Trade, Climate Change and Global Competitiveness

Opportunities and Challenges for Sustainable Development in China and Beyond

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ICTSD welcomes feedback and comments on this document. These can be forwarded to Moustapha Kamal Gueye, gkamal@ictsd.ch.

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ABBREVIATIONS AND ACRONYMS

AC	Alternating Current
ADM	Archer Daniels Midland
AGP	Agreement on Public Procurement
APEC	Asia-Pacific Economic Cooperation
BTAs	Border Tax Adjustments
CDM	Clean Development Mechanism
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CRESP	China Renewable Energy Scale Up Programme
CTE	Committee on Trade and Environment
CTI	Climate Technology Initiative
CTP	Climate Technology Programme
DC	Direct current
ETS	Emissions Trading Scheme
EU	European Union
EuPs	Energy-Using Products
GATS	General Agreement on Trade in Services
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse gas
GSP	Generalized System of Tariff Preferences (EU)
H2	Hydrogen
IEA	International Energy Agency
IP	Intellectual Property
IPCC	Intergovernmental Panel on Climate Change
MDGs	Millennium Development Goals
MEAs	Multilateral Environmental Agreements
MEPS	Minimum Energy Performance Standards
MFN	Most Favoured Nation (status)
MTBE	Methyl tert-butyl ether
Mtoe	Millions of Tonnes of Oil Equivalent
NAPs	National Allocation Plans
NTBs	Non-Tariff Barriers
OECD	Organisation for Economic Cooperation and Development
PPMs	Processes and Production Methods
PURPA	Public Utilities Regulatory Policies Act
PV	Photovoltaic
R&D	Research and Development
S & D	Special and Differential Treatment
SMEs	Small and Medium-sized Enterprises
TBT	Agreement on Technical Barriers to Trade
TCAPP	Technology Cooperation Agreement Pilot Programme
TCE	Tonnes of Coal Equivalent
TRIMs	Trade Related Investment Measures
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
WTO	World Trade Organization

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FOREWORD

Climate change policies aimed at controlling emissions of greenhouse gases (GHG) are leading to realignment in the production and consumption of goods and services around the world. As Annex I Parties to the Kyoto Protocol are taking up various measures ranging from energy-efficiency standards, carbon cap-and-trade programmes and carbon taxes, concerns have been raised that industries in these countries will find themselves at a disadvantageous position vis-à-vis countries where such mandatory measures may not be implemented. There is growing fear that this may lead to "carbon leakage" and industrial relocation from OECD to non-OECD countries, especially for energy-intensive industries, such as steel, cement and chemicals targeted by climate policies. As a major emerging economy not bound by mandatory GHG reduction obligations, China is at the centre of some of these concerns.

In the context of international trade, some countries are worried that by implementing stringent climate change policies they will have to compete with exports from countries where costs of production may be lowered as a result of the absence of mandatory emissions reduction obligations on producers. These concerns have prompted calls within industry as well as by politicians for the introduction of measures, including trade measures, to offset competitive imbalances and level the playing field vis-à-vis "climate free riders". Rhetoric over the use of border tax adjustments and measures with similar effects has particularly been prominent in this regard.

China is poised to weigh heavily on the process and outcome of these debates through its domestic policies and modalities of its participation in the crafting of multilateral regulatory frameworks. In that context, a number of opportunities and challenges for sustainable development arise for China and the international community at large.

This collection of papers is meant to bring together views and perspectives from a wide range of experts and analysts both within China and internationally to contribute to the debate on issues in the trade– climate change relationship that may impact on global competitiveness, with a particular focus on the role of China. Chapter 1 provides an overview of issues in the WTO-Kyoto Protocol relationship that pertain to competitiveness. It situates the debate on the impact of climate change measures undertaken by Annex I countries on competitiveness, discusses approaches being considered in response to such competitiveness concerns and highlights some of the key questions of particular concern to China.

The second chapter presents current policies related to climate change in China and examines key elements of the recently adopted National Climate Change Programme, including challenges that China is likely to face in its implementation. The paper also discusses most likely scenarios regarding China's role in a future climate change regime (post-Kyoto) and the implications for global efforts to tackle climate change.

Chapter 3 provides an analysis of the effects of climate change measures adopted in OECD countries on international trade and competitiveness. The chapter presents initial empirical evidence obtained on the impact of carbon taxes and energy efficiency standards on international trade flows and competitiveness. It addresses the question of whether or not "carbon leakage" is occurring and whether China is benefiting from industrial relocation from OECD countries in energy-intensive industries. The chapter finally examines to what extent climate change policies are driving positive developments in global competitiveness.

Concerns over competitiveness were invoked by the US to justify its non-ratification of the Kyoto Protocol. Such concerns have recently been common in many Kyoto Protocol Annex I countries. This has led to a debate over the need for measures such as border tax adjustments to enable industry in countries subjected to mandatory emissions reduction obligations to insure that conditions are equal vis-à-vis countries that have not accepted similar obligations. In that context, Chapter 4 discusses initiatives being considered in the EU and the US, which may have important implications for China.

As its exports to OECD countries expand, China is bound to comply with increasingly stringent energy efficiency and other climate related standards. Moreover, Chinese exports of certain products such as energy efficient light bulbs have been subjected to anti-dumping measures in the EU. Chapter 5 examines the impact of these measures on China's exports of electric and electronic goods and discusses how industry within China is responding to trade and climate-related policy measures. Finally, the chapter discusses how these measures may be acting as drivers for improvement in resource and energy efficiency and competitiveness in China.

Technological development is a central aspect of climate change mitigation. Access to advanced technologies, including transfer of technology, will enable developing countries to enhance their capacity to reduce their emissions

of greenhouse gases and "leap-frog" in their process of development. Chapter 6 examines the question of whether or not there will be barriers related to intellectual property for developing countries to access clean energy technologies. It does so by analysing the industry structure and intellectual property implications in three clean energy sectors – solar photovoltaic, biofuels and wind energy technologies.

This paper is part of ICTSD's *Trade and Sustainable Energy series*, published under its programme on Trade, Climate Change and Sustainable Energy. The programme aims to generate policy-oriented and solutions-focused knowledge on key issues at the interface between the multilateral trading system and various regimes and initiatives promoting the transition to a sustainable energy future.

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1. Trade, climate change and global competitiveness

Moustapha Kamal Gueye

1.1 Introduction

The debate on trade and climate change has evolved from conceptual discussions on potential harmony or conflict, to one where practical concerns have emerged as to the impacts that climate change measures could have on international trade and global competitiveness as well as the implications of using trade measures to achieve climate change objectives. This paper provides an overview of issues in the climate change and trade relationship that pertain to competitiveness. It aims to situate the debate on the impact of climate change measures on international trade and competitiveness, discuss approaches being considered in response to such competitiveness concerns and highlight some of the key questions of particular concern to China.

Climate change policies aimed at controlling emissions of greenhouse gases (GHG) are leading to realignment in the production and consumption of goods and services around the world. The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC), the current global framework for reducing the emission of greenhouse gases responsible for global warming, commits certain countries - referred to as Annex I Parties – to mandatory emissions reduction obligations. However, many major emitters including the United States, China, India, Brazil, Mexico and South Africa have not accepted or have not been required to undertake mandatory cuts. The role that these countries should play in global efforts for climate change mitigation has polarised much of the debate towards the crafting of a post-Kyoto climate regime, not least because of perceived economic imbalances due to the dual system of countries with mandatory emissions cuts and others without.

The issue of competitiveness is considered in this report in the sense of non-implementation of climate mitigation policies, as a factor creating an uneven playing field between firms in abating countries under the Kyoto Protocol, and firms in countries that are not. A second dimension of competitiveness in the trade and climate change context relates to policies on subsidies, taxation and other support measures that countries may chose to employ in their efforts to reduce emissions of greenhouse gases. These policies and measures may provide specific advantages to certain industries and sectors, against their competitors in other countries. This second aspect, however, is not covered in this report (for a detailed analysis, see Cosbey and Tarasofsky, 2007).

1.2 Climate policies, trade and competitiveness: Are there winners and losers?

As Annex I Parties which are mainly composed of OECD countries are taking up various measures ranging from tightening of energy efficiency standards, engaging in carbon cap-and-trade programmes, and imposing taxes on the carbon content of fossil fuels used in the production of goods and services (carbon tax), concerns have been raised that industries in these countries will find themselves at a disadvantageous position vis-à-vis countries where similar measures may not be implemented. There also is growing fear that this may lead to industrial relocation from OECD to non-OECD countries, especially for energy-intensive industries, such as steel, cement and chemicals and therefore "carbon leakage". As a major emerging economy not bound by mandatory GHG reduction obligations, China is at the centre of many of these concerns.

In the context of international trade, there are concerns that OECD countries will have to compete with exports from countries where costs of production may be lower as a result of the absence of mandatory emission reductions on producers. For example, it is estimated that the total cost of production in the steel, aluminium, newsprint and cement sectors would increase between 1.3 percent and 3.7 percent in Europe (assuming an EU ETS price of CO_2 of €10 per tonne), while these costs increases would not be faced by non-Annex I (developing) countries, thus giving them a cost advantage in the range of 1.3 percent to 3.7 percent (Kraemer, Hinterberger Tarasofsky, 2007).

Competitiveness concerns were partly invoked by the United States to justify its non-ratification of the Kyoto Protocol. In countries that have binding emission reduction commitments, such as in the European Union, the same concerns have prompted calls within industry as well as by politicians for the introduction of measures, including trade measures, to offset competitive imbalances. Reference to the use of border tax adjustments has particularly been prominent in this context. Border tax adjustments (BTA) may be used in order to offset the negative environmental and competitiveness effects of lax or distinctly different climate taxation policy abroad. Through the introduction of measures applied to imports, domestic industries subject to a tax can remain competitive in the domestic market. Alternatively, a border tax adjustment can be applied to products destined for export, by exempting them from internal taxes on carbon, in order to assist local industries to be competitive abroad (Lodefalk and Storey, 2005).

In the anticipation that the US might be part of a future global agreement on climate change, legislation has been proposed in the US that would include a "competitiveness provision". Such a provision would require imports from countries considered not to be acting enough on climate change to offset their emissions by purchasing emission reduction credits from a US internal cap-and-trade programme. Whether in the EU or the US, concerns over the impact of climate measures on competitiveness have been the subject of much debate and are discussed in Chapter 4 of this report.

While the imposition of energy efficiency standards and carbon tax measures on imports have attracted much attention among policy-makers and politicians, little information exists on the economics of such measures and their actual effect on competitiveness and international trade. Similarly, it is not clear to what extent climate policies in industrialised countries are leading to, or might lead to, industrial relocation and carbon leakage. So far, the debate has been mostly based on rhetoric and perceptions of negative impacts on the competitiveness of countries pursuing ambitious climate change policies.

In fact, there is a view, and also some emerging evidence, that climate change policies may not have an overall negative impact on industries and competitiveness in countries where such measures are implemented. Initial empirical evidence suggests that carbon taxes are not impacting on the competitiveness of energy-intensive industries. This is so in part because of a range of complementary policies such as implicit subsidies and exemptions, which eventually result in negating any significant impact of the taxes on the competitiveness of industries concerned (see Chapter 3 in this report). These findings would suggest that carbon taxes are not creating losers, at least to the scale anticipated, and accordingly would not provide a basis for border adjustment. The same line of argument is valid for energy efficiency measures which, although found to generate a decline in international trade, are neutral policy instruments as they apply both to importers and exporters.

