CLAREMONT MCKENNA COLLEGE

INVIGORATING KYOTO'S CLEAN DEVELOPMENT MECHANISM: CLIMATE FRIENDLY DEVELOPMENT IN RAPIDLY INDUSTRIALIZING COUNTRIES

BY
PETER WEISBERG

FOR
SENIOR THESIS

April 23rd, 2007

INTRODUCTION: CONSTRUCTION CRANES CHANGING THE CLIMATE 2

CHAPTER 1: EFFECTIVE GREENHOUSE GAS MITIGATION IN RAPIDLY INDUSTRIALIZING COUNTRIES 5

WHY DEVELOPING COUNTRIES? 5
FOCUS ON THE POWER SECTOR 7
Scale: Large, Long-term Emissions in the Power Sector... 9
Collaboration: Matching Development Priorities 10
UNCOORDINATED DEVELOPMENT IN THE POWER SECTOR 12
SUGGESTED ACTIONS 17
Low-Carbon Fuel Mix: Encouraging Natural Gas...17
Lower Energy Intensity: Encouraging Energy Efficiency..19
Realistic Preparation: Invigorating the Development of Carbon Capture and Storage......................21
CONCLUSION 24

CHAPTER 2: THE CLEAN DEVELOPMENT MECHANISM: FINDING THE LOWEST COST AT ALL COSTS 25

HOW CDM FUNCTIONS 25
PROJECTS OUTSIDE THE ENERGY SECTOR 28
HFC-23, N_2O, and CH_4 Trend 28
Explaining the Trend: Why CDM Favors Industrial/Manufacturing Projects 31
Impact of the Trend..32
IGNORING DEVELOPING COUNTRIES' DEVELOPMENT PRIORITIES 34
Source of the Problem...34
Solution to the Problem: Universal Sustainability Requirements...39
CREATING FUNCTIONAL INSTITUTIONS AND METHODOLOGIES 40
CONCLUSION 42

CHAPTER 3: FLAWS IN THE STRUCTURE OF CDM...43

UNCERTAIN CER VALUE AFTER 2012 43
LACK OF US PARTICIPATION 44
PROJECT SPECIFIC FOCUS 45
MARKET MECHANISM 47
CONCLUSION 50

CHAPTER 4: FUTURE PROJECTS WITH OLD FLAWS 52

BIOMASS PELLETIZATION 53
Explaining the Technology...53
Energy Content 55
Retrofitting Coal Power Plants for Cofiring...56
PELLET MARKETS: DEVELOPING COUNTRIES, THE US, EUROPE AND CANADA, AND CDM 58
Barriers for Developing Countries 58
US Market: Missing the Boat...60
CONCLUSION 64

CONCLUSION 66

SUMMARY 66
FUTURE RESEARCH 68
BEYOND THE CLIMATE 70

REFERENCES 73

ANNEX A. SUMMARY OF INTERVIEWS WITH US PELLET MANUFACTURERS...................77

Introduction: Construction Cranes Changing the Climate

"Development is itself the driving force behind climate change" (Heller and Shulka, 2004, p. 111). I pondered this statement as I created a newfound Chinese game: crane counting. I first played in a tourist trap in the southwestern city of Chengdu. Even in idle water gardens honoring an ancient Chinese poet, the city's construction frenzy could not be fenced out. From the garden's highest tower, I counted 29 construction cranes—development's international symbol. "That's nothing compared to what you will see next year," my translator remarked.

Rapidly industrializing nations like China are vigorously pursuing the energy-intensive economies of wealthy nations. Such industrialization cannot be stopped. Instead, poverty reduction and economic and social development are, rightfully, the overriding priorities of rapidly developing nations. Greenhouse gas emissions will, by necessity, grow as material wealth and therefore global equality improve. These emissions from developing countries will be overwhelming, coming at a time when the developed world alone is failing to stabilize the atmospheric concentration of greenhouse gasses. Governmental, non-governmental and industrial representatives attempting to mitigate human-caused climate change must work with the development of rapidly industrializing countries, making it climate-friendly, to have any hope of stabilizing the quantity of greenhouse gasses humans put into the atmosphere.

How can the transition towards economic prosperity in rapidly changing countries like China, India, Brazil, Mexico, Indonesia, or South Africa be made climate-friendly? How can the greenhouse gas emissions associated with social and economic development be minimized? These are the central questions of this paper. They are theoretically considered in Chapter 1, which examines the greenhouse gas emissions likely to result from current development, the roots of these emissions, and ways in which an effective international climate change regime can minimize emissions without slowing economic growth. This chapter focuses on what should be done to reduce the greenhouse gas emissions associated with development.

After establishing a theoretical framework of what should be done, the rest of this paper considers what the global community, through the Kyoto Protocol, has done to mitigate development's greenhouse gas emissions. The Kyoto Protocol is the amendment to the United Nations Framework Convention on Climate Change that establishes mandatory greenhouse gas emission reductions for its signatories. The Kyoto Protocol tackled the climate-development challenge in Article 12, which established the Clean Development Mechanism (CDM). CDM allows Annex-1 countries of Kyoto, industrialized nations who agree to emission reduction targets, to meet part of their targets through carbon credits purchased from greenhouse gas-friendly development projects in developing (non-Annex 1) countries. CDM is creative environmental policy, a market solution that attempts to please developed and developing countries alike. After Kyoto, it was the talk of the town, labeled "the most innovative and controversial feature of the Kyoto Protocol" (Percival et al., 2003, p. 1069), "the Kyoto surprise," "the win-win mechanism," "a bridge between North and South," and "the front-runner of the Kyoto Regime" (Olsen, 2006, p. 2). The Marrakech Accords of 2001 established CDM's rulebook, and in 2004 the first project was registered.

The Chapters 2, 3 and 4 demonstrate that, despite initial excitement, CDM has not significantly impacted fundamental development choices in rapidly industrializing countries. The Chapter 2 considers how CDM functions and what types of projects it has encouraged. The projects already undertaken by CDM do not align with the needed projects recommended in Chapter 1. Chapter 3 therefore considers how to overcome the fundamental flaws in the mechanism's structure that prevent it from encouraging needed projects. Chapter 4 is a case study of biomass pelletization, a technology of particular interest to CDM project developers. By considering the aspects of biomass pelletization that make it attractive to project developers, the chapter reveals why CDM, as currently designed, will only promote marginal emission reductions instead of fundamentally changing development patterns.

CDM, an international policy negotiated according to political realities, is not perfect. This does not mean the mechanism is a failure. It is an impressive and innovative first step towards including developing countries in a climate regime without mandating reduction targets. Even given the difficulty of international policy making, CDM can be improved. The mechanism needs greater scope and financial strength before it can truly encourage fundamental climate-friendly development.

Chapter 1: Effective Greenhouse Gas Mitigation in Rapidly Industrializing Countries

One must define how to effectively reduce the greenhouse gas emissions of development before analyzing whether or not Kyoto's mechanism is effective. This chapter investigates which climate change mitigation projects are most needed in rapidly industrializing countries. Mitigation work must focus on the power sector, which provides electricity and heat. Within the power sector, the international climate regime needs to reduced the amount of coal burnt in rapidly industrializing countries by 1) encouraging natural gas and energy efficiency and 2) making the coal used cleaner with carbon capture and sequestration.

Why Developing Countries?

It is impossible to stabilize the concentration of greenhouse gasses in the atmosphere without engaging all of the largest emitters of greenhouse gasses. The international climate regime must therefore identify who large emitters are today and who they will be in the future. In 2003, three developing countries, China, India and South Korea, were among the top ten emitters of greenhouse gasses. As development proceeds in these and other rapidly industrializing countries, the developing world will soon become the most important constituent for the international climate regime to engage.

Developing, non-Annex 1 countries are projected to begin emitting more greenhouse gas emissions than developed countries by 2012, with China surpassing the US as the world's largest emitter in 2009 (IEA 2006). This intersection only signifies the beginning of developing countries' emission growth. Non-OECD countries are projected to produce 75% of new emissions expected between 2004 and 2030 (IEA 2006). Over the next half century, large developing countries are expected to become the greatest contributors to human caused climate change.

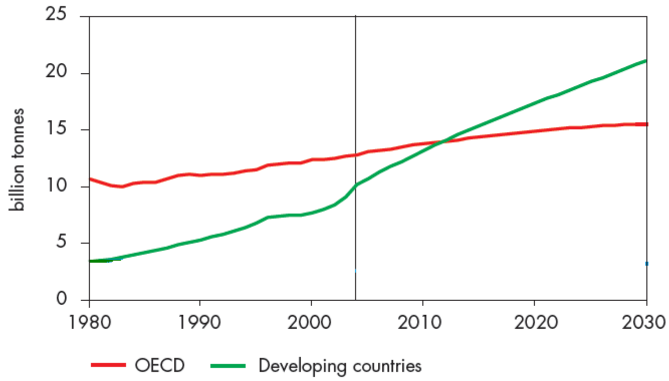

Figure 1. Energy-Related CO_2 Emissions by Region in the Reference Scenario. Y-Axis is billion tones of CO_2 emissions (IEA 2006).

Who, among the developing countries, is currently accounting for and projected to account for this rapid growth in greenhouse gas emissions? A country's greenhouse gas emissions are correlated with four different characteristics: population, GDP, energy intensity of GDP (the amount of energy used per unit of GDP), and fuel mix (the greenhouse gasses emitted per unit of energy). Population and GDP are the two essential factors that set a country's emissions trajectory; variance around that trajectory is determined by energy intensity and fuel mix. The developing countries with growing or already large populations and growing GDP are China, India, Brazil, Mexico, Indonesia and South Africa (Baumert et al. 2005). These countries, which the rest of this paper refers to as rapidly industrializing countries, are the constituents that must be engaged to successfully stabilize or reduce the concentration of greenhouse gasses in the atmosphere. There are over 100 other developing countries that have both low populations and low economic growth; these countries are not threats to the world's climate,[1] but they are equally, if not more, threatened by the changes humans inflict upon it (Baumert et al. 2005).

Given long-term emission projections, there are two reasons it is essential to engage rapidly industrializing countries in climate change mitigation. First these countries are projected to produce the dominant quantitative share of global greenhouse gas emissions. Second, these countries' energy infrastructure will be developed in tandem with their economic growth. Greenhouse gas emissions can be mitigated most effectively by altering infrastructure choices being made today. Developing countries are currently deciding what fuels to rely upon and what technologies to deploy. It is essential for the international climate regime to engage rapidly industrializing countries today because these decisions present the largest opportunity for greenhouse gas emission mitigation.

Focus on the Power Sector

The energy sector of developing countries described in the last section is diverse. It includes the emissions associated with transportation, industry, and the provision of electricity and heat. All these sectors emit significant amounts of greenhouse gasses, but changing the way electricity and heat are generated in developing countries is the most important sector to consider.

[1] Note that greenhouse gas emissions can be unrelated to economic growth. 18.2% of the global greenhouse gas emissions come from land use change, mostly due to deforestation (Baumert et al. 2005). Countries with low economic growth but high rates of deforestation are therefore important constituents of the international climate regime. Still, emissions from the energy use associated with economic growth contribute 61.4% of global greenhouse gas emissions (Baumert et al. 2005). Rapidly industrializing countries are therefore the most essential constituents to engage to mitigate future emissions.

What must the international climate regime do to green the power sector? The regime must first lower the carbon content of fuels used to produce electricity and heat, and secondly use these fuels more efficiently. Electricity and heat can be generated with a variety of fuels. Different fuels have different carbon contents (or no carbon at all). Carbon is most concentrated in coal; the average anthracite coal has 26.8 tons of carbon for every terajoule of energy it produces (Baumert et al. 2005). Oil, for comparison, has 20.0 tons of carbon per terajoule of energy. Gas, the cleanest of the fossil fuels, has only 15.3 tons of carbon. Non-fossil fuels, like nuclear, hydro, wind and other renewable, have no carbon content. Generating needed power with low carbon or no carbon fuels, which means avoiding coal when possible, is essential to mitigating human caused climate change. Beyond the fuel used, efficiency, both in fuel consumption at the power plant and electricity consumption by a consumer, determines the amount of fuel demanded: increasing efficiency provides the same energy service with less fuel and therefore fewer carbon emissions. Using fuels and electricity efficiently is as important and lowering the carbon content of developing countries' fuel mix. Within the power sector, therefore, the international climate regime must encourage developing countries to use clean fuels efficiently

This chapter will conclude with specific recommendations to both lower carbon contents of fuels and increase efficiency. Before recommending specific actions, however, this chapter will establish why greening the power sector of developing countries is the most essential climate change mitigation work. The scale of emissions expected from the power sector, along with the opportunity for collaboration with developing countries development priorities, make the power sector ideal for mitigation work.

