Unintended Consequences

Climate Change Policy in a Globalizing World

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ABSTRACT: The cap-and-trade system introduced by the European Union (EU) in order to comply with carbon emissions reduction targets under the United Nations Framework Convention on Climate Change Kyoto Protocol (1997) has in some instances led to the opposite outcome of the one intended. In fact, the ambitious energy and climate change policy adopted by the EU—known as the Emissions Trading Scheme (ETS)—has led to carbon leakage and in some instances to relocation or a shift in production of energy-intensive manufacturing to parts of the world where carbon reduction commitments are not in effect. EU business organizations state that corporate strategies are now directed toward expanding production overseas and reducing manufacturing capacity in the Union due to its carbon constraints. As the EU has been "going-it-alone" with mixed success in terms of complying with the Kyoto Protocol's binding emissions reduction targets, the net outcome of the ETS market-based climate change policy is more rather than less global CO_2 emissions.

KEYWORDS: cap-and-trade, carbon constraints, carbon leakage, energy-intensive industries, EU Emissions Trading Scheme

International energy and emissions reporting entities present a bleak picture of the future of climate change and project that a pathway to long-term stabilization of greenhouse gas (GHG) emissions concentrations in the atmosphere at around 450 parts per million will likely not be achieved. In the 2008 *World Energy Outlook*—published annually by the International Energy Agency (IEA)—global energy demand is projected to grow by 1.6 percent per year on average until 2030, which translates into an increase of 45 percent over the same period. China and India are expected to account for over half of the increase in energy demand while the Middle East will emerge as a major new demand region (IEA 2008). The scenarios of future energy use as presented by the Intergovernmental Panel on Climate Change (IPCC) in 2007 provide some hope for mitigating emissions of GHGs but the apparent failure of the United Nations Framework Convention on Climate Change (UNFCCC) under the Kyoto Protocol in curbing GHG emissions creates doubt about how effective emissions reduction policies are (IPCC 2007).

Of the greenhouse house gases, CO_2 is the major gas responsible for global warming because of the immense volume in which it is emitted mainly from burning fossil fuel.[1] Although some of the trends predicted prior to the onset of the 2008 global financial crisis may have changed somewhat, the fact that most of the growth of fossil fuel use will occur in non-Organization for Economic Cooperation and Development (OECD) countries suggests that the overall predictions of climate change—a 6-degree Celsius rise by 2050 according to the 2012 IEA report—will

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not significantly alter in the next few decades (BP Energy Outlook 2011). In fact, under current policies, a doubling of CO_2 emissions worldwide by 2050 is not unlikely. The Global Carbon Project (2010) reports that carbon dioxide emissions rose 5.9 percent in 2010. The increase—a half billion extra tons of carbon emitted into the atmosphere—stands as the largest increase in any year since the Industrial Revolution and the largest percent increase since 2003. Researchers suggest that the high growth rate reflects a bounce-back from the 1.4 percent drop in emissions in 2009—the year the recession had its biggest impact—but the Global Carbon Report suggests that little progress has been made in limiting greenhouse gas emissions reduction and that combustion of coal accounts for more than half of the growth in emissions. In China alone, emissions grew 10.4 percent in 2010, mostly attributed to the use of coal.

Debated presently—but not seriously considered at the time when the Kyoto Protocol was first signed in 1997—is the recognition that national emissions reduction commitments have little effect in a global economy driven by a rapid increase in foreign trade and foreign investment and organized around multinational corporations and international production networks (Giddens 2009; Klein 2008; Koch 2011; Newell and Paterson 2011; Schreuder 2009). This naturally leads to questions about the merits of a market-based regulatory approach to curbing CO_2 emissions as adopted by the Kyoto Protocol and implemented by the EU in 2005. As the Kyoto Protocol was based on the premise that developed countries would assume the largest responsibility for the concentration of accumulated GHG emissions in the atmosphere, we now know that a far greater share of CO_2 currently emitted derives from production in emerging economies; India and China in particular.

This article assesses the forces that drive the global market economy and determine why multinational corporations and in particular energy-intensive industries strategize to relocate or outsource production to developing countries that are not subjected to GHG emissions reduction targets under the Kyoto Protocol. The discussion will focus on carbon leakage and the expanded use of coal as a source of energy for electricity generation and manufacturing in developing countries. The expanding economies of India and China, in particular, warrant specific attention because of their rapid growth in industrial capacity. The article's title "Unintended Consequences" refers to the notion that contrary to the Kyoto Protocol's objective, global GHG emissions have increased rather than been reduced, and, ironically, the implementation of the EU Emissions Trading Scheme (ETS) or cap-and-trade system may be partially to blame. Carbon leakage is the term used to describe how, due to emissions reduction policies in one part of the world, enhanced emissions occur in other parts of the world with the net effect that overall global emissions increase. The assessment of the impact of the implementation or the ETS on carbon leakage is presented in the context of the rapidly expanding global economy under the capitalist system of production since the 1980s when the World Trade Organization (WTO), the World Bank, and the International Monetary Fund (IMF) began to develop their policies under the guidance of neoliberal policies promoted in Washington and London. The article forms a case study of how market forces drive growth in the global economy and confront the limits of growth to the Earth resource base and carrying capacity.

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While emissions have stabilized in some of the developed economies, international trade and foreign direct investment by multinational corporations has shifted the source of CO_2 emissions to developing countries (Schreuder 2009). We now recognize that the rise in emissions from goods produced in developing countries (non-OECD) but consumed in industrialized

countries (OECD) was six times greater than the emissions savings of industrialized countries (Peters et al. 2011) and that relocation or shift in production of particularly energy-intensive manufacturing played a key role in the redistribution of emissions.

The Kyoto Protocol recognized two groups of countries; Annex 1, which comprised most of the industrialized countries, and non-Annex I developing countries.[2] Annex I countries committed to legally binding reductions of greenhouse gas emissions of—on average—5.2 percent below 1990 levels between 2008 and 2012, with the US target set at 7 percent and the EU target set at 8 percent. The Kyoto Protocol came into force on 16 February 2005 after 55 Annex I countries covering at least 55 percent of 1990 GHG emissions had ratified the treaty.[3] The United States did not ratify the Kyoto Protocol and the Bush Administration officially withdrew from the Kyoto Protocol shortly after the president's inauguration in 2002. Russia was the last major country to ratify the Protocol in November 2004. India, China, and Brazil ratified the treaty but were not required to commit to emissions reduction targets under the Kyoto Protocol as they were classified as non-Annex I countries.