In Annex I countries it is feared that the imposition of stringent energy efficiency regulations and emission reduction obligations may lead to the relocation of industries to countries with less stringent environmental and climate change requirements. Initial empirical evidence suggests that there is indeed a discernible trend of decline in the export of energy intensive products in OECD countries and an opposite trend of increase in exports from developing country regions, in particular in China. An analysis of the import-export ratio of energy-intensive products in OECD and non-OECD countries is presented in Chapter 3 of this report. While the causality between the implementation of climate change policies and the trend in import and export of energy-intensive products may be difficult to establish, there is a certain correlation that deserves consideration. The fact that industrial relocation and carbon leakage is occurring puts China on the spot, as a principal basis for production and global exports. The discussion in Chapter 3 is consistent with much of earlier empirical analysis on international trade-induced carbon leakage and the role of China as an important destination region (see Sijm JPM et al. 2004).

Apart from the negative spillover effects, i.e. industrial relocation and carbon leakage, climate policies are associated with positive spillovers. These positive spillovers are due to the diffusion of technological innovation, both in countries implementing climate mitigation policies and other countries. They also stem from policy and political influence of industrialised countries mitigation efforts on developing countries abatement actions, such as improvements in energy efficiency (Sijm J.P.M. et al. 2004). By setting high standards on energy efficiency and limitations on production-related carbon emissions, climate policies may have contributed to driving innovation and increase in resource efficiency, and ultimately fostering competitiveness. In China, for example, improvements in energy and resource efficiency have led to increased competitiveness in energy efficient products, making China the world's leading exporter of energy efficient light bulbs. In a carbon-constrained world, it is to be expected that comparative advantage will shift to the benefit of those producers in countries that have taken decisive steps to move away from GHG-intensity, whether or not such a move is driven by mandatory requirements.

Trade policies and trade liberalisation could provide avenues for enhancing gains from the positive spillovers by facilitating freer flow of lower-carbon goods and services. Negotiations on the liberalisation of trade in environmental goods and services under the Doha round of multilateral trade negotiations are meant to concur with this objective. A reduction of trade barriers in EGS could enhance the competitiveness of climate change mitigation technologies and serve to reward industries that take the lead in responding to climate change.

1.3 The "China factor"

Growing levels of emissions

For several years, China had been second, after the United States, in the ranking of leading carbon emitters in the world. But long term projections warned that in the next 10 to 20 years, China will have overtaken the US as the world's largest CO_2 emitter. In November 2006, the International Energy Agency (IEA) forecasted that China could overtake the US in this respect by 2009. According to a report released in June 2007 by the Netherlands Environmental Assessment Agency, China has surpassed the United States as the world's largest source of greenhouse gas emissions in 2006. The report estimated that China produced 6,200 million metric tonnes of carbon dioxide in 2006, compared with 5,800 million tonnes for US China's emissions surged by 8.7 percent in 2006 (fuelled by coal consumption and

increased cement production), while those from the US fell by 1.4 percent due to a slowing economy. CO_2 emissions in China are now said to be 8 percent higher than in America, whereas in 2005 China's emissions were 2 percent below those of the US.

It is important to keep in mind that while emissions of carbon dioxide from China are on the rise, in terms of CO_2 concentration – that is the amount of carbon dioxide stuck in the atmosphere for about a century and trapping heat below – China still is only responsible for 8 percent, the US for 27 percent, and European nations for 20 percent. In addition, on a per capita basis, the US still produces roughly four times as much carbon dioxide as China, at about 20 tonnes per person.

Along with rising emissions, the debate over China's role in addressing climate change comes at a time of high economic growth rates and remarkable boom in its exports to the world, especially in the United States and Europe. The International Monetary Fund (2007) estimates that China's GDP has been growing steadily by about 10 percent every year since 2003. This is beyond the target of 7.5 percent per year, set out in China's 11th Five-Year Plan, covering 2006 to 2010. Strong economic growth has been a driver for high energy consumption.

International trade and carbon leakage

The continuously expanding external trade and rising trade surplus of China vis-à-vis its main trading partners has been correlated to the relocation of certain industries from OECD countries to China, for production and export back to OECD countries. As discussed in Chapter 3, an analysis of the import-export ratio reveals a trend of decline in exports of energy-intensive goods from high-income OECD countries, and a corresponding trend of increase in low-and-middle income countries, in particular China. As a result, a substantial part of China's emissions are attributed to its production of goods for export to the world market. By relocating production overseas and importing back energy-intensive goods, industrialised countries outsource CO_2 emissions and contribute to carbon leakage. For example, it was found that if there had been no increase in international trade between the US and China between 1997 and 2003, US CO_2 emissions would have increased between 3 and 6 percent, if the goods imported from China had been produced in the US. On the other hand, about 7 to 14 percent of China's current total CO_2 emissions were found to be a result of producing for export to the US (Shui and Harriss, 2006, in Kraemer, Hinterberger Tarasofsky, 2007). Meanwhile, a recent report estimates that in 2004, net exports from China accounted for 23 percent of its total CO_2 emissions, a figure comparable to Japan's total CO_2 emissions, and more than double the UK's emissions in the same year (Wang and Watson, 2007).

The phenomenon of carbon leakage is compound by the fact that production processes in developing countries such as China tend to be more energy and carbon intensive than they are in industrialised countries. For example, steel production in China is considered to be around four times more CO_2-intensive than in Germany (Kraemer, Hinterberger Tarasofsky, 2007).

While the absence or less stringency of emissions reduction obligations in China may be regarded as a factor providing a competitive edge vis-à-vis external trading partners, in reality such a perceived advantage is largely offset by increasingly stringent energy efficiency requirements in China's export markets. As a leading exporter of electric and electronic products, Chinese producers are bound to confirm to such energy efficiency standards in order to access those markets.

How China has succeeded or not in addressing these challenges and turning them into opportunities is a matter of crucial importance from the perspective of trade and sustainable development – an issue examined in Chapter 5 of this report. To a certain extent, climate change policies may have contributed to driving innovation and increase in resource efficiency in China, as exemplified in the efficient light bulb industry mentioned in the previous section.

But there are other challenges such as anti-dumping measures facing Chinese exports. Since 2002, the EU has imposed a 66 percent import tariff on energy-efficient light bulbs from China, on the grounds of anti-dumping measures. The hurdles that anti-dumping measures represent for market access raise a new dimension in the debate on competitiveness and are considered contradictory to demands for greater energy efficiency in developing countries and the overall climate benefits of increased resource efficiency in the developing world.

The rising trade surplus of China (USD177.5 billion in 2006), increasing levels of emissions, and the fact that China does not have mandatory carbon reduction obligations have been invoked as reasons for considering border measures on imports in certain OECD countries. In the US, the proposed climate change bills involving GHG tariffs on products entering the US market do not explicitly refer to China, but there is little doubt that concerns revolving around China's growing trade competitiveness are an important consideration in these proposals.

Getting China on board

As negotiations towards a post-Kyoto climate regime proceed, there is increasing demand on non-Annex I countries such as China to take-up higher responsibilities in dealing with climate change. Moreover, these demands are also a manifestation of some of the competitiveness concerns highlighted above.

Officially, China has expressed the desire to explore several options regarding its role in global efforts to tackle global warming. A range of initiatives, which are discussed in Chapter 2 of this report, were announced in a first

climate change initiative launched in 2007. The National Climate Change Programme plan calls for China to reduce energy use by 20 percent by 2010, promote carbon sink technologies and other adaptive technologies, raise the efficiency of coal-fired power plants, and increase the amount of renewable energy it produces.

While stressing the importance of climate change in its agenda, China has also maintained that the "key principles" in its efforts to address global warming include "sustainable development and poverty alleviation", noting that while total CO_2 emissions may be high, per capita emissions are still low. In addition, China has emphasised the principle of "common but differentiated responsibilities" – which requires developed countries to take more of the burden and to support developing countries in their efforts to tackle climate change.

Technological development, innovation and access to clean technologies are central elements of the National Climate Change Programme. China has repeatedly emphasised its need to have access to advanced climate-friendly technologies in order to support its efforts, putting the responsibility for transferring technology on industrialised countries. In this regard, a major issue of concern is the question of whether or not there are barriers, including intellectual property (IP) barriers, for China to access climate-friendly technologies. Chapter 6 of this report examines this question focusing on three clean energy technologies (wind, biomass for fuel and PV). It indicates that as far as China is concerned, it seems unlikely that there will be significant IP-related barriers for access to these technologies.

1.4 Conclusion

With its sustained high economic growth, growing trade competitiveness and increasing carbon emissions, China has come to the centre of the debate on climate change and global competitiveness. Politicians and policy-makers in industrialised countries are considering various approaches to balancing what they perceive as an uneven playing field between countries that are bound by mandatory emissions reduction obligations and those such as China that are not.

From the perspective of international trade regulation, a number of issues arise as to how the international trade system will handle the tensions generated by perceived imbalances in the climate regime and the way in which countries may attempt to address them, including through trade measures. But equally important, is the need to better understand the actual effect of climate policies so as to adequately weigh their implications for competitiveness in the trade context. On both fronts, further analysis is required to better inform policy processes.

As countries are engaged in the process of launching negotiations towards a future climate regime, China is poised to weigh heavily on the process and outcome of such discussions. In that respect, it is facing a major challenge of balancing the objectives of sustained economic growth with environmental sustainability, responding to demands for greater responsibility in tackling climate change along with growing concerns about its rising competitiveness among its trading partners.

Clearly, innovation, technological development and access to climate-friendly technologies will play a crucial role in that regard. At the same time, it would seem logical to ensure that China's efforts in enhancing energy efficiency in its industrial and productive sectors are not constrained; rather these efforts could be rewarded through effective market access in China's major export markets, thus maximising climate benefits.

2. China's new climate change strategy: domestic policy and international politics

Kejun Jiang and Xiulian Hu

2.1 Introduction

In China, due to rapid economic growth, total primary energy consumption increased from 400 Mtoe in 1978 to nearly 1,520 Mtoe in 2005, with an annual average rate of increase of 4.7 percent (see Figure 2.1). Coal is the major energy source, providing 70.7 percent in 1978 and 69 percent in 2004 of total primary energy use (see Figure 2.2). Recent years have witnessed a dramatic surge in the rate of increase of energy use in China and widespread energy shortages.

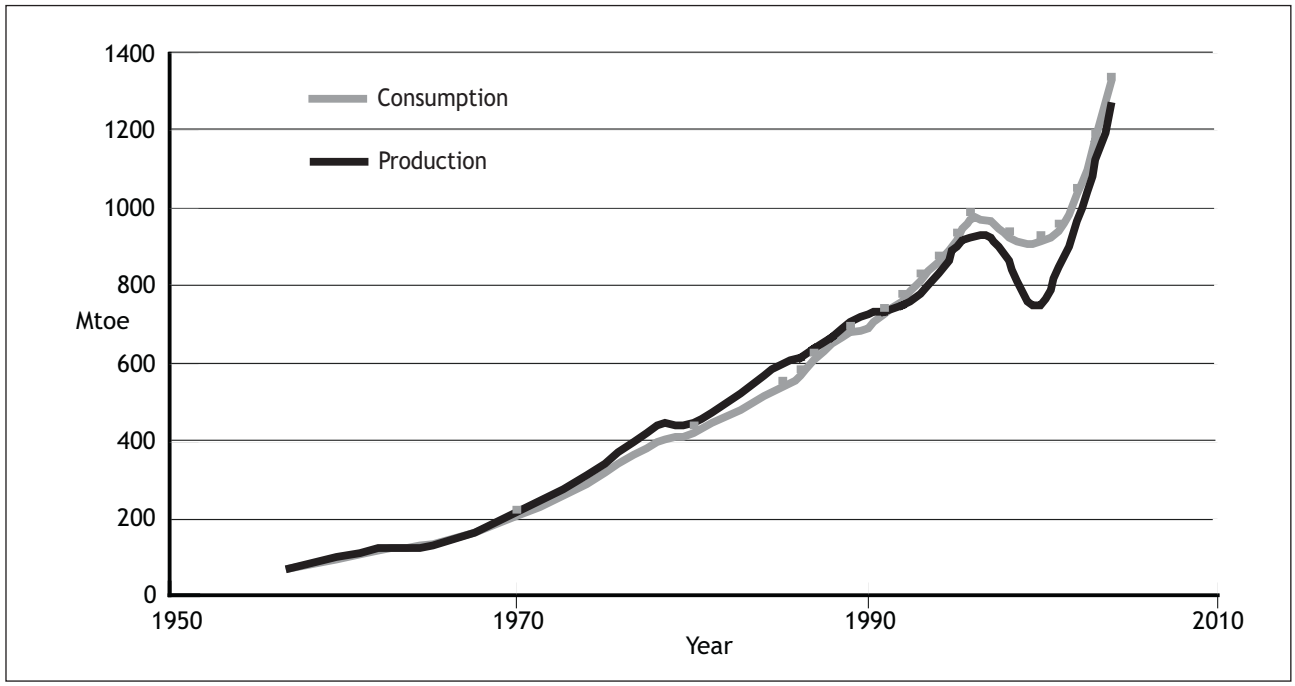
China is the largest coal-producing and coal-consuming country in the world. Between 1980 and 2005, total raw coal output increased from 620 Mt to more than 1100 Mt, with an average annual growth rate of 4.8 percent per year. Prior to 2000, the share of coal use in total energy use decreased, but it increased again from 66 percent in 2000 to 71 percent in 2005. The heavy dependence on coal has led to serious environmental problems and represents a burden for the transportation system.

