Background Papers on Panel Topics prepared for *The Search for Wise Energy Policy* Conference

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Preface

This series of background papers was prepared by a team of graduate students in the School of Public and Environmental Affairs (SPEA) at Indiana University in support of the conference "*the Search for Wise Energy Policy.*" This conference was organized by SPEA and is scheduled for June 11, 2009 in the Mayflower Hotel in Washington, D.C.

The primary purpose of these papers is to provide background information related to most of the primary topics of the conference. The students were asked to review the appropriate literature and web sites in each of seven areas of energy policy and to prepare fairly concise review articles for use of the panelists. These papers have not yet been subjected to expert peer review. The opinions expressed are those of the individual authors, not the School of Public and Environmental Affairs or Indiana University.

This team of students was supervised by Professors Evan Ringquist and J.C. Randolph. Any omissions or errors are the responsibility of this team.

Panel 4: Climate Policy

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A. Abstract

As the U.S. struggles with developing a climate change policy, it is important to review the design of initial efforts to regulate carbon emissions through cap-and-trade schemes, and to assess the initial efforts of those schemes. In this paper I first examine the international and domestic political context of climate change and describe national and regional efforts to reduce carbon emissions. Second, I discuss key design characteristics of climate change policy from a theoretical perspective, and I explain the design of the European Union Emissions Trading Scheme, as well as the proposed legislation in the 111th Congress. Third, I assess the early EU's experience with the Emissions Trading Scheme (ETS), and I discuss the evolution of the ETS in response to initial problems with the policy design. Following this assessment, I review many of the trade-offs inherent with climate change policy design. In particular, I discuss how a tax-based approach provides simplicity and price certainty, while a cap-and-trade based approach allows more flexibility. In addition, I discuss the complexities and trade-offs of the methods of carbon permit allocation. While free allocation helps preserve the international competitiveness of domestic industries, it can lead to distortions in the cap-and-trade system and lead to windfall profits for industry. In contrast, auctioned allowances may place a significant burden on domestic industry, but provide a more efficient allocation that is freer of distortions. The paper concludes with design recommendations for future U.S. efforts to address climate changes.

1.0 International efforts to address climate change

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988, under the auspices of the UN Environment Program (UNEP) and the World Meteorological Organization (WMO). Although initially led by the United States and other industrialized countries, all governments were invited to join and the IPCC has expanded over subsequent years to almost global participation. Its purpose is to provide authoritative assessment reports to governments about climate change. It has evolved into what is probably the most extensive and carefully constructed intergovernmental advisory process ever known in international relations (Grubb, Brack, and Vrolijk 1999).

Though the IPCC does not make policy recommendations, the findings of the IPCC have generally been accepted by governments as the basis to address climate change.[1] The findings of the first IPCC Assessment Report (1990) concluded that greenhouse gases caused by human activity were accumulating in the Earth's atmosphere. This report led to the United Nations Framework Convention on Climate Change (UNFCCC). This treaty, which was opened for signature in the Rio de Janeiro Summit in 1992, entered into force in 1994 and provides the international framework to consider what can be done to reduce global warming and to cope with whatever temperature increases are inevitable.

[1] While most governments have accepted the findings of the IPCC, a small contingent in the United States continues to criticize the IPCC process and findings.

The IPCC Second Assessment Report of 1995 concluded that the balance of evidence suggests that there is a discernable effect on the climate due to anthropogenic causes. The findings from this report provided key input for the negotiations of the Kyoto Protocol in 1997. The Kyoto Protocol committed 35 industrialized countries and the European Community to cut greenhouse gas emissions by an average of five percent from 1990 levels during the 2008-2012 time period. The Protocol was adopted on 11 December 1997, and entered into force on 16 February 2005, 90 days after at least 55 Parties to the Convention, accounting for at least 55 percent of the total carbon dioxide emissions in 1990, had deposited their instruments of accession. To date, 184 Parties of the Convention have ratified the Kyoto Protocol.[2] The Kyoto Protocol allows emissions trading across countries and offset credits – including Clean Development Mechanisms (CDMs) and Joint Implementation (JI) to help countries meet their emissions reduction goal. CDM and JI allow for countries to generate additional permits by offsetting emissions in developing (CDM) or non-participating (JI) countries. A registry system based in Bonn, Germany, keeps an international transaction log to verify that transactions are consistent with the rules of the protocol. Parties report by submitting annual emission inventories and national reports at regular intervals. In addition, an Adaption Fund was established to help finance adaption projects and programs in developing countries. A compliance and enforcement mechanism, negotiated in the 7th Conference of Parties (COP) in Marrakesh in 2001, requires non-compliant parties to make up the difference between their emissions and their allotted emissions during the second commitment period, plus an additional deduction of 30 percent. In addition, a non-compliant Party must submit a compliance action plan and may not make transfers under emissions trading. Nevertheless, compliance with the Kyoto Protocol is essentially voluntary: punishment for non-compliance requires increased emissions reductions in the future, but there is no mechanism in place that allows for the sanctioning or punishment of non-compliant countries.

At COP 14, in Poznan, member participants made minor changes to the Adaption fund, giving the Adaption Board the legal capacity to grant direct access to aid for developing countries. Progress was also made in bolstering capacity-building in areas of finance, technology, disaster management, and in reducing emissions from deforestation and forest degradation. In addition, member parties agreed to present a draft of the post-Kyoto framework at Bonn in June 2009. The post-Kyoto agreement will be negotiated in Copenhagen in December, 2009, and the general expectation is that it will be vastly different from the Kyoto Protocol, due to the perceived failure of the Kyoto Protocol to meaningfully include the United States and developing states. The next treaty must include the United States, Brazil, and other large emitters. With discussions beginning about a post-Kyoto international framework to address carbon, it is necessary to assess the Kyoto framework as well as opportunities for improvement in a global carbon agreement.

2.0 Designing an effective international agreement

An international agreement to address climate change must fulfill several criteria. It ought to be environmentally effective, reducing long-term greenhouse gas emissions. It must allow for the maximization of net benefits, making the agreement efficient. It must be cost-effective, achieving emissions reductions at the least possible cost. The agreement must be equitable, defined as consistent with the “polluter pays” principle (i.e., ensuring that those responsible for emissions

[2] Notably, while President Clinton signed the Kyoto Protocol, the treaty was never submitted for ratification, after the Byrd-Hagel U.S. Senate resolution voted 95-0 to place restrictions on U.S. participation in the treaty without limitations on emissions by developing countries. During initial Kyoto negotiations, China and other developing countries maintained the right to develop without limitations. In 2007, China unveiled a new climate change action program that begins to address China’s responsibility in tackling climate change

are those who pay to reduce them). An agreement must be flexible enough to allow new information to improve policy design, and facilitate a high level of participation and compliance, in order to ensure environmentally effective, cost-effective, and efficient results. (Aldy, Barrett, and Stavins 2003)

While the Kyoto protocol has a variety of provisions that encourage flexibility, cost-effectiveness, and equity, it has been criticized for its inability to facilitate a high level of participation and establish a credible compliance and enforcement mechanism. While there are steep carbon reduction goals for the industrialized countries, developing countries -- in particular large players such as Brazil, China, and India -- are not subject to caps on carbon emissions. Instead, these countries are encouraged to voluntarily adopt carbon commitments. Without an overall cap on global emissions, there is no guarantee the Kyoto protocol will achieve a substantial reduction of carbon emissions (Aldy, Barrett, and Stavins 2003; Barrett 2003).

The Kyoto Protocol also has a weak enforcement mechanism. As discussed above, a country that is not in compliance must make-up for excess emissions, as well as bear a 30 percent penalty in the subsequent trading period. However, this penalty only applies to countries that consent to be bound by it, meaning that countries must voluntarily commit to further reductions. Due to the flexible nature of the agreement, where targets can be renegotiated every period, the punishment mechanism is not attached to a fixed target. Finally, this mechanism relies on self-punishment, since other countries do not take actions to enforce compliance with compliance mechanisms. (Aldy, Barrett, and Stavins 2003).

The Kyoto agreement highlights some of the trade-offs inherent in international climate policy design. Because participation is voluntary, countries are likely to commit only to weak targets. This phenomenon was apparent when more generous credit was given to Russia, Japan, and Canada for their carbon sinks, in order to secure the adoption of this compliance mechanism (Aldy, Barrett, and Stavins 2003). Thus, in order to secure wider participation, as well as the credible enforcement mechanism necessary to make an effective agreement, emissions targets for individual countries will need to be reduced, making the agreement less effective.

Several other approaches have been suggested to help achieve an effective agreement with broad participation. Cooper, (1998, 2001) suggests using harmonized carbon taxes across developing and industrialized nations (Cooper 1998, 2001). Countries would be able to keep revenue from these taxes, and would only have to agree to set a common tax. Aldy, Orszag, & Stiglitz (2001) suggest a hybrid approach where a safety valve provision, which places a ceiling on the price of carbon, helps raise revenue for technological investments and may encourage participation from countries that fear extremely high costs of carbon reduction. A price ceiling on carbon permits essentially turns the cap-and-trade system into a carbon tax system once carbon permits reach a certain price. In addition, the authors suggest experimenting with social and economic sanctions to improve compliance, possibly tying the carbon agreement to the World Trade Organization (Aldy, Orszag, and Stiglitz 2001).

Barrett (2003) advocates a technological-based approach where countries pay into a research and development fund. According to this approach, technological innovations can be achieved through increased research and development, which will eventually lead to reduced carbon emissions. Because of the economies of scale and network externalities associated with R&D, it would be rational for countries to pay into a shared R&D fund, because they should expect to gain from participation, making participation and compliance much more likely. However, a technological-based approach, without market incentives, may be inflexible and inefficient, providing no mechanism to ensure that carbon emissions are reduced at the lowest possible costs.