Whether it was fair or expedient to not submit developing countries to binding GHG emissions reduction efforts under the Kyoto Protocol has been discussed since the beginning of the UNFCCC in Rio de Janeiro in 1992. Clearly, as the largest share of historical greenhouse gases originated in developed industrialized countries and as the per capita emissions in developing countries were still relatively low, developing countries were not eager to commit to binding emissions reduction targets during the Kyoto Protocol's commitment period (2008–2012) but should—according to the main parties of the UNFCCC—be encouraged to participate in a meaningful and eventually significant way to help curb global emissions. From the start of the negotiations in Rio de Janeiro, it was understood that the share of global emissions originating in developing countries would grow as these countries implemented economic development policies to meet their social and development needs. Annex I countries agreed that—as developing countries develop industrial capacity—they would help pay for and supply technologies to them for climate change–related projects in order to encourage a more energy-efficient and lower-emissions development path. This clause in the Kyoto Protocol was defined as the Clean Development Mechanism (CDM) and through the linking of the EU Emissions Trading Scheme (ETS) with the Kyoto Protocol, the CDM has been applied by the ETS as one of the major mechanisms by which countries could meet their agreed-to emissions reduction commitments.[4]

Critics of the Kyoto Protocol—including US government officials under the Bush Administration—had always maintained that since China, India, and other developing countries would soon be among the countries contributing a major share to global GHG emissions, they should come on board with binding GHG emissions reduction commitments for the post-Kyoto negotiations. Without carbon constraints imposed on developing countries, they argued, corporate industries in developed countries would lose their competitive position and would likely expand production in non-carbon-constrained countries like China, India, and Brazil, or any other country competitively positioned for foreign direct investment (FDI) or foreign trade. In that case, there would be no net reduction of GHG emissions concentrations in the atmosphere but just a shift in the geographical distribution of the source of emissions due to expanding manufacturing capacity in the developing non-Annex I countries. The net result would be carbon leakage, which suggests an increase in overall global carbon emissions as a result of emissions reduction strategies and legislation in countries where climate change policies aimed at CO_2 emissions reductions apply.[5] Whereas this may sound contradictory, in fact it is very logical if we consider competitive forces in the global economy. Because CO_2 reduction policies will likely increase production costs in countries where abatement strategies are in effect, the market would shift production to nonabatement countries. This would be particularly the case for

energy-intensive industries, which are defined as industries that use a relatively large amount of energy per unit value manufactured and therefore produce high emissions relative to its useful output.

The market-based approach to climate change policy as designed under the Kyoto Protocol and as later implemented by the EU was heavily influenced by political considerations at a time when neoliberal policies—and in particular US policies—dominated international debates and negotiations. The World Commission on Environment and Development (WCED 1987) had issued the so-called Brundtland Report, *Our Common Future,* which promoted science and technology and a free-market approach to sustainable development. In preparation for the UN Conference on Environment and Development (UNCED) also known as the Earth Summit, in Rio de Janeiro in 1992, the Business Council for Sustainable Development —an international group of CEOs representing the major global corporations—was formed to advise UNCED on business and industry issues and to stimulate involvement by business in UNCED. Its leader, Maurice Strong, became the secretary-general to chair the UNCED negotiations. Environmentalists saw the Business Council as representative of business interests in policy making and as evidence of corporate hijacking of UNCED. Within a year of the Earth Summit, The Ecologist's edited volume, *Whose Common Future?* (1993) questioned the success and credibility of the negotiations. Even though the meetings were perceived to be all-inclusive and broad-ranging, it was clear that the corporate sector was a major player both in the formulation of the various conventions and as actor in the negotiations. In the battle to save the planet, free market environmentalism was promoted and the corporate sponsors were given special access to the secretariat. The philosophy of the Business Council on Sustainable Development prevailed throughout most of the deliberations and the desirability of economic growth, the market economy, and the Western development model based on neoliberal principles were not questioned. UNCED thus never had a chance of addressing the real problems of the environment and development relationship, according to the authors of *Whose Common Future?* (1993). The Earth Summit's action plan, *Agenda 21,* suggested ways to enable poor nations to achieve sustainable development, but did not question the desirability of the rich nations' pursuit of the same. So, the authors of *Whose Common Future?* (1993) asked the question in whose interest we are promoting sustainable development, and who is managing it?

The recommendations for sustainable development as adopted by the UNCED in 1992 followed fairly closely the recommendations made by the WCED. In the Brundtland Report commissioned by the WCED sustainable development is defined as development that meets the needs of the present generation without compromising the ability of future generations to meet their needs. In *Planet Dialectics* (1999), Wolfgang Sachs questioned the recommendations of the Brundtland Report and the support for the Western model of development as it is at odds with both equity considerations in the present generation as well as sustainability of the Earth resource base and carrying capacity considering future generations. Sachs poses that in a fundamental way sustainability is about global citizenship and argues that the principles of equity and sustainability derive from equal access to resources and the global commons. In his critique of the Earth Summit, Sachs claims that the call from the developing countries for a more equitable share in global wealth creation and access to resources was translated in terms of the right to development.

At the Earth Summit the leaders from the developing countries aligned with the business community from the developed countries in their praise for economic development as the solution to all global environmental problems. The argument was that with higher levels of economic development and technological know-how would come greater care for the environment and more efficient use of energy, thus lower pollution and GHG emissions levels. As Sachs (2002)

later stated, the quest for justice was firmly wedded to the idea of development; nobody had to profoundly change, and all parties could turn to business-as-usual, a position amply borne out in recent years. The authors of *Whose Common Future?* (1993) asserted that the UN-sponsored Earth Summit was nothing more than a repeat of the development debates of the 1960s and 1970s. They maintained that mainstream solutions proposed at the Earth Summit would be counterproductive because the Western economic development model was never questioned. The US and EU proposals presented at the Earth Summit to combat global environmental crises, including the UNFCCC climate change policy proposal, recommended limiting population growth, stimulating free-market enterprise, and the application of Western technology and transfer of this technology, know-how, and capital. The recommendations, according to the authors of *Whose Common Future?* (1993) did not sound terribly convincing after decades-long efforts to fight poverty, famine, and starvation by the same means. Repeated efforts to make life for the majority of the population of the developing world more tolerable through programs such as basic needs fulfillment, human resources development and education, and now sustainable development, obscure the real issue, which is that the introduction of the Western development model has more often than not resulted in increased poverty and environmental degradation (Harvey 2006; Peet 2007; Slater and Taylor 1999).[6]

Neoliberal Capitalism and the Limits to Growth

As Daly (1996) pointed out, economic growth can only proceed to the point where throughput of matter and energy stays within the regenerative or assimilative capacity of the Earth ecosystems. Thus, ultimately, sustainable development has to be understood as "development without growth" at a steady state, which requires a major geopolitical change and political-economic adaptation. In pursuit of profit from business-as-usual economic growth, many believe that capitalism in its present neoliberal form is unsustainable (Daly 1996; Harvey 2005, 2006; Klein 2008; O'Connor 1994; Porritt 2005; Schreuder 2009; Wallerstein 2000). Neoliberal capitalism aims to render maximum profit at minimum costs and thus global competition drives many businesses to outsource to locations where labor costs are lower and where strict environmental rules and regulation are not in effect (Chomsky 1999; Sen 1999; Stiglitz 2002). The absence of carbon constraints and the abundance of coal as cheap energy source form two other reasons why relocation may occur; a scenario causing much higher levels of CO_2 emissions than would have been the case had the Kyoto Protocol and the EU Emissions Trading Scheme not been in effect.