Scale: Large, Long-term Emissions in the Power Sector

Currently the generation of electricity and heating produces 24.6% of global greenhouse gas emissions; this overshadows the emissions of all other sectors, including transportation, industry, land use change, and agriculture (Baumert et al. 2005). Because development depends upon increasing power generation, emissions associated with producing electricity and heat are growing at a faster rate than emissions associated with any other sector. According to the International Energy Agency (2006), power generation will produce half of new greenhouse gasses emitted between 2004 and 2030.

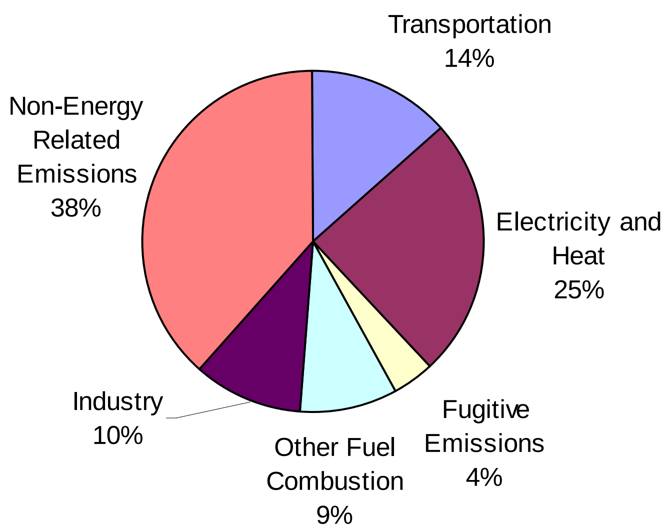

Figure 2. The percentage of global greenhouse gas emissions from different sectors. Non-energy related emissions refers to emission that do not result from the combustion of fuels (Baumert et al. 2005).

Beyond the simple scale of emissions, the power sector of developing countries is also currently building long-term infrastructure as described previously. Regardless of the technology employed, power infrastructure built today will be locked into the world economy. Every inefficient coal power plant China buys today, for example, will operate for an estimated 40 to 75 years.[2] As power generation infrastructure is built, opportunities for emission mitigation are overwhelming. Once this infrastructure is locked in, a country's baseline emissions are set. Reductions from then on will be marginal. Action today, before the baseline is set, can provide drastic shifts in emissions.

The window for changing basic power infrastructure of rapidly industrializing countries is closing. Logan (2007) observes that in 2006 China added 92 gigawatts of new coal-fired power plants, which now account for 5% of global greenhouse gas emissions. The rate at which China is currently building power plants cannot be sustained: "While additional new coal plants will come on-line this year, growth beyond that should slow dramatically as China's newly added supply catches up with demand" (Logan 2007). China is experiencing the tail end of rapid development that is just beginning in other industrializing countries (Katzer et al. 2007). As in China, the window for influencing other developing countries' infrastructure choices will quickly close. Now is the time to capitalize on long-term power sector mitigation opportunities.

Collaboration: Matching Development Priorities

Beyond the scale of its emissions, the power sector provides an equally important opportunity to collaborate with the development of rapidly industrializing countries. Power generation provides economic growth. Stern (2007) writes "energy has a pivotal role in development- it helps promote access to better education, better health, increased productivity, and enhanced competitiveness " (p. 492). Given these benefits, increasing capacity to generate power is the most salient development priority of rapidly

[2] New York Times, 11 June 2006

industrializing countries. A climate regime can help developing countries realize power sector development.

The priorities of the international climate regime, specifically promoting the efficient use of low-carbon fuels, benefit developing countries in two substaintial ways beyond climate change mitigation. First, efficiency and new, low-carbon fuels provide energy security. Low-carbon power sectors, which diversify beyond fossil fuels, make an economy less reliant on any individual fuel (World Bank 2006). Beyond diversifying the energy mix, the climate regime also offers investment dollars to minimize local and regional environmental impacts. Technology that emits less carbon also emits fewer local and regional pollutants.[3] By providing energy security, environmental protection, and reduced greenhouse gas emissions, the power section combines the interests of the climate regime and developing countries.

Why is this synergy of interests so important? Rapidly industrializing countries instinctively reject regimes attempting to limit emissions for fear that such regimes will hinder increases in basic standards of living. Lu Xuedu, the deputy director general of Chinese Office of Global Environmental Affairs, commented, “You cannot tell people who are struggling to earn enough to eat that they need to reduce their emissions.” Rajendra Pachauri, the chairman of the United Nations' Intergovernmental Panel on Climate Change from India, noted that among developing countries, “there has been a loss of confidence, since the developed countries, and particularly the largest ones, have not done more. They are going to shift the burden onto us – that’s the popular view.”[4]

[3] Hydropower is a notable exception to this statement. Due to the energy required to make cement for dams and the local inhabitants and habitats flooded by reservoirs, the international climate regime should not base its power sector reform policy on large scale hydro.
[4] New York Times, 7 Nov. 2006

Industrializing countries are skeptical, even fearful, of climate change regimes because they are a potential barrier to development.

Yet, to stabilize the concentration of greenhouse gasses in the atmosphere, developing countries must participate in the climate regime. Through collaboration in the power sector today, developing countries will engage with the climate regime instead of rejecting it. By focusing on synergies between regime interests and development priorities, rapidly industrializing countries will be more likely to participate in future, more strict international climate regimes.

Uncoordinated Development in the Power Sector

Because the power sector of developing countries offers the greatest potential for greenhouse gas emission mitigation, it is essential to understand how this sector is different in rapidly industrializing countries compared to the North. The owners of energy infrastructure and services in rapidly industrializing countries lack coordination. This means individual economic choices of energy investors, not overarching energy policies, guide investments. Under such disorganization, a climate regime hoping to change energy investments must alter the economic calculus of individual decision makers.

Rapidly industrializing countries recently adopted market-centered electricity and power reforms, shedding their state-controlled past (Heller and Shulka 2004; Victor and Heller 2007; Dubash 2002). This transition from state to private control is nearly universal; by 1998, 73 of 115 developing countries had taken at least minimal steps towards market-oriented reforms (Dubash 2002). Privatization is universal among the rapidly industrializing countries with large populations and economies.

Why did rapidly industrializing countries adopt market-centered reforms? In the late 1980s and early 1990s, economic growth in developing countries created shortages in energy supply. State-owned power providers could not secure the investment dollars needed to buy capital and generate the power economic growth demanded. With this shortage in domestic dollars, and a high priority on eliminating any barriers to economic growth, the governments of rapidly industrializing countries turned overseas to seek investment. Developing countries' plea for investment came during a peak of neo-liberal development doctrine. Wealthy countries, specifically their development banks and private companies, offered to lend rapidly industrializing countries money to purchase power sector capital with the stipulation that developing countries privatize their power sectors. In 1993, for example, the World Bank issued a policy paper making all power sector lending contingent upon market-based reform (Dubash 2002). Developing countries agreed to reform their power sectors, not in a quest for economic efficiency, but instead to insure investment in energy capital.

A "hybrid" power sector, resembling neither a state-controlled system nor the market-oriented (but fairly regulated) ideal, emerged. Energy and utility companies of the developing world are now privatized, but without the competitive markets and comprehensive regulation needed for an efficient private power sector. Hybrid power markets have few competitors because they were previously state-owned (Heller and Shulka 2004; Victor and Heller 2007). Private power markets, which at different stages of generation, transmission and retailing, operate as natural monopolies, require legal and regulatory institutions to control and coordinate the power market. In rapidly industrializing countries, these institutions and regulations are universally weak, lacking independence from the previously state-owned companies they now regulate (Victor and Heller 2007).

This hybrid economy without competition and regulation creates an uncoordinated and chaotic investment environment. Heller and Shulka (2004) write, "In this hybrid context, coordinating authorities that are motivated or able to optimize across policy goals or economic activities are scarce. Instead, choices among development paths flow largely from incentives salient to particular interests" (p. 119). Private investors minimize risk by investing in discrete components of the power sector, thereby separating themselves from the unknown future of the interconnected grid (Dubash 2002). Investors, not policy makers, determine the development path for energy infrastructure in rapidly industrializing countries.

What factors determine the investment decisions of these individuals? Energy developers are under intense pressure to provide and sell energy rapidly and cheaply. This pressure to develop is combined with a bad investment environment and, therefore, a low flow of international investment dollars. The International Energy Agency (2006) estimates that the energy sectors of developing countries require $10 trillion in investment by 2030 to meet the power demands of their growing economies. The weak and unorganized policy framework of these hybrid states, however, makes infrastructural, sector-based investment risky (Stern 2006). The $10 trillion needed in energy investment is, therefore, not flowing from wealthy countries. While economic growth in developing countries is continually increasing the amount of energy demanded, the dollars to make this new energy are nowhere to be found.

This creates huge opportunities for profit with little money available to purchase capital. Upfront investment is therefore minimized. Those attempting to produce power buy cheap capital, i.e. technology that is outdated, inefficient, environmentally dirty, and based on the infrastructure of the old, state-owned power sector. Energy investors short on investment dollars operate myopically: efficient technology that, in the long run, would save money and reduce greenhouse gas emissions is ignored due to higher upfront costs.

China is an excellent example of an uncoordinated hybrid state with individual investors determining national energy policy. Chinese energy sector investors are "many players, with diffuse decision making authority, blurred regulator and commercial interests, and considerable interest contestation" (Katzer et al. 2007). Centralized regulation or policy has little effect. Environmental and economic mandates from the centralized government are frequently ignored by local officials and companies (Katzer et al. 2007). With little control from above, energy infrastructure in China is built from the bottom up, with individual investors, not the central government, determining national energy policy. Infrastructural investments in this chaotic confusion are risky. Therefore, needed municipal or regional power infrastructure is not built. Instead, manufacturers equip their factories with what is labeled "in-the-fence" generation-- diesel generators, unconnected to the local grid, that provide for the entire factory's electricity needs. Ten percent of China's total electric power consumption (and 25% of India's) is "in-the-fence" (Katzer et al. 2007). In this environment, individual investors fulfilling their own energy needs, not governments attempting to fulfill their country's needs, guide energy development.

What does this hybrid state of China and other rapidly industrializing countries mean for the environment? For one, regulators in previously state-run power sectors have no experience making energy markets work to protect the environment. In state-centered systems, environmental policy was internal; the state-run enterprise, upon deciding to prioritize environmental protection, redirected its capital investments and operational decisions (Victor and Heller 2007). Rapidly industrializing countries have no experience crafting the regulation needed to make market-based power sectors protect the environment. Secondly, greenhouse gas emissions and their impact on the global climate are not considered in the individual investor's scramble to minimize upfront costs. Local and regional environmental impacts, whose effects are visible and tangible, are slightly greater priorities.[5] Global warming, without tangible effects, is forgotten. Individual investors crafting energy policy from the bottom up, without coordination from above, do not integrate the environmental and social costs of their actions into their decision making.

What can be done in the chaotic energy sector of hybrid states to prioritize the environment? With uncoordinated energy policy, the cost-benefit analyses of investors determine investment decisions. Clean energy development can therefore be coordinated by favoring the benefits and reducing the costs of clean investments. The rest of this

[5] Wealthy communities, which have the luxury to prioritize environmental quality, can force decision makers to account for the local and regional environmental impacts. Energy development in China's wealthier cities is already changing due to the population's increased wealth. Shanghai, a Chinese city whose per-capita income is equal to Portugal, mandated all future power plants to run on natural gas, not coal (Katzer et al. 2007). Still, the rest of China and other rapidly industrializing countries lag far behind the wealth and therefore environmental consciousness of Shanghai.

chapter therefore considers methods of making investment in energy efficiency, natural gas, and clean coal more profitable than the current investment in antiquated, dirty technology. These changes have the power to funnel the $10 trillion dollars in energy investment expected in developing countries into climate-friendly development.

Suggested Actions

The chapter has, thus far, been entirely descriptive, establishing a context for action in the power sector of developing countries. What should the international climate regime do to make this chaotic context of the power sector produce climate-friendly results? How can the climate regime coordinate the individual investors of the developing world to efficiently use low carbon fuels? The solutions revolve around policies that change the use of coal. The international climate regime needs to first reduce the amount of coal burnt by encouraging energy efficiency and the use of natural gas and secondly ensure coal is burnt cleanly by developing and subsidizing carbon capture and storage.