Other models for international agreements suggest adopting more modest emissions targets to achieve compliance and participation, and later strengthening those targets (Schmalensee 1998);

increases in the use of CDM offsets, as well as other mechanisms designed to facilitate developing country participation (Stewart and Wiener 2001; Victor 2003); and a variety of other schemes that incorporate elements of market-based mechanisms, safety valves to control costs, increasing developing country participation over time, and the provision of incentives for participation and compliance (Aldy, Barrett, and Stavins 2003).

With goals to control costs, increase participation, and promote an effective and efficient agreement, several key choices exist for the design and implementation of a global agreement to address carbon.

3.0 National and regional efforts to address climate change

While most countries have ratified the Kyoto Protocol, national implementation – and guaranteeing that national efforts will lead to Kyoto compliance - has been much more difficult.

Japan has favored voluntary targets for firms; however, because it is not on target to meet Kyoto reduction requirements, it will begin a trial emissions trading market, and is planning stiffer construction standards, tax incentives, and a public awareness campaign (Associated Press 2008).

Australia did not sign the Kyoto Protocol until Kevin Rudd was elected prime minister in November 2007. Since then, the Australian government has set a 20% renewable energy portfolio standard (RPS) by 2020, and is planning a carbon emissions trading market by 2010 (Parkison 2008).

The European Union has begun the implementation of the European Union Emissions Trading Scheme (ETS), a cap-and-trade system intended to align with Kyoto targets. The EU operated its first trading period from 2005 – 2007, and is currently in its second trading period 2008-2012. The system initially employed a burden sharing agreement, which committed states to different goals, totaling up to the EU target. Emissions have been allocated separately across EU countries, with each country responsible for verification and enforcement of facilities within the country, though international trading was permitted within the EU, and coordinated by a system of registries.

With the uncertainty surrounding the Kyoto Process, considerable uncertainty exists for the scheduled 2013-2020 trading period. However, the 2013-2020 trading period will see substantial changes to the ETS due to difficulties with the first trading period. In particular, emissions allocation, reporting, and verification, will be centralized through the EU and will focus on firm compliance, in contrast to the current system that operates through individual country goals and implementation. In addition, there will be a movement towards auctioned allowances from freely distributed allowances, and a re-examination of the CDM and JI offset provisions (Official Journal of the European Union 2003). A full discussion of the ETS design in the first three trading periods follows below.

U.S. strategy, under Presidents Bush and Clinton, was to rely upon voluntary agreements and state-based efforts to address climate change. A large variety of these efforts have existed in the United States, including programs such as Climate Wise, an EPA run voluntary program from 1993-2000, Energy STAR, Climate Leaders, an EPA partnership program designed to help companies develop climate change strategies. While it is difficult to evaluate voluntary programs, a recent study suggests that Climate Wise was ineffective at reducing greenhouse gas emissions among participating firms compared with non-participants (Morgenstern, Pizer, and Shih 2007). At the state and regional level, the Regional Greenhouse Gas Initiative (RGGI) is an effort by the Northeastern and Mid-Atlantic states implementing a cap-and-trade system for GHG emissions and has already begun auctioning allowances. A majority of U.S. states have developed net-metering, interconnection, and access laws, as well as renewable portfolio standards and a host of financial incentives to encourage energy efficiency and the development of renewables. (NC Solar Center 2007). With the U.S. looking to develop a program to deal with carbon, and the EU evaluating its early efforts and developing new rules for the 2012-2020 trading period, it is necessary to assess the design and effectiveness of early efforts to address climate change in order to understand the tradeoffs of different choices in institutional design.

4.0 Design features of climate legislation and review of the EU ETS

Several specific design characteristics must be considered when crafting national climate policy. In particular, the method of reducing carbon, the entities that are covered by a program, the allocation of emissions, the reduction of emissions over time, the interconnection with an international system, and the treatment of key flexibility mechanisms such as CDM, JI and the banking of emissions are the key characteristics that can be manipulated to produce dramatically different impacts regarding environmental effectiveness, cost effectiveness, efficiency, equity, flexibility, and compliance and enforcement (Kopp et al. 2007; Aldy and Pizer 2008). In this section, I discuss the key design choices in a national climate program. Then, I match these design characteristics with the first three trading periods of the ETS as well as proposals for U.S. climate legislation.

4.1 Method of Reducing Carbon

At the national level, market based approaches have been advocated as a means of reducing carbon. Market based approaches can take two forms, or a combination of these approaches. Most national level programs focus on either cap-and-trade programs or emissions tax programs. The benefits from a tax system or a cap-and-trade system continues to receive attention in the academic literature (Nordhaus 2007). Proponents of a tax-based system argue that a price-based approach is more appropriate for climate change, and that a tax system is much simpler and promotes less uncertainty & complexity, while others argue that a carbon trading system can promote more innovation (Chameides and Oppenheimer 2007).

The choice between a price based (tax) and a quantity (carbon-cap) based system is complex and involves trade-offs. A price-based approach guarantees that carbon control will not become excessively costly, and it allows regulators to set a specific price per ton of carbon emissions, which can increase over time. Revenue generated from carbon taxes can be used to offset other factor taxes such as taxes on labor. With high unemployment levels a current policy concern, lowering labor taxes can help spur employment while lowering carbon. However, a priced based approach cannot guarantee a specific amount of carbon reduction; firms can choose to pay the carbon tax instead of reducing their emissions.

In contrast, tradable emissions permits allow a specific level of carbon emissions to be set in the economy, and if auctioned, can have similar revenue raising ability, which can be used to off-set other taxes (Chameides and Oppenheimer 2007). This approach ensures that a specific target of emissions reduction is met. In addition, tradable emissions permits allow offsets and flexibility mechanisms, such as clean development mechanisms, and joint implementation, which can take advantage of low-cost opportunities for emissions abatement (Chameides and Oppenheimer 2007). However, tradable emissions permit markets have high transaction costs, are very complex, and require the ability of firms to value future carbon permits. Smaller firms with less capacity, as well as manufacturing firms that have complex production processes, have had a particularly difficult time adjusting to these markets in the EU (Matisoff, forthcoming).

A hybrid approach, frequently called a safety-valve approach, uses a carbon tax to cap the price of carbon allowances (Burtraw, Palmer, and Kahn 2009; Murray, Newell, and Pizer 2008). For example, once the price of tradable emissions permits reaches $15 per ton, firms will be allowed to purchase unlimited allowances from the government. This approach presents a way in which to mitigate the cost uncertainty of tradable permits, while taking advantage of tradable permit benefits, such as flexibility mechanisms and offsets. However, any use of carbon taxes or a safety valve will make a domestic system incompatible with international systems that do not use this approach, and has the potential to undermine emissions reductions in the same way that a carbon-tax approach does.

The EU ETS has attempted to mimic the Kyoto Protocol guidelines, but is in the process of implementing significant changes to the cap-and-trade program. The ETS follows a quantity-based, cap-and-trade approach. In the initial and second trading periods, each country had a carbon cap that was adjusted when cross-border trades were made. In the first period, emissions reductions did not take place, due to a carbon cap that was set too high. In addition, prices were extremely volatile in the first trading period, as firm emissions were highly uncertain, many firms did not understand carbon trading, and the trading system was slow to become liquid (European Commission, McKinsey & Company, and Ecofys 2006; Ellerman and Buchner 2007). By the end of the trading period, the price of carbon had dropped to zero. Initial prices and options in the second trading period suggest that firms expect emissions reductions to occur, with current spot prices of carbon permits approximately around €11 - €14. In addition, banks and other market intermediaries have emerged and have helped establish a liquid market for carbon. Proposals for the third trading period plan to eliminate specific country caps and centralize allocations and tradable permits with a central EU authority. Carbon will still be capped at an EU level, with firms participating in trading.

4.2 Allocation

If tradable emissions permits are used to regulate carbon emissions, allocation rules must determine how allowances are initially distributed. Allowance can be distributed freely through grandfathering or through a system known as benchmarking. Alternatively, government can auction allowances, raising revenue that can be used to offset other taxes or help fund research and development projects.

4.2.1 Freely allocated permits

Firms prefer freely allocated permits because they do not have to pay for current emissions. By regulating carbon, the government creates a valuable commodities market for carbon. If permits are allocated freely, the government essentially subsidizes firms through the allocation of permits, at the cost to the public. Because these permits are valued in the market, firms have the incentive to pass along the market costs of permits to consumers, even though those permits were obtained freely, potentially generating a phenomenon called windfall profits. However, in a regulated industry such as electricity generation, or when electricity generation is purchased through advanced contracts, the potential for windfall profits becomes unclear (Grubb and Neuhoff 2006).

4.2.2 Grandfathered permits

Under a system of grandfathered allowances, the government freely allocates tradable permits on the basis of historical emissions, which was the case for the SO_2 program in the United States, as well as phases I and II in the EU ETS.

Grandfathered allowances have the advantage of being politically palatable for many firms, as firms do not have to pay for any current emissions, and only have to pay for increases in future emissions. However, a system of grandfathered permits leads to incentives that can undermine emissions reductions and can lead to large profits for firms, at a cost to consumers (Grubb and Neuhoff 2006).

Grandfathered permits require a specific baseline for permit allocation. Under most systems, this permit allocation generally takes place at specific intervals of time – such as 3, 5, or 8 year periods, in order to allow the emissions cap to be adjusted. If firms reduce carbon emissions in one period, firms risk losing future allocations of emissions permits, providing a disincentive for firms to reduce carbon emissions (Grubb and Neuhoff 2006). Firms that reduce their emissions are punished by the system, and are awarded fewer permits in the future. This system decreases the value of investments in efficiency or innovation, and discourages firms from investing in cleaner technology. (Grubb and Neuhoff 2006)

4.2.3 Benchmarking

In order to encourage firms to invest in cleaner technology, allocations can be determined by benchmarking, where allowances are distributed based on the emissions intensity of firm production. Thus, firms with the least amount of carbon emissions per unit of production will receive allowances freely. Firms that have greater carbon intensity, or more emissions per unit of production will receive fewer free allowances, and will have to purchase or trade for additional emissions permits. This system provides incentives to innovate and reduce carbon emissions, while providing firms with freely allocated emissions (Grubb and Neuhoff 2006). Depending on the exact method of allocation, benchmarking may discourage plant closure or distort emissions allocation towards higher emitting plants and processes (Grubb and Neuhoff 2006).