In essence, it can be argued that an economic system built on profit and global competition has caused an irreparable rift with the natural laws of life (Chomsky 1999; Harvey 2006; Klein 2008). Stern admits in *The Economics of Climate Change* (2006) that climate change policy under the UNFCCC Kyoto Protocol shows clear evidence of market failure. In his persuasive expose, *Capitalism as If the World Matters*, Porritt (2005) charges that the forces of capitalism and the challenges of the biophysical limits to growth require profound transformations if we want to avoid dramatic disruptions to life on earth. Arguing that capitalism in its present form is unsustainable, he asserts that only principles of sustainable development can provide the foundations upon which to base the transformations necessary to the global challenges we now face. He suggests that core values like a sense of interdependence, empathy, equity, personal responsibility, and intergenerational justice should be the guiding principles for a new world vision, but how to channel national interests, individualism, materialism, greed, and pursuit of riches, into a more sustainable lifestyle, remains the question. Such a transformation requires a major adjustment or change from our business-as-usual approach to development and economic growth.

The US directed neoliberal model of development has been the dominant model of global economic development since World War II (Sachs 1999). Western development strategies and capitalist interests and pursuits have become the guiding principles of most international negotiations (including the UNFCCC) and UN institutions like the WTO, the World Bank, and the IMF. These institutions, initiated and supported by the US and the EU have formed the mechanism by which foreign investment and trade have been promoted. The so-called neoliberal principles have directed development—in particular since the days of Ronald Reagan and Margaret Thatcher—under the banner of the Washington Consensus. The term Washington Consensus was first coined in the late 1980s by John Williamson (1990) of the Institute for International Economics; a research institution devoted to the study of international economic policy to promote a relatively specific set of economic policy prescriptions that were considered to constitute a standard reform package recommended for countries in economic distress by Washington-based institutions such as the IMF, the World Bank, and the US Treasury Department. The policies the Washington Consensus promoted were policies pursued in Chile after the fall of President Salvador Allende (Valdez 1995) and the oil crises of the 1970s but they became a set of quite specific prescriptive dictates during the 1980s with the debt crisis in Latin America when the IMF and World Bank signed on to them (Harvey 2006; Sachs 1999).[7] The term neoliberalism refers to an intellectual and political movement that espouses economic liberalism as a means to promoting economic development and securing political liberty. Inspired by Friedrich Hayek and Milton Friedman, the movement is sometimes described as an effort to revert to the economic policies of nineteenth-century classical liberalism based on Adam Smith's and David Ricardo's ideas of national economic growth but, more specifically, it refers to the historically specific reemergence of economic liberalism among economists and policymakers during the 1970s through 1990s—the period of the Washington Consensus.[8]

Neoliberalism is not a unified economic theory or political philosophy but it denotes neoclassical influenced economic approaches and libertarian political philosophies that portray government control over the economy as inefficient, corrupt, or otherwise undesirable. It largely rejects post–World War II Keynesian economics and—as pursued by the WTO, the World Bank, and the IMF—has greatly advanced the interests of multinational corporations. Also, neoliberal economic policies have led to rapid expansion of foreign investment in and trade with emerging markets like China and India. As a result, both India and China have entered a period of rapid economic growth. In the case of India, outsourcing of information technologies (IT) and financial services played an important role in the growth spurt. In China, rapid growth occurred in industrial production, much of it through investments by multinational corporations for export production. China's real gross domestic product (GDP) has grown at around 10 percent per year for the past decade and economic forecasts for further growth remain strong. Together with strong economic growth, consumer demand is surging in both India and China because of the growing affluence of an emerging urban middle class. With China's entry into the WTO in November 2001, the Chinese government made many specific commitments to trade and investment liberalization that have substantially opened up the Chinese economy to investment by foreign firms through FDI and foreign trade. Much of the investment has occurred in the energy-intensive sector, which has contributed to the rapid increase in carbon emissions (EIA 2006).[9]

In both India and China, manufacturing capacity is fueled mostly by direct combustion of coal. Predictions are that the growing energy demand could drive a fourfold increase in the use of coal by 2030, which would result in a greatly increased annual emissions total. Together with strong economic growth and increased consumer demand, India and China's demand for fluid fuels is surging as well. The EIA (2006) forecasts that China's oil consumption will increase

by almost half a million barrels per day, or over 40 percent of the total growth in world oil demand in the next decade.[10] Other rapidly growing developing countries in Latin America, such as Brazil and Argentina, or Mexico and Chile, are also fast becoming large energy users and carbon emitters. In terms of the increase in pressure on the carrying capacity of the Earth ecological system as a result of the rapidly growing global economy, important questions arise as to how the world's ecosystems can withstand the ongoing increase in carbon emissions in the atmosphere. The IPCC (2007) alerts us to the fact that carbon dioxide concentration in the atmosphere has increased from a preindustrial value of about 280 parts per million to a rapidly approaching critical figure of 450 parts per million. The 2005 Millennium Ecosystem Assessment conducted under the auspices of the United Nations concluded that the world's ecosystems, ranging from water, soils, the biosphere, and the atmosphere, are seriously undermined as the world's rapidly developing countries are moving to center stage of the global economy (World Health Organization 2005).

The EU Emissions Trading Scheme and Carbon Leakage

The best example of a failure of a market-based approach to climate change policy is the EU ETS implementation of cap-and-trade. The implementation of the EU ETS provides an opportunity to assess how the forces of corporate capitalism address and deal with carbon emissions reduction in a partially carbon constrained global economy. In analyzing the impact of EU climate change policy, I focus on carbon leakage and the more prominent place of coal in fuelling manufacturing industries around the world leading to increased global emissions.

