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Climate Change, Trade and Competitiveness: Issues for the WTO

Creating incentives for clean technology trade, transfer, and diffusion: The role of non-distorting policies [1]

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Thinking Ahead on International Trade (TAIT)

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2 World Bank

1. Introduction

Interaction between trade and climate change regimes has received much attention lately. They have generated more heat than light in illuminating issues of common concern. While one can think of a number of "climate-positive" reasons for exploring synergies between the two regimes and for aligning policies that could stimulate production, trade, and investment in cleaner technology options, much of focus instead has been on using trade measures as weapons in the global climate negotiations to bring developing countries into the fold. This stems mainly from competitiveness concerns in countries that are now racing to reduce GHG emissions to meet Kyoto targets and beyond and in the US primarily to allay domestic fears of a tightening climate regime. These concerns have led to proposals for tariff or border tax adjustments (BTAs) to offset any adverse impact of capping CO2 emissions. This also has roots in the fear of leakage of carbon-intensive industries such as steel and chemicals to non-implementing countries.

The recent Waxman-Markey bill introduced in the US Congress provides for trade sanctions against countries that do not impose controls on carbon emissions by levying tariffs on certain goods from those countries. The provisions are similar to the earlier bills introduced in the US Senate by Senators Lieberman and Warner and by Senators Bingaman and Specter. If passed in their current form, these bills would require foreign manufacturers and importers to pay for and hold special allowances to "cover" the carbon contained in U.S.-bound products. The requirement for such purchases would be an alternative to offsetting border measures in the form of tariffs.

Similarly, the European Commission's plans to tighten Europe's greenhouse gas reduction regime also recognizes the risk that new legislation could put European companies at a competitive disadvantage compared to countries with less stringent climate protection laws, such as the US, China and India. To address this, the draft legislation includes a "carbon equalization system" that could take the form of an obligation for foreign companies doing business in Europe to obtain emissions permits alongside European competitors.

The issue of imposing trade sanctions (or BTAs) on environmental grounds has been much discussed in economic and legal spheres. The WTO permits members to adopt measures to protect the environment and human health and life as long as such measures comply with GATT rules. But legal experts remain divided on whether climate-related measures proposed by the EU or the US would be compatible with international trade regulations, as the WTO so far has not come out with clear provisions on the subject. Some suggest that the offsetting border provisions in the US and EU bills have been carefully crafted to avoid—or survive if necessary—any challenges in the WTO dispute settlement process.

The international trade literature (Markusen 1975; Baumol and Oates 1988; Copeland 1996; Ludema and Wooton 1994; Mani 1996) points to a role for trade restrictions for environmental purposes in a second-best setting, Pigouvian (environmental) taxes being the first-best measures. They suggest use of trade measures either as tools to maximize the welfare of the importing country, if it is directly affected by pollution from the exporting country (as in a tranboundary pollution), or as weapons to persuade the exporting country to introduce some standard measure of pollution control. It is difficult in such a general framework to get much sense of the appropriate magnitude of such tariffs and their potential effects. Further, much of the focus in the theoretical literature is on local pollution in a two-country setting where transboundary pollution in one affects the other, as opposed to global pollution (like GHG emissions) which affects the entire world.

From a developing country perspective, this is an issue of serious concern as the BTAs of the variety proposed in the US and EU could significantly impact their manufacturing export base. A recent background analysis (Atkinson and others 2009) done for the World Development Report suggests that exports from countries like China, India and South Africa could be subject to an average applied tariff of 8-10 percent of total exports if a carbon tax of around $50 is imposed on imports. However, these calculations were based on estimating carbon content using input-output framework which is highly complex and subject to dispute. Further, analysis based CGE modeling is subject to high level of aggregation and does not lend to a proper assessment of unilateral policy measures as proposed in US and EU (Wooders, Cosbey and Stephenson 2009).

Measuring the carbon content for BTAs, particularly when these would lead to the imposition of carbon standards, requires more detailed (even plant level) data.