Benchmarking involves many complexities. First, a government organization must determine the emissions intensities for specific and numerous production processes across all industries. Second, political decisions will ultimately determine allocation criteria. A government organization must determine which production processes are considered comparable and should be grouped together, and whether emissions should be benchmarked based on fuel type and production process (Grubb and Neuhoff 2006). Decisions regarding benchmarking criteria can greatly impact the efficiency of the process (Grubb and Neuhoff 2006). For example, one difficulty is whether or not electricity generation from coal should be compared only to other coal-based production processes, or whether benchmarking should include nuclear or renewable energy sources. Benchmarking based solely on production, rather than on fuel or process produces fewer distortions in the system and is much simpler to implement for a regulatory agency, but is likely to be less politically popular with entrenched interests. Despite the shortcomings of benchmarking, the third phase (2012-2020) of the ETS is likely to employ a type of benchmarking to allocate any freely distributed allowances.

4.2.4 Auctioned permits

Auctioned permits present a variety of advantages over other forms of allocation. First, auctioned permits have the ability to remove any distortions from the allocation process, as firms determine the market value for allocation (Grubb and Neuhoff 2006). In addition, if the revenue is recycled and used to reduce distorted taxes on labor or capital, auctioned permits may have the potential to offset any inefficiencies caused by the emissions permit process and to improve the macroeconomic efficiency of a system (Hepburn et al. 2006). In fact, auctioned permits guarantee a more efficient outcome than any free allocation process (Hepburn et al. 2006).

Auctioned permits are widely opposed by firms who argue (usually wrongly) that auctions lead to increased costs on consumers and that free allocation will prevent adverse impacts of an emissions trading system on the competitiveness of industry vis-à-vis countries without carbon controls (Hepburn et al. 2006). Regardless of whether permits are grandfathered or auctioned, firms will seek to attempt to pass the opportunity cost of permits on to consumers.[3] Thus, the

[3] In states where utility prices are regulated by a state agency, it is possible that the regulatory agency may be able to prevent rate increases if permits are allocated freely. In some EU states, strict regulation of

method of allocation (auctioned permits versus free allocation) is likely to have little impact on product prices, because firms will pass on the opportunity costs of allowances to downstream prices (Hepburn et al. 2006). If permits are auctioned, rather than allocated freely, revenue can be used to compensate consumers for the increased costs of carbon intensive goods, or the revenue can be used to decrease other input costs, such as labor taxes, which will prevent price increases to the consumer. No matter how permits are allocated, regulating carbon will lead to a comparative increase in the price of carbon intensive goods, compared to non-carbon intensive goods.

Most sectors are not directly exposed to foreign competition, and thus competitiveness concerns are not directly relevant (Hepburn et al. 2006). However, firms that are subject to international competition, such as those producing cement, steel, non-ferrous metals, and some chemical products are disadvantaged because they must compete with firms that do not have carbon costs, leading to possible carbon leakage, where production shifts outside of the regulated area (Grubb and Neuhoff 2006; Demailly and Quirion 2006). Auctioned permits require firms to raise capital to purchase emissions allowances, which may be particularly difficult in the current recession, and raises significant political opposition from firms that can profit from freely allocated allowances. In addition, firms that have long-term production contracts, such as in electricity production, can be harmed because they cannot pass along increased generating costs to consumers.

4.3 Coverage

An emissions trading system makes trade-offs regarding what industries and pollutants are covered through the system, and at what threshold firms are excluded from the system. While covering only CO_2 is simpler than covering all greenhouse gases, other greenhouse gases such as NO_x, CH_4, and SF_6, have significant global warming potential and can often times be reduced much more cheaply. Including these pollutants in a trading scheme or tax system can help improve efficiency and reduce costs.

Covering too many firms with low emissions leads to inefficiencies such as high transaction costs, and compounds the difficulties in allocation. In contrast, if too few firms are included, or if industries are excluded, there may be inequality across sectors, leakage, and the system will not be able to maximize efficiency. In addition, covering too few entities can lead to thin markets, which hindered the first trading period of the U.S. SO_2 trading program. [4]

Permits or taxation can occur upstream, at the point of extraction, or downstream, on the point of consumption. While economic theory holds that regulation at the point of consumption produces the least amount of distortion, taxing or capping carbon upstream reduces transaction costs, improves coverage throughout the economy, and eliminates many of the issues faced with smaller users.

The first phase of the EU ETS covered about 40% of total emissions under the cap-and-trade program. Installations covered in the ETS (10,800 total installations) represent a large range of emitters with annual emissions varying from less than 5,000 $mtCO_2$/yr (metric tons of CO_2 per

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utilities prevented firms from passing along the opportunity costs of freely allocated carbon permits to consumers. However, in Germany, for example, utilities passed along the "cost" of freely allocated permits to consumers, raising utility rates significantly.

[4] Even with the possible exclusion of thousands of installations, the EU ETS will have many more installations than the US SO_2 program. While there have been problems with thin markets in the EU ETS, this has little to do with the number of covered installations, and these issues will be discussed further in section 7.

year) (about 3,000 installations) to more than 5 million $mtCO_2$/yr (about 70 installations) (Commission of the European Communities 2008). According to estimates from the UK, administering the ETS program costs between €2,000 and €15,000 per site, per year for operators, and between €3,000 and €10,000 per site, per year for governments (Commission of the European Communities 2008). The largest 7% of emitters cover over 60% of emissions, while the smallest 31% of emitters represent only 1% of total emissions (European Commission and Ecofys 2007). The smallest emitters have transaction costs between €0.5 - €3/$mtCO_2$ while larger emitters average less than €0.01/$mtCO_2$ (Commission of the European Communities 2008).

Current proposals from the European Commission include expanding the scheme across many more industries in order to improve efficiency and coverage, and raising the cap to 10,000 $mtCO_2$/yr or 25,000 $mtCO_2$/yr to exclude smaller installations. Analysis of various scenarios suggests that raising the limit to 25,000 $mtCO_2$/yr will exclude only 2.5% of total emissions but will exclude over half the installations in the system and would drastically reduce transaction costs (Commission of the European Communities 2008). The EU is likely to include NO_x and PFCs in the third phase.

4.4 Flexibility Mechanisms

4.4.1 Joint Implementation / Clean Development Mechanisms

As described above, Joint Implementation and Clean Development Mechanisms are seen as ways to include countries without specific climate caps in climate change mitigation efforts, while lowering costs of participation for countries with carbon mitigation commitments. Under the mechanism, countries can exceed emission quotas by supporting emissions reduction projects in developing countries. Developed countries view the CDM as a way to gain access to cheap mitigation opportunities in developing countries, and to reduce mitigation costs. Developing countries view the CDM as a new channel for development assistance (Lecocq and Ambrosi 2006).

A major problem with CDM is that it creates new emissions credits in countries without emissions reduction commitments, while transferring those credits to countries with commitments, increasing the total amount of emissions credits in circulation (Lecocq and Ambrosi 2006). In addition, many of the aspects of the agreed Protocol left significant ambiguities in the CDM mechanism (Lecocq and Ambrosi 2006). A requirement for CDM projects to be approved is the “additionality principle,” which requires that CDM projects that produce offsets are projects that would not have occurred without the CDM offset mechanism. In practice, however, it is extremely difficult to limit projects based on whether or not they would have occurred without the CDM mechanism, and many projects that are approved would have occurred regardless of the offset program. This loophole allows firms to use strategic investment in China to generate offset credits. Due to the uncertain technical nature of offset projects, the amount of greenhouse gases that are offset is also highly uncertain. Other problems with the offset program include significant uncertainty in the medium to long-term viability of the CDM program, as well as administrative bottlenecks that delay project approval.

Despite these shortcomings, the CDM has developed into a vibrant market, with over 180 transactions channeling $2.5 billion of carbon finance to developing countries in 2005 alone. The number of projects submitted for validation has increased exponentially since 2003, and by 2006, a total of 386 projects totaling 660 million tCO_2e have been registered. Most projects have been located in China, with some projects being sited in Brazil and India (Lecocq and Ambrosi 2006). The market has been dominated by European (64%) and Japanese (30%) buyers (Lecocq and

Ambrosi 2006). Increasingly, however, speculative funds in the United Kingdom and the United States have entered this rapidly developing market.

The CDM has substantially assisted developed nations in achieving compliance with quantified emission limitation and reduction requirements, and CDM plays a significant role in providing finance to developing countries – providing about 2.5% of net official development assistance. Nevertheless, some questions remain regarding the impact of the CDM projects and possible disincentives for developing countries to adopt stronger environmental policies. As long as developing countries benefit from CDM projects that provide a benefit additional to what would have happened otherwise, developing countries may not pass strong policy in order not to lose the opportunity to attract CDM resources (Lecocq and Ambrosi 2006). Further, the political uncertainty regarding the future of CDM projects complicates the future prospects for continued CDM investment.

4.4.2 Emissions Banking

Bankable allowances let firms carry permits from period to period, and can smooth the price over time. However, allocation mistakes can become entrenched in the system (Fell, MacKenzie, and Pizer 2008). In the first phase of the ETS, emissions could not be banked, which proved extremely important to establishing a credible second trading period. Because emissions were over-allocated in the first trading period, it was crucial that firms could not carry excess permits to the second trading period. In the second trading period, emissions can be banked until the third trading period. In addition, CDM credits that have already been approved will be grandfathered into the third trading period.