The EU ETS was implemented in 2005 and forms the cornerstone of the EU climate change policy covering about 45 percent of total EU CO_2 emissions. The ETS became the showcase of the EU commitment to reduce GHG emissions. Since the EU ETS is linked to the Kyoto Protocol's Flexible Mechanisms, it also has a global reach and is considered the model for climate change policy worldwide.[11] The ETS has been studied and analyzed by business groups and environmental groups alike as both groups tried to influence policy makers by showing how effective or ineffective or damaging the ETS was going to be on global emissions and industrial competitiveness. Many considered the first phase of the EU ETS (2005–2007) as an experiment or test case but as we are now approaching the end of the second phase of the ETS (2008–2012), it is time to make up the balance sheet.[12]

Emissions trading or cap-and-trade was chosen as it promised to meet the EU GHG emissions reduction goal in the most cost-effective way (Ellerman and Joskow 2008; Hillebrand et al. 2002). The ETS only covers CO_2 emissions from large industrial and energy installations in a limited number of energy-intensive sectors such as refining, coke ovens, cement, pulp and paper, glass, steel and metal, and power generation. By establishing a market price for carbon, EU policymakers envisioned that industrial firms in these sectors would make investments based on reducing emissions and improving energy efficiency. Combined with a robust compliance system, emissions trading would ensure that emissions reduction targets would be met and as such the ETS would comply with the implementation of the Kyoto Protocol targets. In balancing effectiveness and competitiveness, complex, and sometimes perverse incentives were entered into the scheme that contributed to a good deal of skepticism among the public.

The EU ETS introduced the national allocation of CO_2 allowances, which permit particular segments of industry to emit certain amounts of carbon dioxide. Each member state of the EU had to first submit a National Allocation Plan (NAP). Based on the agreed-to Kyoto reduction of CO_2 emissions, each EU member had established its own reduction target. In the NAP, member

states could specify which industrial sectors would be covered and which would be excluded.[13] Furthermore, each country could specify how new entrants, closures and transfers or mergers would be treated, and what kind of allocation methodologies would be used. In the decision-making process, industrial representatives, environmental groups, and other interested stakeholders had a good deal of influence, and the ultimate reason why some sectors were included and others excluded was not always clear. Many believe that harmonization of the NAPs and better oversight is urgently needed for the EU ETS to gain credibility and for the scheme to become the model for CO_2 emissions trading. Even though the EU ETS will ultimately be judged based on its effectiveness as a tool to reduce GHG emissions, the underlying rationale for choosing emissions trading was based on economic considerations.

By implementing the EU ETS an attempt was made to account for a market externality (CO_2 emissions) with a minimal impact on competitiveness. In theory, the market price of carbon is driven by the abatement costs of CO_2 emissions reduction, ensuring that the target reduction is achieved at the least cost. By creating a market price for carbon, investment would be made in energy efficiency and better process technology. The ETS offered business flexibility to achieve the objective by low-cost abatement or by allowing credits from the Kyoto Protocol's Flexible Mechanisms to be used for compliance. Correct allocation of the number of permits per industry and installation was critical. The number of permits should be fewer than the CO_2 emissions reported in 1990, however, during the ETS first round most member countries allotted a far greater number of permits than would serve the carbon market. During phase I (2005–2007), allowances were allotted for free, which meant that there was hardly a price for carbon and therefore no incentive to invest in energy efficiency or improved process technology. At the end of the first phase of the ETS, the parties involved realized that the Kyoto Protocol CO_2 emissions reduction scheme was not on target, which led to an intensive debate on the effectiveness of issuing free allowances and the desirability of auctioning carbon credits during the second phase. By this time, the EU had begun a public debate on the wisdom of the EU going-it-alone policy as interested parties anticipated that higher energy costs would eventually affect the Union's global competitiveness and slow down investment in Europe with the subsequent expansion of production to non-Annex I countries or the United States. This response, known as carbon leakage, suggests that an increase rather than a reduction in global GHG emissions would be the result.

As discussed earlier, carbon leakage is the term used to suggest an increase in overall global carbon emissions as a result of emissions reduction strategies in countries where climate change policies aimed at CO_2 emissions reductions apply (Annex I) in instances where the producer cannot pass on the increase in cost of production to the consumer. This is the case, for instance, in aluminum production where prices are set on a global exchange, and where the manufacturer will want to locate production where carbon constraints are not in effect and where coal is abundant and cheap. Thus, CO_2 emissions reduction targets in some parts of the world may have an effect on demand for fossil fuels with higher carbon content in nonabatement countries (Sijms et al. 2004).

The lobbying group for energy-intensive industries began a public debate about the wisdom of the EU's going-it-alone policy from the very beginning, when the EU Commission began the deliberations about the ETS targeting energy-intensive industries in 2001 (Alliance of Energy Intensive Industries 2004, 2005). A cap-and-trade system to reduce carbon emissions would carry a carbon price and carbon would thus become a cost of production. Anticipating that the EU economy under the Kyoto regime would become a carbon constrained economy, industry leaders lobbied hard to give specific direction to the implementation of an emissions trading scheme. The Alliance of Energy Intensive Industries has been the main lobbying group

for the industry. It was argued that goods that contained more carbon or had been produced with greater energy intensity would be relatively more expensive than goods that contained less carbon or used less energy. Therefore, in a partly carbon constrained global economy, carbon constrained countries would import goods from nonabatement countries where no carbon constraints applied. In November 2005, the Alliance issued a call for action on the part of the EU to resolve these fundamental problems associated with the rise in energy prices as the position of EU energy-intensive industries in the global market was seriously undermined (Alliance of Energy Intensive Industries 2005). As the EU manufacturing industry was paying the price for a hastily designed ETS, they argued, policymakers should take responsibility for the failure of the scheme and solve the problem by reforming the ETS. The Alliance recommended that CO_2 prices should be separated from power prices and that windfall profits on the part of power producers should not be at the expense of energy-intensive manufacturers.[14]

Producers of energy-intensive products such as iron and steel, and aluminum manufacturers have four choices in dealing with cost increases due to carbon constraints. First, they can invest in more energy-efficient plants or process technology. If this is not an option then they can buy allowances provided these are available on the carbon market at a reasonable price. If they cannot afford to buy allowances or carbon permits to facilitate production then future business prospects will be affected and market share of the company will fall. The fourth and final option is to relocate production outside the carbon-constrained region. The latter, obviously, is the most damaging as carbon leakage occurs mainly between Annex I and non-Annex I countries of the UNFCCC and between those Annex I countries that have committed to CO_2 emissions reductions under the Kyoto Protocol and Annex I countries that did not ratify the Protocol and therefore did not commit to binding emissions reduction targets (e.g., the United States). Carbon leakage may also occur among committed Annex I countries with high reduction targets (like the West European EU members) and countries such as Russia, the Ukraine, and some East-Central European countries, which experienced a decline in emissions due to stagnating economic performance after the fall of communism (see Table 1).

Carbon leakage can be triggered by direct carbon costs (price for carbon allowance or carbon credits) and indirect carbon costs resulting from higher power or electricity prices. Carbon leakage is likely to occur if carbon costs are high and cannot be passed on to the consumer via higher product prices and if production is exposed to international competition and foreign

Table 1. Comparison of Greenhouse Gas Emissions, 2005 (total, per capita, per GDP)

	Total (in Mt CO_2 equiv.*)	**Per Capita (in tons CO_2 equiv.)**	**Per GDP (in tons CO_2 equiv. per thousand US$)**	**Percent Change in total greenhouse gas emissions (1990–2005; %)**
China**	4,963.1	3.9	4.1	31.7
European Union	4,953.5	10.7	0.5	–5.8
Russian Federation	2,289.2	15.9	6.5	–23.0
United States	7,241.5	24.2	0.7	18.6

* Mt CO2 Equiv.: Million metric tons of CO2 equivalent.