Low-Carbon Fuel Mix: Encouraging Natural Gas

Natural gas is the cleanest of the fossil fuels. It emits fewer local, regional and global environmental pollutants than oil or coal. In terms of greenhouse gas emissions, natural gas produces the same amount of energy as coal with 60% of the carbon dioxide emissions (Baumert et. al 2005). If developing countries are to deploy a low-carbon fuel mix, a significant amount of natural gas will have to be used.

Fueling power plants in rapidly industrializing countries with coal is cheaper than natural gas. Coal, unlike other fossil fuels, is produced and consumed domestically.

Countries with large coal reserves use them, and many rapidly industrializing countries have these reserves: India, China, and South Africa have respectively, the third, fourth, sixth largest domestic coal reserves in the world (Baumert et al. 2005).[6] These large reserves make coal readily available and cheap. Katzer et al. (2007) estimate that in these rapidly industrializing countries, natural gas provides useable energy for $6-$12 per MMBtu while coal costs only $1-$2 per MMBtu.

Beyond its financial attractiveness, the coal infrastructure is already installed in rapidly industrializing countries. In the past, state-owned power enterprises built coal-based infrastructure, namely mining and transportation, because coal was a cheap, locally abundant fuel (Victor and Heller 2007). Coal is therefore established as the business as usual development path that new investments naturally follow. Any change away from coal is especially risky in the chaotic and unpredictable power sector of hybrid economies.

Given the investor's control over energy policy in these hybrid states, the best way to encourage natural gas is to reverse this infrastructural inertia and make gas more financially attractive than coal. This can be done by subsidizing or funding new natural gas infrastructure: specifically, pipelines, regasification terminals for liquid natural gas, and urban distribution networks. Once this infrastructure is in place, investments are less risky and more profitable. With this infrastructure, the marginal costs of building and operating a natural gas power plant are cheaper than the marginal costs of building a coal plant (Heller and Shulka 2004). The investors guiding energy policy will, therefore, favor the cleaner fuel. The climate regime can build this infrastructure in conjunction

[6] Note that Mexico and Brazil are absent from this list. Mexico has large reserves of oil; Brazil has large hydroelectricity potential. These countries will therefore not rely use coal to as their central fuel for generating electricity and heat (Victor and Heller 2007).

with private businesses in the natural gas industry who have the expertise and financial resources to develop the industry in developing countries.

In this focus on individual investors, the climate regime cannot forget the importance of the state's regulation. In the competitive, well-regulated markets of developed countries, relative capital and operating costs of different power generators steer investment decisions. When market competition is weak and the line between the regulator and the regulated is blurred, as in rapidly developing countries, rules can be tailored to favor specific fuels and power generators. The international climate regime must lobby regulators to ensure that regulation is fair and does not give unfair advantage to dirtier fuels. The regime can do this by offering investment in natural gas infrastructure to those countries who regulate gas fairly.

How much of an impact can the climate regime have by building natural gas infrastructure? Jackson et al. (2006) estimate that with two additional natural gas pipelines from Russia or nine additional large scale regasification terminals for liquid natural gas, China would replace nine percent of the coal it is projected to burn with natural gas. Infrastructural projects, by changing both marginal costs and business as usual development paths, have the power to transform energy markets, shifting their focus from coal to natural gas.

Lower Energy Intensity: Encouraging Energy Efficiency

Encouraging natural gas lowers the carbon content of the fuel mix of developing countries. Such fuel switching does not affect a country's energy intensity (the amount of energy used per dollar of GDP). To lower energy intensity, a country must produce and consume electricity and heating efficiently. The infrastructure to produce (power plants) and consume (factories, residential and commercial buildings) electricity and heat is being built today. On the consumption side, it is projected that half of China's commercial and residential urban buildings will be constructed between 2000 and 2015 (World Bank 2006). Once this infrastructure is installed, its energy efficiency is more or less locked in. The buildings China constructs today are projected to last over the next 50-100 years (World Bank 2006).[7] This means working to increase the efficiency of energy-consuming infrastructure in rapidly industrializing countries is an urgent and essential task for the international climate regime.

There are three reasons why rapidly industrializing countries will not, on their own, invest in the optimal amount of energy efficient technology. The first is non-economic pricing of energy. As previously stated, the attempt to liberalize energy markets in the late 1980s and early 1990s is incomplete. Stern (2006) estimates non-OECD countries subsidize fuels, particularly coal and oil, with over $160 billion dollars a year. These subsidies are not tax credits or incentives for innovation, but instead one effect of the hybrid power sector in which government and private business collude to benefit private interests. The prices power plants pay for fuel and consumers pay for electricity and heat are artificially lowered by these subsidies.

Cheap fuel and electricity stimulates unnecessary consumption and waste. The cost of energy drives the individual decision of whether or not to invest in efficient technology. With artificially low prices, technologies that lower carbon emissions and make economic sense are not deployed. The climate regime therefore must work with

[7] Power plants, factories and buildings can usually be retrofitted to use energy more efficiently, but such retrofits are much more expensive than building with efficient technology to begin with. In the investment starved energy environment of rapidly industrializing countries, such retrofits are unlikely to be undertaken.

the regulators of rapidly industrializing countries to expose and reform subsidies for dirty fuels.

Even with energy priced economically, developing countries would not consume an adequate amount efficient technology because energy-efficient capital costs more upfront. The lack of investment dollars available in the hybrid power sectors means investors are forced to lower upfront costs at the expense of paying greater recurring costs. Efficiency, that over time would pay back its greater upfront costs, is not purchased. The climate regime can overcome this upfront cost barrier by subsidizing efficiency projects. This investment should focus on paying for the additional upfront cost of efficient capital.

The barriers to efficiency are not simply financial. Producers and consumers of power in developing countries are frequently unaware of efficient technologies (World Bank 2006; Stern 2006). An international climate regime should not only subsidize efficient technology, but also advertise it. This spreading of awareness should focus on those technologies that save producers and consumers money under current energy prices.

Efficiency can be encouraged by enforcing economic pricing of energy, subsidizing expensive capital and advertising for available technology.

Realistic Preparation: Invigorating the Development of Carbon Capture and Storage

The two solutions outlined thus far focus on substitutions for coal. While reducing the amount of coal burnt is an essential priority for the international climate regime, coal cannot be avoided entirely for a number of reasons. First, as mentioned in the natural gas section, China, India and South Africa have some of the world's largest domestic coal reserves. Energy infrastructure has already developed accordingly, with coal as the baseline for the production of electricity and heat (Victor and Heller 2007). In addition, coal is the only fossil fuels whose largest reserves are concentrated outside of the politically unstable Middle East. The world's largest natural gas reserves are in countries with large oil reserves, specifically Russian, Iran, Qatar, Saudi Arabia, UAE (Yergin and Stoppard 2003). Therefore, domestic coal provides fossil fuel dependent developed and developing countries with needed energy security. As a cheap, available and secure fuel, coal will be burnt.

Given coal's high carbon content, what can the international climate regime do to reduce the emissions associated with the coal that will inevitably be burnt? As already stated, all fuels should be used efficiently. Yet highly efficient coal plants still emit twice the CO_2 of efficient natural gas plants (World Bank 2006). Reducing the emissions of coal requires more than efficient technology.

Carbon Capture and Storage (CCS) is needed for coal to become a low-carbon fuel. CCS broadly refers to capturing the carbon dioxide associated with burning coal and storing it in geologic reservoirs before it reaches the atmosphere. Why is CCS the best hope? CCS works with coal power plants, which account for 68% of the world's coal use (Baumert et al. 2005). CCS could also be developed for coal liquefaction or other conversions that turn this domestic, widely available fuel into more desired fossil fuels. The development and commercialization of CCS therefore has more power than any other technology to lower the carbon content of fuel mixes in developed and developing countries alike.

Unfortunately, this technology is far from commercially ready. While the literature on mitigating the emissions of rapidly industrializing countries repeatedly stresses the need to transfer CCS from developed to developing countries (World Bank 2006; Stern 2006) the CCS literature reminds its readers that, as of yet, there is little commercial technology ready to transfer. Katzer et al. (2007) stress the importance of government assistance for private companies attempting to develop and commercialize this essential technology, which, of the most optimistic estimates, will not be ready until 2020 (World Bank 2006). As a second best, the mitigation literature stresses the importance of building coal power plants that are CCS-ready (World Bank 2006). Yet, at this point, retrofitting coal plants to capture and store carbon after they have been built without CCS technology is not and will not be economically feasible. Katzer et al. (2007) write, “the concept of a ‘capture ready’ [i.e. retrofittable] IGCC or pulverized coal plant is as yet unproven and unlikely to be fruitful” (p. 99).

Rapidly industrializing power sectors need to build electricity generation today. By 2030, most of the needed power plants will already be built, locked in, and unable to be retrofitted (Logan 2007). The inability to retrofit adds urgency to both offsetting coal use with cleaner fuels, but also developing CCS as quickly as possible. The international climate regime can do two things to encourage the development of CCS. First, as an international body, the regime can coordinate and provide of forum for collaboration between the research and development efforts of different countries. Secondly, the international climate regime can prepare mechanisms for technology transfer that, when CCS is ready, will disseminate the technology rapidly to non-OECD countries.

Conclusion

In summary, mitigation efforts focused on the power sector could drastically reduce the projected emissions of rapidly industrializing countries. The international climate regime can promote low carbon power sectors in rapidly industrializing countries by making clean energy markets and technologies attractive to uncoordinated investors. The efficient use of low carbon fuels can be encouraged by subsidizing natural gas and energy efficient infrastructure and aiding in the development of Carbon Capture and Storage.

Chapter 2: The Clean Development Mechanism: Finding the Lowest Cost at All Costs

The previous chapter established what should be done to mitigate rapid industrialization's impact on the climate. How does this compare to what is being done? To answer this question, this section analyzes trends in projects supported by the Clean Development Mechanism. It first explains how CDM functions and then focuses on the mechanism's accomplishments.

How CDM Functions

CDM provides financial incentive for development projects that are climate-friendly— a concept that includes classically green projects, like renewable energy, and more mainstream ideas, like using natural gas instead of coal to generate electricity. Governments, domestic or international companies, NGOs, development banks and the like can initiate a CDM project. Once project design and financing are arranged, projects are registered and validated by the Executive Board—a panel of ten members that oversee the implementation of CDM.

To register with the Executive Board, project developers first prove additionality— that, due to financial or technical barriers, the clean development project would not occur without the additional incentive CDM provides. Then developers establish a baseline— the business-as-usual project likely to have occurred without CDM. Imagine a private company interested in building a wind farm to generate electricity in China. To register with the Executive Board, the company must demonstrate additionality-- that without the money and expertise it brings to the projects, the wind farm could not be built. The project is additional if it could not be initiated without CDM. With additionality proven, project developers then establish a baseline-- how the electricity they plan to produce with wind would have been provided if CDM did not exist. The baseline in this case is likely to be a coal-fired power plant, a more profitable alternative in China.

CDM brings additional money to projects like wind farms by generating and selling carbon credits. Credits, called Certified Emission Reductions (CERs), are calculated by subtracting the greenhouse gas emissions of a CDM project (like the wind farm) from the emissions of that project's baseline scenario (the coal-fired power plant). CERs therefore signify the greenhouse gas emissions avoided by taking an alternative development path, by using wind instead of coal.

The cycle for developing a project and certifying its carbon credits can be summarized in the following four steps:

1. **Initiation** →	2. **Registration** →	3. **Monitoring** →	4. **Verification**
Project developers (NGO, government development bank, private investor) identify and formulate potential CDM projects and then propose the project to Executive Board.	The Executive Board approves a project's additionality/baseline/other methodologies. The host country assures the project meets individually defined goals for sustainable development.	Project developers track performance and collect data regarding their projects.	A third-party (known as the Designated Operational Entity) assesses the quantity of emission reductions achieved. The Executive Board certifies and issues CERs to be sold.

Annex-1 countries, or companies within these countries, then buy the issued credits. Annex-1 countries have been assigned emission reduction targets under the Kyoto Protocol. To meet these targets, companies can change their behavior at home or, through CDM and other Kyoto flexibility mechanisms, pay someone to change their behavior abroad. These two options have the same impact on the atmosphere because, through additionality, CDM assures credit buyers are paying for emission reductions that would not occur without the mechanism. Stringent standards for additionality, which guarantee that polluting companies are paying for new reductions, ensure that purchasing credits from abroad is interchangeable with changing behavior at home.