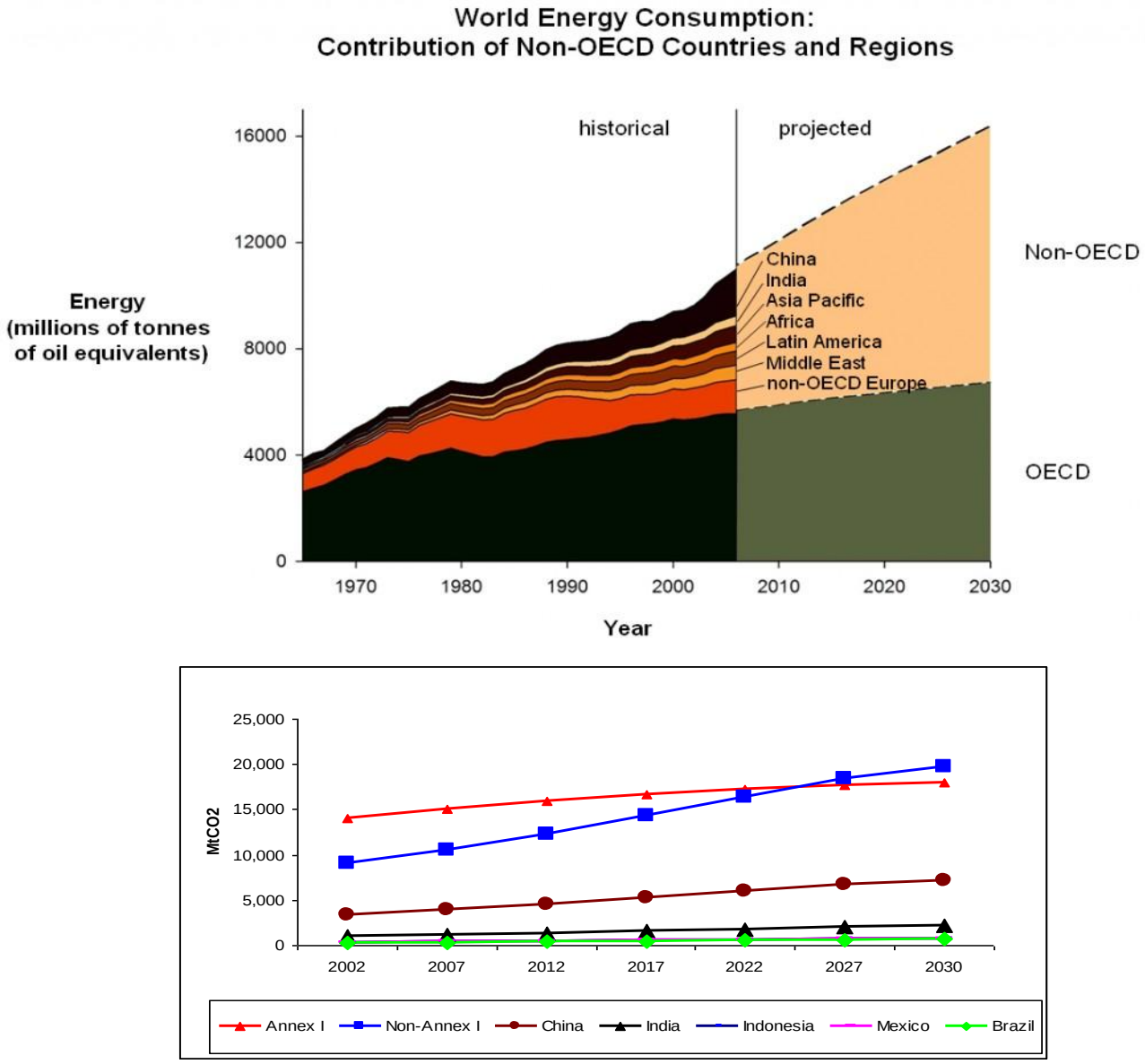
In a similar vein, firms in some high-income countries are adopting "carbon labeling" as a mechanism for mitigating climate change. Carbon labeling involves measuring carbon emissions from the production of products or services and conveying that information to consumers and those making sourcing decisions within companies. It is possible that well-designed schemes would create incentives for production in different parts of the supply chain to move to lower-emission locations. The downside of carbon-labeling schemes is that they are likely to have a significant impact on exports from low-income countries (Brenton, Edwards-Jones, and Jensen 2009). Exports from low-income countries typically depend on long-distance transportation and are produced by relatively small firms and tiny farms that will find it difficult to participate in complex carbon-labeling schemes.

These proposed provisions also in some ways circumvent the UNFCCC process which has adopted the principle of "common but differentiated responsibility." The principle recognizes historical differences in the contributions of developed and developing States to global environmental problems, and differences in their respective economic and technical capacity to tackle these problems. Further, as per the principle, developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command (Principle 7 of the Rio Declaration). This requirement is not in line with BTAs, which seek to level the playing field by equalizing costs to producers across the world

If one were to look beyond the competitiveness and justice concerns, the idea of developing countries adhering to some form of carbon control or consciousness makes sense if one were to subscribe to the view that global efforts of reaching the 2 degrees target (as agreed in the Copenhagen accord) would *not* be possible without the concerted effort by some high emitting developing countries who in all likelihood would be contributing to a large share of the global emissions in the coming years. While developed countries remain the largest per emitters of

greenhouse gases today from a stock perspective, the growth of carbon emissions in the next decades according IEA (IEA 2009) will thus come primarily from developing countries, which are following the same energy and carbon intensive development path as did their rich counterparts. By 2030 developing country emissions of carbon from energy use will exceed that of developed countries in aggregate (Figure 1).

Figure 1: Energy Consumption and CO_2 Emissions from Energy use



Source: IEA, Global Energy Statistics (2007)

Irrespective of the resolution of debates over border tax adjustments, the more important objective should therefore be to create incentives to develop "green" technologies and propel their diffusion as quickly as possible so as to move development processes toward a low-carbon growth path. This brings to light the issue of technology transfer, development and diffusion in the broader context of climate discussions. It is in this context that this paper discusses the role of non-distorting policies for transfer, diffusion and development of technologies, in particular to developing countries. The paper will argue that this should become a particularly key element of any effective international response to the global climate change challenge.

2. Technology Transfer in the Climate Change Context

Technology issues have always been at the forefront of the global climate change debate. It is even suggested that just like the food crises of 1960 triggered the need for a "green" revolution, we need nothing short of a technology revolution to deal with climate change especially if one were to get rapidly growing developing countries on a low carbon path.

However, if we look over the horizon, there isn't enough of a sense of urgency being exhibited when it comes to technology, either internationally or at the country level. An Expert Group on Technology Transfer was created by UNFCCC to identify ways to facilitate and advance technology transfer activities. Unfortunately, the expert group has not done much except prepare some documents on clean technology issues. There has been no specific discussion on institutional mechanisms needed to ensure effective technology transfer, at the national level in developing and industrialized countries, and at the multilateral level to connect differing national actors and achieve multilateral mitigation and adaptation goals.

Energy technologies, both currently in use and under development, have the potential to reduce carbon emissions substantially. Such options include renewable energies, carbon capture and storage, more efficient power generation from fossil fuels, nuclear power, and improved efficiency of endues technologies, industry, and transport. While, clean energy generating technologies and energy efficiency technologies have equal abatement potential, it is often difficult to say where the biggest bang for the buck in taxation/regulation/investment. It is often

cited that energy efficiency measures are somewhat of 'low hanging fruits' as far as costs of mitigation are concerned (as popularized in McKinsey Marginal Abatement Cost curves), yet measures to create incentives and scale-up energy efficiency measures are still demonstrably lacking. One still sees carbon-intensive infrastructure and cities being built rapidly and expanded with little emphasis on cleaner and more efficient technologies.

Recently, a number of regional/national low carbon studies have been undertaken (some supported by the Bank) but they present limited representation of some regions, countries, sectors, gases, and barriers. In general they suggest that comparatively high costs and insufficient operating experiences very often hamper deployment of clean energy technology on the scale needed for climate change mitigation and to meet rising global demand for primary energy. Further, while the more widespread adoption of existing technologies can have significant mitigation potential and should definitely be pursued, they conclude that a truly sustainable energy future can only be achieved if new and improved clean energy technologies beyond those commercially available today are developed.