Rapid increase of energy use in China has resulted in a large amount of CO_2 emissions in China. Figure 2.3 presents the recent year's CO_2 emissions in China. According to certain sources, China is believed to have surpassed the US as the world's largest emitter of CO_2.

This increase has put enormous pressure on China to control its GHG in the future in order to implement the UNFCCC objectives to curb emissions. However, few policies have been adopted to reach domestic energy efficiency and renewable energy targets. Nonetheless, all these policies are consistent with emission mitigation policies. Most important, the Chinese government considers climate change as one of its major issues for government action. On 4 June 2007, the National Programme on Climate Change was released. This is an important document in China to guide the future national and provincial policies on climate change.

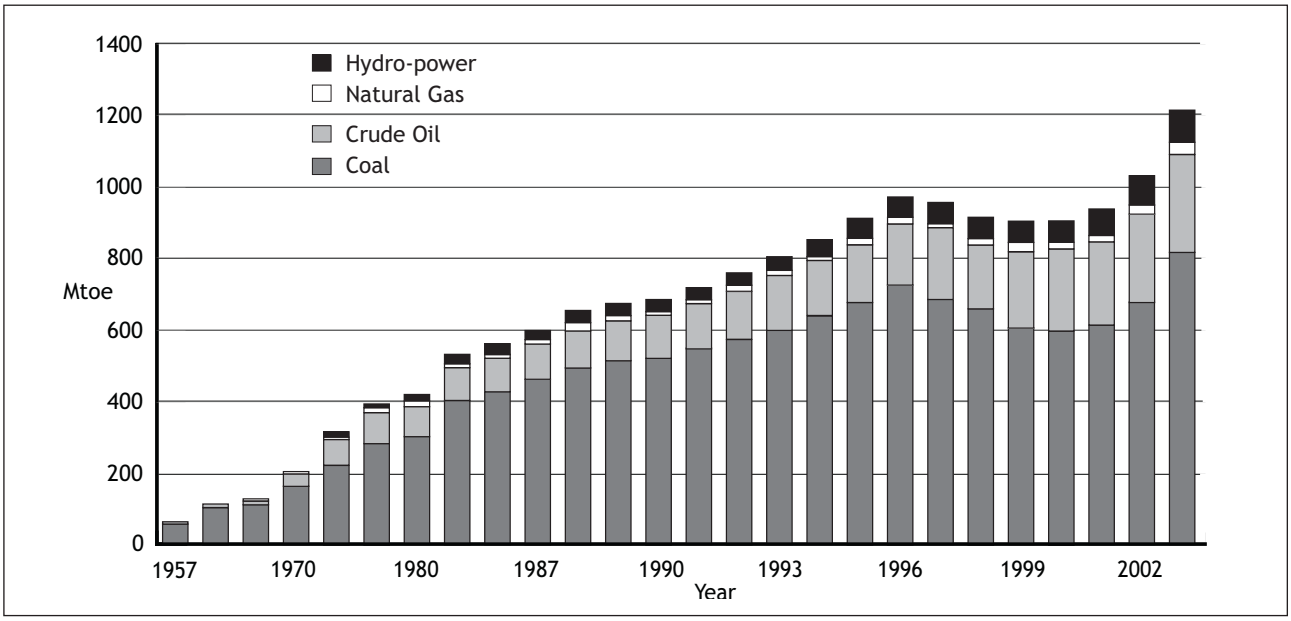
In the short term, emission mitigation policies will be implemented mainly through domestic policies on energy efficiency, renewable energy development, nuclear energy development, and by pursuit of domestic sustainable development and energy security. In the long-term, China's climate change policies will adopt more GHG emission reduction and adaptation focused policies, such as carbon tax, carbon pricing, etc. China will also work together with other countries by joining international reduction programmes.

Figure 2.1. Energy production and consumption in China



Source: China Energy Statistical Year Book 2006, 2007.

Figure 2.2. Primary energy use in China by energy type



2.2 Energy policies and climate change policies in China

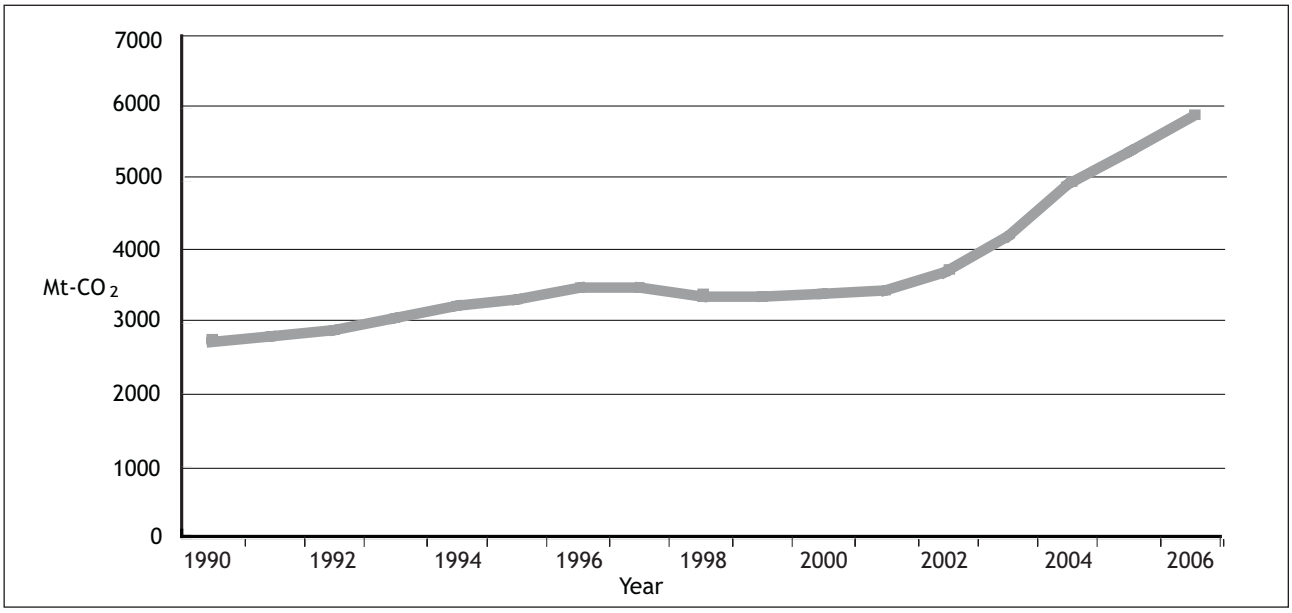
Government programmes to promote energy efficiency under the 11th Five-Year Plan

In November 2002, during the 16th National Congress of the Communist Party of China (CPC), China proposed to achieve the objectives of building a society that is well-off in every aspect by 2020. Along with the increase of population and the acceleration of industrialisation and urbanisation, particularly the rapid development of heavy industry and transportation, the demand for energy will increase significantly. The imbalance between energy constraints and economic development and the environmental pollution brought about by energy utilisation will become even more evident.

In November 2004, China's Medium and Long Term Energy Conservation Plan was announced. This plan aims to push the entire society towards energy conservation and energy intensity reduction, to remove energy bottlenecks, to build an energy saving society and to promote sustainable social and economic development and thus realise the grand objective of building a society that is well-off in every aspect.

The programming period is divided into the 11th Five-Year Plan (2006-2010) and the next period from 2010 to 2020. The energy conservation objectives and the focus

Figure 2.3. CO_2 emissions in China



of development by 2010 are essentially planned, whereas the objectives stated for 2020 are proposed. These are:

(1) Macro energy conservation indicators: by 2010, energy consumption per 10,000 Yuan GDP (constant price in 1990, the same below) (around USD1,650) is expected to drop from 2.68TCE (tonnes of coal equivalent) in 2002 to 2.25TCE, with an annual average energy conservation rate of 2.2 percent from 2003 to 2010. The energy conservation capacity is expected to reach 400 million TCE.

Energy consumption per 10,000 Yuan (around USD1,650) GDP will drop to 1.54TCE in 2020, with an annual average energy conservation rate of 3 percent from 2003 to 2020. The energy conservation capacity is expected to reach 1.4 billion TCE, 111 percent as much as the total planned newly-increased energy production of 1.26 billion TCE during the same period, with a corresponding reduction of 21 million tonnes of sulphur dioxide.

(2) Energy consumption indicators per unit of major products (amount of output): By 2010, China's products as a whole are expected to reach or approach the advanced international level of the early 1990s in terms of the indicators, of which large and medium sized enterprises are expected to reach the advanced international level at the beginning of the 21st century; and by 2020 China is expected to reach or approach the international advanced level.

(3) Energy efficiency indicators of major energy consuming equipment: by 2010, energy efficiency of newly-added major energy consuming equipment is expected to reach or approach the international advanced level, and some automobiles, motors and household electric appliances are expected to reach the international leading level.

(4) Objectives of macro-regulation: By 2010, relative laws, regulations and a standards system governing energy conservation will be established, a policy support system, supervision and regulation system and a technical service system, which are suitable for a socialist market economy, will also be put into place.

In the plan, key fields for energy conservation were listed and they form a framework for state government and local government to make Five-Year Plans. In order to reach the target, 10 key categories of projects were decided during the 11th Five-Year Plan (2006-2010), as follows:

- Coal-fired industrial boiler (kiln) retrofit projects
- District Cogeneration Projects
- Residual Heat and Pressure Utilisation Projects
- Petroleum Saving and Substituting Projects
- Motor System Energy Saving Projects
- Energy System Optimisation Projects
- Building Energy Conservation Projects
- Green Lighting Projects
- Government Agency Energy Conservation Projects
- Energy Saving Monitoring and Testing, and Technology Service System Building Projects

Renewable energy development and nuclear energy development plan

In 2005, China announced a Renewable Energy Law in which an energy development target was given by raising the share of renewable energy to 15 percent in 2020. Later, the renewable energy development plan was further developed and major renewable energy development targets were set for 2020.

Table 2.1 Renewable energy development targets in China (2020)

Source of energy	Capacity
Wind	30GW
Solar power PV	1.8GW
Solar heater	300 million m^2
Biomass Power	30GW
Biomass diesel	2Mt
Biomass	10Mt
Biomass solid fuel	50 million tonnes
Small hydro	80GW

According to the National Energy Plan, published by the National Development and Reform Commission (NDRC) in 2005, total nuclear power generation should be 40 GW by 2020, while new plants generating 18GW will be under construction at the same time.[1]

National Programme on Climate Change

On 4 June 2007, the National Programme on Climate Change (NPCC) was released. This is the first such plan formulated by a developing country and is a milestone in climate change policy. This programme specifies China's objectives, basic principles, key activities and projects, as well as policies and measures for the country as a response to climate change up to the year 2010. According to the National Programme, China commits to complete in the specified time period all the tasks under the National Programme, strives to construct a resource-conservative and environment-friendly society, build up national capacity to mitigate and adapt to climate change, and to make significant contributions to the protection and understanding of the global climate system.