4.5 Enforcement / compliance

At the international level, there are significant questions that remain regarding compliance and enforcement in a carbon trading regime, due to the weak enforcement mechanism in the Kyoto Protocol. While there has been discussion regarding tying foreign aid or trade sanctions to an international climate treaty compliance, it is unclear how politically viable these mechanisms might be, or how supportive the WTO will be of climate change efforts. Technologies such as remote sensing may be useful in helping monitor greenhouse gases at a national level, but have not been developed sufficiently for this purpose.

In the EU during the first trading period, national emissions authorities had broad discretion over the verification and enforcement of emissions, which are generally conducted based on fuel-based and engineering-based estimates (Commission of the European Communities 2008).[5] During the initial trading period, EU officials believe that most firms were in compliance with ETS regulations, and only a few firms were fined for non-compliance; however, EU officials acknowledge the need for more stringent verification measures (Personal Communication with German Emissions Trading Authority Officials). During the second and third trading period the consensus view is that increased harmonization and standardization of monitoring, reporting and verification procedures would benefit the ETS (Commission of the European Communities 2008). In particular, a common system of accreditation for verifiers has been suggested, and increased attention must be paid towards small installations where the current monitoring and reporting mechanism has been particularly burdensome (Commission of the European Communities 2008).

[5] While real-time monitoring technology exists, and is employed in many power-plants in the United States, this technology remains excessively costly for widespread use. Continuous emissions monitoring is permitted in the ETS, but most monitoring and verification is done through engineering based estimates.

4.6 Leakage / Border Adjustments

In a system that only covers specific geographic areas, carbon leakage occurs when production of carbon-intensive goods shifts outside of the regulated area. While carbon leakage is relatively low for goods that must be produced and consumed locally, such as electricity, other goods such as steel can easily be shipped across borders, and production can shift to countries that are not included in a cap-and-trade program. It is possible to adjust for these leakages through a border tax on imports, border rebate on exports, full border adjustment, or a domestic production rebate, as long as the adjustments only represent direct costs of regulation, as opposed to opportunity costs (Fischer and Fox 2009; Morgenstern 2009). However, these types of arrangements could run into difficulties with compatibility with the WTO and other international agreements, as the WTO has traditionally not considered other international agreements in dispute resolutions unless the parties to the dispute are also members of those agreements (Bernasconi-Osterwalder 2008). The EU ETS does not currently account for border adjustments. However, the ETS is currently assessing the sectors and sub-sectors which are at prime risk for carbon leakage. Those sectors will likely receive freely allocated allowances based on benchmarking.

According to the EU Directive, a sector or subsector is "deemed to be exposed to a significant risk of carbon leakage if:

* the extent to which the sum of direct and indirect additional costs induced by the implementation of this directive would lead to a substantial increase of production cost, calculated as a proportion of the Gross Value Added, of at least 5%; and

* the Non-EU Trade intensity defined as the ratio between total of value of exports to non EU + value of imports from non-EU and the total market size for the Community (annual turnover plus total imports) is above 10%." (European Parliament 2008)

4.6.1 What happens to the revenues?

A variety of proposals have been designed to return auctioning revenues to consumers through lower labor taxes, an income tax reduction, or a straight dividend (Burtraw 2008). These possibilities can affect the efficiency of the overall mechanism. It is possible that by using auctioning or tax revenue to reduce other factor taxes, economic efficiency of the tax system can be increased (Nordhaus 2007). In the ETS, any revenues generated from auctioned permits in the first and second trading periods were raised by individual member states, which used revenue to offset administrative costs. In the third trading period, states are obligated to use revenue generated from the sale or auctioning of permits for climate change related activities, including the support of emerging technologies.

5.0 U.S. Proposals to address climate change

5.1 Congressional proposals to implement climate change policy

While a multitude of proposals have existed in the 109th and 110th Congresses, currently, two major competing bills seek to establish climate change regulation in the United States. The Waxman-Markey "The American Clean Energy and Security Act of 2009" uses a quantity based approach to limit carbon emissions through a cap-and-trade mechanism. The cap-and-trade bill contained in this energy legislation is similar to many other climate change bills that have been introduced during the 109^{th} and 110^{th} Congresses. In contrast, the Larson Carbon Tax takes a price-based approach to carbon regulation. In this section, I will briefly describe these two main U.S. legislative initiatives to address climate change and then provide a summary table which explains the differences between the bills.

5.2 Waxman-Markey "The American Clean Energy and Security Act of 2009"

Title 3 of the Waxman-Markey bill contains a cap-and-trade mechanism based on recommendations from the U.S. Climate Action Partnership, a coalition of electric utilities, oil companies, chemical companies, automobile manufacturers, and environmental organizations. The bill establishes a program that covers greenhouse gases from electric utilities, oil companies, large industrial sources, and other entities that are collectively responsible for 85% of U.S. greenhouse gas emissions. Entities that emit less than 25,000 tons of CO_2 equivalent are not covered by the program. Using 2005 as a baseline, the program reduces emissions by 3 percent by 2012, 20 percent by 2020, 42 percent by 2030, and 83 percent by 2050. In addition, it directs the EPA to achieve additional reductions through the prevention of deforestation. (Waxman and Markey 2009)

The cap-and-trade approach includes flexibility mechanisms such as offsets, banking and borrowing, and a strategic reserve. Domestic and international offsets are allowed up to 2 billion tons of total emissions each year, and entities must submit 5 tons of offset credits for every four tons of emissions being offset. Permits in the program can be banked indefinitely, and can be borrowed from one to two years in the future without penalty. Additionally, the EPA will create a strategic reserve of about 2.5 billion allowances by setting aside a small number of allowances each year in order to provide a cushion, should prices rise faster than expected. If prices rise to unexpectedly high levels, the EPA will be able to auction these excess permits and use proceeds to replenish the reserve.

Table 4A: Summary of EU ETS design, phases I, II, & III (changes in bold)

ETS Trading Period	**2005-2007**	**2008-2012**	**2013-2020 (proposed)**
Regulatory Authority	Member States	Member States	EU (Centralized)
Total Cap			**20% by 2020 with linear reductions** **30% objective if international agreement is reached**
Allocation Method	Annual, grandfathered, freely allocated emissions allowances	Annual, grandfathered, freely allocated emissions allowances	**Mix of auctioned permits & freely allocated permits via benchmarking** **Full auctioning for electricity; free allocation for district heating & cogeneration; some eastern European states get up to 70% free allocations for power stations, declining to 0% in 2020** **Transition from 80% free allocation in 2013 to 30% free allocation in 2020; no free allocation by 2027 for non-utility industries** **Free allocation for carbon leakage industries** **Auctioning conducted by member states based on 2005 emissions or 2005-2007 average emissions**
Coverage (pollutants)	CO_2 only	CO_2 only	CO_2, **NO_x and PFCs**
Coverage (industry)	Combustion plants, oil refineries, coke ovens, iron and steel plants, and factories making cement, glass, lime, brick, ceramics, pulp and paper	Combustion plants, oil refineries, coke ovens, iron and steel plants, and factories making cement, glass, lime, brick, ceramics, pulp and paper	Combustion plants, oil refineries, coke ovens, iron and steel plants, and factories making cement, glass, lime, brick, ceramics, pulp and paper **Addition of aviation related emissions; aluminum producers, petrochemicals, ammonia producers; shipping if no international agreement by 2013**
Coverage (size)	12,000 installations Capacity thresholds vary by state	12,000 installations Capacity thresholds vary by state	**Installations with emissions <25 kmtCO_2 and capacity < 35MW and can opt out if they adopt alternative emissions reduction plan**
Banking and Borrowing	Banking and borrowing within the period only	Banking and borrowing within the period AND **banking (no borrowing) with future period**	Banking and borrowing within the period AND banking (no borrowing) with future period
CDM / JI	Credits generated through provisions of Kyoto, excluding credits from carbon sinks and nuclear power; includes non CO_2 projects Limits for CER / ERU usage vary by state	Credits generated through provisions of Kyoto, excluding credits from carbon sinks and nuclear power; includes non CO_2 projects Limits for CER / ERU usage vary by state	Credits generated through provisions of Kyoto, excluding credits from carbon sinks and nuclear power; includes non CO_2 projects **50% limit of ETS emissions reduction effort can be covered by CER / ERU credits**
Enforcement	Enforcement by national commissions; oversight by EU 40 Euros / ton penalty for non-compliance	Enforcement by national commissions; oversight by EU **100 Euros / ton penalty for non-compliance**	Enforcement by national commissions; oversight by EU **with increased harmonization & standardization of practices** 100 Euros / ton penalty for non-compliance
Use of Auctioning Revenue			At least 50% must be used for climate change related activities

The market for allowances and offsets will be regulated by the Federal Energy Regulatory Commission (FERC), and appropriate financial agencies will be delegated responsibility for regulating derivatives markets. For emissions not covered under the program, the EPA is directed to set emissions standards on HFCs and black carbon under the authority of the Clean Air Act.

The Waxman-Markey bill has three other titles that address additional issues relating to climate change and energy. Title I employs a national renewables portfolio standard that requires 6% of energy to be renewable by 2012, rising to 25% in 2025. It provides research and development funding for carbon capture and sequestration, electric vehicles, smart grids, and provides for the long-term government purchase of renewable electricity.

Title II, addressing Energy Efficiency, supports new building efficiency codes, provides funding for retrofitting and energy efficiency improvements, and directs the EPA to improve and strengthen standards for energy efficiency and transportation efficiency in the areas of appliances, vehicles, and utilities.

Title IV provides subsidies for U.S. manufacturers who may be disadvantaged by overseas competitors and provides the U.S. with the authority to levy tariffs on foreign manufacturers to adjust for carbon emitted in the production of imports. It provides subsidies for green job training and for consumers who may be disadvantaged by increased energy bills. Lastly, it provides for funding to address the impacts of climate change.