** China figures based on data from 2000.

Sources: Population: UN, Eurostat; GDP: IMF, World Bank; Greenhouse Gas Emissions: UNFCCC, WRI. Data compiled by: Econsense (2007).

trade (Alliance of Energy Intensive Industries 2004, 2005). Carbon leakage is less likely to occur if the costs of carbon credits can be passed on to consumers or if products are highly specialized and serve a regional market.

The occurrence of carbon leakage under the Kyoto Protocol is usually expressed as a percentage of CO_2 emissions increase that results from an increase in emissions in a nonabating country divided by the reduction of emissions by a country subject to an emissions reduction target under the Kyoto Protocol. Thus a 20-percent carbon leakage rate means that 20 percent of reductions in emissions in an abatement country are reversed as a result of increased emissions elsewhere. Measurement of carbon leakage is not an exact science as the increase in CO_2 emissions in any one country as the result of CO_2 abatement in another country is difficult to separate from other factors, like lower labor costs, that may determine a market shift or a shift in CO_2 emissions. Still, by understanding the mechanisms through which carbon leakage can occur, it is possible to assess the impact of climate change policies to some extent.

Various simulation models have been developed and numerous studies calculating CO_2 induced costs increases have been made by industries and affected parties (Sijms et al. 2004). Most estimates are derived from Computable General Equilibrium (CGE) models, which are economic models that use actual economic data to estimate how an economy might react to changes in policy, technology, or other external factors. The equations often assume cost-minimizing behavior by producers and consumers. A CGE model database consists of tables of transaction values, showing, for example, the value of coal used by the iron and steel industry and is usually presented as an input-output table. However, these are static models and cannot forecast the future. To account more fully for the effects of the anticipated market changes and geographical distribution of energy-intensive production, trade, and carbon leakage, models incorporating strategic interaction among firms producing energy-intensive products have been developed using hybrid datasets based on the Global Trade Analysis Project (GTAP) and energy balances, prices, and taxes derived from IEA accounts, which created so-called GTAP-E models (Babiker 2005; Weyant 1999).[15] Results from the different models and estimates vary greatly and have been the source of much controversy with regard to the economic impact of the implementation of the Kyoto Protocol (Stern 2006). The typical CGE model estimated values of carbon leakage due to the implementation of the Kyoto Protocol are at between 5 percent and 25 percent worldwide but some GTAP/IEA dataset-based models or GTAP-E models predict carbon leakage rates as high as 130 percent (Babiker 2005). In the latter case, the Kyoto Protocol would lead to a huge increase in global carbon dioxide emissions. In one study, it is estimated that the United States will be the largest contributor to carbon leakage in 2020 if the country decides not to participate in a Kyoto-type emissions trading scheme (Hamasaki 2007).

EU country and industry studies have identified the different industrial sectors most immediately affected by carbon abatement policies (Hamasaki 2007; Sato 2007; Weinreich 2009). These studies calculated and identified both direct and indirect CO_2 induced costs increases for various industrial sectors and found that by far the highest costs increases were incurred by the lime and the cement industries (Weinreich 2009). However, because there is little or no international competition and foreign trade involved in these sectors, the impact of cost increases due to carbon pricing is insignificant. Less affected by the impact of carbon price but more vulnerable to international competition is the iron and steel sector especially in coastal locations. The aluminum and aluminum products sector as well as basic chemical products, pulp, copper, glass, dyes, and pigments are fully exposed to international competition and have experienced relocation effects of high carbon costs (Weinreich 2009). From these and other studies conducted, the impact of trade liberalization is viewed as a major contributing factor to carbon leakage (Kuik

and Gerlagh 2003; Sijms et al. 2004; Taylor and Copeland 2005). Abatement measures in Annex I countries—under conditions of liberalized trade—changes geographical production and consumption patterns of manufacturing and energy production and will in effect increase CO_2 emissions of non-Annex I and nonabatement countries through enhanced international trade and global investment flows (CRU News, March 2006).[16]

Coal as a Global Energy Source

The 2008 market report of EURACOAL—the industry association representing the European coal industry—documents that global coal production increased by over 200 million tonnes (mt) during 2008, most of which was mined in China. In contrast, EU production was down from previous years and Europe was the only region where coal production is decreasing according to EURACOAL (2009). In fact, over the past decade, EU production has fallen by 35 percent in the expanded EU-25 region and by 50 percent in the EU-15 region (see Table 2).[17] At the same time there has been an upsurge in EU coal import of 40 percent in just ten years. The combined effect of EU regulations governing state aid for the coal industry, which expired in 2010, and the EU ETS, which commits some 12,000 energy-intensive plants to buy carbon permits, are the major reasons for the EU decrease in coal production and use for electricity generation. Coal emits approximately twice as much CO_2 as natural gas and the-cap-and trade regime favors the use of gas in electricity generation as EU industrial emissions are capped, since 2008, at 20 percent below 2005 levels by 2020 in order to reduce emissions more quickly.[18]

At the same time, the United States, China, and Russia are all increasing coal production and are holding among the largest coal reserves, which suggests that if they do not commit to drastic and binding emissions reduction targets, sharp increases in coal production and coal use can be expected. In 2009, the prospect of regulating emissions via carbon trading—as the Obama Administration promoted—alarmed coal-producing and steel-producing states in the American Midwest, and congressmen from these states actively rallied against the Obama plan. Presently, supporters of reducing GHG emissions in the United States bank their hopes on regulation of emissions through the Environmental Protection Agency.[19] Meanwhile, for as long as Russia, China, India, and other emerging economies are on the sidelines with respect to climate change policy it is unlikely that the US federal government will go much further than what is currently being legislated. Furthermore, it is unlikely that the EU going-it-alone cap-and-trade policy will continue without a firm international Kyoto-type climate change policy in place as unilateral climate change policy greatly diminishes the EU's global market position.[20]

Table 2. Coal Production and Consumption at the end of 2008

	Production			Consumption		
	1998	Mt oil equiv. 2008	Change 2008 over 1998 (%)	1998	Mt oil equiv. 2008	Change 2008 over 1998 (%)
United States	603.2	596.9	–1.0	545.7	565.0	3.5
Russian Federation	103.9	152.8	47.0	100.7	101.3	–0.6
China	628.7	1414.5	125.0	651.9	1406.3	115.7
European Union	229.2	171.5	–25.2	323.5	301.2	–6.9

Source: Data compiled from British Petroleum, *Statistical Review of World Energy* (2008).