The National Programme covers the following elements:

- Status of climate change in China and efforts to deal with it
- Impacts and challenges of climate change on China
- Guidelines, principles and objectives of China to respond to climate change

- China's policies and measures to address climate change
- China's position on key climate change issues and need for international cooperation.

Other policies and administration

Sustainable development is recognised as an important issue in China. Thus, in 1994, in accordance with Agenda 21, the Chinese government announced and stated explicitly that: "Taking the path of sustainable development is a choice China must make in order to ensure its future development in the century. Because China is a developing country, the goal of increasing social productivity, enhancing overall national strength and improving people's quality of life can not be realised without giving primacy…. At the same time, it will be necessary to conserve natural resources and to improve the environment, so that the country will see long-term, stable development". Since 1994, Agenda 21's objectives have been translated into other policy plans, including the successive Five-Year Plans. Other objectives include reducing the large differences in wealth in different areas (especially the rural areas and the regions in the west of the country), and hence to reduce poverty and to control population growth.

Tree-planting and afforestation campaigns and enhancing ecology restoration and protection have been part of long term policy in China since the 1970s. According to the Sixth National Forest Assessment, the acreage of conserved artificial forests in China was 54 million hectares, giving China the highest ranking in the world in this category. The amount of growing stock was 1,505 million cubic meters. The total area of forest cover in China was 174.91 million hectares, and the percentage of forest coverage increased from 13.92 percent to 18.21 percent during the period from early 1990s to 2005. In addition to tree-planning and afforestation, China initiated many other policies for ecology restoration and protection, including natural forest protection, converting cultivated land to forest or grassland, pasture restoration and protection, further enhancing the capacity of forest as the sinks of greenhouse gas. Meanwhile, urban greening grew rapidly in China as well. By the end of 2005, the total green area in built-up urban areas reached 1.06 million hectares with a 33 percent green coverage and 8.1 square meters of public green area per capita. The green area helps absorb CO_2 in the atmosphere.

China established the National Coordination Committee on Climate Change (NCCC), which presently comprises ministers from 17 ministries and agencies. The NCCC has taken the lead in the formulation and coordination of China's important climate change-related policies and measures, providing guidance for central and local governments' response to climate change.

2.3 Future options for climate change mitigation

According to the Fourth Assessment Report released by the Intergovernmental Panel on Climate Change (IPCC) in April 2007, for a 550ppm (parts per million) CO_2 concentration, the cost of mitigation will be quite limited by 2030 if mitigation starts very soon; the cost will be very high if no action is taken. Another report, the Stern Review on the Economics of Climate Change, also reports similar findings.

As the 2010 end of the first period of commitment under the Kyoto Protocol period gets closer, negotiations for a post Kyoto regime have started. Several other talks on climate change have also been initiated, including the G8+5 Summit, APEC, etc.

For future action on climate change, policy for energy conservation, renewable energy development, nuclear energy development, and other policies on sustainable development, will be major choices facing China. It is possible for China to continue the energy intensity target in the following Five-Year Plans. This is very important for China to contribute to GHG mitigation activities internationally. The 20 percent energy intensity target in the 11th Five-Year Plan is the largest CO_2 mitigation action in the world, even though the own target is not for CO_2 emission mitigation.

The important point so far is that it is quite hard for the Chinese government to reach the target due to rapid economic development and a worsening economic structure. Full efforts were made to reach this target, by using many more policies and regulations, public campaigns, technology development etc. In order to reach the target, the government performance assessment system was revised by including energy intensity as one of the indicators. This shows the Chinese government is very serious regarding energy conservation and domestic sustainable development. If this target cannot be reached, it will be impossible to reach other targets on CO_2 emission mitigation. Therefore, using domestic policy for energy conservation, and renewable energy, nuclear energy could be the first choice in China, together with other sustainable development policies, including tree-planting and afforestation.

For a future international regime on climate change mitigation, there are several options under discussion. Those that are being contemplated in China mainly include:

- Continuation of a Kyoto-like regime: Commitment from parties will be given under UNFCCC framework. A protocol like the Kyoto Protocol will be negotiated, including a menu of ways to commit.

- Asia-Pacific Partnership on Clean Development and Climate (AP6): This is a regime different from the Kyoto Protocol. More practical approaches to mitigation are used through technology collaboration now. But collaboration within parties on common commitment is possible.
- Bilateral collaboration such as the China-EU partnership, or the China-Australia Partnership, etc.
- G8+5 Forum: The annual summit provides good opportunities for high level officials to discuss climate change mitigation.
- Top 20 emitters: Recent proposals raised the possibility to invite top 20 emitters to sit together and take action on climate change. This is also one option for China to be involved in on an international regime and to take specific actions.
- Regional, city collaborations: Some cities or provinces could work together with other countries' cities and provinces to address climate change.

2.4 Conclusion

In conclusion, the Chinese government is making significant efforts to curb GHG emissions in China. The 20 percent energy intensity target in the 11th Five-Year Plan is the largest CO_2 mitigation action in the world, even though the target is not a CO_2 emissions reduction target *per se*. Due to domestic energy and environment concerns, this policy will continue for the following Five-Year-Plans. Therefore, using domestic policy for energy conservation, renewable energy and nuclear energy development could be the first choice in China, together with other sustainable development policies, including tree-planting and afforestation. For international regimes on climate change mitigation, there are some options under discussion which may be possible for China to join.

3. The effects of climate change policies on international trade and competitiveness: the China factor

Muthukumara Mani

3.1 Introduction

Efforts to reduce emissions to meet Kyoto targets and beyond have raised issues of competitiveness in countries that are implementing these policies, as well as fear of leakage of carbon-intensive industries to non-implementing countries. This has also led to proposals for tariff or border tax adjustments to offset any adverse impact of capping CO_2 emissions. This paper examines the implications of climate change policies on competitiveness across industries, as well as issues related to leakage, if any, of carbon-intensive industries to developing countries. It then draws implications of the analysis for China and other developing countries.

3.2 Competitiveness

There is a widespread concern regarding international competitiveness of major industries, especially in the energy-intensive sector, among countries that have undertaken several measures to reduce GHG emissions. They especially worry that higher energy costs not only burden them domestically, but also give competitors in countries that do no have these measures (especially the United States and China) a competitive edge and an unfair advantage.

To test the hypothesis, we looked at the impacts on export competitiveness of energy-intensive sectors as a result of the implementation of OECD measures to reduce GHG emissions. The focus was on two types of instruments: (1) carbon taxes associated as a fiscal measure, and (2) energy efficiency standards associated as a regulatory measure. The reason for choosing them is that both have been in existence for quite some time in many countries. Hence, the impacts on competitiveness are much more traceable than the emission trading and voluntary regimes which are more recent. While both carbon taxes and energy efficiency standards aim to reduce energy consumption, they use very different mechanisms by which they affect emissions reduction.

In a country that imposes a carbon tax (or a similar energy input tax), one would then expect that energy-intensive industries are likely to suffer a significant increase in production costs compared to their trading partners. Consequently, these industries either become less competitive internationally and lose some of their market share or, in order to avoid this loss, migrate to countries with no such taxes. In each case, exports of energy-intensive commodities with the carbon tax would decrease, while their imports are expected to increase. Conversely, a carbon tax by an importing country will increase exports of the exporting country, thereby making it more competitive.

Similarly, the cost and time needed to comply with different energy efficiency programme requirements could add to the cost of internationally traded products. However, since such regulations in principle could be applied equally to imports and locally manufactured products, effects on trade in countries with higher energy efficiency standards could be nullified to some extent. On the other hand, it could adversely impact trade from countries with lower or no standards to countries that have higher efficiency standards.

Our results, obtained by using an econometric modelling exercise, show that when a carbon tax is imposed only by the importing countries, then it adversely affects the competitiveness of exporting countries. This could be due to the offsetting measures applied by importing countries to mitigate and nullify the impact of such taxes on domestic industries. On the other hand, when a carbon tax is imposed by the exporting countries, or by both importing and exporting countries, then the overall trade between countries increases. This suggests that subsidies and other exemptions on those energy-intensive industries may be over compensating the disadvantages arising from the imposition of the carbon tax. When we look at the effects of energy efficiency standards we find strong negative effects on export competitiveness irrespective of whether or not the standard is imposed by exporting countries, importing countries, or both.

When we examine how these policies affect specific industries that use energy intensively, results suggest that the net effect varies considerably across the various industries. Trade competitiveness is adversely impacted by a carbon tax in the case of the cement industry, but the paper and steel industries actually benefit from a carbon tax. Similarly, energy efficiency standards mainly impact the transport equipment and metal products industries.

The results emerging from analysis suggest that carbon taxation policies do not impact on the competitiveness of energy-intensive industries. This suggests that complementary policies including implicit subsidies and exemptions – which are used in conjunction with carbon taxation policies levied by these countries, particularly

Table 3.1 Impact of carbon taxes and energy efficiency standards on export competitiveness

	Carbon Tax (imposed by country)			Energy Efficiency Standards (imposed by country)		
Measures	**EXP**	**IMP**	**EXP and IMP**	**EXP**	**IMP**	**EXP and IMP**
Carbon Tax only		Marginally Significant (-)				
Energy Efficiency Standards only		Marginally Significant (-)		Highly Significant (-)	Highly Significant (-)	Highly Significant (-)
Carbon Taxes and Energy Efficiency Standards		Highly Significant (-)		Highly Significant (-)	Highly Significant (-)	Highly Significant (-)
Energy-Intensive Industries	Highly Significant (+)		Highly Significant (+)			
Industries Subject to Energy Efficiency Standards				Highly Significant (-)	Highly Significant (-)	Highly Significant (-)

on energy-intensive industries – could be negating any impact of carbon taxation. A more detailed study of this issue is warranted, as it will yield a greater understanding of the implicit subsidies/costs that are associated with each industry. The importance of this finding cannot be understated, as trade measures are justified based on perceptions of higher costs and associated loss of competitiveness on account of these costs on energy-intensive industries in developed countries. The political economy of carbon energy taxation policies may be used to gain greater insights into the policy bundle as well.

3.3 Carbon Leakage

Many industrialised countries are concerned about the potential impact that mandatory carbon reduction targets would have on their economies. Among these concerns is that any plan that exempts developing countries from emissions limits would not be effective because carbon-intensive industries would simply shift their operations to one of the exempt countries. A "leakage" would undercut the environmental benefits of the Kyoto Protocol; in addition, the competitiveness of industrialised-world industries could suffer.

Most emissions in industrialised countries result from inherently domestic activities such as transportation, heating, cooling, lighting and other such activities, where leakage is either difficult or impossible. On the other hand, for energy-intensive industries such as cement, chemicals and others, international competitiveness is an important concern. This is somewhat akin to the "pollution havens" debate that dominated the environment literature in the 1990s.