5.3 Larson "America's Energy Security Trust Fund Act of 2009"

In contrast to the Waxman-Markey bill, the Larson "America's Energy Security Trust Fund Act of 2009" aims to establish an emissions tax on carbon dioxide, implemented at the refinery, mine-mouth, or place of import. This bill would begin taxing carbon at a rate of $10 per short ton (non-metric tons), increasing $10 per year, with taxes collected by the Internal Revenue Service. The bill sets a long-term carbon target of 80% reduction by 2050 from a 2005 baseline, but allows for the EPA to set interim carbon targets. If carbon emissions targets are not reached, the tax will increase $15 in the following year, rather than $10. While the bill only addresses carbon dioxide, it authorizes the Secretary of the Treasury to explore options for taxing other greenhouse gases. Larson's carbon tax bill follows John Dingell's carbon tax proposal, which he withdrew in April, 2008, after it failed to generate significant traction in Congress (Snyder 2008). Increasingly, however, industrial manufacturers, such as Exxon-Mobil, have expressed support for a carbon tax over a cap-and-trade approach due to its simplicity, transparency, and cost-containment (Johnson 2009).

The bill also implements a border adjustment, taxing incoming goods that are not covered by a carbon cap, and subsidizing exports to countries that do not have a carbon cap. In addition, the bill refunds taxes paid if goods sequester carbon, rather than releasing emissions to the atmosphere. Offset provisions are unclear in the bill, but the bill mandates the Secretary of Energy to make provisions for offsets inside and outside the United States within a year of program implementation.

Revenues from the bill fund a payroll tax reduction for citizens, as well as a clean energy research and development fund and a fund to help affected industries transition. This transition fund allots 9/10 of the revenue collected in 2010 for this purpose, decreasing by 10% per year until 2019, when the transition fund expires.

5.4 Table 4B: Comparing Waxman-Markey Energy bill and Larson Carbon Tax

Congressional Bill	Waxman-Markey (2009)	Larson Carbon Tax (2009)
Total Cap or Price	3% by 2012 20% by 2020 42% by 2030 87% by 2050 (2005 baseline)	$15/ton in first year, increasing $10 per year, taxed upstream at mine mouth, refinery, or point of importation; (not metric tons) Targets set by EPA, if target is not reached, tax increases $15 in following year, rather than $10 Target of 80% reduction from 2005 baseline by 2050;
Allocation Method	Quarterly Auctions of % TBD, with "rebates" going to energy intensive firms with high international competition	Not Applicable
Coverage (pollutants)	CO_2, CH_4, NO_x, SFl_6, HFCs, PFCs, Nitrogen Trifluoride Any other greenhouse gases	CO_2 only Direction to IRS to study possible taxation on non-carbon GHGs
Coverage (industry)	All industries & installations	Upstream taxation on coal, petroleum products, natural gas
Coverage (size)	Installations >25,000 $mtCO_2e$	
International Competitiveness / Linking	Possible linking with programs with carbon cap; free allowances for firms with significant international competition	Carbon equivalency fees paid as border adjustments Carbon rebates for exports
Banking and Borrowing	Indefinite banking, borrowing for 1-2 years; strategic reserve run by EPA to mitigate against large price fluctuations	Not Applicable
CDM / JI	Up to 2 billion offset credits per year for efforts within or outside U.S., offsets administrated by EPA (allows carbon sinks)	Refunds if taxed carbon is sequestered, other offset projects TBD
Enforcement	Enforcement by EPA 2x market value of allowances for fine Additional oversight by FERC, financial regulators	Enforcement by IRS & EPA
Use of Auctioning Revenue	TBD (Possible tax cut, "dividend", or energy research)	Payroll tax rebate; 1/6 up to $10 billion to energy R&D; Industry transition fund, equal to 90% of revenues in 2009, decreasing by 10% per year and reaching 0 by 2019; additional 1/12 of environmental tax revenue in 2009

6.0 Impacts of Climate Change Policy: Lessons from the EU

Significant review of design of the ETS has been conducted which allows an assessment of the ETS across a variety of criteria, including environmental effectiveness, cost effectiveness, equity, flexibility, compliance, & competitiveness. We can best understand the relationship between policy design and outcomes in climate change by examining the results of the ETS. Further, this analysis can allow policy-makers to make informed decisions regarding the potential tradeoffs inherent in policy design.

6.1 Allocation of Emissions Permits

The allocation of emissions permits has been one of the most dramatically changed features of climate change policy design in the EU. As discussed above, the allocation of emissions has been shifted from a state-based approach to a centralized authority, with emissions allocated directly to firms. During the first trading period, it proved to be very difficult to implement a trading mechanism that was coordinated across many national registries and national implementation authorities. Increasingly, it has been seen that permits should be directly allocated to firms, with a centralized emissions monitoring and verification authority (Olmstead and Stavins 2007).[6]

In the first two trading periods, emissions permits were generally freely allocated on the basis of historical emissions. Auctioning in the first trading period of the ETS amounted only to about 3 million EUAs auctioned in the first trading period, totaling 13% of regulated emissions. This method of allocating permits proved to be highly problematic for many reasons discussed previously. In addition, emissions permits were widely believed to be over-allocated, causing the price at the end of the trading period to drop to zero. Fortunately, firms were unable to bank permits and hold them to the second trading period, allowing for a correction in the 2008-2012 trading period.

By grandfathering permits, policy-makers also provided disincentives to early action on carbon mitigation (Neuhoff, Martinez, and Sato 2006). In order to retain flexibility in the system, the EU chose trading periods that would require re-allocation of permits at 3, 5, or 8-year intervals. When reallocation occurs, it is extremely important not to punish firms that reduced their carbon emissions during the previous trading period (Neuhoff, Martinez, and Sato 2006).

In the third trading period, there will likely be a shift towards auctioned allowances. However, due to staunch political opposition and concerns of international competitiveness, auctioning of allowances will be phased in for many industries as well as for Eastern Europe. Most electric utilities in Western Europe will have to auction all allowances, with some exceptions for district heating and cogeneration. Eastern European electric utilities will receive 70% free allocation in 2013, declining to 0% in 2020. Other industries and manufacturers will receive 80% freely allocated allowances in 2013, declining to 30% in 2020, and 0% in 20207. Sectors at risk for international competition and carbon leakage will receive 100% freely allocated allowances.

Free allocation will be distributed based on benchmarking, which hopes to reward firms that are the most energy efficient producers. However, despite the promises of benchmarking, many political uncertainties exist regarding how benchmarking is to be conducted. Benchmarking may

[6] This trend towards centralizing emissions trading regimes in the EU is very different from those in the U.S., which suggest that GHG regulation should be managed at a state level. In the ETS, it proved very difficult to manage a trading system where each country had to operate separate registries, and firms had to coordinate across countries. However, the EU has allowed each state to manage individual plans for meeting carbon reduction targets outside of the ETS covered industries.

discourage plant closure, and if benchmarking is based on fuel type, it will also distort production to higher emissions plants (Grubb and Neuhoff 2006).

While most economists agree that auctioning allowances is the most efficient mechanism for permit allocation, several problems exist with auctioned permits. First, free allocation of permits compensates firms for existing assets devalued by environmental regulation that was not foreseen at the time of construction (Grubb and Neuhoff 2006). Second, many firms fear increased costs that will affect competitiveness. While some firms are able to pass along increased costs to consumers, other firms are not able to do so due to international competition. If international firms are not subject to similar environmental regulation, these firms may have lower marginal costs of production. Research regarding competitiveness is discussed further below.

6.2 Market Liquidity and Trading

The first trading period in the ETS demonstrated some obstacles for market liquidity. In early assessments of the trading regime, many firms reported difficulties in trading, due to inoperable registries, a poor understanding of trading and the trading system, and thin markets with few sellers and many buyers (European Commission, McKinsey & Company, and Ecofys 2006, 2006). Since the beginning of the ETS, the volume and number of trades has increased dramatically, and most participants believe that the market has become much more liquid (Convery and Redmond 2007).

Further analyses demonstrate that firm capacity and industry type affect the way firms behave in the market (Matisoff, forthcoming). The vast majority of permit supply and demand originated from the power sector, where most of the largest players were active traders of carbon (Convery and Redmond 2007). Large utilities employ between 3-15 dedicated carbon traders, and use derivatives to hedge risk on fuel positions (Matisoff, forthcoming). In contrast, smaller players have few, if any, dedicated carbon traders and have had difficulties participating in trading (Matisoff, forthcoming). Surveys demonstrate that many banks had minimum sizes for trades, effectively limiting the ability of smaller firms to participate (Convery and Redmond 2007). However, survey results also note that banks are increasingly willing to trade smaller amounts of carbon, and the amount of carbon traded has increased, demonstrating increasing liquidity of the market (Convery and Redmond 2007).

While there was considerable volatility in the market during the first trading period, many attribute this volatility to a lack of information about actual emissions (Convery and Redmond 2007). Because verified emissions are only released yearly (and sporadically at first), and there was little historical information to work with, firms did not have good information with which to gauge pricing decisions. As experience in the market increases, and as the release of verified emissions data becomes more systematic, volatility in the market should decrease (Convery and Redmond 2007). In addition, the increase of the percentage of permits to be auctioned by government should help dampen volatility and improve liquidity (Hepburn et al. 2006).