In theory, this system of credit trading benefits developed and developing countries. Non-Annex 1 countries receive additional investment and technology to encourage clean development, without sacrificing their more salient development priorities. Under this structure, climate change mitigation projects are investment opportunities for developing countries, not barriers to development. At the same time, Annex-1 countries are given flexibility to find the cheapest projects for reducing emissions. CDM is expected to save Annex-1 countries money because it is cheaper to construct low-carbon technologies from scratch rather than replace or renovate existing technology in already industrialized nations (Goodward 2006; Olsen 2005). As the rest of this chapter demonstrates, however, because the mechanism aims to be a win-win it fails to impact the fundamental development decisions currently made in industrializing countries. To win for Annex-1 countries, the mechanism must provide low-cost emission reductions. This focus on cheap reductions has taken attention away from the projects articulated in the first chapter as truly needed and given priority to marginal reductions from projects outside the energy sector.

Projects Outside the Energy Sector

HFC-23, N_2O, and CH_4 Trend

Chapter 1 identified the importance of working within the power sector, specifically through encouraging natural gas infrastructure and energy efficient technologies. Projects which modify the output of industrial or manufacturing processes, however, make up the majority of the CDM market. Seventy-five percent of credits from already registered projects or projects awaiting validation involve one of three gasses, HFC-23, N_2O, or methane (Fenhann 2006). These gasses are undesired by-products of the production process: HFC-23 is let off while making a refrigerant, N_2O while making adipic acid (Ellis and Gagnon-Lebrun 2004). Methane results from the anaerobic fermentation of organic material, commonly in landfills or animal waste.[8] Chapter 1 advocates mitigating climate change by generating new, clean outputs or promoting efficiency in the power sectors of developing countries. CDM projects have focused in an entirely different area. Seventy-five percent of the mechanism's credits come from eliminating outputs, the aforementioned waste gasses, from industrial/manufacturing processes.[9] CDM therefore has minimal impact on the production of energy or goods but instead filters the end result of already occurring production processes.

---

[8] Methane, unlike HFC-23 or N2O, can be used to generate electricity and therefore contribute to the energy sector. As Goodward (2006) observes, however, "not all methane recovery projects utilize their biogas, some simply flare it, and their contribution in terms of power capacity is quite small" (p. 14).
[9] Note that industrial/manufacturing processes do use energy. The described industrial CDM projects are not changing this energy used (and therefore reducing CO_2 emissions) but instead eliminating waste gas products (and therefore reducing non-CO_2 emissions not associated with the energy sector).

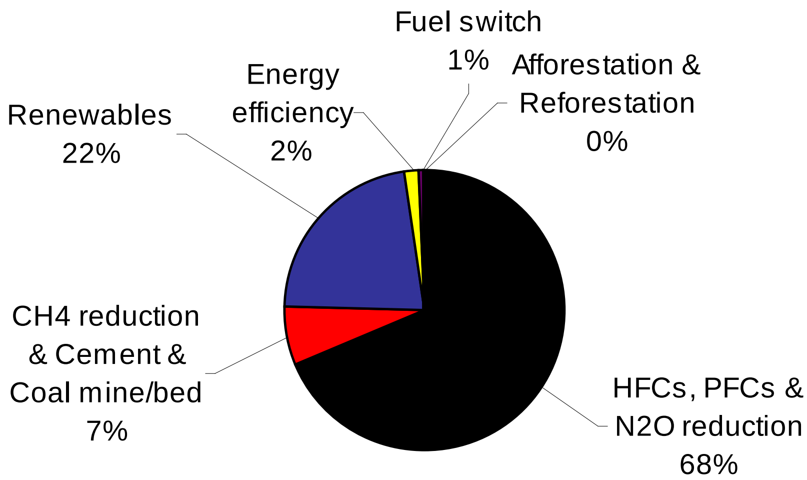

Figure 3. Percentage of Certified Emission Reductions generated by different sectors. Includes all projects up to April 1st, 2007 (Fenhann 2007).

As the market learns that non-CO2 projects are the most profitable, it has shifted its attention to such projects. As project developers gain experience with CDM, a trend favoring HFC-23 and N_2O projects has emerged.

The initial players in the CDM market were altruistically motivated. For example, before the rulebook for CDM was solidified at the Marrakech Accords of 2001, the Prototype Carbon Fund, a trust of concerned governments and private investors, entered the market with a $145 million budget to initiate CDM projects (Streck 2004). Compliance with Kyoto targets did not motivate the creation of this fund. It was formed to gain experience in project development and jumpstart the CDM market. Motivated by altruism not compliance, those controlling the fund wanted to support a diversity of projects. The Prototype Carbon Fund's project portfolio is therefore geographically and technologically diverse.

The time for altruism has passed. CDM credit buyers are now motivated by compliance with Kyoto targets. With such a mindset, developers seek cheap credits.

Enough time has passed for project developers to understand that non-energy sector projects generate the cheapest credits. At the market's beginning, CER value was uncertain. This made it risky to invest in projects that only eliminate waste gasses because such projects generate no sellable commodity other than CERs (Goodward 2006). Now that credit value is established, however, projects funded only by CERs are financially viable. The compliance-concerned market has therefore shifted from its diverse beginnings to a focus on non-energy sector projects.

Comparing the variety of project types in the whole CDM market (Figure 2) to the lack of diversity in the 53 projects which requested registration in May 2006 (Figure 3) reflects the new market favoritism for non-energy sector projects. Projects eliminating HFC-23 (labled F-gas in Figure 3) generate 32% of credits in the overall market of October 2006 (Fenhann 2006), 65% of credits in the overall market of April 2007 (Fenhann 2007; see Figure 1) and 78% of credits from only projects registered in May 2006 (Ellis and Karousakis 2006). Clearly, the market has realized the profitability of HFC-23 projects and therefore concentrated more attention on them.

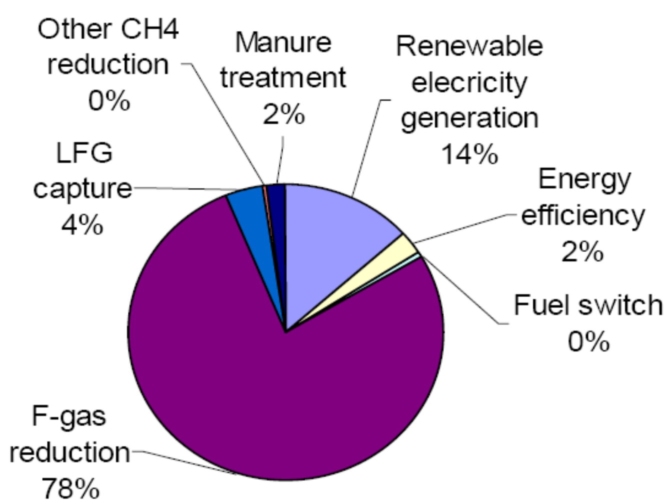

Figure 4. Percentage of Certified Emission Reductions to be generated by 2012 in different sectors from the 53 projects requesting registration in May 2006 (Ellis and Karousakis 2006).

Explaining the Trend: Why CDM Favors Industrial/Manufacturing Projects

Two factors explain why non-energy sector projects are so profitable. First, eliminating non-CO_2 greenhouse gasses, commonly not associated with the energy sector, generates large amounts of credits with minimal investment because these gasses have a more potent effect on climate change. The gasses HFC-23, N_2O and methane trap heat more efficiently than CO_2. The IPCC made a scale to represent discrepancies in heat trapping values of these various gasses. On this scale, CO_2 is assigned a heat trapping value of 1. With this basis for comparison, methane's value is 21, N_2O 310, and HFC-23 11,700 (IPCC 1996). Given this discrepancy, projects which eliminate a small amount of gas not associated with the power sector (non-CO_2) generate a lot of credits. A project eliminating just one ton of HFC-23, for example, receives as many credits as a project which eliminates 11,700 tons of CO_2. These heat trapping values partially explain the favoritism of CDM for non-power sector projects.

Non-CO_2 projects have a second advantage—they are easily approved. Because they eliminate outputs (waste gasses) instead of generating sellable outputs, establishing additionality and a baseline is easy. Additionality is obvious because, with nothing to sell, such projects rely entirely upon CERs for profit. Power sector projects, which generate sellable electricity, could be profitable without CDM and therefore non-additional. Proving additionality is a costly, laborious process for projects with sellable outputs. Similarly, baselines (what would have occurred without CDM) are obvious for non-energy sector projects—the same manufacturing process without the end-of-pipe greenhouse gas filter. Baselines are more ambiguous when considering the broad array of development options available in the energy sector. Therefore, establishing a baseline in the energy sector is, once again, difficult and costly. In addition, a developer must pass hundreds of small-scale energy projects through the costly approval process to generate the number of credits one non-CO_2 project provides (Ellis and Gagnon-Lebrun 2004). In summary, CDM favors non-energy sector projects because they generate lots of credits with minimal investment and transaction cost.

Impact of the Trend

Non-CO_2 gasses are potent and eliminating them does mitigate climate change. CDM has accomplished this elimination. Marc Stuart, co-founder of EcoSecurities, stresses that there is no incentive, other than CDM, to destroy HFC-23, N_2O and CH_4.[10] To eliminate these gasses, the mechanism implemented environmental technologies, previously unknown except to specialists, with the force and efficiency of a profit driven market (Michaelowa 2005).[11]

Yet, such non-energy sector reductions are not mentioned as essential in Chapter 1. End-of-pipe elimination of waste gasses does not fundamentally change the means by which a country develops. Instead, filters can be installed at any stage of the development process. Working in the power sector is more important because energy development choices made today determine the way development will unfold over the next century. Development will be built upon the energy infrastructure installed today, and if such infrastructure is dirty, development will be as well.

By finding low-cost emission reductions in other places, CDM no longer has the financial force to significantly influence the energy sector. Cheap credits from projects

---

[10] Author's interview with Marc Stuart, Claremont, CA, October 2006.
[11] Ellis (2004b) demonstrates that this reasoning is not entirely true for HFC-23: independent of CDM, "emissions of HFC23 from HCFC22 manufacture should, in the medium-term, be limited by Montreal Protocol requirements….Thus, even if all available HFC23 reduction opportunities are taken up, this would not be sufficient to deliver large and long-term emission reductions" (Ellis, 2004b, p. 35).

that filter outputs flood the market and lower the price for CERs. Market analysts estimate CERs are worth $5 Euros less than they would be in a market without HFC-23 and N_2O projects.[12] At this lower CER value, CDM cannot justify expensive alternative energy-sector projects. Without large amounts of additional investment, the energy sector follows its business-as-usual trend of purchasing cheap, dirty technology.

It is this financial weakness that makes CDM a poor mechanism for transferring Carbon Capture and Storage once it is developed, an essential role the international climate regime must play once CCS is commercialized in OECD countries. Katzer et al. (2007) estimate that once CCS is developed, a ton of CO_2 will need to be worth at least $30 in order to make it economically feasible. By promoting low cost HFC-23 projects, a ton of CO_2 trades for much less than this on the CDM market. In April 2007, for example, a CER (representing one ton of CO_2) was worth somewhere between $8-13.

In summary, CDM is providing immediate but marginal greenhouse gas reductions. Yet to mitigate emissions from developing countries, the climate change regime cannot focus exclusively on the present. The regime must build a foundation of climate friendly infrastructure, which will reduce future, not current, emissions. Non-energy sector projects, by reducing the value of CERs, lessen the financial incentive CDM provides to build this foundation.

[12] Segalen, Laurent. Point Carbon, "ViewPoint: Should buyers be diversityfing risk from China and HFC?" 7 Feb. 2007.

Ignoring Developing Countries' Development Priorities

Beyond working with the energy sector, Chapter 1 also stressed the importance of considering the development priorities of rapidly industrializing nations. Similar to the mechanism's inability to change development in the energy sector, CDM has largely sidestepped the development priorities of developing countries. The authors of Kyoto wanted CDM to contribute more than emission reductions to developing countries. Therefore, Article 12 explicitly requires projects to contribute to sustainable development beyond greenhouse gas reductions. This section demonstrates that the means of ensuring this contribution to sustainable development are weak. Given this weakness, the majority of CDM projects focus on generating low-cost emission reductions. This indicates that developing countries have been unable control the types of CDM projects developed within their own borders.

Source of the Problem

CDM intends to both reduce greenhouse gas emissions and contribute to sustainable development. The mechanism defines these two purposes as equally important. Kyoto authors hoped the two would be positively correlated-- that projects with the cheapest reductions would contribute the most to sustainable development. Experience demonstrates the opposite. Olsen (2005) writes, "the initial assumption of the synergy and win-win relationship between the dual aims of the CDM does not hold for many projects studied in the literature" (p. 7). Instead, cheap reductions and sustainability benefits are negatively correlated: projects that contribute the most to sustainable development are the most costly.