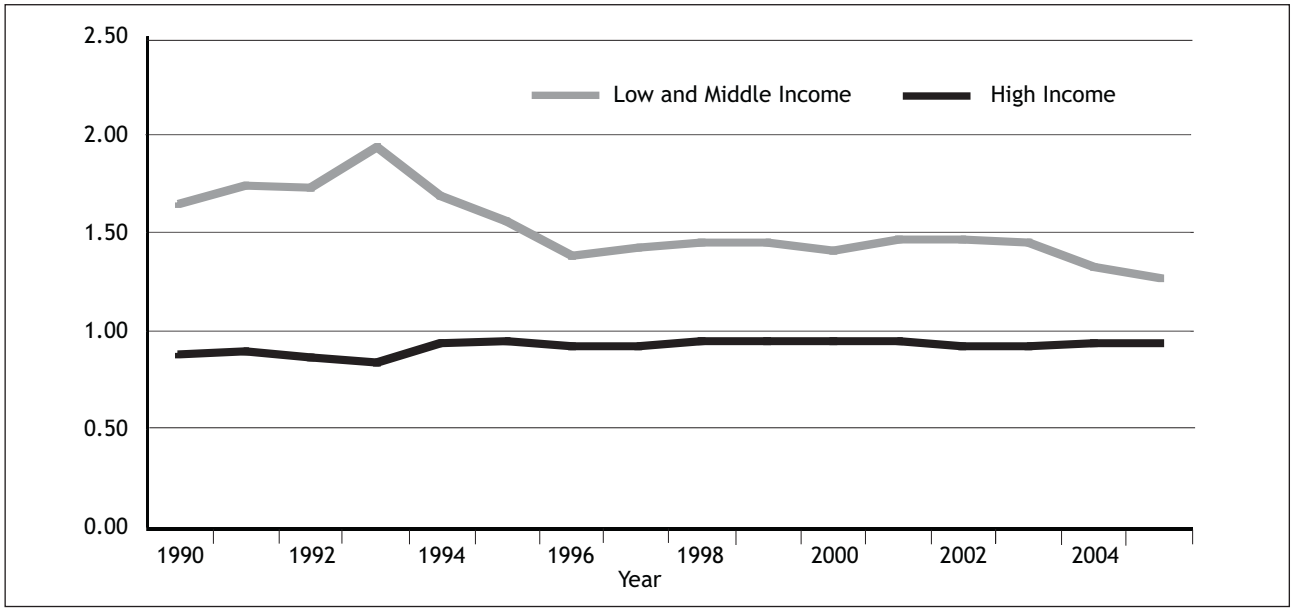
Is such leakage really happening? In this section, we examine the evidence for any relocation of carbon-intensive industries due to more stringent climate policies, mostly in the OECD countries. We identified industries that will be most impacted by carbon reduction targets. These are energy-intensive industries – pulp and paper, industrial chemicals, iron and steel, non-metallic mineral products and nonferrous metals –that have an incentive to relocate to avoid more stringent energy/carbon pricing policies.

Examining the actual data on imports and exports across various income groups and regions since the 1990s provides some interesting results. The import-export ratio of energy-intensive production in high-income OECD countries shows an increasing trend (probably reflecting an increase in imports and decrease in exports). When the same ratio is examined for low-and middle-income developing economies, there is almost a mirror image of the OECD graph (Figure 3.1). This could be a reflection of some relocation of energy-intensive industries to developing economies, which were not imposing any additional constraints on these industries on account of climate change.

Among the developing country regions we find that there is indication of some relocation of industries from the US to mainly East Asia, and especially China. While China does reflect the general declining trend in import/export ratio observed in East Asia, it is not driving the trend, as its economic growth probably continues to fuel increased imports of energy-intensive products (Figure 3.2).

This analysis thus suggests a gradual increase in the import-export ratio of energy-intensive industries in

Figure 3.1. Import-export ratio of energy-intensive products in high-income OECD countries and low- and middle-income economies



developed countries and a gradual decline in the ratio in some developing regions. There is some evidence – although it is not very pronounced – of leakage of carbon/energy-intensive industries to developing economies that could be attributed to more stringent climate change policies and energy efficiency standards.

3.4 Implications for China

There is no conclusive evidence to suggest a loss in competitiveness from climate change measures adopted in OECD countries or of a leakage or exodus of carbon/energy intensive industries to developing countries. These countries have implemented various polices and measures to achieve their targets and showed some progress in mitigating climate change. However, in a number of cases economic considerations have far outweighed the consideration for the global climate. Many of the incentives, especially for energy-intensive industries to reduce their emissions, have been nullified through special tax concessions, rebates, exemptions and other such measures.

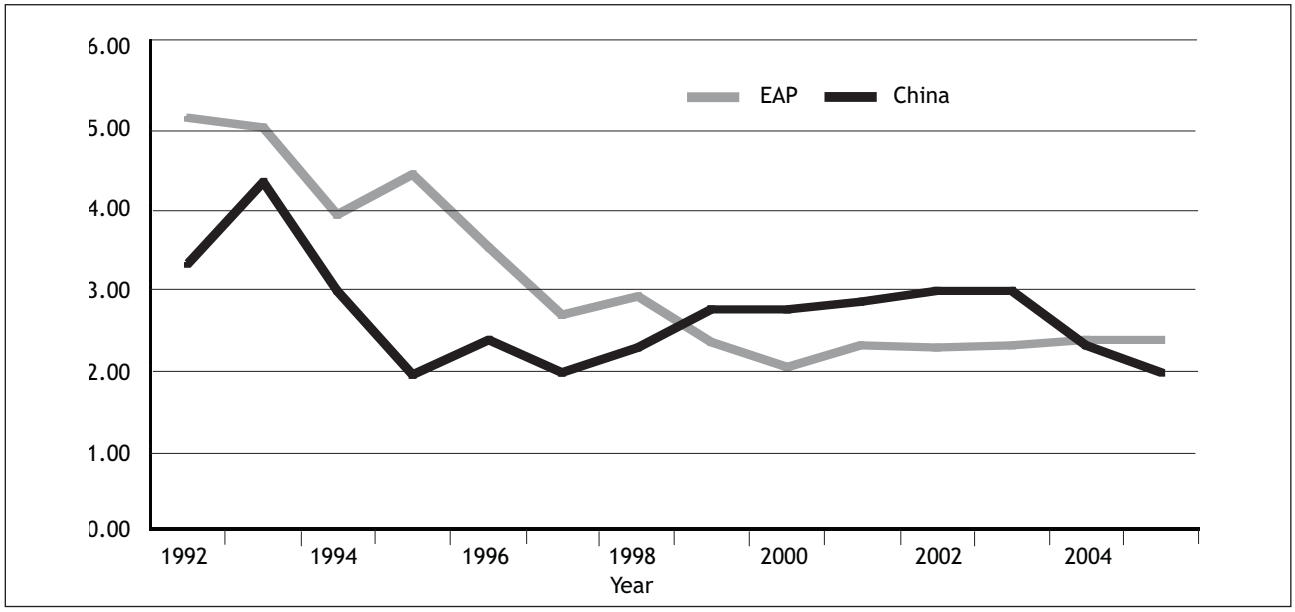
However, in the medium-to-long run, the increased stringency of climate policies in some industrial countries to meet Kyoto targets and increased economic growth in some developing countries in the next decades could accentuate the existing trends. The increased concentration of energy-intensive sectors in some developing countries like China and India could not only signal their greater future involvement in any post-Kyoto global GHG reduction measures, but also could subject them to punitive trade sanctions for not participating in any global arrangements related to climate change.

Successful GHG mitigation approaches, however, need to be supportive of developing countries' economic and social development needs and institutional, financial, and technical capacity. These countries cannot take on the same commitments as the developed countries as they often lack institutional, financial, and technical capacity, which will influence their ability to implement and comply with climate commitments. In addition, developing countries must deal with poverty and other social challenges, and they may be reluctant to adopt restrictive policies that could limit economic growth and pose any threat to energy security.

However, developing countries are also more vulnerable to the impacts of climate change. Their economies are more dependent on climate-sensitive sectors such as agriculture and forestry, and they lack the infrastructure or resources to respond to the results of changes in climate. Hence, any market-driven mechanism that facilitates the transfer of clean technology — at the same time entailing minimal costs to their economies — may be viewed more favourably than the more traditional command-and-control regimes.

The Stern Review report on the economics of climate change and the recent IPCC report both identify transfer of energy efficient and low-carbon technologies to developing countries as key to reducing the energy intensity of production. The Stern Review further observes that "the reduction of tariff and nontariff barriers for low-carbon goods and services, including within the Doha Development Round of international trade negotiations, could provide further opportunities to accelerate the diffusion of key technologies". The importance of technology transfer and facilitating low-carbon policies and investments in developing countries to move to a low-carbon development path has been emphasised in a number of recent World Bank reports.

Figure 3.2. Import-export ratio of energy-intensive products in low-and middle-income East Asian and Pacific economies and China



Access to climate-friendly clean energy technologies is especially important for the fast-growing developing economies. Removal of tariff and nontariff barriers (NTBs) can significantly increase the diffusion of clean technologies. The ongoing WTO negotiations on environmental goods thus have the potential to contribute significantly to trade liberalisation efforts, but will need to address a number of challenges. In addition, intellectual property rights, investment rules and other domestic policies should be streamlined for widespread development and assimilation of clean technologies.

It is important to note, however, that as a result of their improving investment climate and huge consumer base, developing countries are increasingly becoming major players in the manufacture of clean technologies. A key development in the global clean energy market is the emergence of China as a significant player, both in manufacturing and in investing in additional wind power capacity, solar photovoltaics (PV) and energy efficient lighting. Similarly, other developing countries have emerged as manufacturers of renewable energy technologies. India's PV capacity has increased several times in the last four years, while Brazil continues to be a world leader in the production of biofuels. These developments augur well for a buoyant South-South technology transfer in the future. Further, it is also in the interest of the developing countries to engage in the global efforts to liberalise trade and investment in clean energy and energy efficient technologies. Moving to low-carbon growth paths could be key to reducing global tension surrounding climate policies and their economic impacts.

4. Addressing climate change related competitiveness concerns: approaches in the EU and the US and their implications for China

Thomas L. Brewer

4.1 Introduction

The purpose of this paper is to describe developments in the EU and US concerning border measures that could be imposed on imports from countries whose policies are considered to be insufficiently responsive to the need for climate change mitigation.

Abstractly, the underlying problem – in the terminology of political economy – is that there can be "free riders" on international agreements, including in this case multilateral climate change agreements. The problem, in short, is that any given country can benefit from such an agreement without incurring the costs of participating in it. In particular, countries, industries and firms may fear that their international competitive position is being undermined by lower energy prices in non-participating countries. In the EU, these issues have arisen from time to time during the past several years in regard to US non-participation in the Kyoto Protocol. In the US, they have become salient during the past year in regard to emerging economy countries (especially Brazil, China and India). This paper considers these issues in three sections: activities in the EU, activities in the US and implications for China.

4.2 European Union

The European Parliament has passed resolutions calling upon the European Commission to consider the possibility of imposing offsetting tariffs on imports from countries that are not parties to the Kyoto Protocol such as the United States.

The Commission's reaction to these measures has been to oppose them on the grounds that they risked exacerbating trade relations with the United States, particularly at a time when trade relations were already strained and when trans-Atlantic relations more generally were unusually conflicted over a broad range of issues. In addition, there have been concerns that such a measure would undermine support in the US among those political and business circles that have been hoping for increased EU-US cooperation on climate change issues. Finally, there have been concerns that such a tariff might be challenged in a WTO dispute settlement case, and the outcome of such a case would inevitably be uncertain.

However, before leaving office in 2007, French President Chirac and Prime Minister de Villepin suggested again that such measures be undertaken – a position also supported by President Sarkozy - , but European Commissioner Mandelson responded that it would not be helpful to do so. For now, the issue is quiescent at least in public. However, since the issue is of continuing concern to the European cement industry and other GHG-intensive industries, the issue is not likely to go away.

4.3 United States

Similar issues have appeared in 2007 on the agenda in the US in the context of the introduction of climate change bills in the Congress. As in the EU, it is a combination of international competitiveness and climate change free-rider concerns that have put the issue on the active agenda in the US Congress.