The general lack of progress in development, deployment and diffusion of clean energy technologies can be attributed to classic market failure both on the innovation and diffusion sides: price signals are not adequate to call forth innovation sufficiently rapidly to mitigate emissions consistent with social targets; and second once the innovation occurs, the market mechanism does not propel diffusion as rapidly as would be socially optimal.

A recent World Bank study (Avato and Coony 2009) suggests that the research, development, and deployment (RD&D) activities needed to commercialize these clean energy and energy efficient technologies have finally—after a period of significantly reduced activity—increased over the last two to three years. From the mid-1980s to the early 2000s, energy research and development (R&D) spending was well below historic highs. By 2003, public energy R&D spending in the OECD had fallen to 60 percent from its peak in 1980, and private sector spending had fallen from $8.5 billion in the late 1980s to $4.5 billion in 2003. While absolute investments in energy innovation continue to lag behind historical levels, the trend appears to be

reversing as concerns about climate change, energy security and high oil prices are prompting intensified private and public R&D activities.

The study adds, however, that these renewed efforts will face significant barriers that impact the ability to develop and deploy promising clean energy options such as (a) uncertain future value of CO2 emissions abatement; (b) provision of a public good being hampered by free-riding across space—countries that free-ride on the mitigation efforts of others; (c) the "Valley of Death," which occurs when promising technologies languish between public and private sector RD&D efforts in innovation; (d) intellectual property rights (IPRs) issues where the large RD&D investments needed for technical advances in clean energy will be undermined by uncertain global IPR protection; (e) challenges developing and transferring technology to developing countries. Responsible for substantial source of incremental emission growth as they will need OECD resources and expertise to deploy the needed clean energy technologies; (e) subsidies for conventional energy products at both the retail and production levels reduce to below-cost the price with which new energy technologies must compete; and (f) deployment of clean energy and energy efficient technologies is often hampered by trade barriers.

All this suggests for an "activist" public policy to support development, deployment and diffusion of clean technologies. A classic example of policy and market failure in case of clean energy technology is the "valley of death" that refers to the period in product development between public and private sector involvement. Once potentially profitable products have been identified, public-sector participation usually declines as the government backs away from "picking winners." Furthermore, governments do not want to subsidize private industry or distort the market because investors stand to profit handsomely from the ultimately commercial products. However, the private sector often still sees too much risk to get fully involved and to continue the product development process on its own. Promising technologies do not progress to the demonstration and scale-up stages needed to achieve full commercialization (Avato and Coony 2009).

Technology transfer occurs through a number of channels such as trade, investment, international joint ventures, licenses and international development assistance. A recent World Bank study

(World Bank 2008) suggests that liberalizing trade can significantly increase the diffusion of clean technologies in developing countries.

While liberalization policies may help in access to international technology, the success of technology diffusion in general depends on a range of other enabling factors, particularly the capacity to absorb and improve technologies in the host countries. Beyond trade, foreign direct investment (FDI) can be an important means of transferring technology. However, weak IPR regimes (or perceived weak IPRs) and other barriers often cited as reasons that inhibit diffusion of specific technologies beyond the project level. These barriers range from weak environmental regulations, fiscal feasibility, financial and credit policies, economic and regulatory reforms, and the viability of technology to local conditions (including availability of local skills and know-how). So governments need to complement IPRs with appropriate policy infrastructure, governance and competition systems in order to be effective conduits for technology transfer and diffusion. Recently, a number of governments have begun to implement policies and programs to support development and deployment of renewable and energy efficient technologies as a part of their broader climate change strategies and action plans (Box 1: India's Clean Energy Agenda).

Box 1: India's Clean Energy Agenda

Although India currently has a relatively low carbon footprint on a per-capita basis, CO2 emissions are set to grow rapidly due to the government's growth and development objectives. India has unique development challenges among the large economies, as it is committed to providing lifeline electricity to about 400 million people who currently do not have access and to address chronic energy shortages within the context of a poor endowment of natural and clean energy resources.

The scale of the growth of energy demand in India raises obvious questions about the time path of the country's CO2 emissions, which has strong global implications: India's CO2 emissions from fuel use in 2007 were less than 5 percent of the world total, according to the International Energy Agency but its share of the global emissions is likely to increase with economic development. India relies heavily on coal for its commercial energy demand (53 percent of installed generation capacity) but lacks other domestic energy resources, and is increasingly dependent on imports of fossil fuels to meet demand. With an expectation of a substantial increase in energy use, reduction in the growth in total CO2 emissions will depend on the extent to which total growth in energy use is offset by a combination of (a) further reduction in energy intensity of GDP, allowing growth and development goals to be met with less growth in energy

use and associated CO2 emissions than anticipated; and (b) a further reduction in the CO2 intensity of energy use through greater increases, where possible, in the share of energy demand met by lower-carbon or even carbon-neutral energy resources.

Recently, there have been major initiatives at the domestic level to deal with energy security, which invariably address carbon emissions, India's first National Action Plan on Climate Change was released in 2008, outlining existing and future policies and programs addressing climate mitigation and adaptation (Government of India 2008). The plan identifies eight national missions running through 2017 and directs nodal agencies to submit detailed implementation plans to the Prime Minister's Council on Climate Change. The Prime Minister's Council has already approved the Energy Efficiency Mission, which target 5 percent reduction in annual energy consumption, and the National Solar Mission, which has set a target of installing 20 gigawatts (GW) of solar power by 2020. Prior to the Copenhagen Climate Change Conference, the government also announced that India will cut its carbon intensity by 20–25 percent from 2005 levels by calendar 2020. India's ability to secure a reliable supply of energy resources at affordable prices will be one of the most important factors in shaping its future energy consumption. This will require the government of India to maintain and increase the momentum for improving efficiency in the supply chain and developing and tapping into renewable energy at both the national and regional levels to the fullest extent possible.

