210	Thermostats
903220	Manostats

Annex IV: Climate-Smart Technologies' Appearances in Previous Proposed Lists

H.S. Code	OECD	APEC	WTO	World Bank	ICTSD Renewables	ICTSD Buildings
380210	x	-	-	-	x (ex)	-
392010	-	-	x	x	-	-
392690	x	x (ex)	-	-	x (ex)	x (ex)
560314	-	x (ex)	x	x	-	-
700800	x	-	-	-	-	x
701931	-	-	x	x	-	-
730431	-	-	x	-	x (ex)	x
730441	-	-	x	-	x (ex)	-
730451	-	-	x	-	x (ex)	-
730820	-	-	x	x	x (ex)	-
730900	x	-	x	x	x (ex)	-
732111	-	-	x	x	-	x (ex) (HS2007 7321.19)
732190	-	-	x	x	-	-
732490	-	-	x	x	-	-
761100	-	-	x	x	x (ex)	-
761290	-	-	x	x	-	-
840219	-	-	x	x	-	-
840290	-	-	x	x	-	-
840410	-	x	x	x	-	-
840490	-	-	x	x	-	-
840510	-	x (ex)	x	x	x (ex)	-
840681	-	-	x	x	x (ex)	-
840682	-	-	x	-	x (ex)	-
841011	x	x	x	x	x (ex)	-
841012	x	x	-	-	x (ex)	-
841013	x	x	-	-	x (ex)	-
841090	x	x	x	x	-	-
841181	-	-	x	x	x	-
841182	-	-	x	x	x	-
841581	-	-	x	x	-	x (ex)
841861	-	-	x	x	x (ex)	x (ex)

841869	**-**	**-**	**x**	**x**	**-**	**-**
841919	**x**	**x (ex)**	**x**	**x**	**-**	**x (ex)**
841940	**-**	**x**	**x**	**x**	**x (ex)**	**-**
841950	**x**	**x**	**x**	**x**	**x (ex)**	**x**
841989	**x**	**-**	**x**	**x**	**x (ex)**	**x (ex)**
841990	**x**	**-**	**x**	**x**	**x (ex)**	**x (ex)**
842129	**x**	**x**	**x**	**-**	**x (ex)**	**-**
842139	**x**	**x**	**x**	**-**	**x (ex)**	**-**
847989	**-**	**x (ex)**	**x**	**-**	**x (ex)**	**-**
848340	**-**	**-**	**x**	**x**	**x (ex)**	**-**
848360	**-**	**-**	**x**	**x**	**-**	**-**
850161	**-**	**-**	**x**	**x**	**x**	**-**
850162	**-**	**-**	**x**	**x**	**x**	**-**
850163	**-**	**-**	**x**	**x**	**x**	**-**
850164	**-**	**-**	**x**	**x**	**x**	**-**
850231	**-**	**x**	**x**	**x**	**x**	**-**
850239	**-**	**-**	**x**	**-**	**x (ex)**	**-**
850300	**-**	**-**	**x**	**-**	**x (ex)**	**-**
850440	**-**	**-**	**x**	**-**	**x (ex)**	**-**
850680	**-**	**-**	**x**	**x**	**-**	**-**
850720	**-**	**-**	**x**	**x**	**-**	**-**
853710	**-**	**-**	**x**	**x**	**x**	**-**
853931	**x**	**-**	**-**	**-**	**-**	**x**
854140	**x**	**x (ex)**	**x**	**x**	**x (ex)**	**x (ex)**
890790	**-**	**x (ex)**	**x**	**-**	**x (ex)**	**-**
900190	**-**	**-**	**x**	**x**	**x (ex)**	**-**
900290	**-**	**-**	**x**	**x**	**x (ex)**	**-**
902830	**-**	**x**	**x**	**-**	**x**	**-**
903020	**-**	**x**	**x**	**-**	**x**	**-**
903031	**-**	**x**	**x**	**-**	**x**	**-**
903039	**-**	**x**	**x**	**-**	**x**	**-**
903210	**x**	**x**	**x**	**x**	**-**	**x**
903220	**x**	**x**	**x**	**x**	**-**	**-**