Both Russia and China have greatly expanded coal-generated electricity capacity. Today, most of Russia's energy is generated from gas but Russia's domestic demand for coal is increasing and the country's government has decided to reduce gas consumption in domestic power generation and increase coal use in order to maximize gas exports. Russia trails China, the United States, Indonesia, and Australia in terms of coal output but it is expected that the country will heavily invest in improving the electric grid infrastructure and rail and port facilities in order to improve the use of coal for energy generation. As a result, Russia's supply of coal for domestic use will likely rise from a current 130 mt per year to between 250 and 325 mt by 2020.[21] This will make Russia attractive for investment by foreign companies in energy-intensive industrial sectors and is likely going to contribute to more carbon leakage.

Coal currently fuels over 40 percent of electricity worldwide and will play a vital role in electricity generation in the next few decades according to information from the World Coal Institute (2009). With availability of abundant, affordable, and geographically dispersed reserves, coal is considered a secure and reliable source of energy worldwide. Coal prices have historically been lower and more stable than oil and gas prices and despite an increase in volatility of the energy market this has essentially remained the case. Coal is therefore likely to be the most affordable and reliable source of fossil fuel for power generation in many developing and industrialized countries in the foreseeable future. For energy-intensive industries, the impact of fuel and electricity price increases and price volatility will have important implications for location decisions and countries with access to indigenous energy supplies and affordable fuels from a well-supplied market can avoid volatility and uncertainty, enabling them further economic development and growth potential from a manufacturing industry.

International trade in coal reached 917 mt in 2007 accounting for about 17 percent of the total amount of coal consumed (World Coal Institute 2009). Australia is the world's largest coal exporter with over 244 mt of coal in 2007 exported out of its total production of 323 mt. Australia is also the largest supplier of coking coal —used in iron and steel production—accounting for 53 percent of world exports. Consumption or use of coal for electricity generation is projected to grow by 1.5 percent per year until at least 2030. Coking coal is more expensive than coal used in electricity generation, which means that Australia is able to afford the high freight rates involved in shipping coking coal over long distances. The largest market for Australian coal is Asia, which currently accounts for over 50 percent of global coal consumption (World Coal Institute 2009). Although China imports the largest share of Australian coal, other Asian countries that do not have carbon fuel resources sufficient to cover their energy needs, also import Australian supplies to help meet their demand. Japan, Taiwan, and Korea, for example, import significant quantities of coal for electricity generation and coking coal for steel production (World Coal Institute 2009). According to *BP's Statistical Review of World Energy* (2008), coal has been the fastest-growing major fuel and coal consumption grew by 3.1 percent in 2008. China's share of world energy consumption growth in 2007 was 52 percent much of it derived from coal with more than two-thirds of global growth in coal consumption attributed to increase in coal consumption in China (see Table 2).

China has entered a period of rapid economic growth based on industrial investments by multinational corporations for export production (Li 2008; Zang and Pearce 2012). Together with strong economic growth that increases energy demand, consumer demand is surging also because of the growing affluence of an emerging urban middle class. With China's entry into the WTO, the Chinese government made specific commitments to trade and investment liberalization, which substantially opened up the Chinese economy to investment by foreign firms. Much of the investment has occurred in the energy-intensive sector, which has contributed to the rapid increase in carbon emissions as manufacturing is fuelled mostly by direct combustion of

coal. The EIA has predicted that China's growing energy demand could drive a fourfold increase in the use of coal by 2030, which would translate into the largest growth in global carbon dioxide emissions (EIA 2006: table A-10). As carbon-emitting industries multiply at a rapid rate, China is building on average one coal-fired power plant every week. Coal makes up approximately 70 percent of China's total primary energy consumption and the country was both the largest consumer and the largest producer of coal in the world in 2007 at 1,311 mt and 1,289 mt, respectively, or over 41 percent of the world total in both consumption and production of coal. In addition, China records 114.5 billion mt or 13.5 percent of the world total of proven coal reserves, which places it third in the world behind the United States and Russia (Table 2). Opening up to foreign investment and foreign trade gave China a competitive advantage over the more mature economies of the EU and the US. As the demand for energy has put China on the fossil-fuel coal-based development path, the investments made and the infrastructure developed will shape the manufacturing economy for several decades to come. China is currently not constrained by climate change policies and GHG emissions levels have increased over 30 percent above 1990 levels by 2005 (Table 1). It is likely that the trend will continue or resume after the global recession ends.

The Impact of Cap-and-Trade Policies on the Iron, Steel, and Aluminum Industries

If the metal industry trade publications are any clue, then the projected increases in coal consumption and carbon dioxide emissions are not far off. According to a report issued by the American Iron and Steel Institute in 2006, worldwide production of steel increased by about 470 million tonnes during the preceding decade, with most of the expansion occurring in countries that use less energy-efficient production methods and impose weaker environmental regulation or enforcement (i.e., fewer carbon constraints). China's share of world production of steel had almost tripled from 13 percent in 1996 to 35 percent in 2006, a 316 percent increase (American Iron and Steel Institute 2006). China's steel export also tripled, increasing 309 percent between 1995 and 2005, and China is now the largest steel-exporting country in the world. India, similarly, is rapidly expanding its steel production capacity and export. Therefore, the American Iron and Steel Institute report concludes that if measures to control carbon emissions do not take international trade and environmental costs into account, then total global carbon emissions will increase dramatically (see also Sato et al. 2007).[22] Meanwhile, the EU is the only major region to show a drop in export of steel. The European Confederation of Iron and Steel Industries (EUROFER 2009) reports that Europe's steel production was only 198 mt in 2009 while China's production was more than double that at more that 70 percent of the growth in world steel production expected to occur in Asia. Taking into account that carbon emissions by Chinese producers are far higher and more than double those of European producers, EUROFER arrives at the conclusion that the EU ETS leads to carbon leakage to non-ETS countries. The report notes that only about 30 percent of the world's steel producing countries have signed up to the obligations of the Kyoto agreement whereas 90 percent of all new capacity is being developed in the 70 percent not covered by a Kyoto obligation. The incentive for China, India, and other rapidly developing countries to join a cap-and-trade system is greatly diminished under these circumstances. Participating in a cap-and-trade treaty would mean affecting the economic growth that has occurred due to competitive advantages of not participating in a binding and targeted emissions reduction scheme. Key overseas competitors are reaping the economic benefits as production cuts in Europe due to carbon constraints begin to take effect (EUROFER 2009).