Source: World Bank, 2010.

3. Policies to ease barriers in the diffusion of clean technology in developing countries

Technology transfer and diffusion is essentially motivated by economic incentives, and largely takes place in the private sector. Thus policies that influence the market conditions (like current and potential market demand, market access and expected price) in the host country play a critical role in the technology transfer and diffusion.

While the private sector will be the key for driving diffusion and deployment of clean and climate friendly technologies, investors, both foreign and domestic, will consider a number of factors when making decisions on clean energy investment as well as investments in energy-efficient products and services, a large number of which can be rolled together under the broad heading of investment climate, Investors look for such things as political and macroeconomic stability, educated workforce, adequate infrastructure (transportation, communications, energy), functioning bureaucracy, rule of law, strong finance sector, as well as ready markets for their

products and services. In so doing, they assess how risky or difficult it will be to make an investment in a given country using a given technology, and add this to the expected costs.

On the other hand, overarching challenges in this area are (i) government commitment to changing the trajectory of carbon emissions, and (ii) government incentives for low-carbon investments. These types of policy barriers will differ fundamentally from country to country and diagnostic studies could help to identify the full range of potential actions that are needed to help make clean energy investment more attractive to both domestic and foreign investors. We describe below some policy areas which could impact the development, diffusion and deployment of clean energy technologies.

There are three broad ways in which a government can encourage the growth of a market for clean energy:

- By implementing policies that indirectly encourage the purchase of clean energy (examples: pollution reduction targets, carbon cap-and-trade program). These are policies which broadly encourage an overall outcome – e.g., reduced carbon emissions – for which increasing the purchase of renewable energy is one of a number of potential means to the end. (Other means include reducing use, increasing efficiency, etc.).

- By implementing policies that directly encourage the purchase of clean energy (examples: Renewable Portfolio Standards, Renewable Electricity Standards, and Energy Efficiency Standards). These are policies which directly require an increase in the purchase of renewable energy (e.g., by utilities).

- By directly purchasing renewable energy (examples: buying and installing solar panels on rooftops; installing wind turbines on military bases) and energy efficient appliances (CFL bulbs and other equipments). In this approach, government entities act as consumers, buying directly from renewable energy companies.

Any government policy which ensures or encourages (or discourages) growth in market demand for clean energy will also encourage (or discourage) capital investment in clean energy generation. In addition to these policy interventions, governments can directly intervene in the markets providing guarantees to encourage private credit and financing of renewable technology.

a. Removing market distortions

Institutional constraints: The bias towards conventional fossil fuels is often built-in the system due to government subsidies. This policy-distortion is true for both developed as well as developing countries, where fossil-fuels are the cheaper alternative energy source. Government subsidies to energy are widespread, distortionary, and represent a heavy burden on public budgets in many countries in addition to creating huge environmental externalities and highly regressive distributional effects.

When there are uninternalized externalities associated with energy production and consumption, the expanded use of energy resulting from subsidies also exacerbates the harm done by these externalities, thus increasing the gap between price and social opportunity cost. Spillover effects include carbon emissions causing climate change, local pollution, and other externalities such as traffic congestion. Subsidies to non-carbon energy sources can also give rise to concerns about externalities, e.g. competition for arable land to grow biofuels and concerns with handling of nuclear materials.

While subsidies vary across different countries, the most common subsidies are for motor fuel consumption, and for electricity supply and consumption. In general, subsidies are paid both to energy producers, and to energy consumers. Subsidies that principally favor consumers are however particularly harmful due to their high impact on overall energy consumption (and thus carbon emissions), and their different distortionary effects on consumer behavior in the long run.

A commitment has recently been articulated by major country governments to work toward removing energy subsidies. The communiqué from the G20 meeting in Pittsburgh, in September 2009, contains a call to phase out energy subsidies, in the G20 countries themselves and

worldwide. Based on the momentum there is clearly a need to assess more comprehensively the economic and distributional consequences of energy subsidies, and their political economy underpinnings, in order to help identify strategies for subsidy reform in different countries, according to their circumstances. Policies that support removal of fossil fuel subsidies or policies that discourage fossil fuel use (carbon tax) should be encouraged if climate concerns are to be taken seriously.

Regulatory gap: Inadequate environmental norms in particular for greenhouse gas emissions and clean energy standards fail to provide the incentive to substitute towards low-carbon technology. Energy and environment policies also need to be supportive of green growth. In many developing countries environmental policies and in particular the monitoring and enforcement thereof leaves a lot to be desired. The efficacy of environmental regulation has been further weakened by an over-reliance on command and control policies that are conducive to rent-seeking behavior. The relative outlay of government spending for the environment has also stagnated in most countries. There is clearly a need for modernization of environmental policies with a view to incentivizing through use of economic instruments such as pollution tax etc. Similarly, energy norms and energy efficiency standards in many countries continue to be voluntary and not backed by adequate energy audits or similar assessments.

Even developed countries which do have some king of a "carbon tax" regime as a way of internalizing externalities, efforts are often made to protect their competitive sectors from the impact of the tax. A recent World Bank study (World Bank 2008) finds no evidence that industries' competitiveness is affected by carbon taxes. In fact, the analysis suggests that exports of most energy-intensive industries increase when a carbon tax is imposed by the exporting countries, or by both importing and exporting countries. This finding gives credence to the general presumption that recycling the taxes back to the energy-intensive industries by means of subsidies and exemptions may be overcompensating for the disadvantage to those industries. A "carbon tax" of this nature doctors trade rather than supporting broader objectives of reducing global emissions.

Trade barriers: Removal of tariff and nontariff barriers (NTBs) can significantly increase the diffusion of clean technologies. Within the current global trade regime, the World Bank study (World Bank 2008) finds that removing tariff and non-tariff barriers for four basic clean energy technologies (wind, solar, clean coal, and efficient lighting) in 18 high-emitting developing countries will result in trade gains of up to 13 percent. Translated into emissions reductions, these gains suggest that (albeit within a small subset of clean energy technologies and for a select group of countries), the impact of trade liberalization could be substantial. The ongoing WTO negotiations on environmental goods thus have the potential to contribute significantly to trade liberalization efforts, but will need to address a number of challenges.