6.3 Market uncertainty

During the first trading period, many firms expressed concern regarding the stability of the market, and uncertainty for future trading periods (European Commission, McKinsey & Company, and Ecofys 2006, 2006). Because permitting and building a power-plant takes upwards of 9 years, and life-spans for power plants may be as long as fifty years, the lack of a long-term cap, changing rules on offsets, and uncertainty regarding future allocation rules added a great deal of uncertainty to the market (Matisoff, forthcoming). Numerous surveys of firms demonstrate that many firms have not developed carbon strategies and may not have a good understanding of carbon trading (European Commission, McKinsey & Company, and Ecofys 2006, 2006; Kolk and Pinske 2004; Nill and Heiner 2008). In surveys of participating firms, many firms expressed the desire to lengthen trading periods, set firm long term caps, and clarify the allocation process.

6.4 International Competitiveness and Carbon Leakage

One of the most controversial aspects of any carbon trading program is the extent to which it will impact international competitiveness of industrial firms, and to what extent the program will be effective without a firm commitment from developing countries.

Recent research that analyzes the impacts of emissions allowances on energy-intensive sectors suggests that in many sectors, firms may profit from carbon regulation, depending on the amount of permits that are freely distributed. Freely distributed allowances serve as a subsidy to firms, and firms will be able to pass other costs along to consumers. If a portion of allowances are freely distributed, firms may be able to profit from carbon regulation (Smale et al. 2006). Thus, many researchers argue that only a portion of allowances need to be distributed freely to achieve profit neutrality for firms (Vollebergh, de Vries, and Koutstaal 1997; Bovenberg and Goulder 2000; Quirion 2003; Demailly and Quirion 2008, 2006; Smale et al. 2006). The impact on international competitiveness of allocation method varies by industry. In simulations that incorporate the cost of trade and assume freely allocated allowances, the ETS delivered emissions reductions and produced increased profitability (between 10-25%) for the cement, newsprint, petroleum, and steel sectors (Smale et al. 2006). Prices rise to consumers in the cement and steel sectors, due to the large percentage that remains domestically produced (90%-95% for cement, 80% for steel). Under a 30 Euros per ton policy scenario, output reductions for cement and steel are 10% and 5%, respectively. The one exception in this simulation is aluminum smelting; EU production ceases due to international competition and the increase in the cost of electricity.

If some permits are auctioned rather than freely distributed, Demailly and Quirion (2006) demonstrate that grandfathering 50% of historic emissions maintains profitability for the cement industry, with some production losses and CO_2 leakage. At 75% freely allocated allowances, the impacts on profitability and production levels are insignificant, with lower levels of emissions abatement. In the iron and steel industry, allocating approximately half of emissions allowances for free maintains profitability and production levels for EU iron and steel firms, while allocating more than half of allowances freely greatly enhances the profitability for firms in this sector. Bovenberg and Goulder (2000) demonstrate that in the U.S., no more than 15% of allowances need to be grandfathered in the oil, coal, and gas industries to maintain profits and equity values. Firms profit in these scenarios because international production cannot fully substitute for domestic production. Once transport costs are considered, prices generally rise to consumers, as firms pass along costs of permits, and freely allocated allowances provide a generous production subsidy to domestic producers.

Experience in the first trading period led the EU to recognize the increased profitability that can result from freely allocated permits. In the electricity sector, CO_2 pass through rates varied between 60% and 100% of CO_2 costs in the Netherlands and Germany. Because permits were freely distributed, this led to substantial windfall profits by electric generators (Sijm, Neuhoff, and Chen 2006). Because of the early experience in the ETS, the 2008-2012 trading period will likely incorporate fully auctioned allowances for electricity generators, and 20% auctioned allowances for other industrial firms in 2013, increasing to 80% auctioned allowances in 2018. Firms in energy intensive sectors that are subject to international competition will continue to receive freely allocated permits based on benchmarking.

The impacts of freely allocated emissions permits during the first trading period, and the allocation methods through the National Action Plans in the EU highlighted the potential for changes in the allocation method to vastly impact firm profitability (Sijm, Neuhoff, and Chen 2006; Hepburn et al. 2006). Hepburn and others argue that by using auctions combined with border-tax adjustments, carbon leakage can be minimized, while also minimizing the potential for distortions from freely allocated emissions permits (Hepburn et al. 2006). While border tax adjustments raise questions of WTO compatibility, border tax adjustments can be WTO compatible if they are set at the average costs of CO_2 allowances, excluding opportunity costs (Hepburn et al. 2006). Because companies can only be compensated up to the level of actual, average costs incurred, in order to implement an effective border-tax adjustment, auctioning or a carbon tax is necessary for WTO compatibility (Hepburn et al. 2006).

6.5 Green Jobs

While significant concern exists for certain sectors to remain competitive with carbon regulation due to international competition, one mechanism that can reduce the impact of a shifting economy is the generation of green job growth, which has been touted as a solution to the current recession (Scheven 2009). Germany, for example, claims that there are currently 250,000 green jobs in the renewable energies sector, which will triple by 2020 (Scheven 2009). Estimates from the United States suggest that 1.6 – 8.5 million people were employed in 'green jobs', not including the organic industry, and that green businesses were growing at a rate of 5% per year (Wingfield 2007; Greenhouse 2008).

Nevertheless, significant issues exist with these estimates. It is extremely difficult to characterize what is meant by a green job, and it is unclear whether these jobs represent true job growth. For example, a steelworker job that existed to build low-efficiency automobiles was considered a blue-collar job; the same steelworker job that exists to build wind turbines is considered a green-collar job. Other firms demonstrate that green jobs may be high-paying and for educated employees. Plextronics, a Pittsburgh start-up which produces polymer inks used in solar power circuitry, employs 51 workers, of whom 20 have Ph.D.s. Johnson Controls, which manages heating and cooling systems, expects to hire 60,000 people over the next decade in its building efficiency business (Greenhouse 2008). Two industries specifically related to climate change include the carbon trading industry – valued at $28 billion in 2006, and the green building industry valued at $12 billion in 2006 did not exist as few as 10 years earlier (Wingfield 2007). Unfortunately, few peer-reviewed studies make quantified projections of possible green job growth due to carbon regulation.

6.6 Joint Implementation / Clean Development Mechanism

Joint implementation and the Clean Development Mechanism were inserted into the Kyoto Protocol to "assist Parties in Annex I in achieving compliance with their quantified emission limitation and reduction commitments. (Kyoto Protocol 12.2)" CDM projects may already supply 680 million tons of CO_2e, or 17-19 percent of the total expected shortfall of 3.6 – 4 billion tons of CO_2e for Europe, Japan, Canada, and New Zealand in the 2008-2012 commitment period (Lecocq and Ambrosi 2006).

JI and CDM offset credits have proven to be a useful tool in providing liquidity to the market, reducing the burden of emissions reductions for firms in the ETS, and have provided sources of profitability for EU firms able to generate emissions reduction units (ERUs), and certified emissions reductions (CERs). The Linking Directive allows companies in the second trading period to use credits from JI and CDM as a proportion of their allocation of emission allowances, to cover their emissions. Once an individual company has reached the limit of the number of offset credits it can use, companies can sell these offset credits on the market. Due to some of the political uncertainty surrounding these permits and some restrictions regarding their use, these permits currently trade at a discount on the carbon permit market.

During the first and second Kyoto trading periods, many larger firms focused emissions reduction strategies primarily on offset projects, due to the extensive availability of cheap sourcing of offset credits. For example, firms could invest in offset projects, investing approximately €4-5 per ton and then selling ERU and CER credits at €16-20 per ton (Matisoff, forthcoming). Further, many larger firms were able to pair strategic investments in developing countries (mainly China, India, and Brazil) with potential offset credits. In contrast, smaller firms generally do not have the resources or international reach with which to take advantage of offset opportunities (Matisoff, forthcoming).

Due to the widespread use of CDM and JI during the first and second trading period, concern arose in the EU about the extent to which firms ought to be required to reduce domestic emissions, rather than simply offset emissions abroad. In the post 2012 proposal, existing operators may only use 20 percent of offset credits to meet carbon permit requirements. New entrants are allowed to make greater use of offset credits, but the total amount of offset credits in use is limited to 50% of the overall required reduction in the 2012-2020 trading period. (EUROPA 2008)

Overall, existing operators will be able to access a total level of approximately 1.6 billion credits over the 2008-2020 period, meaning that operators can use credits up to a minimum 11% of their allocation during 2008-2012. New sectors and new entrants in the third trading period will have a guaranteed minimum access of 4.5% of verified emissions in the 2013-2020 trading period. While projects from 2008-2012 will be grandfathered into the third trading period, beginning in 2013 it is expected that criteria for approving JI and CDM projects will be tightened and will specifically exclude land-use credits. The ETS proposal makes provisions for greater access to offset credits, should an international agreement be concluded that includes least developed countries. Finally, provisions are made to allow the generation of credits within EU countries in sectors that are not covered. (EUROPA 2008)

7.0 Discussion of tradeoffs of policy design in the U.S.

The above discussion of policy design choices and impacts of climate change legislation in the EU highlights many tradeoffs inherent in designing effective and efficient climate change policy in the United States. An effective climate change policy rests on setting either a carbon cap or carbon taxes that discourage the use of carbon intensive fuels.

The choice between taxes and a cap-and-trade system is largely a choice between price certainty versus quantity certainty. A cap-and-trade approach can guarantee a minimum level of carbon reduction, while a tax-based-approach guarantees a maximum cost. However, these design choices incur other tradeoffs as well.

7.1 Cap-and-Trade versus Carbon Tax

Cap-and-trade systems may cause immense transaction costs, may be more difficult for smaller installations to adjust to, and may produce volatile markets. Further, cap-and-trade approaches spur many questions regarding the allocation of allowances and problems with windfall profits. Balancing international competitiveness versus equity to producers and consumers seems to be a delicate task. Cap-and-trade approaches in the EU and as proposed in the U.S. exclude many installations and sectors, in order to provide greater efficiency and reduce transaction costs. The EU approach, post 2012, will need to include additional measures to address smaller installations and sectors not covered by the cap-and-trade system, adding further complexity to regulatory regime that has undergone extensive revision with every trading period. As evidenced in the EU and in the Waxman-Markey draft bill, a cap-and-trade approach is an extremely complex policy tool to design and implement. Firms in the EU have been slow to develop strategies to deal with the ETS; adjusting to such a tool may be difficult for many U.S. firms.