Evidence of the extent of carbon leakage from the EU to China is substantiated by various reports and predicted to be significant based on various projections of trade and energy intensity of production (i.e., GTAP-E models).[23] China has been expanding its market share in energy-intensive manufacturing, in particular in the iron, steel, and aluminum industries and Germany stands to be significantly affected by carbon leakage. As the most industrialized economy of the EU-15, Germany is heavily dependent on export and trade exposure of particularly its iron, steel, and aluminum industry is substantial. The EUROFER (2009) has studied the impact of emissions trading taking into account that steel is made in one of two ways: basic oxygen furnace (BOF) primary production and electric arc furnace (EAF) production involving recycling of scrap metal.[24] Nearly 100 percent of emissions in the EAF process are indirect electricity-related emissions, whereas 90 percent of BOF production is direct (i.e., process-related) emission and only 10 percent is indirect energy-related emissions. Products produced by the EAF process (recycling scrap metal) compete mostly in regional markets and are therefore able to pass on their production costs to their consumers. Conversely, the production of cold rolled flat steel using the BOF process is competing in global markets.

The EU aluminum industry is most threatened by the implementation of carbon constraints. Although excluded from participation during the first phase of the EU ETS, the aluminum industry is severely exposed to higher energy costs because of higher electricity prices and because the price of aluminum is set at a global exchange. Half of the EU's aluminum is produced by primary smelting and half by secondary smelting/recycling. The process of smelting consumes over 15 megawatt hour of electricity per tonne of aluminum, which immediately exposes the industry to cost increases due to energy price increases. As the industry is not able to pass on the costs of abatement to the customer, the EU is losing market share. The industry held 21 percent of world market share in 1982 but in 2010 the EU share of the global aluminum market was to 10 percent.[25]

A New Scenario for Climate Change Policy in a Globalizing World

Although various considerations play a role in location decisions, a factor of increasing importance noted by corporate investors and policymakers is differential environmental costs and regulatory burdens across national boundaries. Traditionally, environmental costs were external to the cost of production but under the conditions of the Kyoto protocol and the EU ETS this is no longer the case. Taking increased carbon costs and energy and electricity prices into account, the cost of production—in particular energy costs for energy-intensive industries—are substantially higher in the EU than in most parts of the world. Simultaneously, the institutionalization of a global free trade and investment regime under the WTO, the World Bank, and the IMF induces multinational corporations to relocate or shift production to countries where environmental regulations are less stringent and where no carbon constraints apply. Host economies encourage the export of high-carbon content products to developed countries' home markets and have set up free-trade zones or export platforms for that purpose. The combined effect has unintended consequences for climate change policy and is the driving force behind the increase in consumption of fossil fuels, increases in CO_2 emissions, and the development of a fossil fuel-based (or more specifically coal-based) infrastructure in developing countries. Despite the efforts to curb global CO_2 emissions through the implementation of the Kyoto Protocol, global carbon emissions have increased dramatically. While emissions have stabilized in some of the developed countries, international trade and foreign investment by multinational corporations has shifted the source of CO_2 emissions to developing countries (Schreuder 2009).

How to deal with and account for emissions embedded in products manufactured in nonabatement countries and exported to countries where carbon constraints are in effect remains an unresolved issue. Under the current international trade regime guided by the principles of the WTO, there is no compensation for the negative spillover effects of the shift in production from abatement to nonabatement countries. In fact, any measure that would compensate for the effect of the implementation of the Kyoto Protocol or the ETS in the context of the free-trade and investment regime that is currently in place would likely be interpreted as protectionism in disguise and would not be well received by the business community in the developing world. Whereas we might think of introducing import taxes (tariffs) on high carbon content goods and services or impose some other polluter pays principle on multinational corporations that relocate or shift production to noncarbon constrained parts of the world, in reality it would seem unlikely that any measures will be taken by the same institutions that established the neoliberal trade regime in the first place.

Derived from the same concern about unfair competition in a partial carbon-constrained global economy, we might also consider a more sector-specific approach to emissions trading. Different plants in a specific industrial sector in different parts of the world experience different cost structures and energy-intensive industries in Annex I countries where carbon constraints apply are most vulnerable to international trade if they cannot pass on the increased cost of production to their customers. Instead of accepting the business-as-usual response to competition and shift production to nonabatement countries, a particular sector or industry could decide to take action at the international level through global trade associations and pledge to achieve a sectorwide goal of reducing GHG emissions through sharing best practice standards and stimulating increased energy efficiency and technology transfer. Sector- or industry-specific initiatives could seek endorsement from national governments but because industry is not a party to the UNFCCC, such a scheme has little chance of success. Furthermore, such a solution might alienate developing nations and undermine the cooperation needed to move negotiations forward.

One alternative to the problems associated with the current climate change policy regime is to focus the frame of reference more specifically on the multinational corporation and ask the question who is to blame and who is to pay, or who stands to gain from the carbon embedded in imported goods manufactured abroad by multinational corporations. Is it the producer, the consumer, or the shareholder who profits from the investments made abroad for the purpose of avoiding carbon constraints (Schreuder 2009)? Full disclosure of ownership and full accounting of corporate activities throughout the production chain would be imperative under such a framework. In other words, at every step in the production process we would need to know how much CO_2 is added to the product and the national GHG pool. This amount would then be subtracted from the total amount of the country where multinational corporate production occurs and be added to the corporate home country's CO_2 budget or the country to which the product is shipped for consumption. Hypothetically, we could also attribute CO_2 emissions on a profit-rate basis. If a refinery in China operated by a foreign-owned multinational corporation generated 100 million tones of CO_2 per year and if 50 percent of the profits are returned to headquarters or to the multinational corporation's shareholders, then 50 mt of CO_2 emissions should be accounted for and subtracted from the host country's national emissions budget and added to the home country's CO_2 budget. All this would require far greater transparency than is presently the case and will likely be resisted by the corporate establishment. But unless we come to realize that global climate change policy requires global cooperation, we will not make much progress in global CO_2 reduction efforts. As part of reaching global consensus and cooperation, global corporations will have to restructure the way they operate in developing countries and their share in increase in global CO_2 emissions will have to be accounted for.