Efforts have been made, including by the World Bank, to move these negotiations forward by identifying climate-friendly goods and services that currently face tariff and nontariff barriers to trade, and making the removal of these barriers through the WTO negotiations a priority. This effort has proved challenging, because WTO members have yet to agree on a definition of "climate friendly" that both contributes to climate policy objectives and generates a balanced distribution of trade benefits among members. Two particular areas of controversy involve "dual use" technologies that may be used to reduce emissions as well as to meet other consumer needs, and agricultural products, which are mired in a very contentious part of the Doha negotiations.

Investment Barriers: At the level of investment generally, investors look for such things as political and macroeconomic stability, educated workforce, adequate infrastructure (transportation, communications, energy), functioning bureaucracy, rule of law, strong finance sector, as well as ready markets for their products and services. There are a number of barriers that are specific to clean energy investment. These include a lack of clear guidance on future energy policy (lack of signals), monopoly structures for existing producers with lack of purchase agreements or feed-in tariffs for independent producers, lack of fiscal incentives for clean energy production, weak environmental regulation and enforcement, subsidies for conventional energy sources, a domestic financial sector that has little experience with new technologies, lack of concern for clean energy transition in international investment agreements and so on (Cosbey, 2008).

Deficiency in technical absorptive capacity in recipient country: The clean energy industry, especially for power generation, is knowledge-intensive. Thus technology transfer in recipient developing countries requires the knowledge-base and skill to absorb and innovate on the imported technology for successful diffusion. Programs to develop the capacity of the relevant professions and trades to identify opportunities and implement energy efficient solutions are often lacking in most developing countries. The capacity depends on a variety of factors including technological literacy, workforce skill, education, and government institutions. This relates to the broader issue of education policy with a particular focus on skills development.

b. Creating incentives

To address the barriers listed above and facilitate technology transfer in clean power, developing country government policies need to augment demand for clean energy technology and also enhance basic domestic knowledge and skill base for absorption and adaptation of the more advanced technology. Cost reduction through scale economies in the generation of clean energy, like solar and wind, is closely linked to market development, government policies, and support for research and development.

a) *Establishing carbon efficiency and emissions norms/ regulations*, which would create an incentive to reduce carbon emissions per unit energy. The energy efficiency of output has been different in the growth path of different developed countries (the US, for instance, is a higher energy using economy compared to Japan) indicating that carbon-efficiency norms can help steer countries towards a low-emission growth path. The declaration by the Chinese government of an overall emission per unit GDP in the wake of the Copenhagen summit reflects a commitment for adoption of a low-emission growth path for its emerging economy.

b) *Regulations on energy mix for utilities*, which essentially forces utilities to buy energy produced from renewable resources when supplying through the grid to consumers. Several governments enforced such mandatory renewable component in energy mix for

utilities to create a minimum demand for clean energy in the system until such renewable forms became competitive in the market.

c) *Absorptive capacity through funding R&D and/or demonstration projects:* Research and development, and demonstration projects help build the knowledge and skill-base required to increase the adsorptive capacity of advanced technology. Demonstration projects also help to showcase the technical viability of the newer technology. In an empirical study on transfer of climate change technology from Annex I countries to developing countries during 2000-2004, the absorptive capacity (proxy estimate being the number of patents for climate change technology invented in recipient country) found to be significant positive factor (Hascic and Johnstone 2009). The study observed that local scientific capacity or, domestic innovation seems to "crowd in" imported technology.

d) *Tax incentives to investors in building renewable energy farms*: Since upfront costs of setting up clean energy capacity like wind and solar power constitute the major barriers for investors, special tax incentives for building renewable farms has typically encouraged their establishment. The account of different country experiences illustrate that all governments have offered complementary (to other policies) fiscal concessions for investment in renewable energy capacity, including subsidies, accelerated depreciation and investment tax credits, and in developing countries dependent on technology imports additional concessions are available for custom duties on technology-embodied equipment (see Box 2 for Spanish experience in incentivizing clean energy technologies)

e) *Liberalization and Intellectual Property Rights regime*: Open trade regime can facilitate the transfer and deployment of technology through higher market access of associated equipment (environmental goods), design and engineering (environmental services), foreign direct investment and licensing of foreign technology. Enforcing and strengthening intellectual property rights is expected to provide incentives to firms from industrialized countries to transfer clean technology in recipient developing through

licensing and foreign direct investment (although market-power related price increase and insufficient transfer remains an open question). An empirical study of factors determining climate change technology transfer from Annex I countries to developing countries found that does not appear to be significantly affected by the strength of the intellectual property rights regime in the recipient country (Hascic and Johnstone 2009).

f) *Public-private joint-ventures/ government provision of venture capital* helps to overcome the financial crunch faced by clean energy investors for the high capital cost in new renewable power.

g) *Feed-in tariffs* that ensure a basic price (based on cost) to clean energy suppliers until a self-sustaining market develops. Feed-in tariffs were implemented in Europe and the US through regulatory and legislative measures, which ensured revenue for the renewable power producers and overcome the barrier of market risk and return. Section 4 below recounts this ensured-price policy that has been implemented widely across Europe and other states.

Box 2: Spanish Experience in Incentivizing Clean Energy Technologies

Spain has recently emerged as one of the leading nations in the installation of grid-connected wind energy (after the US and Germany) and solar photovoltaic energy (after Germany). It has also increased deployment dramatically over the last decade. While early efforts to promote wind energy began in 1979 with a research program, and several small wind projects were taken on during the 1980s, the wind power sector began to take-off only in the 1990s. The rapid growth of on-shore wind power began in 1995 due to a multiplicity of technical and institutional support policies, which made wind energy technically and economically feasible.