Cap and trade systems offer some advantages as well, particularly in the area of flexibility mechanisms and the ability to link the system internationally. Offsets and the international trade of permits can be seamlessly integrated across different systems. With the EU, Australia, and Japan experimenting with a cap-and-trade approach, there is a clear benefit to providing compatibility with those systems. If developing countries are included in a future cap-and-trade system, then offset provisions can dramatically reduce the cost of complying with a cap-and-trade regulation.

In contrast, a tax approach might be much simpler to implement, offering transparency and simplicity, but offers other challenges. A carbon tax may provide less flexibility in the form of offsets and banking. The handling of offsets is not yet specified in the Larson carbon tax bill. And while a cap-and-trade approach can allow for banking, to smooth prices across time, a carbon tax offers price certainty but does not reward the early reduction of emissions. Coordination with other countries who have favored a cap-and-trade approach may prove difficult, and international competitiveness must be handled through a border tax adjustment, which may be extremely difficult and complex to implement, and be susceptible to international legal challenges through the WTO.[7]

7.2 Permit Allocations: Auctioned, Grandfathered, Benchmarked

Individual rule changes highlight tradeoffs as well. The allocation of permits is a particularly tricky issue. While auctioned permits provide the most transparency and efficient initial allocation, helping to reduce trading and transaction costs and eliminating distortions from the allocation process, fully auctioned permits put domestic business at a competitive disadvantage and lead to carbon leakage (Grubb and Neuhoff 2006; Demailly and Quirion 2006, 2008). When permits are allocated freely, a number of other distortions can be introduced, and consumers may be disadvantaged as firms pass along costs of freely allocated permits, generating windfall profits. Further, firms are less likely to alter their production methods, due to a preference for business-as-usual production, and distortions that discourage plant closure and favor production from higher emitting plants (Grubb and Neuhoff 2006). When allowances are distributed freely, significant differences can occur between grandfathered allowances, or allocation based on benchmarking, and whether or not fuel type is considered in the allocation process. While grandfathered allowances help mitigate the redistributive impacts of carbon regulation, benchmarked allowances provide fewer distortions. Grandfathering emissions can lead to distortions that favor production from higher emitting plants, reduce incentives for energy investments, and can shield output from the cost of carbon permits (Grubb and Neuhoff 2006). Benchmarked allowances fare a bit better, but can still discourage plant closures and favor production from higher emitting plants (Grubb and Neuhoff 2006). Output based benchmarking that does not take fuel into consideration provides fewer distortions as well, while benchmarking that considers fuel type is more likely to promote production from higher emitting plants (Grubb and Neuhoff 2006).

[7] As discussed above, under the framework of the WTO, direct costs of carbon regulation can be incorporated into a border-tax-adjustment; however, this provision has not been tested.

7.3 Flexibility Mechanisms: Emissions Targets, Offsets, and Banking

Flexibility allowed in a cap-and-trade system has the ability to provide increased stability and can allow the revision of targets in response to improved scientific knowledge, but it can also undermine the ability for firms to plan for the future. The revision of rules and emissions targets provides significant uncertainty to firms attempting to form long-term carbon strategies. The EU ETS made the first trading period a 'trial period' with the knowledge that many changes were likely. Indeed, allocation methods are likely to be completely overhauled for the 2012-2020 trading period. However, the EU is attempting to maintain a 20% reduction target by 2020, and an 80% reduction target by 2050 in order to help set a clear long-term price signal.

Allowing firms to take advantage of flexibility mechanisms can allow firms to reduce the cost of compliance with a specific environmental goal. When firms bank emissions, they reduce carbon emissions earlier, at a cheaper cost, providing environmental benefits, and then they can later use banked permits to reduce the cost of compliance. However, if emissions are over-allocated, or if targets need to be revised, banking can be problematic.

Offsets, such as CDM and JI, allow firms to take advantage of cheaper reductions abroad; however, if emissions are not capped in the country where offsets are sourced, or if they are sourced in a non-covered sector, offsets can allow for an overall increase in the total carbon cap, reducing the effectiveness of the program.

7.4 Industries and Coverage

The two major current proposals in the U.S. vary dramatically regarding the types of industries addressed through a carbon cap or tax. In the carbon cap method, all industries and all greenhouse gas pollutants are included, but installations under 25,000 mtCO_2e / yr are excluded from coverage. While this provides coverage over all industries and all pollutants, there will likely be thousands of regulated entities, creating high transaction costs for government and firms. With concern that a cap-and-trade program can negatively impact small businesses, and that transaction costs can be passed along to society in the form of higher prices, it is important that these are considered in the policy design. The EU system demonstrates that this method covers about half of emissions in Europe (and non-CO_2 greenhouse gas emissions are not included in the EU), and though there have been some problems with market stability, it is expected that the market will become more stable over time. However, the exclusion of non-CO_2 gases in the EU, and the exclusion of many industries and processes, leads to the fear that the burden of CO_2 reduction is highly uneven. In contrast, the Larson Carbon Tax only taxes carbon and taxes it at the point of extraction, providing means for a rebate for firms that sequester the carbon. This system leads to fuller and more uniform coverage, and minimizes the enforcement costs by focusing on the largest sources of carbon emissions and allowing those effects to trickle down through the rest of the economy. In its current form, however, the Larson Carbon Tax does not tax non-CO_2 greenhouse gases, providing some of the same problems that exist with the EU ETS. The bill makes provisions for taxing other greenhouse gas emissions in the future.

7.5 Affordability and distributional impacts

Many economists believe that the benefits of strong, early action on climate change strongly outweigh the costs. According to the Stern Review on the Economics of Climate Change and later adjustments to the model, the costs of addressing climate change are estimated at about 2% of GDP, per year in order to prevent damages that range from 10% to 22% of GDP per year (Stern 2007). While the report was highly criticized for particularly pessimistic assumptions and a low discount rate, further research has suggested that previous estimates of damages due to climate change may have been underestimated, lending increased legitimacy to the conclusions of the report.

Estimates of costs to the U.S. and U.S. households have been subject to significant speculation by various interest groups. The non-partisan Congressional Budget Office provides reasonable estimates that can be used to gauge a range of possible impacts of climate change regulation. In the U.S. alone, estimates of a 15% reduction in carbon via a cap-and-trade approach suggest a cost of about $12 billion in total costs per year by 2018, while auctioning those allowances would generate revenues of $1.19 trillion over the 2009-2018 time period – or annual revenues totaling tens to hundreds of billions of dollars (Orszag 2008).

At a household level, prices of carbon intensive goods and electricity will increase. The Congressional Budget Office estimates that a 15% reduction in carbon would raise expenses on households between $700 (3.3%) for the lowest income quintile to $2,200 (1.7%) for the highest income quintile, and averaging about $1,600 per family (Orszag 2008). However, the distribution of the large amount of revenues becomes highly important in order to understand the net effect of a cap-and-trade approach. If lump-sum rebates are given to households, income would increase (after taxes and household expenses) by 1.8% for the lowest income quintile and decrease income by .7% for the highest income quintile (Orszag 2008). If allowances were sold and used to cut corporate income taxes, net income would decrease by 3% for the lowest income quintile, and increase by 1.6% for the highest income quintile. If allowances were given away for free, net income would decrease 2% for the lowest quintile and increase 1.4% for the highest quintile (Orszag 2008).

8.0 Conclusions

Climate change policy design in the United States is a highly contentious issue, as distributional impacts will affect consumers and industries. These distributional impacts are largely a function of the design of carbon regulation. Both cap-and-trade and carbon tax proposals have components that will likely impact production decisions of firms. Cap-and-trade, however, appears to have many more complexities that allow flexibility through offset projects and banking, and offer a possibility for firms to profit from carbon regulation at a cost to consumers. With cap-and-trade programs the policy tool of choice in Europe, Japan, and Australia and a simpler method to include developing countries, it is important to consider the distributional impacts and distortions that arise from the allocation of carbon permits. If too many permits are given away freely, American consumers suffer while firms generate windfall profits. If too few permits are given away freely, American firms will lose production to developing countries, and the program will be ineffective as carbon emissions will increase abroad.

In addition, it is extremely important to consider the impacts of carbon regulation on different types of firms. As discussed earlier, distributional impacts of allocation of carbon permits impacts industries differently. While the electricity industry can pass along most costs of regulation to consumers, other industries, such as iron and cement, may require 25 – 50 percent free allocation, in order to maintain competitiveness. Smaller firms seem to be at a significant disadvantage under cap-and-trade programs, due to less capacity to deal with carbon regulation. While increasing the threshold for regulation can exclude many of the smaller actors, it increases the burden on the economic sector that is covered in the trading system, in comparison to the sectors that are not covered. Excluding small installations leads to the need to develop additional regulations to deal with these entities, which can include a large percentage of total greenhouse gases in an economy.

Developing carbon regulation in the United States requires careful consideration of the tradeoffs inherent in policy design. As the world moves forward with carbon regulation, it is important that the U.S. not only considers trade-offs for the domestic economy, but also considers how implementation in the United States will interact with implementation abroad. In addition, as the U.S. designs carbon policy, it is important to balance the flexibility needed to improve policy design over time, with the need to set firm, long term targets necessary to establishing firm strategies and a stable market.

References Cited

Aldy, Joseph, Scott Barrett, and R. N. Stavins. 2003. 13+1: A Comparison of Global Climate Change Policy Architectures. *RFF Discussion Paper* (26).

Aldy, Joseph, P Orszag, and Joseph Stiglitz. 2001. Climate Change: An Agenda for Global Collective Action. In *The Timing of Climate Change Policies*. Washington, D.C.: Pew Center on Global Change.