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NOTES

1. Greenhouse gas is a gas that allows high-temperature solar radiation to enter the Earth atmosphere unhindered but blocks the lower-temperature reradiation of heat from the planetary surface causing the so-called greenhouse effect. Greenhouse gases include carbondioxide (CO_2), hydrochlorofluorocarbon (HCFC), hydrofluorcarbon (HFC), nitrousoxide (N_2O), methane (CH_4), ozone (O_3), perfluorocarbon (PFC), sulphurhexafluoride (SF_6), and water vapor. Of the greenhouse gases, CO_2 is the principal greenhouse gas responsible for global warming.
2. Parties to the UNFCCC are classified as: (1) Annex I countries, i.e. industrialized countries and economies in transition in East-Central Europe; and (2) non-Annex I countries, i.e. developing countries. Annex I countries that ratified the Protocol have committed to reduce their emission levels of greenhouse gasses to targets set mainly below their 1990 levels. Non-Annex I countries are not required to reduce emission levels but may participate in the Kyoto Protocol if they subscribe to the global emissions reduction efforts. As parties to the UNFCCC Kyoto Protocol they can participate in the Clean Development Mechanism. Setting no immediate restrictions under UNFCCC for developing countries serves three purposes: (1) it avoids restrictions on their development, because emissions are strongly linked to industrial capacity using fossil fuels; (2) developing countries can sell emissions credits through the Clean Development Mechanism (CDM) to Annex I countries that have difficulty meeting their emissions targets; and (3) developing countries can receive money and technologies for low-carbon investments from technologically advanced industrialized Annex I countries. Developing countries may volunteer to become Annex I countries when they are sufficiently developed. For further detail see the website for UNFCCC: http://unfccc.int/kyoto_protocol/items/2830.php/.
3. The Kyoto Protocol covers 194 countries including developing countries that subscribe to the global emissions reduction efforts.
4. The CDM is defined in Article 12 of the Kyoto Protocol, stating that Annex I countries can undertake emissions reduction projects in developing countries (non-Annex I) for Certified Emissions Reduction (CER) credits that can be used for compliance with the agreed to emissions reduction target on the part of industrialized Annex I countries.
5. Carbon leakage is usually expressed as a percentage of the CO_2 emissions increase that results from emissions increases in a nonabating (non-Annex I) country divided by the reduction of emissions by a country subject to the emissions-reduction target under the terms of the Kyoto Protocol.
6. See also World Bank, *World Development Report,* 67, quoted in The Ecologist, *Whose Common Future?* (1993: 111).
7. The coup against Allende had been backed by the CIA and was supported by the-then US secretary of state Henry Kissinger. Allende's successor, General Augusto Pinochet, called in a group of economic advisors who had been trained by Milton Friedman at the University of Chicago. They advised the general to transform the Chilean economy along free-market principles, privatizing public assets, opening up natural resources to private investors, and facilitating foreign direct investment. Export-led growth was to replace import substitution, which until then had been the dominant model for development in Latin America.

8. Friedrich August von Hayek (1899–1992) was best known for his defense of classical liberalism. His pioneering work in the theory and the analysis of the interdependence of economic, social, and institutional phenomena brought him great renown. He considered the efficient allocation of capital to be the most important factor leading to sustainable and optimal GDP growth, and warned of harm from monetary manipulation of interest rates. Milton Friedman (1912–2006) taught at the University of Chicago for more than three decades and is best known for his research on consumption analysis and monetary history and theory. As a leader of the Chicago School of Economics he influenced the research agenda of the economics profession in the United States in the second half of the twentieth century.
9. Energy-intensive industries include power generation, oil refineries, coke ovens, cement and concrete manufacturing, paper and pulp industries, glass and limestone, and steel and metals.
10. At present, China is the world's third largest net importer of oil behind the United States and Japan. Accordingly, carbon dioxide emissions from China and India have increased at an alarming rate, but, whereas the total amount of carbon emitted by China and India is approaching levels of the traditional industrialized countries, like Europe, Japan, and the United States, the per capita carbon emissions rates are still far behind those of the more mature industrialized economies (World Watch Institute 2006).
11. Under the Flexible Mechanism of the Kyoto Protocol, Annex I parties can contribute to their emissions targets by investing in emissions-reduction projects in other Annex I countries (Article 6, Joint Implementation), or by undertaking emissions reduction projects in developing countries (non-Annex I), defined in Article 12 as Clean Development Mechanism. Emissions Trading as defined in Article 17 of the Kyoto Protocol allows Annex I parties to acquire emissions credits from other Annex I parties and use them for compliance under the Kyoto Protocol. See www.unfccc.int/kyoto_protocol/items.
12. The first phase of the ETS allotted free allowances for target industries; the second phase auctioned allowances at a predetermined set price.
13. During the first phase, the aluminum industry was excluded from the ETS because it was fully exposed to global competition. However, because of high indirect costs due to high electricity prices—as utilities were not excluded from the ETS and windfall profits were charged—the industry was severely affected.
14. Windfall profits among energy providers occurred during the first phase of the ETS when the value of CO_2 allowances were passed on as opportunity costs even though the allowances were free and electricity may have been generated from noncarbon sources. The situation was enhanced by the fact that European power markets are not truly competitive.
15. GTAP is a global network of researchers and policymakers conducting quantitative analysis of international policy issues. It is coordinated by the Center for Global Trade Analysis at Purdue University's Department of Agricultural Economics.
16. Concern about the impact of the Kyoto Protocol on the US economy was clearly expressed in the Byrd-Hagel resolution in the Senate in 1997, which opposed the ratification of the Kyoto Protocol. Free trade would weaken the effectiveness of the Kyoto Protocol and emissions reduction schemes, according to US legislators and would bring harm to the US economy and to the global atmosphere.
17. EU-25 excludes Romania and Bulgaria, which were admitted to the EU in 2007 and only participated in the EU-ETS since 2008.
18. Following the agreement among EU member states and the European Parliament, the EU ETS Directive was significantly revised, as part of the EU 2020 Climate and Energy Package in December 2008, which established a 20 percent emissions reduction target by 2020 based on 1990 levels.
19. Under the Clean Air Act, the Environmental Protection Agency has been authorized to control CO_2 emissions for new power plants. Any new plant built in the United States cannot emit more than1,000 pounds of CO_2 per megawatt hour. The vast majority of modern natural-gas plants meet that standard but conventional coal plants average upward of 1,800 pounds per megawatt hour. This effectively means that it will be impossible to build any new coal-fired power plant in the United States that cannot capture and store its own carbon emissions. For the time being this means that there is a moratorium on all new coal-powered plants.

20. Setting ambitious unilateral EU emissions reduction targets while mitigation efforts in third countries are limited should be discouraged according to the European Alliance of Energy Intensive Industries March 7, 2012 statement in response to the EU Commission's roadmap to a competitive low-carbon economy by 2050. http://www.cembureau.eu/sites/default/files/documents/2012-03-07%20Alliance%20statement%20low-carbon%20economy%20roadmap%202050.pdf (accessed 15 May 2012).
21. Reuters Business News, June 6, 2007 (accessed 9 June 2009).
22. A study conducted by researchers from the US National Center for Atmospheric Research (NCAR) confirmed this and calculated that between 1997 and 2005 higher levels of Chinese exports to the United States increased total carbon dioxide emissions by some 720 million tonnes (Sato et al. 2007)
23. See the previous section on the EU Emissions Trading Scheme and Carbon Leakage.
24. The European Confederation of Iron and Steel Industries (EUROFER) website: http://www.eurofer.org.
25. See European Aluminium Association: http://www.alueurope.eu/about-aluminium/facts-and-figures (accessed 12 September 2012).

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