Regulations, targets and promotion plans: The 1980 Energy Conservation Law, in response to the earlier energy crisis laid the foundation for creating a renewable power sector. Under the law, electricity utilities were required to buy energy produced from renewable sources at a fixed price. Targets for wind energy expansion were set through the years. In 1991 the Energy Savings and Efficiency Plan 1991-2000 set a target of 200 MW by the end of the decade. The 1999 Plan for Promotion of Renewable Energy set a more radical target of wind energy diffusion of 9,000 MW by 2010, and in 2004 revised it upwards to 20,000 MW in view of the rapid growth experienced. The Plan also set a target for solar PV electricity of 400MW in installed capacity by 2010, which was surpassed as the installed capacity was 680MW by 2007-end. The Royal Decree 1663/2000 laid down technical conditions for grid-connection

of low-voltage PV systems, however the PV energy generators were obliged to bear the extra of cost transformers to use the grid.

The year 2008 witnessed dramatic capacity installation, when 2,700MW of solar PV were added bringing up the total solar PV capacity to 3.5GW (IEA 2009c: 94). A new National Renewable Energy Plan will target for renewable sources to supply 20% of total domestic energy by 2020 in line with the EU goal.

Feed-in Tariff and price premium: The price support measures in Spain offered renewable power generators two options: a premium on the market price or a fixed price, both of which have been adjusted annually since 1999 (Rio and Unruh 2007: 1503). The Feed-in law was implemented in 1994, and subsequently revised and strengthened through the years. The Royal Decree 2818/1998 set a incentive of 39€cents/kWh for PV installations connected to the grid with a capacity lower than 5kWand 21€cents/kWh for PV installations more than 5kWh.

Tariffs and premiums for electricity produced from renewable energy sources are regulated, differentiated by each kind of facility (under Royal Decree 436/2004 and more recently Royal Decree 661/2007). The favorable solar feed-in tariff of 44cents/kWh (allowed till September 30, 2008), was successful in supporting a dramatic growth in PV power in recent years. The Royal Decree 1578/2008, however reduced feed-in tariffs, and the new tariffs are 32cents/kWh for ground installation and 34cents/kWh for roof installations, which is expected to stunt the growth in PV power.

Investment subsidies: The Spanish government offers investment subsidies and soft loans, with some regional subsidies providing 15 to 50% of the total investment, however the funding for wind energy seemed more favourable than for solar energy.

Local Content requirement: As Spain was a relative late-comer in the wind power technology, a strategy to bolster local manufacturing capacity included encouraging foreign commercial presence with local content. Several provincial governments used local requirement - in terms of local assembly, manufacture of turbines and components - before granting development concessions to wind turbine manufacturers. The growth of Spanish firms like Gamesa, the leading wind turbine manufacturer, benefitted from such support policies. By 2002, Spain ranked second in the world in terms of wind turbine operations.

The Spanish PV cell manufacturing is considered to be a high quality, competitive and dynamic industry. Spanish cell manufacturers are among the top producers in Europe, including Isofotón (ranked #1in Europe), BP Solar and Astra solar (Rio and Unruh 1509) In 2008, the industrial production capacity of solar PV was 1000MW with more than 500 firms in manufacture (IEA 2009c: 95). It is expected that with declining PV costs and increasing energy prices, solar energy will reach grid-parity cost.

4. Financing

To stabilize atmospheric concentrations of GHGs at levels that may be considered 'safe', estimates suggest the additional investment costs for mitigation could be anywhere between US$200 billion to over US$1 trillion per annum (Table 1). In addition, at least tens of billions of U.S. dollars per year should be added to finance the cost of adaptation due to the inevitable amount of warming that the world would experience, albeit the estimates of the adaptation cost are very incomplete and preliminary (Table 2).

Current climate-related financial flows to developing countries, though growing, cover only a miniscule fraction of the estimated amounts as suggested in Tables 1 and 2 that developing countries need over the next several decades. This amount would be greater if, as a growing body of science indicates, even lower levels of GHG concentrations are needed to avoid catastrophic impacts.

Suffice it to say that the emerging and yet incomplete cost estimates of additional investments needed in from public and private sources—are on the order of hundreds of billions of dollars a year for several decades. While most funding sources have to be generated domestically, it is anticipated that for developing countries some financing may become available through the creation of an international financial architecture.

Under the rubric of UN Framework Convention on Climate Change (UNFCCC), the Clean Development Mechanism (CDM) was conceived as a vehicle for transferring cleaner technology and financing to developing countries. However, projects implemented through the CDM are too small-scale and the processes too convoluted to deliver technology to the extent required for rapid climate change mitigation. In the absence of bold measures to reform the CDM market, the CDM mechanism cannot achieve technology transfer along the scale required to combat greenhouse gas (GHG) emissions. It may thus be the right time to re-examine the more traditional mechanisms such as trade, investment and licensing which have been the conduits for global technology transfer for centuries.

Public institutions—national governments, international organizations, and the official financing mechanisms of the UNFCCC will be among the key drivers of financing transition to low carbon and climate resilient growth. The Copenhagen Accord did not deliver much--$30 billion upto 2012 and $100 billion a year by 2020 although estimates of the scale of climate mitigation and adaptation run into trillions of dollars. A High Level Panel is to be set up "under the guidance of and accountable to the Conference of the Parties (COP) to study the contribution of the potential sources of revenue, including alternative sources of finance, towards meeting this goal" (Copenhagen Accord, Para 9). The timeline and next steps for setting up this panel, however, have not been announced so far. Similarly, the accord mentions a Copenhagen Green Climate Fund to channel these proposed large flows. Again, further developments on this Fund are awaited.

Official Development Assistance has been a source of energy sector investments in developing countries and could significantly influence future GHG emissions. Following the G8 Gleneagles communiqué of 2005, bilateral and multilateral donors have responded to the increasing challenge of climate change with an agenda for action to integrate climate concerns into the mainstream of developmental policymaking and poverty-reduction agendas. The World Bank Group has committed about US$1.4 billion in loans, credits, equity investments and guarantees for low-carbon projects in 2007-2008. This is welcome but again not commensurate with the needs indicated in Table 1. It should be pointed out in this context that the incentive framework outlined in the previous sections—by removing distorting taxes and subsidies and by putting in place an implicit price on carbon and taxes/regulations/public investments to support it are much more important than whatever transfers would be coming through ODA. Further, institutions such as the World Bank could in fact play a key role in helping countries create the enabling environment as much as providing direct financial assistance.