Aldy, Joseph, and William Pizer. 2008. Issues in Designing U.S. Climate Change Policy. *RFF Discussion Paper* (20).

Associated Press. 2009. *Japan PM targets cutting carbon emissions by 60-80 percent by 2050*. Associated Press, 9 June 2008 2008 [cited 27 March 2009 2009]. Available from http://www.iht.com/articles/ap/2008/06/09/asia/AS-GEN-Japan-Climate-Change.php.

Barrett, Scott. 2003. *Environment and Statecraft: the strategy of environmental treaty making*. Oxford: Oxford University Press.

Bernasconi-Osterwalder, Nathalie. 2008. Climate Change and Trade: How trade rules must support efforts to combat climate change. In *New Thinking on Trade Policy and Development: Trade and Climate Change*. Brussels: Socialist Group in the European Parliament.

Bovenberg, A.L., and Lawrence H Goulder. 2000. Neutralising the Adverse Industry Impacts of CO2 Abatement Policies: What Does it Cost? Washington, D.C.: Resources For The Future.

Burtraw, Dallas. 2008. Auctions and Revenue Recycling under Carbon Cap-and-Trade. *Resources* (Spring).

Burtraw, Dallas, K Palmer, and Daniel Kahn. 2009. A Symmetric Safety Valve. *RFF Discussion Paper* (06).

Chameides, William, and Michael Oppenheimer. 2007. Carbon Trading over Taxes. *Science* 315 (21 March 2007):1670.

Commission of the European Communities. 2008. Commission Staff Working Document: Accompanying document to the Proposal for a Directive of the European Parliament and of the Council amending Directive 2003/87/EC so as to improve and extend the EU greenhouse gas emission allowance trading system. Brussels.

Convery, Frank, and Luke Redmond. 2007. Market and Price Developments in the European Union Emissions Trading Scheme. *Climate Policy* 1 (1):88-111.

Cooper, R. 1998. Towards a Real Treaty on Global Warming. *Foreign Affairs* 77 (2):66-79.

———. 2001. The Kyoto Protocol: A Flawed Concept. *Environmental Law Reporter* 31 (11):484-492.

Demailly, Damien, and Philippe Quirion. 2006. CO2 abatement, competitiveness and leakage in the European cement industry under the EU ETS: grandfathering versus output based allocation. *Climate Policy* (6):93-113.

———. 2008. European Emission Trading Scheme and competitiveness: A case study on the iron and steel industry. *Energy Economics* 30 (4):2009-2027.

Ellerman, A Denny, and Barbara Buchner. 2007. The European Union Emissions Trading Scheme: Origins, Allocation, and Early Results. *Review of Environmental Economics and Policy* 1 (1):66-87.
EUROPA. 2009. *Questions and Answers on the Commission's proposal to revise the EU Emissions Trading System*, 23 January, 2008 2008 [cited 23 March, 2009 2009]. Available from http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/08/35&format=HTML&aged=0&language=EN&guiLanguage=en.
European Commission, and Ecofys. 2007. Report under the project "Review of the EU Emissions Trading Scheme". Brussels: European Commission, Directorate General for Environment.
European Commission, McKinsey & Company, and Ecofys. 2006. Review of EU Emissions Trading Scheme: Free Text Answwers - EU ETS Survey. Brussels: European Comission.
———. 2006. Review of EU Emissions Trading Scheme: Survey Results. Brussels: European Comission.
European Parliament legislative resolution of 17 December 2008 on the proposal for a directive of the European Parliament and of the Council amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading system of the Community (COM(2008)0016 – C6-0043/2008 – 2008/0013(COD)). 17 December, 2008.
Fell, Harrison, Ian A MacKenzie, and William Pizer. 2008. Prices versus Quantities versus Bankable Quantitites. *RFF Discussion Paper* (32).
Fischer, Carolyn, and Alan Fox. 2009. Comparing Policies to Combat Emissions Leakage: Border Tax Adjustments versus Rebates. *RFF Discussion Paper*.
Greenhouse, Steven. 2008. Millions of Jobs of a Different Collar. *New York Times*, 26 March, 2008.
Grubb, Michael, Duncan Brack, and Christiaan Vrolijk. 1999. *The Kyoto Protocol: a guide and Assessment*. London: Energy and Environmental Program, Royal Institute of International Affairs.
Grubb, Michael, and Karsten Neuhoff. 2006. Allocation and competitiveness in the EU emissions trading scheme: policy overview. *Climate Policy* (6):7-30.
Hepburn, Cameron, Michael Grubb, Karsten Neuhoff, Felix Matthews, and Maximilien Tse. 2006. Auctioning of EU ETS phase II allowances: how and why? *Climate Policy* (6):137-160.
Johnson, Keith. 2009. Exxon's Tillerson: Give Me a Carbon Tax, Not Cap-and-Trade. *Wall Street Journal*, January 8, 2009.
Kolk, Ans, and Jonatan Pinske. 2004. Market Strategies for Climate Change. *European Management Journal* 22 (3):304-314.
Kopp, Raymond, William Pizer, Daniel Hall, Richard Morgenstern, Juha Siikamäki, Joseph Aldy, Ian Perry, K Palmer, Dallas Burtraw, Mun Ho, Evan Herrnstadt, and Joseph Maher. 2007. Assessing U.S. Climate Policy Options. *RFF Report*.
Lecocq, Franck, and Philippe Ambrosi. 2006. The Clean Development Mechanism: History, Status, and Prospects. *Climate Policy* 1 (1):134-151.
Morgenstern, Richard. 2009. Competitiveness and Climate Policy: Avoiding Leakage of Jobs and Emissions, edited by U. S. H. o. R. C. o. E. a. C. S. o. E. a. Environment. Washington, D.C.: RFF Press.
Morgenstern, Richard, William Pizer, and Jhih-Shyang Shih. 2007. Evaluating Voluntary U.S. Climate Programs: The Case of Climate Wise. In *Reality Check: The Nature and Performance of Voluntary Environmental Programs in the United States, Europe, and Japan*, edited by W. Pizer and R. Morgenstern. Washington, D.C.: RFF.
Murray, Brian, Richard Newell, and William Pizer. 2008. Balancing Cost and Emissions Certainty: An Allowance Reserve for Cap-and-Trade. *RFF Discussion Paper* (24).

NC Solar Center. 2007. Database of State Incentives for Renewables and Efficiency: North Carolina State University.

Neuhoff, Karsten, Kim Martinez, and Misato Sato. 2006. Allocation, incentives and distortions: the impact of EU ETS emissions allowance allocations to the electricity sector. *Climate Policy* (6):73-91.

Nill, Moritz, and Raphael Heiner. 2008. *Herausforderungen an das Risikomanagement im CO2-Emissionshandel*. Germany: PricewaterhouseCoopers AG.

Nordhaus, William. 2007. To Tax or Not to Tax: Alternative Approaches to Slowing Global Warming. *Review of Environmental Economics and Policy* 1 (1):26-44.

Euorpean Parliamant and of the Council. 2003. *Establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC*. Directive 2003/87/EC.

Olmstead, Sheila, and Robert Stavins. 2007. A Meaningful Second Commitment Period for the Kyoto Protocol. *Economists' Voice*.

Orszag, Peter. 2008. Containing the Cost of a Cap-and-Trade Program for Carbon Dioxide Emissions, edited by o. E. a. N. R. Committee, U.S. Senate. Washington, D.C.: Congressional Budget Office.

Parkison, Giles. 2009. *Australia: Rudd turns carbon policy on its head Down Under*. ClimateChangeCorp.com, 12 March 2008 2008 [cited 27 March 2009]. Available from http://www.climatechangecorp.com/content_print.asp?ContentID=5200.

Quirion, Philippe. 2003. Allocation of CO2 Allowances and Competitiveness: A Case Study on the European Iron and Steel Industry: CENTRE-CIRED.

Scheven, Franziska. 2009. Germany says green jobs will shorten recession. *Reuters*, 24 February 2009.

Schmalensee, Richard. 1998. Greenhouse Policy Architecture and Institutions. In *Economics and Policy Issues in Climate Change*, edited by T. Nordhaus. Washington, D.C.: Resources for the Future.

Sijm, Jos, Karsten Neuhoff, and Yihsu Chen. 2006. CO2 cost pass-through and windfall profits in the power sector. *Climate Policy* (6):49-72.

Smale, Robin, Murray Hartley, Cameron Hepburn, John Ward, and Michael Grubb. 2006. The impact of CO2 emissions trading on firm profits and market prices. *Climate Policy* (6):31-48.

Snyder, Jim. 2009. *Dingell withdraws idea of carbon tax*. Capitol Hill Publishing Corp 2008 [cited May 15, 2009 2009]. Available from http://thehill.com/leading-the-news/dingell-withdraws-idea-of-carbon-tax-2008-04-15.html.

Stern, Nicholas. 2007. Stern Review on the Economics of Climate Change, edited by H. Treasury. London.

Stewart, R, and J Wiener. 2001. Reconstructing Climate Policy: The Paths Ahead. *Policy Matters*.

Victor, David. 2003. International Agreements and the Struggle to Tame Carbon. In *Global Climate Change: The Science, Economics, and Politics*, edited by J. Griffin. Cheltenham, UK: Edward Elgar.

Vollebergh, H.R.J., J.L. de Vries, and P.R. Koutstaal. 1997. Hybrid carbon incentive mechanisms and political acceptability. *Environmental and Resource Economics* 9:43-63.

Waxman, Henry, and Edward Markey. 2009. American Cean Energy and Security Act of 2009 Draft, edited by House of Representatives. Washington, D.C.: Committee on Energy and Commerce.

Wingfield, Brian. 2007. For Job Market, Green Means Growth. *Forbes*, 3 July, 2007.