As of the beginning of September 2007, the prospects for the many climate bills under consideration in the House and Senate were uncertain. However, whatever the outcome of votes in the two houses on these bills and any presidential action that might ensue, it is clear that there is much political support for some kind of border measure provision in climate legislation that includes a mandatory cap-and-trade system. But there is a key difference in the form of the measure that is on the agenda in the US, as compared with the tariff proposal in Europe. In particular, the proposal in the US is to require US importers in some circumstances to purchase GHG emission allowances. Such a measure could be less vulnerable than a tariff to challenge in the WTO, because it could more clearly be considered an environmental measure which would qualify as an exception under GATT Article XX(g), which allows measures "relating to the conservation of exhaustible natural resources."[2]

One legislative proposal of special interest that was under consideration in September 2007 was Senate bill S. 1766, which is commonly know as the Bingaman bill or Bingaman-Specter bill after its sponsors. It includes Title V, "Periodic Review and International Leadership," which requires reviews every five years of "whether each of the five largest trading partners"[3], of the US has taken "comparable action" to limit GHG emissions (section 501(2)(B)(i)). "Comparable action" is defined as "greenhouse gas regulatory programmes, requirements, and other measures adopted by a foreign country that are determined by the President to be, in combination, comparable in effect to the action taken by the United

States to limit greenhouse gas emissions pursuant to this Act, after taking into account the level of economic development of the foreign country" (section 502(a)(2)). US importers of "covered" GHG-intensive goods from countries that have been found not to have taken comparable actions must purchase "international reserve allowances" (i.e. greenhouse gas emission credits) to be issued by the US government. A "covered good" is one "that the President identifies, by rule, as a greenhouse gas intensive good that is closely related to goods, the cost of production of which in the United States is affected by this Act" (section 502(a)(5)).

These and many other technicalities of the bill are of course subject to revision in Congressional deliberations and in any negotiations that may occur between members of Congress and the President. However, it is significant that there is already quite specific and extensive language formulated and under active consideration in the Congress. It is also noteworthy that there would be much flexibility in how the provisions of the bill would be applied to particular circumstances. Further, the bill would require negotiations with countries before the import measures are implemented.

Perhaps more important than the legal technicalities or procedural issues at this point, though, is the political support that has already been expressed for the concept of border measures on imports from countries whose actions are deemed in the future to be deficient by the United States government. Indeed, the proposal was first vetted jointly by one of the country's largest electricity producers, American Electric Power, and one of the largest labour unions, The International Brotherhood of Electrical Workers. It has subsequently been endorsed by other major business and labour organisations. In short, the issue is now a significant item on the climate policy agenda in the United States and has much domestic political appeal.

4.4 Implications for China

In order for these issues and their prospects in both the EU and US to be fully understood, it is important to recognise that they are arising in the context of concerns about the future of international trade relations, especially with China, as well as the future of the international climate regime and China's place in it. Whatever internal political pressures are brought to bear in the EU and US on these issues are being driven in substantial part by concerns about patterns, trends and policies in Chinese international trade. Those concerns are particularly intense, of course, in a few industries, notably those which are both energy intensive and which harbour fears about Chinese competition (whether from the economics of international comparative advantage and/or from specific trade policies such as barriers to imports or subsidies of exports).

These internal pressures seem especially strong in the US, where it is likely that climate change legislation establishing a mandatory cap-and-trade system will be passed, signed and enter into force in 2009 or 2010, or possibly before. In any case, it is likely to include border measures along the lines discussed above in the legislation that is currently pending in Congress.

In the EU a plausible scenario is that pressures to put in place some kind of import measures will grow as the debate and legislative process in the US progress. Ironically, the debate in the US will tend to legitimise any similar measures by the EU. The precise form that such a measure would take in the EU, however, is uncertain. On the one hand, as noted above, there has already been movement towards the establishment of offsetting tariffs in the EU; on the other hand, certain features of the possible US measures, particularly in regard to challenges in the WTO, may make required GHG allowance purchases more appealing than a tariff. Furthermore, the international competitiveness concerns in the EU are more advanced, tangible and current than in the US because the EU's Emission Trading Scheme is already in operation.

Yet another development that could emerge from present circumstances is that the EU and US will join together in an effort to develop border-measures provisions to be included in a post-2012 multilateral climate regime. Now that the concept has become part of the climate change dialogue in Washington as well as Brussels, it will be natural for a trans-Atlantic dialogue, whether explicitly and officially endorsed or not, to expand as ideas for the post-2012 agenda becomes increasingly tangible and detailed.

Finally, the emergence of these issues makes abundantly clear that climate change issues and international trade issues have intersected. They will have to be addressed in a variety of climate and trade forums. One hopes they will be addressed in a way that is constructive for both climate change mitigation and international trade relations.

5. Turning challenges into opportunities: energy efficiency requirements and market access for China

Sun Xinhua and Shuaihua Cheng

5.1 Introduction

The issue of climate change and global warming is one of the most demanding challenges for the world to address. With global warming on the increase and species and their habitats on the decrease, many scientists agree that climate change may be one of the greatest threats facing the planet. Ironically, the use of many of the inventions that mankind was once proud of, like refrigerators, air conditioners, televisions, clothes washers and dryers, dish washers, water heaters, computers and motor vehicles, constitutes one of the important driving forces of climate change and global warming. In this sense, enhancement of energy efficiency of these energy-using products (EuPs) not only contributes to the security of energy supply but also is the quickest, most effective and most cost-efficient way of reducing greenhouse gas emissions. That is, improved energy efficiency will play a significant role in meeting the Kyoto commitments in an economic way. Therefore, an ever increasing number of more stringent energy efficiency regulations, standards and conformity assessment procedures on EuPs have been developed throughout the world in the past few decades.

The implementation of these climate change-related energy efficiency requirements has strong implications for the market access of EuPs originating in China, a principal global EuP supplier. On the one hand, Chinese exporters of EuPs, SMEs in particular, face the challenges of the lack of knowledge, capital, technology and infrastructural, technical and managerial capacities to cope with new and more stringent energy efficiency measures of the importing countries. On the other hand, for the "double-edged sword" effect of technical barriers to trade (TBT), climate change and global warming issues also provide unprecedented opportunities for China to step up its efforts to readjust and upgrade its industrial structure, promote technological progress and phase out low energy efficiency industries, hence finding a fundamental solution to the chronic problem of extensive economic growth pattern, which is still in the dominant position in China. More proactive and coordinated adjustment approaches to energy efficiency requirements will help China meet new requirements and turn challenges into opportunities. Such approaches may also contribute to China's realisation of security of energy supply, one of its priority policy objectives in the 21st century.

5.2 Energy efficiency requirements throughout the world and implications for China

Energy efficiency requirements throughout the world

In the past few decades, countries throughout the world have implemented a large number of energy efficiency standards and labelling programmes. According to the Collaborative Labelling and Appliance Standards Program (CLASP), as of the end of 2005, 62 countries had adopted 1,818 separate standards or labels covering 82 products[4]. Moreover, more energy efficiency programmes are under development.

Viewed from a global perspective, the world-wide energy efficiency requirements display the following main trends. First, the coverage of such requirements have been expanding, as an increasing number of products have been brought under the scope of mandatory or voluntary minimum energy performance standards (MEPS) or energy efficiency labelling schemes. Energy efficiency requirements have gone far beyond the original household appliances to cover a much broader range of EuPs, including commercial and industrial equipment. Secondly, energy performance levels have been more stringent. Thirdly, MEPS and labelling schemes frequently differ from export market to export market. Finally, there has been a trend for mandatory MEPS to replace voluntary industry targets.

The following makes three case studies (three OECD members: the EU, USA and Australia) to show the energy efficiency legislation in different areas of the world.

The European Union implements energy labelling and compulsory minimum efficiency requirements for household appliances such as washing machines, dishwashers, oven and air-conditioning systems,[5] etc. It also has the Energy Star Programme – a voluntary legal instrument to promote energy efficiency of office equipment like computers, monitors, printers, fax machines, copiers, scanners and multifunction devices. Manufacturers, assemblers, exporters, importers and retailers are invited to register with the European Commission allowing them to place the Energy Star label on products that meet or exceed energy-efficiency guidelines[6]. In terms of potential impact one of the most significant environmental directives proposed by the European Commission is the EuP Directive – a directive establishing a framework for

the setting of eco-design requirements for all energy-using products except vehicles for transport[7]. Up to now, three existing EU Directives on MEPS for specific products (hot water boilers, household refrigeration appliances and ballasts for fluorescent lighting) have been brought within the framework of the EuP Directive, and possible implementing measures are under preparatory study for a first round of 19 product groups including boilers and combi-boilers, water heaters, personal computers, imaging equipment, consumer electronics, etc. A second round preparatory studies for a further five product groups are to start in 2007. The EuP Directive represents a new approach by setting eco-design requirements for products eligible for "implementing measures". What is worth mentioning is that the all the implementing measures for the EuP Directive will impose specific energy efficiency requirements from the early stage as the design phase.

In the United States, the U.S. Energy Policy and Conservation Act (EPCA) and the Energy Policy Act of 2005 (EP Act) require the Department of Energy (DoE) to set appliance efficiency standards at levels that achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified[8]. Recently, the growing importance of MEPS is worth special attention. Firstly, there has been a move from voluntary targets to MEPS. In 1975, the Energy Policy Conservation Act (EPCA) directed the U.S. Department of Energy (DoE) to develop voluntary appliance efficiency targets. However, the National Energy Conservation Policy Act of 1978 (NECPA) directed DoE to set MEPS in replacement of the EPCA voluntary targets. Secondly, there has been a growing number of MEPS. In January, 2006, the DoE released a five-year plan outlining how it will address the appliance standards rulemaking backlog and meet all of the statutory requirements. The DoE claims that it "is aggressively implementing process improvements to speed up the development and issuing of appliance standards rulemakings".

In Australia, minimum energy performance standards and energy labelling schemes are established through State-based legislation. All products within the scope of energy labelling and/or MEPS must be registered and approved by a State authority. In recent years, more and more equipment and appliances have been made subject to its MEPS and mandatory labelling systems. And the MEPS and labelling have been introduced for some types of domestic air-conditioners, extended to clothes dryers and external power supplies.[9]

Challenges and opportunities in meeting energy efficiency requirements for China's EuP producers

In recent years, China's exports of electromechanical products witnessed a rapid growth. Statistics indicates that the total export value of China's electromechanical products amounted to USD549.44 billion in 2006, 28.8 percent increase over the year 2005. Given such a big export value, China's EuP producers will no doubt be affected by the world wide energy efficiency requirements. For the majority of China's EuP producers, which are mainly composed of state-owned enterprises and SMEs, the increasingly stringent external energy efficiency requirements mean trade loss. Take the EU energy efficiency measures as an example. According to the China Chamber of Commerce for Import and Export of Machinery and Electronic Products (CCCME), the implementation of the EuP Directive alone will cause no less than 50 billion *Yuan* loss for China's household appliances industry[10]. The TBT/SPS cost survey conducted by the General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ) in China in 2007 displayed a similar result.

In order to find out to what extent China's exports in 2006 were affected by the technical trade measures of the importing countries, AQSIQ conducted a country-wide TBT/SPS cost survey early in 2007. The survey shows that more than 31.4 percent of China's exports were more or less affected by the technical trade measures of the importing countries in 2006, resulting in USD35.92 billion of direct trade loss and USD19.155 billion of increment in compliance costs. Among the various categories of products most affected by overseas technical trade measures, electrical and electronic equipment ranked first. The survey also shows that energy efficiency and product recycling requirements is one of the various types of technical trade measures that posed the highest market access barriers for China's exports in 2006.

In the view of the authors, it is almost impossible to identify the changes in China's trade flows in products badly affected by certain external energy efficiency requirements. This is because energy efficiency requirements are only one category of a wide range of specifications that a Chinese producer must meet in order to access a market. In addition, it is often difficult to conclude that it is an energy efficiency measure that is creating the problem with market entry; an analysis of the above-mentioned main trends in energy efficiency requirements throughout the world show that the market entry problems China experienced in 2006 have much relevance to the world-wide implementation of energy efficiency measures.