Why were the legislation's authors unable to recognize the negative correlation between sustainable development and cheap credits? The focus of CDM projects on the industrial and manufacturing sectors was not anticipated by those crafting the mechanism (Michaelowa 2005). Authors imagined CDM working in the clean power sector, in which large numbers of credits create electrification without local pollution. Instead, the cheapest credits, those from industrial/manufacturing projects, are unassociated with key development issues.

Because this trade-off between cheap reductions and development benefits was not recognized when crafting the mechanism, the legislation's authors did not enact the necessary safeguards to ensure sustainability benefits. Verifying additional development benefits requires a one time approval that the project meets its host country's self-defined criteria for sustainable development. Greenhouse-gas reductions, to compare, must be continually verified on the ground by an uninvolved third party. With a negative correlation between cheap reductions and sustainable development, stronger regulation that requires the advancement of social goals is needed.

Who within the host country defines the criteria for sustainable development and judges whether or not projects meet it? CDM assigns this responsibility to Designated National Authorities, a new government agency within each developing country in charge of promoting CDM investment and defining what constitutes a contribution to sustainable development. These are opposing interests— maximizing investment means Designated National Authorities want to approve as many projects as possible, while defining valid sustainability criteria means this government agency is also in charge of rejecting projects (Olsen 2005). The identified trade-off between cheap reductions and sustainability benefits means compliance-driven developers focus investment in countries where reductions are the cheapest—countries whose Designated National Authorities have defined low sustainability standards. This creates competition among Designated National Authorities to set the lowest standards and therefore maximize investment (Olsen 2005). Countries that forbid cheap reductions by defining stringent sustainability criteria are left out of the market. Investment maximizing is prioritized, leaving Designated National Authorities without the incentive, or the intellectual and on-the-ground resources (Anagnostopoulous et al. 2004), to verify sustainability. The resource-strong developers define project terms (Olsen 2005), leaving developing countries without control over the types of CDM projects which occur within their borders.[13] This dynamic alienates rapidly industrializing countries, killing the participatory attitude needed for future climate change regimes.

A market focused on credits, not development issues, has developed. The alienation of credits from sustainable development is caused by a tradeoff between fungibility and accountability. Credits that are fungible or interchangeable intermix and therefore can no longer be traced back to the projects that created them. A market only works if credits are fungible—if CERs from wind farms and industrial HFC-23 projects, for example, can be mixed and sold as the same item. To make CDM functional, accountability of individual credits is sacrificed.

Those purchasing CERs do not know how the credits they buy were generated. Instead of a direct relationship between credit buyer and project developer, the norm in

[13] With such a dominant share of potential CDM projects, China has the more leverage in project negotiation. It has crafted an innovative tax to encourage projects with greater development benefits. Taxes take 65% of CERs from HFC-23 projects, 30% from N2O projects, and only 2% from other projects (which generally have greater development benefits) (Ellis and Gagnon-Lebrun 2004). Whether or not this tax money is spent on sustainable development, however, is unknown.

the market is for an intermediate company to buy credits from many different projects and aggregate them together into an offset portfolio. Buyers purchase credits from this intermediate aggregator. This system minimizes risk because intermediates are diversified. Even if a few individual projects do not deliver the credits promised, most projects in the portfolio will. Buyers are therefore guaranteed credits that do not depend on one individual project's performance.

Given this system, however, buyers no longer connect their dollars to specific projects. Intermixed credits are alienated from the original projects that created them. As long as the credits meet the minimum sustainability criteria host countries define, they are interchangeable in the intermediate buyer's portfolio. Once the credit passes the host country overview, the quantity of credits, not quality, determines a project's value.

Recognizing this problem, a Gold Standard was developed for higher-priced CERs from projects with high sustainability benefits. The Gold Standard is an intermediate credit aggregator initiated by the World Wildlife Fund and hosted by the Basel Agency for Sustainable Energy. It sets up additional screens beyond the requirements applied by the Executive Board of CDM regarding what constitutes additionality, acceptable technologies, and sustainable development (Gold Standard 2006).

What CDM projects does Gold Standard consider to be of high quality? For technologies, Gold Standard only accepts clean energy projects, either renewable energy or energy efficiency projects. To verify sustainability benefits, among other additional screens, the Gold Standard uses a Sustainable Development Assessment matrix to measures a project's positive and negative environmental, social, economic and technological impacts. A project's impact on indicators like biodiversity, livelihood of the poor, and employment are measured and then assigned a score between -2 and 2. To constitute a benefit to sustainable development, a project's overall score must be positive, and its score within each of the environmental, social and economic sub categories cannot be less than -2 (Gold Standard 2006). The Gold Standard's Sustainability Matrix is outlined below:

Local/regional/global environment	
• Water quality and quantity	
• Air quality (emissions other than GHGs)	
• Other pollutants (including, where relevant, toxicity, radioactivity, POPs, stratospheric ozone layer depleting gases)	
• Soil condition (quality and quantity)	
• Biodiversity (species and habitat conservation)	
Sub total	
Social sustainability and development	
• Employment (including job quality, fulfilment of labour standards)	
• Livelihood of the poor (including poverty alleviation, distributional equity, and access to essential services)	
• Access to energy services	
• Human and institutional capacity (including empowerment, education, involvement, gender)	
Sub total	
Economic and technological development	
• Employment (numbers)	
• Balance of payments (sustainability)	
• Technological self reliance (including project replicability, hard currency liability, skills development, institutional capacity, technology transfer)	
Sub total	
TOTAL	

Figure 5. The Gold Standard's Sustainability Matrix. For a project to qualify as a contribution to sustainable development, each sub-total must be non-negative, the total score must be positive, and no indicator can have a score of -2 (Gold Standard 2006).

This matrix allows flexibility, proving that projects provide overall benefits without damaging any of the individual characteristics of sustainability.

The Gold Standard charges more for the quality credits these screens insure. Yet this attempt to add value to sustainable projects has failed in the CDM market. "Gold Standard projects continue to have a negligible CER market share" (Michaelowa, 2005,

p. 14) because CDM is driven by compliance not altruism. Large investors want to meet Kyoto targets as cheaply as possible. Investors do not care where credits come from so long as they can be used to meet Kyoto targets. A market mechanism like CDM should not rely upon investor philanthropy, but instead foster it by making it profitable. In summary, creating a separate market for high quality credits will not foster mainstream changes. Instead, the required quality of credits needs to be universally raised.

Solution to the Problem: Universal Sustainability Requirements

Credit fungibility is essential for a functional CDM. Given its tradeoff with accountability, the bar for what qualifies as a contribution to sustainable development needs to be universally raised. How should this be done? To give developing countries more power to negotiate the types of projects implemented within their borders, requirements for sustainable development must be defined by CDM itself, not individual host countries. This levels the playing field, erasing competition among developing countries to maximize investment by minimizing standards.

A universal sustainability concept is hard to develop, however, because "nations have different economic conditions, natural resources, social goals, environmental and ecological priorities and development plans" (Anagnostopoulos et al., 2004, p. 4). Such a standard needs flexibility, insuring projects contribute to environmental, social, economic or technological sustainability, but allowing host nations to initiate projects according to their individual priorities. The Gold Standard's Sustainability Assessment Matrix demonstrates that both flexibility and accountability are possible. An adaptable but universal standard for what constitutes sustainable development would engage rapidly industrializing nations in climate change mitigation, ensuring their participation in future, more stringent regimes.

Creating Functional Institutions and Methodologies

Despite the criticism of this chapter, the impact of the mechanism extends beyond its failure to work in the power sector or contribute to sustainable development. CDM has formed working institutions and methodologies which allow successful trading of a intangible commodity. These institutions and methodologies can be used in future carbon markets.

The crafting of methodologies has been refreshingly bottom-up. Developers undertaking a new type of project craft unique methods to demonstrate additionality and baselines specific to their project. The Executive Board of CDM decides whether or not these methodologies are legitimate. This makes CDM adaptable, essential because mitigation technologies and strategies are constantly changing.

The bottom-up process means the mechanism is not elegant but instead requires significant transaction costs. Project developers complain that it takes the Executive Board too long, up to two years, to approve methodologies or projects (IETA 2006). This frustration alone deters quality projects from implementation. Still, accepted methodologies slowly emerge from arguments between environmental NGOs, project developers and the Executive Board. Once project specific methodologies are accepted, they can be applied to similar types of projects, lowering transaction costs (because new methodologies do not have to be written) and investment uncertainty (because similar projects have already been approved).

While business interests and environmental watchdogs complain, the academic literature praises the rule-making process of CDM. Michaelowa (2005), for example, writes "an international body of rules with unprecedented transparency and independent control has been implemented relatively consistently" (p. 3). When developers consider the overall picture, and not just project specific frustrations, they too appreciate the approval process of CDM. Marc Stuart, for example, observed, "Everyone is complaining, indicating a good balance between market-based efficiency and environmental concern."[14] CDM crafted an effective and adaptable (albeit slow and frustrating) project approval process.

New carbon markets can adopt the hard won methodologies CDM created. The UK, for example, announced its interest in introducing CDM standards in its voluntary market.[15] The Voluntary Carbon Standard, an up and coming certification scheme for global voluntary offsets, will use the methodologies of CDM as the framework for its certification process. The Executive Board has done the leg work of verifying methodologies as legitimate. This work is respected by both academics and business-men. By adopting the methodologies of CDM, new carbon markets can add procedural legitimacy at a minimal cost.

Beyond methodologies, CDM has also created clean development agencies around the world. Over 70 developing countries have set up Designated National Authorities to oversee and encourage CDM projects (Michaelowa 2005). This agency gains up-to-date understanding of environmental technologies, knowledge which undoubtedly spreads beyond the scope of CDM.

---

[14] Author's interview with Marc Stuart, Claremont, CA, October 2006.
[15] Point Carbon, "UK government may introduce CDM standard in voluntary market," 24 Jan. 2007.

Conclusion

The hard-won institutions and methodologies of CDM have not been applied to the needed power sector shifts described in Chapter 1. Yet the successful, bottom-up process for making methodologies could easily apply to truly needed projects as well. At the very least, CDM has established the institutional capacity to fundamentally change the way development unfolds in rapidly industrializing countries. Now CDM needs to be restructured to apply this capacity to needed projects.

Chapter 3: Flaws in the Structure of CDM

What needs to change in order to shift the focus of the institutions and methodologies of CDM onto essential mitigation projects? This chapter identifies the structural and political flaws that weaken the financial strength and infrastructural influence of CDM. By establishing a clear market for CERs after 2012, bringing the US into this market, and broadening what constitutes a CDM project, the mechanism could gain the scope and financial strength needed to implement the mitigation strategies outlined in Chapter 1.

Uncertain CER Value after 2012

Kyoto targets expire in 2012, and the regime replacing Kyoto is unknown. CDM is entirely dependent upon reduction targets because Annex-1 countries buy CERs to meet them. Without targets, there is no market for CERs. Most developers and governments believe targets and, therefore something like the CDM, will continue after 2012. What form these targets will take, however, is unknown. Without a concrete understanding of future targets, developers cannot predict long-term market demand or CER value. As long as this uncertainty prevails, sound CDM investments must prove profitable before 2012. This short term nature of the CER market is one essential flaw of the mechanism.

The important mitigation strategies outlined in Chapter 1 require long-term vision. Investments in the energy efficiency or natural gas infrastructure have “long gestations times and high capital costs” (Michaelowa, 2005, p. 19). This means they require a lot of time to pay their higher upfront costs. By shortening the time projects have to be profitable, CDM again favors non-essential projects, like those involving non-CO_2 gasses. For example, HFC-23 and N_2O projects take two years to become profitable; renewable energy projects require six (Goodward 2006). Post-2012 uncertainty also increases the percentage of proposed projects that are non-additional—that would occur with or without CDM (Trexler et al. 2006). The financial boost the mechanism provides becomes weaker and weaker while approaching the 2012 deadline. Developers are therefore forced to look outside of this financial boost, towards non-additional projects, to insure profitability.

Developers need a clear picture of future emission targets to predict future market value for CERs. Understanding future CER value allows developers to safely invest in needed long-term projects. The most recent November 2006 UN Climate Change Conference in Nairobi acknowledged the importance of resolving post-2012 uncertainty, but did nothing to overcome it. Concrete targets after 2012 will refocus the attention of CDM on needed mitigation projects.