At the Conference of The Parties (COP) to UNFCCC meeting held in Bali, Indonesia, the President of the World Bank Robert Zoelick in his speech reiterated that the Bank will work to integrate climate action – both adaptation and mitigation – into core development strategies of countries. He further added in the meeting that the Bank would focus on the key areas of: (a) providing innovative and concessional financing to facilitate both public and private sector

investments in low-carbon and adaptation projects; (b) pioneer and advance new market and trading mechanisms; (c) facilitate technology deployment and transfer to developing countries; (d) help create an enabling environment to tap the private sector; and (e) support policy research on climate change and development integrating adaptation and mitigation into core development work.

He further reiterated that the Bank has already been building on synergies between climate action and development – working on energy security and efficiency, encouraging renewable energy, protecting urban air quality, helping with the management of arid lands, and assisting with adaptation of agriculture, it will focus its attention on and help shift countries to a development paradigm based on low-carbon growth and adaptation to new risks.

The Bank is already playing a key role in the emerging carbon market for green house gas (GHG) emission reductions. Significant progress has been made in the development of the carbon markets. The Umbrella Carbon Facility was fully funded in August 2006 with total capital of $1 billion. Two new Carbon Facilities—the Carbon Partnership Facility (CPF) and a Forest Carbon Partnership Facility (FCPF)—were launched in December 2007 to scale up carbon finance. The Bank also played an active role in adaptation through GEF projects and in adaptation and mitigation through the recent Climate Investment Facility.

Although additional funds will be forthcoming, the experience with development assistance suggests that there are constraints on the amount of traditional donor finance that can be raised. Moreover, there is a worry from some developing countries that contributions from developed countries may not be fully additional to existing development assistance. Especially, countries like India have openly expressed their desire to have a new international financial architecture under the rubric of UNFCCC than multilateral development banks for the fear of mixing up development assistance and climate assistance. Also developing countries have been insisting that any climate related assistance should be in the form of a grant and not underwritten as a loan (even concessional).

Other sources of international finance will therefore have to be tapped, and there are several proposals, particularly for adaptation.

- Internationally coordinated carbon tax. Proposals for a nationally administered but globally levied carbon tax have the appeal that the tax base would be broad and the revenue flow fairly secure.

- Tax on emissions from international transport. A tax more narrowly focused on international aviation or shipping would have the advantage of targeting two sectors that so far have not been subject to carbon regulation and whose emissions are growing fast.

- Auctioning assigned amount units: Setting aside a fraction of each country's AAU allocation and auction it to the highest bidder, with revenues earmarked for adaptation.

Until an adequate global policy response and a financial architecture are negotiated (one that would send adequate, predictable and long-term signals to leverage public and private resources), it will be impossible to cover the expected financing gap. In the meantime it is also critical to explore innovative mechanisms (eventually tapping new sources of support) to scale up funding to the required level. Slow progress in agreeing on and creating such architecture will delay climate action mitigation in developing countries with catastrophic consequences. The reason is that as the economies of these countries grow and as they eliminate energy poverty, the investment decisions they make could lock them into a high carbon trajectory. This also brings to light critical issues concerning conditions for transfer of these resources.

Meaningful action on climate change thus calls for strengthening the international financial architecture for development at an unprecedented scale. This includes appropriate reforms in development assistance mechanisms in terms of external assistance instruments—loans, concessional financing, grants, risk mitigation through equity and guarantees—from bilateral and

multilateral sources. Indeed, this paper would like to see that strengthening and reform may not suffice and a whole new system may need to be put in place.

5. Conclusions

Countries have generally been reluctant to bring the trade and climate regimes closer for fear of one overwhelming the other. While there could be many benefits to bringing the trade and climate regimes closer, the potential for harm to the international trade regime from actions such as unilateral imposition of border taxes on carbon should not be underestimated, especially since the burden will fall disproportionately on developing countries. This is unfortunate because trade in clean energy technologies potentially offers an economic opportunity for developing countries that are emerging as major producers and exporters of these technologies. It is thus in the interest of developing countries to ensure that the pursuit of global climate objectives is compatible with maintaining a fair, open, and rule-based multilateral trading system as a foundation for their growth and development. If climate-related trade measures bite deeply enough, developing countries can and should use the trade and climate negotiations to push back.

The success of the WTO's 1997 Information Technology Agreement suggests that implementation of any agreement on climate-friendly goods and technologies will certainly need to follow a phased approach to enable developing countries to deal gradually with implementing liberalization, including increasing the efficiency of customs administration and harmonizing customs classifications for climate-friendly goods. This should be supported through a package of financial and technical assistance measures. Postponing action on the trade and climate agenda until another lengthy round of WTO negotiations beyond the Doha Round is risky because of the imminent danger that climate-related trade sanctions of the variety proposed in the United States and the European Union could become a reality.

Beyond trade, the paper highlights the critical role that public policies can play in creating an enabling environment for development, deployment, and diffusion of clean energy and energy efficient technologies. First and foremost, the discussions on removing distorting subsidies on fossil fuels is just beginning and this along with broader discussions surrounding carbon pricing

should be taken up in the right earnest. The commitments by G-20 countries should go beyond rhetoric and need to translate into real action on the ground. There is a role for OECD, IEA ad the World Bank in supporting this initiative through data and analysis. Creating incentives for development (R &D), deployment and diffusion of clean energy and energy efficient technologies is another area where there is need for distillation and dissemination of knowledge especially from countries that have successfully tried and tested these measures. It is obvious that the private sector would play a critical role but needs the supporting and consistent public policy framework highlighted in this paper.

The ODA has been playing an important role in the energy sector in general and now moving to clean energy areas. However, as the paper highlights there are serious limitations to scaling-up ODA to assist in technology diffusion of the scale required to meet global GHG emission targets. Especially as conflicts are bound to arise as multilateral and bilateral agencies try to keep the right balance between climate financing and the more traditional developmental assistance. There are already sentiments from some developing countries to keep climate financing beyond the purview of multilateral development institutions. At the same time, issue of conditionalities are bound to crop up from the Bank's major shareholders as illustrated in the recent Bank loan to a coal-fired power plant in South Africa (Box 3).