Apart from the complexity, stringency or technical characteristic of certain energy efficiency requirements, Chinese enterprises face a number of other constraints. First, as was reflected in AQSIQ's 2007 TBT/SPS cost survey, a majority of the sample Chinese enterprises found it difficult to identify the changes in technical requirements of the importing countries. For lack of an authoritative one-stop national channel providing updated information on market access conditions, the level of awareness of the technical requirements in key export markets among China's enterprises, State-owned enterprises and SMEs in particular, is relatively low. Secondly, they often find it difficult to access or afford

the required specific technology, which is often protected by patents. Thirdly, due to the lack of adequate testing and metrology facilities esp. in the inland areas of China, many EuP producers lack the ability to demonstrate compliance in a credible manner. Fourthly, though China has administrative measures in place to control the illegal importation of second-hand high energy consuming products, some EuP producers simply cannot operate without them because of their low price.

Last but not the least, as tariff barriers have become less important and the potential impacts of non-tariff or technical measures on trade have been growing, some countries may use energy efficiency regulations and standards as strategic tools to protect domestic markets or market share. As was pointed out in the WTO's *2005 World Trade Report*, while technical regulations and standards can deliver important benefits, they "can also be used as protectionist measures and can result in higher operating costs for developing country producers".[11]

However, things usually have two sides. While more stringent energy efficiency requirements of importing countries adversely affect competitiveness of China's EuP producers and exporters at the sector or enterprise level, they may also generate economic and environmental benefits for China's long-term sustainable development at the national level. Besides, external efficiency requirements will push China's EuP producers and exporters to make more energy efficiency related investments and adjustments. The "law of the jungle" will further consolidate the competitiveness and profitability of those producers engaged in supplying high energy efficient products. Moreover, early, active and effective participation of Chinese Government and industry in the pre-regulation and pre-standard setting consultations as well as in ex-ante impact assessments initiated by the importing countries could decrease the undesirable impacts of new energy efficiency requirements on trade, economic, social and environmental conditions of China.

It is interesting to note that after six years of imposing high anti-dumping duties against energy saving light bulbs from China, the European Commission decided on 29 August 2007 to remove it, not immediately but one year later. According to the EU Trade Commissioner Peter Mandelson, this decision is "in the interest of the EU" because efficient energy use and conservation is also a key priority of the EU and the EU is able to meet only 25 percent of its demand for energy saving light bulbs through domestic production.

It is surely absurd for the EU to maintain tariffs for another year at a time when the EU is making efforts to increase the use of green technologies in order to achieve its dual goal of cutting energy use and CO_2 emissions by 20 percent by 2020. However, on the part of the Chinese producers of energy efficient light bulbs, something is better than nothing. The likely removal of EU anti-dumping measures against Chinese-made energy efficient light bulbs in one year itself shows that investment in energy efficiency promises hope and opportunity.

In short, energy efficiency requirements mean not only challenges but also opportunities. From the authors' point of view, to what extent China can turn challenges into opportunities depends on what adjustment approaches China takes and how effective they are.

5.3 China's adjustment approaches to energy efficiency requirements

Different approaches taken in China

Chinese EuP producers and the government generally adopt very different adjustment approaches in response to new energy efficiency requirements. The former tend to adopt a mainly fire-fighting, reactive approach to addressing the energy efficiency requirements in China's key export markets, while the latter implements proactive policies to address domestic energy efficiency problems as well as the challenges posed by new and more stringent energy efficiency requirements in international markets.

Chinese EuP producers, the largest proportion of which is SMEs that export under foreign brand names, are generally slow in making adjustments. What is worse than their lack of technical, infrastructural and managerial capacities is their lack of sense to make the necessary adjustments beforehand. They generally delay compliance until after a problem has arisen. And once a problem occurs, they usually resort to the government for help. What is more, very few of them have the sense or knowledge to safeguard their rights under the WTO/TBT Agreement by actively participating in the regulation consultation process and providing comments in a timely manner.

Of course, it is useful to make a distinction between the above-mentioned SMEs and large EuP manufacturers. In fact, many of the large EuP manufacturers are already aware of the opportunities arising from preferences for more environment-friendly energy efficient products. Therefore, they are making necessary efforts to respond to both domestic and external energy efficiency requirements. For example, Haier Co., China's leading manufacturer of household appliances has established a specific test house to test and monitor energy consumption throughout the whole product chain. Hisense Group adds investments from product design to production phases and invites authoritative third-party testing bodies to be involved in the product energy consumption monitoring process. Chigo Air Conditioning Co. makes active efforts to develop new generation of low energy consuming products, and at the same time sets up a plant in Turkey where energy efficiency standards are not so high and production costs are low. This strategy has helped Chigo to reduce costs and evade high energy efficiency barriers.

It should be pointed out that it is primarily the Chinese Government that drives the adjustment process. Under the context of China's current efforts to build "harmonious society" and promote "scientific development", the Chinese Government attaches great importance to addressing climate change and spares no efforts to tackle domestic energy consumption problems and make adjustments to respond to external climate change related market access

requirements. The Chinese Government is proactive in developing and amending its domestic policies, legislation, standards and labelling systems.

In the outline of the 11th Five-Year Plan, the Chinese government puts forward the target of reducing annual energy consumption per unit of GDP value by 20 percent in 2010 from the end of the 10th Five-Year Plan. Besides, on 4 June of this year, the Chinese government released *China's National Climate Change Programme*, its first comprehensive strategy on addressing climate change calling for improved energy efficiency and reduced greenhouse gas emissions. A national steering team for climate change led by Chinese Premier Wen Jiabao was also established.

In August 2004, the National Development and Reforming Committee (NDRC) in conjunction with AQSIQ promulgated Decree No. 17, stipulating that the *Energy Efficiency Labelling Regulation* be implemented from 1 March 2005. The regulation requires covered products to display energy efficiency labels indicating the relative energy performance of the goods for sale. To date, products subject to the regulation include household refrigerators, room air conditioners, electric motor washing machines and unitary air conditioners.

Energy efficiency standards could play an important role in encouraging enterprises to improve energy efficiency. China's efforts on energy efficiency standards have been and are being made in some energy consuming sectors such as the petrochemical industry, metallurgical industry, chemical industry, power industry, construction material industry as well as household appliances, lighting products and industrial equipment.

As incentives for improving energy efficiency, on 30 July 2007, the State Council promulgated a Notice establishing a mandatory government procurement system for energy saving products. The system will make it compulsory for Chinese governments to give precedence to procuring products of outstanding energy efficiency performance.

In terms of information gathering, analysis and dissemination, China's national WTO/TBT Enquiry Point based at AQSIQ has kept track of the developments in energy efficiency regulations and standards and has provided comments on a large number of new energy efficiency regulations notified to the WTO.

Finally, the Chinese delegation is one of the most active delegations in raising energy efficiency related trade concerns at the WTO/TBT Committee regular meetings and other multilateral occasions. China is making a much bigger voice in the relevant international arenas.

Suggested future actions

Despite the various efforts China has made in the past few decades to deal with energy efficiency and other climate change related issues, additional steps are needed to further improve the effectiveness and efficiency of such efforts.

On the part of the Chinese Government, first and foremost, it needs to make coordinated efforts to establish an integrated and comprehensive national TBT early warning system, which can function as the sole authoritative official channel for the gathering, retrieving, analysis and dissemination of information on energy efficiency requirements. According to current actual conditions, China's national WTO/TBT enquiry point needs to further extend its responsibilities to play such a role.

In line with international practice, and taking into account the difficulties that Chinese enterprises confront in meeting external energy efficiency requirements, the Chinese Government should consider providing reasonable subsidies to those enterprises involved in technological innovation, as incentives for their efforts to improve energy efficiency.

On the part of EuP producers, they should shift from a reactive to a more proactive approach, and make quick efforts to integrate environmental consideration as early as possible into the product development process. This is the most effective way of introducing changes and improvements to the products.

It is also worth highlighting that resolving climate change related problems is a global "shared responsibility". In this sense, every responsible country has obligations to take concrete steps to repeal measures that are harmful to the fulfilment of their climate change related commitments. Here, the authors appeal to the EU to put an immediate end to its anti-dumping duties on the light bulbs from China. Moreover, pursuant to the transparency and Special and Differential Treatment (S & D) provisions under the WTO/TBT framework, developed countries should faithfully fulfil their obligations by providing more opportunities for China to participate in their stakeholder consultations and ex-ante impact assessments, and providing China with all reasonable trade-related technical assistance to strengthen its efforts for energy efficiency.

5.4 Conclusions

Energy efficiency is the front line defence against climate change. Unlike other approaches to carbon reduction such as renewable energy and forest management, energy efficiency can be most effectively achieved through proactive, coordinated and integrated approaches jointly taken by the government, producers and industry associations. In essence, energy efficiency can best be improved by the government changing the market rules through regulations, standards and letting the market respond. China's enterprises need to adopt a more proactive and strategic adjustment approach to respond to energy efficiency requirements in export markets, particularly through early integration of environmental consideration into the product development process and increasing energy efficiency during use. OECD and other countries have shared interests and responsibilities with China to address energy efficiency and other climate change related challenges. Win-win situations can arise where enhanced energy efficiency can be achieved through cooperation and dialogue instead of confrontation or protectionism.

6. Technology transfer, intellectual property and access to clean energy technologies in China

John H Barton

6.1 Introduction

As part of the world's move to combat global warming, China is likely to seek to reduce its emissions of greenhouse gases, and particularly of (CO_2. It may have to obtain new technologies in order to do so. This note explores whether there will be barriers, particularly intellectual property (IP) barriers, to accessing those technologies. It reviews the general technology transfer system and then examines the industrial and IP structure of three sectors, PV, bio-mass and wind energy.

6.2 The international context

There are several international programmes implementing technology transfer in the renewable energy area. Thus, Article 12 of the Kyoto Protocol creates a "clean development mechanism" (CDM), under which entities in industrialised nations can satisfy their domestic CO_2 reduction obligations through facilitating an emissions reduction in a developing nation. This certainly encourages installation of emissions-reduction facilities and may, under some circumstances encourage transfer of technology. The Global Environment Facility (GEF) is designed to subsidise developing nations' actions to respond to environmental concerns in those situations in which the developing nation making the expenditure will obtain little benefit for itself even though the action will, on net, benefit the rest of the world. The World Bank has a Renewable Energy Division, which supports a variety of programmes, and has long been active in China.

In addition, there are important bilateral programmes. For example, the United States and China set up a working group on climate change in 2003, looking to cooperative research in a number of areas. The European Union and China created a partnership in 2005, looking particularly toward zero-emissions coal technology, and the UK is taking a lead role in the first phase of this effort.

6.3 The achievement in technology transfer

There are several modes of technology transfer. One is to transfer products incorporating the technology, e.g. to transfer photovoltaic panels for off-grid electrical supply. Another is to license the capability to produce such products, perhaps to an indigenous firm or a joint venture. And a final one is to support developing national capability to research and produce the products independent of a licensor (or at least in a relatively equal position with the licensor).

There are different patterns of technology transfer in the public and the private sectors, sometimes based on a license from a foreign to a local entity, and sometimes based on supply of equipment. And in the CDM process, there may be an agreement between a specific developed world entity that wishes a carbon credit and a specific developing nation entity able to provide one. An example is a recent wind-energy park in China, supported by a Japanese electrical power firm and the Swedish energy agency.[12] In this case, the wind turbine manufacturer was Vestas, a Danish company, chosen by public bidding.