Lack of US Participation

By not participating in the CDM market, the United States has also taken financial strength away from CDM by significantly lowering the value of CERs. The US was expected to account for more than half of the world's demand for CERs. Because the US did not accept emission reduction targets, there is instead zero US demand. Trexler et al. (2006) estimate that, with the US participating, the world's demand for CO_2-equivalent offsets would more than double from the current demand of .75 gigatons of CO_2 to 1.75

gigatons of CO_2. Despite this huge cut in demand, supply from developing countries remains the same with or without the US. Half the demand with the same supply reduces the value of CERs significantly, from an estimated $60-$160 per ton of CO_2-equivalent with US participation to $3-$87 per ton of CO_2-equivalent without it (Heller and Shulka 2004). CER value determines how significantly CDM can change business-as-usual development in rapidly industrializing nations. By not participating in Kyoto, the US cut the financial strength of the CDM in half.

Project Specific Focus

Another factor weakening the influence of CDM is that the mechanism only allows credits to be generated from specific projects. Chapter 1 demonstrated that essential mitigation is sectoral, making sector wide markets for natural gas by installing the needed infrastructure. Investment at this level influences many projects, not just one specifically. This influence across projects is difficult to track and measure. To insure Annex-1 countries did not use the mechanism for false reductions, developing countries, while writing Article 12, forbid CDM from generating credits from difficult to track infrastructural or sectoral projects. Instead, developing countries only allowed CDM to generate CERs from tangible reductions from specific projects (Samaneigo and Figueres 2002).

As Chapter 1 demonstrated, an individual project focus simply does not have the influence to effectively mitigate climate change. Heller and Shulka (2004) write, "discrete projects, such as a retrofitted power plant or small-scale renewables, though beneficial and symbolic, affects emissions only marginally" (p. 126); Samaneigo and

Figueres (2002) comment “specific projects… [are] unlikely to promote broad policy changes, such as industrial strategy, more efficient transportation, or cleaner energy mix” (p. 97). Only sectoral or infrastructural projects have the scope to significantly affect the ways in which the expected $10 trillion in investment in the energy sector is spent. If such projects are not allowed, CDM will never have more than marginal influence on climate change mitigation.

CDM authors hoped that only allowing specific projects to generate credits would insure objective assessments of baselines and additionality. In their view, not allowing sectoral or infrastructural projects would insure no false reductions are sold on the CDM market, quelling the fears of developing countries. The climate change regime needs to give up hope of crafting a mechanism that makes perfect assessments of baselines and additionality. Even at the project specific level, objectivity does not exist. Subjectivity is unavoidable when trying to assess the future in developing countries which, by definition, are rapidly changing. Additionality and baseline assessments, for individual projects or entire sectors, are based on politically-debatable variables (Trexler et al. 2006). A technical model claiming objectivity hides the political choices within it. Given this universal imperfection, sectoral or infrastructural projects should not be denied credits because they too require subjective projections. The mechanism must be trusted to resolve such ambiguity openly and fairly. Despite developing countries fears, if the CDM is to effectively mitigate climate change, it must grant credits to sectoral and infrastructural projects as well.

What do such projects look like? Samaniego and Figueres (2004) provide an example. CDM currently grants credits for increasing energy-efficiency at specific cement manufacturing plants. A Sectoral CDM project would push a national policy requiring efficiency improvements across the cement industry, using CER revenue to fund the policy. To prove additionality, the government must demonstrate that such a policy would not be possible without the additional money credits provide. The emissions of the current cement industry provide a baseline. At this sectoral level, additionality and baselines are larger, more theoretical concepts. Still, through open debate, a fair number of credits for such a sectoral project can be settled upon.

The basic concept behind CDM has large mitigation potential. Accepting imperfect assessments of additionality and baselines, and therefore allowing larger-scale projects, is the next an essential step towards strengthening the mechanism’s global influence.

Market Mechanism

In this analysis of CDM, I do not want to be too caught up in the intricacies of the market thereby forgetting the basic concept of the mechanism’s design. CDM is market-based—it provides financial incentives for the private sector to mitigate climate change in developing countries. This section will explain how a centralized international agency controlling large sums of money for mitigation projects, in addition to CDM-like market solutions, can compensate for the weaknesses of the mechanism. It will compare the advantages of markets to the advantages of centralized control, advocating the next climate regime to utilize both types of policy.

How would a centralized agency raise the money to initiate mitigation projects in developing countries? One possibility is command and control legislation, in which governments, not profit-motivated markets, set laws which generate revenue and then spend this revenue on mitigation projects in the developing world. The most commonly discussed legislation of this type is a carbon tax, which requires direct payments to governments or international agencies for activities that emit greenhouse gasses (Baumert 1998). Beyond a carbon tax, a centralized agency could also be funded by donations from regime participants. Alternatively, this agency could collect fines from countries that do not meet their reduction targets.

What are the advantages of centralized control? As this analysis of CDM demonstrated, global governments could not predict how the private sector would respond to the rules they designed for CDM. The legislation's authors, for example, did not foresee the trend favoring non-energy sector projects (Michaelowa 2005). With centralized control, legislators do not have to experiment with how to make truly needed mitigation projects profitable. Instead, mitigation experts within the agency directly implement the projects. With such an outlook, money will not be funneled into marginal reductions outside the power sector but instead used to build clean energy infrastructure.

This centralized control can funnel money into sectors that market mechanisms like CDM fail to work within. CDM does not adapt well to projects whose reductions are small, spread out and therefore difficult to quantify. The mechanism, for example, has not established methodologies to quantify the emissions saved end use energy efficiency projects (Stern 2006).[16] Reductions in this sector, which are advocated as essential in the

[16] Note that 2% of CDM credits come from projects that promote the efficient use of fuel in power plants (Fenhann 2007). Because these projects are centralized at a power plant, instead of distributed across many electricity consumers, emission reductions can be easily quantified. Also, CDM has created a methodology for quantifying the emissions saved by projects which promote efficient consumer use of electricity, but it only applies to small-scale projects therefore having no impact on the large scale efficiency projects needed.

first chapter, are difficult to quantify because they are an aggregation of many small actions. Accurately quantifying the emissions avoided by replacing thousands of inefficient light bulbs is difficult. An agency whose funding for mitigation projects is already secured does not have to precisely quantify the emission reductions of its projects, saving considerable transaction costs. A well funded international agency is needed to work within sectors whose reductions are difficult to quantify.

There are also advantages to market mechanisms like CDM. Allowing the private sector to implement projects makes climate change mitigation adaptive. The private sector, with its many actors, effectively and efficiently micromanages the diverse mitigation projects occurring around the world. The private sector has the man-power and motivation to maximize mitigation opportunities, expanding or shrinking the number of projects and exploring new technologies as the market changes. In the rapidly evolving fields of development and environmental technology, such adaptation is essential for effective action. If all control is given to a centralized agency, a climate regime loses some of its ability to innovate and adapt.

Given the advantages of market mechanisms, how can they be designed to do the most societal good? Writing the rules for how a market like CDM functions requires finding the right balance between governmental regulation (safeguards within the mechanism like additionally and baselines that insure project reductions are real) and still allowing private actors the freedom innovate and evolve. The failure of CDM to implement the projects suggested in Chapter 1 indicates that future mechanisms need additional safeguards and regulation. CDM has given too much freedom. To insure CDM projects contribute to sustainable development, future authors need to include universal and strenuous requirements for projects to qualify as contributors to sustainable development.

With such redesigned rules, the market will change and the private sector will adapt. Changes could be minor, like the aforementioned addition of universal sustainability requirements. Yet there is also opportunity for major innovation. Markets could be designed to deal only with technology types legislators deem. For example, a CDM-like mechanism that only considers energy efficiency or renewable energy projects (like the portfolio of the Gold Standard) or alternatively only allows CO_2 reductions (forbidding projects which reduce the other five greenhouse gasses) overcomes the barriers that have prevented CDM from working with power infrastructure. Such a redesigned, clean energy or CO_2 only mechanism means energy projects no longer compete with cheaper non-CO_2 projects.

A redesigned CDM, however, should not be a climate regime’s only tool for working with developing countries. The scale of emissions expected from rapidly industrializing nations warrant both a centralized agency and a CDM-like market. With government agencies and the private sector working in separate spheres, businesses freedom to innovate is preserved, while the regime itself can work in sectors that do not adapt well to market regulation.

Conclusion

This chapter proposes specific and broad-based changes to the structure of CDM and Kyoto as a whole. International policy making is slow and drafting new reduction targets will take time. A redesigned Kyoto must add additional capacity to reduce the emissions of developing countries. This means the next regime must first allow CDM to consider large-scale, sector-based projects and second including non-market mitigation strategies.

Chapter 4: Future Projects with Old Flaws

The last chapters reviewed the accomplishments of CDM since the first project was registered two years ago. It identified a growing favoritism for projects that destroy waste greenhouse gasses, specifically HFC-23 and N_2O of the industrial and manufacturing sectors. Developers have tenaciously pursued all opportunities to initiate such profitable non-energy sector projects. The persistence for developing such projects, however, means only a limited number of HFC-23 and N_2O project opportunities are still available. Marc Stuart, director of project development at EcoSecurities, estimates that there are only six remaining refrigerant manufacturing plants in the world that still release the HFC-23 they produce into the atmosphere.[17] All other plants, because of CDM, already decompose the gas. These last six plants are soon to become the final HFC-23 CDM projects.

Once all HFC-23 and N_2O project opportunities are developed, on what projects will the mechanism focus its attention and dollars? In Fall 2006 I interned for EcoSecurities, a private CDM project developer, investigating a new technology, biomass pelletization, in the search for the answer to that question. EcoSecurities recognized the potential of this technology to become a profitable venture. It was my job to investigate whether or not biomass pelletization is a profitable technology for CDM projects. Attempting to understand whether or not a new technology is financially attractive gave me an intimate look at the types of technologies CDM encourages and the types of technologies it cannot support. The technology the mechanism encourages determines a

[17] Author's interview with Marc Stuart, Claremont, CA, October 2006.

large part of its impact on developing countries. This chapter uses biomass pelletization as a case study for investigating the types of technologies CDM favors.

This chapter finds that biomass pelletization, although attractive to project developers like EcoSecurities, will not shift the type of development that takes place in rapidly industrializing countries. Like HFC-23 projects, biomass pelletization is attractive to CDM project developers because it is a cheap way to marginally reduce greenhouse gas emissions without investing in costly infrastructure or fundamentally changing the way energy is produced. These characteristics, which make biomass pelletization attractive for CDM, make the technology secondary to the energy infrastructure projects needed to mitigate the impact of development on climate change. This case study of biomass pelletization finds that the technologies CDM encourages, like biomass pelletization, do not align with the technologies the developing world needs.

This chapter begins by investigating how biomass pelletization works and how EcoSecurities could use the technology. It will compare the pellet markets of the US with the markets of Europe and Canada, demonstrating how financial incentives, non-existent in the US, have changed the role of the technology abroad. Finally, the chapter will generalize how this specific technology illuminates strengths and weaknesses of CDM and the types of technologies it is capable of promoting.

Biomass Pelletization

Explaining the Technology

EcoSecurities is looking for new ways to turn biomass, organic matter like wood waste or agricultural residues, into energy. Under the current paradigm, biomass is not transported long distances. Because of the odd shape and low energy density of almost all biomass, shipping it is not economical. In today's paradigm, energy producers generating power with biomass build power plants or boilers next to the biomass source, burning it and generating power on site.

Biomass pelletization breaks this paradigm by making biomass a uniform shape with high energy density. Wood wastes or agricultural residues are compressed in a pelleting plant to a uniform size, usually around 1/4 inch. Small and uniform in size, pellets can be handled as a liquid. Drying the biomass, combined with the compression, give pellets a high energy content compared to normal biomass: a ton of wood pellets, for example, yield four times as much energy as a ton of wood chips.[18] Pelletization makes biomass a mobile fuel that can be sold and shipped globally. Because pelleting is yet to catch on in developing countries, for reasons to be discussed later, large sources of biomass, million ton piles of rice hulls or wood chips, are unused and cheaply available in Brazil, Indonesia and the like. Pelleting, with the additional financial incentive CDM offers, has the potential to turn these piles into profit.

How would EcoSecurities do this? The company would construct large-scale pelleting plants in developing countries next to million ton biomass piles. It would then sell the pellets it produces to coal power plants, which, with minor modifications, can co-fire pellets in their boilers alongside coal. CDM adds a financial incentive to this projected type of project in two ways. First, by using biomass piles instead of letting them decompose, the project prevents methane (CH_4), a potent greenhouse gas with 21 times the heat trapping potential of CO_2, from being released into the atmosphere.

---

[18] Jones, Jackie. "A Fuel of Convenience: Why pellets are packing the power." *Earthscan Magazine*. 5 Feb. 2006, p. 3.