One cannot but emphasize the more critical role that organizations such as the World Bank can plan in supporting the creation of broader enabling environment in countries that would lead to increased private investment in clean energy and creation of carbon markets. Their role in supporting policy research on climate change and development integrating adaptation and mitigation into core development work should be overlooked either.

Box 3: World Bank's coal conundrum

The World Bank recently approved a controversial $3.75bn loan to build one of the world's largest coal-fired power plants in South Africa, defying international protests and sharp criticism from the Obama administration that the project would fuel climate change.

The proposed Medupi power station, operated by South Africa's state-owned Eskom company, was fiercely opposed by an international coalition of grassroots, church and environmental activists who said it would hurt the environment and does little to help end poverty. As planned,

it would put out 25m tonnes of carbon dioxide a year and would prevent South Africa making good on a promise to try to curb future emissions.

The major shareholders America, Britain, the Netherlands, Italy and Norway registered their opposition to the loan by abstaining from the vote, the traditional method of dissent on the board which operates by consensus. In a statement, the US treasury department said the loan was incompatible with the Bank's stated commitment to promoting low carbon economic development. "We expect that the World Bank will not bring forward similar coal projects from middle-income countries in the future without a plan to ensure there is no net increase in carbon emissions," it said. Britain, registering its abstention, noted the controversy surrounding the plant. "The project raises several sensitive and potentially controversial issues which it has not been possible to resolve before this period began," a statement from Dfid said.

But in responding to the criticisms, the Bank President Zoellick said the Bank was balancing the development benefits of projects such as the Eskom plant with other environmental objectives. South Africa, he said, has well-developed plans to address climate change but no alternative for quickly boosting its power capacity.

"South Africa represents one-third of sub-Saharan Africa's economy, so slowdowns precipitated by lack of energy will ripple throughout the continent," Zoellick wrote.

"Without an increased energy supply, South Africans will face hardship for the poor and limited economic growth," said Obiageli Ezekwesili, the World Bank's vice president for Africa.

Table 1 Global Estimate of Costs and Investment Requirements for Mitigation

Study	***Estimate***	***Basis***
WBG, Clean Energy Framework[1] 04/2006	US$30 billion/ annum for power sector in developing countries	Investment estimate, assuming stabilization at 450 ppm, on top of US$160 billion per year for electricity supply in developing countries over 2010–30, of which currently only half is financed
Stern Review[2] 11/2006	US$1,000 billion/annum	Annual global macroeconomic cost; central estimate by 2050, consistent with stabilization at 550 ppm; represents 1% of global GDP by 2050, ranging from net gains of 1% global GDP to reduction of 3.5%
UNFCCC[3] 08/2007	US$200-210 billion/annum	Estimate of annual global investment and financial flows by 2030, broadly consistent with stabilization at 550 ppm
IPCC[4] 11/2007	5.5% to -1% (gain) reduction in global GDP	Estimate of annual macroeconomic costs to global GDP, ranging from 3% to small increase by 2030 and from 5.5% cost to 1% gain by 2050 for targets between 445 to 710 ppm
OECD Environmental Outlook to 2030[5] 05/2008	US$350-3,000 billion/annum	Annual global macroeconomic cost, central estimate, consistent with stabilization at 450 ppm; represents a 0.5% loss to global GDP by 2030 and 2.5% by 2050 or an average 0.1% slow down of growth
IEA Energy Technology Perspectives 2008[6] 06/2008	US$400-1,100 billion/annum for energy sector	Global cumulative additional investment needs between now and 2050 for energy sector estimated at US$17 trillion, or 0.4% of global GDP (~550 ppm), and US$45trillion, or 1.15 of global GDP (~450 ppm)

[1] World Bank. 2006. *Clean Energy and Development: Towards an Investment Framework*, available at http://siteresources.worldbank.org/DEVCOMMINT/Documentation/20890696/DC2006-0002(E)-CleanEnergy.pdf.

[2] Stern, Nicholas. 2007. *The Economics of Climate Change: The Stern Review*. Cabinet Office - HM Treasury, available at http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_Report.cfm.

[3] UNFCCC. 2008. "Dialogue on long-term cooperative action to address climate change by enhancing implementation of the Convention," Dialogue Working Paper 8, available at http://unfccc.int/files/cooperation_and_support/financial_mechanism/ financial_mechanism_gef/application/pdf/dialogue_working_paper_8.pdf.

[4] IPCC. 2007. Fourth Assessment Report Synthesis Report, available at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf.

[5] OECD. 2008. *OECD Environmental Outlook to 2030*, available at http://www.oecd.org/environment/outlookto2030.

[6] IEA.2008. *Energy Technology Perspectives 2008: Scenarios and Strategies to 2050*, available at http://www.iea.org/w/bookshop/add.aspx?id=330.

Table 2. Estimates of Costs and Investment Requirements for Adaptation in Developing Countries

Study	*Date released*	*Estimate*	*Basis*
Various academic	1990s on	Various	Usually sectoral and long term—for instance, end of century—and with widely differing assumptions
World Bank (CEIF) as revised by the Stern Review	04/2006 11/2006	US$4–37 billion/annum	Investment to "climate proof" all adaptation-related activities in developing countries
IPCC	4/2007		No new estimates, but argue that most studies show a high benefit-cost ratio for adaptive actions
Oxfam	5/2007	US$8–33 billion	Costs of immediate priorities similar to those in national adaptation programs of action (NAPAs) applied to all developing countries
UNFCCC	10/2007	US$28–67 billion in 2030	Investment needs for adaptation activities in developing countries in 2030—all sectors, private and public
UNDP (HDR 2007–08)	01/2008	US$86 billion/annum by 2016	"New and additional" finance for adaptation through transfers from rich to poor by 2016 to protect progress toward the MDGs and prevent post–2015 reversals in human development

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