There are two types of markets for renewable energy capabilities for developing nations. The most obvious one is the market for enabling the nation itself to reduce its CO_2 emissions, either to satisfy its own national goals or to provide carbon offsets under the CDM system of the Kyoto accord. The other is the market for exporting renewable products, such as biofuel (or conceivably electricity), and equipment, such as wind turbines, in which the developing-world industry may become integrated into the global industry as a supplier. In general, the competition (and therefore the prices) in each of these markets will be different. In the first market, the economic comparison is with alternative energy sources (which may include conservation) or alternative sources of offsets, which may be in other developed nations. And in the second, the competition is with other suppliers of the particular internationally-traded product.

Many renewable technologies are currently unlikely to be successfully applied unless they are subsidised or required by regulation. In the PV and wind sectors, the incentive has come from requirements on electrical utilities that they use renewable sources for a certain percentage of their energy – or that they buy renewable energy, often on favourable terms set up in a "feed-in tariff." In the case of biofuels, there may be subsidies or requirements that fuels contain a particular percentage of components made from renewable sources. China has enacted analogous arrangements, as exemplified in China's Renewable Energy Law which entered into force on 1 January 2006, but it is not clear whether these are yet strong enough to provide an adequate incentive to encourage broad use of the technologies.[13]

6.4 Photovoltaic

For evaluating the implications of intellectual property, this note considers three technologies. The first is PV technology, a technology based on panels which produce electricity when exposed to sunlight. The production of

PV panels is expensive and requires large-scale precision manufacturing capability. Nevertheless, the industry is only moderately concentrated: five firms, Sharp, Kyocera, Shell Solar, BP Solar and Schott Solar hold 60 percent of the market.[14] There are five firms in the developing world, each producing at least 10 MWp. They include Ningbo Solar Cell, Shenzhen Topray Solar, Suntech Power, Motech (Taiwan, China) and BP Solar (India).[15]

In China, the industry has long been encouraged by the government, primarily through government support for research into various forms of PV cells and through encouragement of the import or design of PV production equipment. The import of certain of the fabrication technologies was accomplished in part by a programme with the US Department of Energy in the early 1980s. As of a 2003 study, most of the actual production line equipment (or at least the key equipment) has been imported from the United States or Canada, but one firm, GoFly Green Energy Co., built its own production equipment.[16]

China's most recent success story in the area is Suntech Power Co., Ltd. This firm was founded in 2001, started its first assembly line in 2002, and produced 60 percent of China's PV cells by 2005. The firm went public in New York in December 2005. The firm has its own R & D centre. In 2006, the firm acquired a Japanese PV firm, MSK.[17] The same year, it is said to have become the world's fourth largest PV producer (superseding the earlier data considered above).[18] Its corporate prospectus makes no mention of concerns about obtaining technology; rather, it emphasises concerns about access to the silicon supply needed for continued expansion.[19] China is clearly finding the benefits of the basic technology, and does not appear to be barred by patents

6.5 Biomass for fuels

There are two currently important technologies for production of transportation fuel from biomass. One is the production of ethanol for use in automotive fuel. It is produced quite efficiently from sugar-cane in Brazil, and much less efficiently from corn in the United States. The alternative process, emphasised in Europe, is of diesel fuel (bio-diesel) from a variety of forms of bio-mass. In addition to these relatively traditional technologies, there are new approaches. To use more than the starches and sugars used in current processes requires the breaking down of cellulose, a task which is currently the topic of significant research and public research support.[20] So far, this has happened only on a demonstration scale, and the apparent leader is Logen, a Canadian company.[21]

The industrial structure here is very different from that for PV energy. The economics of bringing the biomass to the production plant favour decentralised conversion of biomass to fuel. There are substantial ethanol industries in a number of developing nations, including China, which has built the world's largest plant.[22] This suggests that there are few technological difficulties in entering the sector. The same is almost certainly true in the biodiesel context, where the major producers are European.

Patent issues are likely to arise primarily with the newer technologies, because the older ones are long off-patent, and there is enormous patenting activity in the new areas. For example, a recent study of bio-diesel technology found an increase in patenting in the area from two patents in 1998 to 88 in 2005.[23] Moreover, there have been at least two US lawsuits involving ethanol production processes, both relevant to corn-based processes, as used in the United States, and not to sugar- based processes.[24] In cases in which royalties were established, they amounted to about USD0.10 cents per litre of fuel .

At this point, it thus again appears that China will have quite adequate access to the current generation of technology. Confidence of access to future generations of technology is less clear, but such access is likely to be achieved as a result of market forces. There will, of course, be problems in exporting biofuel to global markets, as reflected, for example, in the US tariff on Brazilian ethanol. Considering the incredible protectionism and market management of the global sugar economy, it is not surprising that there is protectionism in the product of the sugar.

6.6 Wind

Windmills go a long way back, so, again, the basic technology is not new. But there are many recent improvements in the technology, primarily in control and in dealing with variable wind speeds. These have given rise to a number of publicised patent disputes and licensing discussions, all primarily affecting the US market.[25] The industry is the most concentrated of the three analyzed here; the top four firms serve almost three-quarters of the market. Clearly, however, there is enough competition so that developing nations will be able to build wind farms with equipment from the global market without substantial IP costs.

For developing nations to enter the global market for wind turbines is more difficult. The existing industrial leaders are strong. They are hesitant to share their leading technology out of fear of creating new competitors.[26] And it is always difficult for a new entrant to catch up. Nevertheless, the firm in 5th place is an Indian firm and that in 10th place a Chinese firm. China has succeeded in serving its own market, but is not, at this point, a significant exporter. It appears able to produce wind turbines about 20 to 40 percent less expensively than developed-world firms, but, at least as of approximately 2003, all Chinese technology in the area originated from agreements with US and European firms, and in none of the cases was state-of-the-art technology transferred. It was always older technology (typically for windmills with smaller total power per unit).[27]

The leading Chinese firm is Goldwind, which initially obtained its technology from Jacobs, a German firm, for a royalty of 10,000 DM per machine.[28] Considering that

the "standard" approximate cost of an onshore turbine is USD1000/KW,[29] and that the typical Goldwind machine is about 750 KW, this amounts to roughly a 1 percent royalty. But, as noted above, Goldwind only had some of the technology needed; as of approximately 2003, it was not manufacturing the entire turbine in China. It had begun to acquire blades locally, but not the entire product.[30] Of several smaller Chinese firms, one (Zhejiang Yunda Windey) is developing some of its own technology.[31] Nevertheless, there is evidence that China's technology is still lagging, because the Vestas turbines chosen for the Gansu Datung Yumen CDM project discussed above were described as having superior technology to that of any turbines of Chinese manufacture.

It is not clear how much of China's technology lag is based on the need for Chinese firms to gain experience and how much is based on unwillingness of the technology licensing firms to provide particular technologies. Part of the reason has been restrictions in tied-aid programmes that require use of the donor-nation's products.[32] China is attempting to help develop the missing technologies, and is subsidizing research[33] and considering local intellectual property requirements in addition to local content requirements.[34]

6.7 Implications for China

With respect to access to the benefits of the technology, i.e. for the markets for reducing CO_2 emissions or for providing emission offsets to developed nations, there seem unlikely to be significant IP barriers to Chinese access to technology. For the market of exporting PV cells, ethanol (or other renewable fuel), or wind engines, the picture is slightly more mixed. Certainly, for ethanol, the key concerns will be tariff and similar barriers, not IP barriers. For PV, the IP system is still unlikely to be a significant barrier. For wind energy, the issue is slightly less clear, but there will still probably be little IP problem. Nevertheless, precisely because of the global concentration in some of the industries, it is important to be alert to the risks of cartel behaviour, although there have been no serious public allegations of such collusion in the industries considered here.

There is a possibility that China would benefit from stronger IP protection to encourage its own industries.[35] This is exemplified in the case of wind power – but it is not clear how much the barriers to technology flow are really general concerns about transferring core technologies rather than IP concerns.

The available evidence is agnostic on the benefit of nationally-funded research programmes oriented toward helping national firms gain the technology needed to compete globally. Clearly, there have been major benefits of such research in the developed world, but data are not yet in on China's effort to help its wind industry.

Of particular importance is the role of developed-nation public support of technologies, a source of much of renewable energy research. Governments are likely to seek to ensure that patents are gained on the results of the research and then seek to ensure that national firms are favoured in the licensing process. This may make it difficult to transfer technology to developing nation firms, who could potentially be competitors. As part of climate change negotiations, a developed-nation commitment to make the technology more readily available might be included, perhaps as a quid-pro-quo for stronger environmental constraints upon developing nations. Or such a commitment could be part of a stand-alone technology arrangement, with the quid-pro-quo based on reciprocity among research funders.

In general, in the renewable energy industries, the basic approaches to solving the specific technological problems have long been off-patent or there are a number of such approaches that may be patented by different firms. What are usually patented are specific improvements or features. Thus, there is competition between a number of patented products. Moreover, there is competition not only between the firms in the specific sector but also between different sectors and alternate sources of fuel or electricity. In such circumstances, the normal result of competition is to bring prices down to a point at which royalties and the price increases available with a monopoly are reduced. In effect, the benefits of the technologies are shared with the ultimate customers.

ENDNOTES

1 NDRC 2005: *National Energy Plan*.

2 There are a variety of technical legal issues, which are beyond the scope of this short article, but which have been the subject of extensive analysis (see the list of suggested readings at the end of the article for details).

3 A second Senate bill, the Lieberman-Warner "America's Climate Security Act" - as described by an "Annotated Table of Contents" released by the Senators on 2 August 2007 - was also expected to contain a border measure that would require US importers to purchase GHG allowances in some circumstances. However, because the bill had not yet been formally introduced as this article was being written, the details of the proposal were not yet known.

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5 http://ec.europa.eu/energy/demand/legislation/domestic_en.htm

6 http://ec.europa.eu/energy/demand/legislation/energy_star_programme_en.htm

7 For the full text, visit http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32005L0032:EN:NOT

8 North American Energy Standards and Labelling: http://www.eere.energy.gov/buildings/appliance_standards/pdfs/naewg_report.pdf

9 A full list of products regulated for energy efficiency in Australia is available on http://www.energyrating.gov.au/productmenu.html.

10 http://www.tbtinfo.org.cn/Website/index.php?ChannelID=17&NewsID=24295

11 WTO: 2005 PRESS RELEASES http://www.wto.org/english/news_e/pres05_e/pr411_e.htm

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26 J. Lewis & R. Wiser. (2005), "A Review of International Experience with Policies to Promote Wind Power Industry Development", prepared for Energy Foundation China Sustainable Energy Program, 10 March.

27 J. Lewis. (2005) supra.

28 J. Lewis. (2007). "A Comparison of Wind Power Energy Development Strategies in Spain, India, and China, Center for Resource Solutions", 19 July.

29 Lewis & Wiser, supra.

30 J. Lewis, 2007.

31 RELaw Assist. (2007). Renewable Energy Law in China – Issues Paper (Baker & McKenzie, Renewable Energy Generators of Australia, Chinese Renewable Energy Industry Association, Centre for Renewable Energy Development), June..

32 RELaw Assist, supra.

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- Support the transition to a sustainable energy future by providing relevant stakeholders in different policy processes with innovative analysis regarding opportunities and challenges in the trade and sustainable energy nexus;
- Generate policy-oriented and solutions-focused knowledge on the interface between the multilateral trading system and various regimes and initiatives promoting the transition to a sustainable energy future;
- Expand the knowledge community on trade and sustainable energy by including non-traditional actors and view-points in the debate, including oil producers, climate scientists, agricultural economists, specialists in services trade, labour and consumer organisations; and
- Support existing capacity-building efforts through knowledge outputs and dialogues, particularly for poor countries and disadvantaged communities.

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Founded in 1996, the International Centre for Trade and Sustainable Development (ICTSD) is an independent non-profit and non-governmental organisation based in Geneva. By empowering stakeholders in trade policy through information, networking, dialogue, well-targeted research and capacity building, the Centre aims to influence the international trade system so that it advances the goal of sustainable development.