Credits equivalent to the methane that would have been released had the piles been left to decompose can be generated and sold. In addition, the biomass co-fired in a coal power plant is carbon neutral.[19] By burning biomass instead of coal, EcoSecurities is replacing one of the world's dirtiest fuels with an energy source with zero net greenhouse gas emissions. Projects that co-fire with pellets generates carbon credits equivalent to all the CO_2 a power plant would have emitted if it used coal instead of pellets to fire its boilers.

Energy Content

Because EcoSecurities envisions replacing coal with pellets, it is important to understand the difference in energy content (energy per unit of volume) between the two fuels. Energy content is fuel specific, varying with the type of biomass used. Table 1 compares the energy content of different pelletized biomass feedstocks. It also indicates a fuel's ash content—the percent of the original fuel that is non-combustible and therefore left as ash after the fuel is burned.

Table 1. Comparison of energy and ash content of different pelletized feedstocks. Original feedstock data from Twin Ports testing.[20] Converted to pellet data assuming all pellets have a 5% moisture percentage and an energy density of 650 kg/m^3.

Pelletized Feedstock	Estimated pellet BTU/lb	GJ/m^3	Ash %
Wood Pellet	8246	12.47	0.43
Wild Rice Hull Pellet	7832	11.84	4.54
Alfalfa Pellet	7403	11.19	7.94
Corn Stover/Stalks Pellet	7377	11.15	6.81
Eastern Coal	13639	20.62	5.25
Western Coal	9252	13.99	4.21

[19] When pellets are burned, they do release CO_2. These emissions, however, are equivalent to the CO_2 the plant absorbed from the atmosphere while it was growing. Therefore, there are zero net emissions from growing and then burning biomass.
[20] Author's interview with Chris Wiberg of Twin Ports Testing, Claremont, CA, November 2006.

There are a few important things to note from this table. First, the energy content of a pellet is relatively similar regardless of the type of biomass pelletized. Agricultural residues have a slightly lower energy content, but not significantly so. This is good for developing countries, whose broad array of different biomasses are all useful as pelletized fuels. Ash content of a pellet does vary according to the type of biomass used. The ash content of agricultural residues is much higher than wood. This is important if pellets are burned in residential heaters, because these machines can only handle fuels with an ash content of 2% or less—meaning residential heaters can only use wood pellets. When co-firing pellets in a coal power plant, however, ash content is less important. Coal fired power plants are equipped to deal lots of ash because coal has an ash content of 4-5%. Pellets intended for co-firing can therefore come from any type of biomass.

Retrofitting Coal Power Plants for Cofiring

Pellets have little more than half the energy content of coal. Therefore, a larger volume of pellets is needed to produce the amount of heat a smaller volume of coal can generate. In order to co-fire with pellets, coal power plants need to retrofit their machinery to handle this greater volume of fuel.

Co-firing retrofits do not add to a plant's capacity to generate energy. Power plants use coal simply to generate heat. Pellets replace a percentage of this heat, while the overall amount of heat produced with or without pellets remains the same. When biomass generates a small percentage of this heat (5% or less) only fuel handling and storage equipment need to be retrofitted to handle the slightly greater volume of pellets

(Mann and Speth 2001; Federal Energy Management Program 2004). These retrofits are cheap, around $100 for every kilowatt of biomass capacity added, or $300,000 to add 3 megawatts of biomass power.

If project developers use pellets to generate 15% of a plant's heat, fuel volume increases significantly. At this level, "the coal and the biomass piles are about the same size."[21] With this additional volume, coal power plants need a separate feeding and pulverizing system. These retrofits are more expensive, between $230 (Federal Energy Management Program 2004) and $250 (Baxter, personal communication) for every kilowatt of biomass capacity added to a plant. Therefore, to add 15 megawatts of biomass power costs $3,500,000.

Although this cost is significant, it is nothing compared to the price of new renewable energy infrastructure. Co-firing capitalizes on large investments already made in existing fossil fuel technology, turning these investments into a partially renewable energy resource (Baxter and Koppejan 2005). This makes co-firing the cheapest and easiest means of generating energy with a renewable fuel source. Due to this low price tag, CDM favor those project developers who use current, fossil-fuel based infrastructure over those who spend heavily to create new, renewable infrastructure.

---

[21] Author's interview with Larry Baxter of BYU University, Claremont, CA, November 2006.

Pellet Markets: Developing Countries, the US, Europe and Canada, and CDM

Barriers for Developing Countries

Currently, no pelleting takes place in developing countries. What are the barriers preventing the spread of this technology, and is the financial incentive CDM provides through CERs enough to overcome these barriers? To answer these questions, I interviewed 11 different US manufacturers of pelleting equipment. These interviews are summarized in Annex A. Again and again, the reason these manufacturers are not selling equipment to developing countries is the large and therefore financially and energetically expensive scale of the mainstream pelleting operation.

Pelleting plants are massive, and therefore require large upfront investment that private companies in developing countries are unwilling to make. Kevin Schultze, of KS Equipment Sales, stressed that only centralized, large-scale operations are profitable. The plant must produce "6 tons of pellets per hour to make any money," he said.[22] Large-scale, centralized plants therefore dominate the industry: ten of the 11 manufacturers interviewed only make equipment that produces more than 4 tons of pellets per hour. Only one company, BHS Energy, focuses on small-scale, 2 tons of pellets per hour, machine. BHS Energy is clearly on the fringe of the pellet movement: "we are among the first (if not the first) to produce a small scale pelletizer," said Adam Reggie of the company, whose mission statement includes a promise to resist to current "corporate outfit" that is centralized, large-scale pelletizing.[23]

---

[22] Author's interview with Kevin Shultze, Claremont, CA, September 2006.
[23] Author's interview with Adam Reggie, Claremont, CA, September 2006.

Mainstream large-scale plants have large upfront costs: quoted prices varied significantly, but a pellet plant (which consists of dryers, coolers, multiple pellet mills and packing equipment) costs at least $4 million US. "No one is trying to spend that kind of money on the developing world," Steve Gordon of Industrial Turn-Around concluded.[24]

The large-scale focus of the pelleting industry creates more than financial problems for developing countries. Large-scale plants also demand a lot of electricity, and according to pellet manufacturers, the supply of this electricity is not stable enough to warrant large investment. Averill Cook, of Wendling Bioenergy Consulting, said "Densification of biomass has not yet taken hold in developing countries because technology requires electricity and lots of it to refine biomass into pellets."[25] How much electricity exactly? Electricity demand varies significantly according to how much the original biomass needs to be dried and ground before it can be feed into the pellet mill. Despite the variance, all estimates, calculated according to the number of gigajoules needed to produce a cubic meter of pellets, are high: Cook estimates that processing dry material requires 0.234 GJ/m^3, Samson et al. (2005) estimate 0.146 GJ/m^3. In countries for whom a stable electrical grid is not a guarantee, pelleting operations are financially risky.

Clearly, if a technology like biomass pelletiziation is to be implemented in developing countries, additional financial incentive, to encourage large-scale investment and offset electricity risks, is needed. Whether or not the incentive CDM provides is large enough to offset this risk is impossible to concretely assess: specific costs and CERs

---

[24] Author's interview with Steve Gordon, Claremont, CA, September 2006. The electricity demanded to process biomass into pellets emits greenhouse gasses, meaning pellets are not truly carbon neutral.
[25] Author's interview with Averill Cook, Claremont, CA, September 2006.

granted are both site specific numbers. CDM, with the double credits for methane prevention and cleaner power generation, does add a significant financial incentive, enough to keep EcoSecurities and other private companies interested in a venture that pre-CDM private companies have written off as too risky and expensive.

My investigation of biomass pelletization for a for-profit project developer proves CDM is spreading interest in clean energy technologies. Interviews with US companies demonstrated that without additional financial incentive, cofiring coal power plants with pellets is not a secure financial investment. With CDM, companies are showing interest in this clean technology.

US Market: Missing the Boat

It is not just developing countries which, without pelletization, are underutilizing their biomass resources. US companies, compared to Canadian and European ones, operate on a different paradigm regarding the potential uses of biomass pellets. Investigating the differences between the US and the international pelleting industries is a telling example of how, by refusing to accept Kyoto emission reduction targets, the US is missing significant clean energy business opportunities that the rest of the would is aggressively pursuing.

The US is the fourth largest producer of biomass pellets, but uses none of its pellets for co-firing. US pellets, all of which are consumed domestically, are used for residential heating in specially designed pellet stoves.[26] This means US equipment manufacturers focus on developing technology that produces the low ash-content wood

---

[26] Natucka, Dorota. "Wood pellet industry update from North America." *Bioenergy Intternational Magazine.* Dec. 2005, nr. 17.

pellets residential heaters require. With a residential heating focus, domestic equipment manufacturers have ignored equipment that makes cheap co-firing pellets by utilizing many types of biomass to produce high-ash content pellets.

Browsing the websites and speaking with representatives from US pellet equipment manufacturers, it is clear that US pelleting companies do not consider themselves renewable energy companies. BHS Energy, the only small-scale operation, is the only company that advertises itself using renewable rhetoric. For most of the ten other companies, pelleting is only one part of the company's greater feeding mill operations. Without operating under the paradigm of being first and foremost renewable energy companies, the US pelleting industry is slow to realize the broad array of international clean energy incentives for which their technology is eligible. Not one of the eleven pellet manufacturers I interviewed could identify the Clean Development Mechanism. Only half were familiar with the Kyoto Protocol and the impact it has had on pelleting.

How has Kyoto changed pelleting outside the US? Much of Europe, in partial attempt to follow its Kyoto emission reductions, has created a vast incentive system to encourage the technology. Pellets play well into the type of sacrifice Europe is willing to endure to reduce their emissions. Originally, Europe planned to eliminate new coal power plants entirely. As the price of such a drastic step became clear, European nations realized they were unwilling pay so much for the global climate while the US sat on the sidelines of Kyoto. Europe therefore looked for the second best option: keeping the coal-based energy infrastructure but still reducing emissions. The answer they found, co-firing, heavily favors biomass pelletization. "The Kyoto Protocol is single-handedly responsible for a new shift in the pellet business. With the demand to reduce emissions, the international business, which used to be entirely focused on domestic heating, is now concentrating on providing electricity through co-firing" commented Steve Mueller, President of DG investors, one of the few US companies interested in exporting pellets.[27]

With Europe's decision to rely upon cofiring with pellets to meet Kyoto reduction targets, the demand for pellets quickly outgrew European natural resources, creating an international demand.[28] Canada's pelleting companies were already operating under the paradigm of being renewable energy companies, in part because Canada had accepted its own Kyoto reduction targets. This meant Canadian companies had the technology in place to produce the types of pellets the European markets were demanding, which are larger with high ash contents. Canada quickly jumped into the European market which, according to Steve Mueller, was willing to pay three times more for a bag of pellets than US markets.[29] Canada currently exports 80% of the pellets it produces.[30] The US, stuck in the residential heating market, exports nothing.

The US is not forbidden from selling pellets to the European market. Yet, without signing onto the Kyoto Protocol, US companies face financial barriers to entering the market. These barriers explain why, when Kyoto created a co-firing demand, Canadian and European pelleting companies quickly shifted to producing pellets for cofiring while US companies remained in the residential heating market. Financing large scale pelleting plants is much more difficult in the US than in Europe or Canada. The scale at which US

---

[27] Author's interview with Steve Mueller, President of DG Energy, Claremont, CA, February 2007.
[28] Author's interview with Jason Kessler of Kesco Inc., Claremont, CA, October 2006.
[29] Author's interview with Steve Mueller, President of DG Energy, Claremont, CA, February 2007.
[30] Author's interview with John Swaan, Executive Director of the Wood Pellet Association of Canada, Claremont, CA, October 2006. Part of this 80%, however, is being exported to the US for domestic heating.

companies produce pellets today is too small to be profitable in an export market because exporting adds significant transportation costs. Exporting pelleting plants must be massive to be profitable. These large plants are expensive to build: Steve Mueller estimates building a profitable export plant costs $50 million upfront. Canadian plants looking to export face the same upfront cost (European plants can be of a smaller-scale because they face lower transportation costs). Because this technology is relatively unproven in the US, bankers refuse to lend money to US pelleting companies interested in starting a large scale, export pelleting business. "Americans can't borrow from the bank to build one of these," commented to Steve Mueller.[31] Canadian companies have been able to secure loans to meet the large upfront costs. As a Kyoto signatory, cofiring is part of the mainstream paradigm of Canadian banks and pelleting businesses. Mueller, on the other hand, turned to companies like EcoSecurities to secure investment.

This financial barrier is not permanent. As time progresses, the US, a country which Steve Mueller estimates uses only 4% of its wood waste[32], will surely supply pellets to the profitable cofiring market. Once this operation has proven itself, bankers will lend money to other US companies interested in exporting pellets. Yet, without signing onto Kyoto, the US adapts to new clean energy markets more slowly than the rest of the Kyoto-concerned world.

---

[31] Author's interview with Steve Mueller, President of DG Energy, Claremont, CA, February 2007.
[32] Author's interview with Steve Mueller, President of DG Energy, Claremont, CA, February 2007.

Conclusion

There is a distinct parallel between what makes HFC-23-like projects profitable to CDM project developers and what makes co-firing profitable. This parallel illustrates the inability of CDM to encourage fundamental change in the way rapidly industrializing nations develop. Co-firing is a profitable manner of generating renewable electricity to EcoSecurities because it relies upon expensive fossil-fuel infrastructure that has already been built. In this way, both co-firing and HFC-23 projects modify an already occurring process, the manufacture of a refrigerant or the generation of electricity with coal. These projects are desirable because they work with business-as-usual, decomposing HFC-23 or adding pellets to a coal-fired plants, instead of creating new processes entirely, like building a wind-farm or infrastructure to fire a power plant with natural gas. These later projects, which fundamentally alter the ways in which rapidly industrializing countries develop, are costly and long term. Marginal reductions, like HFC-23 or co-firing projects, are profitable before 2012, while fundamental changes to development require more time to make money.

It is not that modifications like decomposing HFC-23 or co-firing with pellets are bad, or even unnecessary. The problem is they are marginal. Effectively mitigating climate change in developing countries requires changing the way development unravels first—installing the infrastructure needed to generate energy in entirely new ways—and then making marginal reductions. By focusing on marginal reductions today, attention is taken away from the infrastructural projects that continue without the benefit of CDM and whose greenhouse gas impact will be felt over the next century. Kyoto relies upon CDM alone to work with developing countries, and as the previous two chapters show, this is not enough to change the way rapidly industrializing countries chose the develop. If CDM were given greater financial strength and longer time horizons, project developers like EcoSecurities would not focus their attention on marginal reductions like co-firing with biomass pellets.

Conclusion

Summary

By considering something as broad as the power sector of developing countries and as specific as biomass pelletization, this paper attempts to evaluate whether or not Kyoto's Clean Development Mechanism is an effective tool for greenhouse gas emission mitigation in countries with rapidly growing economies, specifically China, India, Brazil, Mexico, Indonesia and South Africa.

Chapter 1 considers how an international climate regime should effectively reduce the greenhouse gas emissions of rapid development. Emission mitigation should focus on the largest source of emissions—the power sector which provides electricity and heat. The power sectors of rapidly industrializing countries are not completely private or public. Instead, privatized companies collude with government regulators in a hybrid environment of weak regulation and competition and insufficient investment dollars. In this chaos, the decisions of individual investors determine energy development. The international climate regime needs to make profitable markets for clean energy development. Market making is accomplished by changing energy infrastructure, specifically building natural gas pipelines or LNG terminals, and by subsidizing and thereby advertising energy efficient appliances and technologies. Market making fundamentally changes the energy infrastructure of the power sector. If development is seen as a house, marking making has the potential to build a foundation of clean energy infrastructure.

Chapter 2, which analyzes trends in the types of projects CDM supports, concludes that the mechanism does not currently have the financial force to make new markets and alter development's foundation. Instead, the mechanism has focused on the house's chimney, filtering the smoke of business as usual with non-power sector projects. With a race to find the cheapest emission reduction projects and no system to rewards projects with lasting foundational impacts, CDM has focused on eliminating the potent, non-CO_2 waste gases of industrial and manufacturing processes.

Chapter 3 then considers how to make the CDM projects of the second chapter more like the ideal for mitigation described in the first chapter. CDM is an innovative design but needs teeth. To shift the mechanism's attention towards the foundation of development, the value of credits must increase and credits must be granted for sectoral level projects. Beyond these small fixes, market-based approaches like CDM are simply weak for certain types of mitigation projects. Trading emission reductions requires quantifying them, a costly process that involves lends itself more to some projects (like HFC-23 projects, which must only quantify the elimination of a single gas) than others (like distributed, end-user efficiency projects whose energy savings are spread among many different customers). The international regime needs, beyond CDM, non-market based approaches that do not need to accurately and expensively quantify the results of projects with distributed impacts.

Yet many believe that CDM, as is, will begin to work on energy sector projects once it exhausts the low hanging fruit of industrial/manufacturing waste gas projects. Chapter 4 considers, if this is the case, what types of power sector projects CDM will undertake. Currently, project developers are considering implementing biomass pelletization projects. These turn biomass into dense and therefore transportable pellets which can be substituted for coal in power plants. This technology is attractive to project developers because it utilizes, instead of replacing, already installed coal infrastructure. Biomass pelletization is a marginal carbon reduction, eliminating emissions cheaply because it requires no change to already installed energy infrastructure. This case study demonstrates that, in its current form, CDM will continue to support those technologies that provide only marginal reductions without shifting emission baselines and instigating the market making foundational changes that are truly needed.

In this time of rapid industrialization, effective climate change mitigation requires fundamental development changes the mechanism is not currently capable of promoting. The United States' unwillingness to participate in Kyoto is at the heart of all of the mechanism's structural and political flaws. The Kyoto negotiation process was clouded with distrust (Percival et al. 2003). Developing countries feared Annex-1 countries would abuse CDM; non-Annex 1 countries therefore did not design the mechanism to provide large scale, meaningful, sectoral reductions. Developing countries' distrust is warranted, because the world, following the US, has been slow to accept sacrifices for the sake of our climate. US leadership has the power to jumpstart this acceptance, bringing politics on board with scientific realities. Innovative policy-making, like CDM, will never compensate for non-existent international motivation and support. With the US leading a forceful climate change regime, CDM, with greater scope and financial strength, can begin to hammer away at development's foundation.

Future Research

Due to this paper's focus on effective climate change mitigation, it ignores three important issues that involve both developing countries and climate change.

First, CDM funds developing countries with rapidly growing economies instead of developing countries whose economies are projected to remain stagnant. Those countries that will remain undeveloped have low baselines for projected emissions and therefore do not offer large offset opportunities for CDM project developers. CDM funding has therefore gone almost exclusively to countries with growing economies.

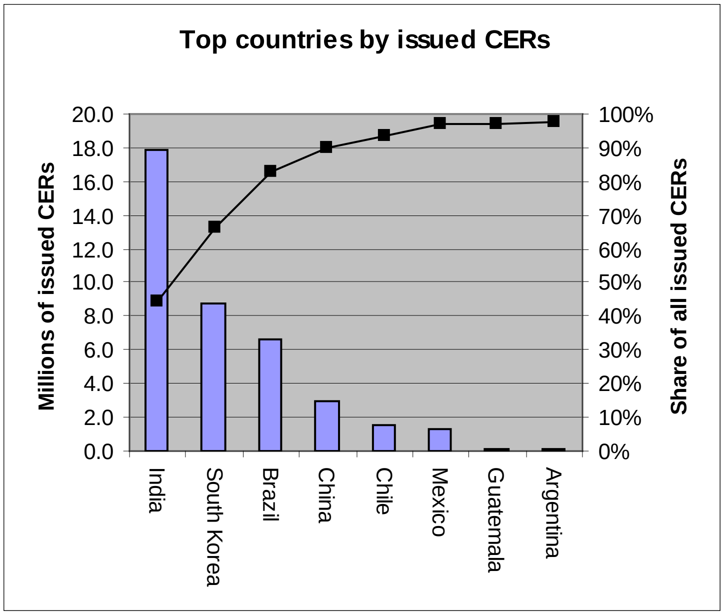

Figure 6. The number of credits that are generated from projects in specific host countries, demonstrating CDM's favoritism for countries with rapidly growing economies (Fenhann 2007).

Is this favoritism for wealthier developing countries an issue? The answer to this question varies according to one's interpretation of CDM's purpose. If CDM aims to only mitigate emissions, it should focus where it does, on the economies projected to be large emitters. If CDM is instead a means of promoting sustainable development, than it should support all developing countries, not just wealthy ones. Article 12 of Kyoto establishes both purposes, but experience with the mechanism demonstrates that it consistently prioritizes emission mitigation with little consideration of sustainable development.

The second issue ignored thus far is adaptation, which considers what to do once mitigation has failed and countries begin to experience negative effects of climate change. Lower latitude countries are the most susceptible to the effects of climate change and frequently have the fewest resources to deal with these effects. What obligation, under the polluter pays principle, do developed and rapidly developing countries owe the susceptible but lesser developed countries? These are integral questions, but exceed the scope of this paper.

Beyond lesser developed countries, this paper also ignores the Global Environmental Facility (GEF). The GEF is a fund established by the World Bank to enhance the attractiveness of investments with environmental benefits. The World Bank (2006) calls this facility "the largest source of multilateral grant financing for low carbon technologies" (p. 8) but notes its need for more financing to fundamentally change the power sector of rapidly industrializing countries. Comparing strengths and weakness of the GEF and CDM could illuminate means of invigorating the mitigation effort in developing countries. This research, once again, exceeds the scope of this paper.

Beyond the Climate

This paper advocates that all large greenhouse gas emitters, including rapidly industrializing countries, must be engaged to stabilize the concentration of greenhouse gasses in the atmosphere. Yet, what does stabilization mean? What is a safe level of greenhouse gas concentration? These questions are not tackled, and science struggles to define definite targets. Despite this uncertainty, emissions will grow with or without action by the international climate regime because so many countries have growing economies and populations. It is not clear that, simply by using clean fuels efficiently in developing countries, greenhouse gas emissions can be stabilized to a safe level.

Without a specific goal, this paper continually advocates for developed countries to spend money on emission mitigation. How can this expense be justified without a concrete guarantee that it will mitigate climate change?

As this paper has shown, emission mitigation requires reframing energy development as a whole. Climate change is one of many energy issues we face today. Environmentalists, politicians and every day citizens are also increasingly worried about energy security, with an increasing amount of our fossil fuels coming from the politically instable Middle East, and peak oil, given the potentially expensive nature of substitutes for conventional crude oil. Low carbon energy development not only puts fewer greenhouse gasses in the atmosphere but also diversifies the world's energy supply. Lowering the world's dependence upon conventional fossil fuels increases global energy security and decreases our vulnerability to running out of cheap energy.

Mitigation in developing countries also has the potential to preserve global biodiversity. Humans are currently causing the most rapid mass extinction of life ever recorded over the earth's 4.6 billion years (Thomas et al. 2004). Tropical deforestation and associated habitat loss are the greatest cause of this biodiversity crisis. Land-use change, specifically deforestation, is also responsible for 18.2% of world greenhouse gas emissions (Baumert et al. 2005). Preserving forests is therefore in the interest of both climate change mitigation and biodiversity preservation. Protecting the climate therefore demands protecting biodiversity.

The expense of climate change mitigation can be justified because it protects more than the climate. Access to cheap energy fostered the rapid changes and associated environmental problems of the last century. Changing our sources of energy fundamentally changes our impact on the environment. Climate change, with increasing political support, is an avenue through which the world's environmental problems, local, regional or global, can be effectively tackled and overcome.

References

Anagnostopoulos, Kostantinos, Alexandros Flamos, Argyris Kagiannas and John Psarras. 2004. The impact of clean development mechanism in achieving sustainable development. *International Journal of Environment and Pollution* 21(1): 1-23.

Baumert, Kevin. 1998. Carbon Taxes vs. Emissions Trading: What's the Difference, and Which is Better? Global Policy Forum. http://www.globalpolicy.org/socecon/glotax/carbon/ct_et.htm. Accessed 25 January 2007.

Baumert, Kevin, Timothy Herzog, Jonathan Pershing. 2005. Navigating the Numbers: Greenhouse Gas Data and International Climate Policy. Washington DC: World Resources Institute.

Baxter, Larry and Jaap Koppejan. 2005. Biomass-coal Co-combustion: Opportunity for Affordable Renewable Energy. *Fuel* 84: 1295-1302.

Dubash, Navroz. 2002. Power politics: Equity and environment in electricity reform. Washington DC: World Resources Institute.

Ellis, Jane, Jan Corfee-Morlot, and Harald Winkler. 2004. Taking Stock of Progress Under the Clean Development Mechanism (CDM). Paris, France: OECD Environmental Directorate, International Energy Agency.

Ellis, Jane and Frederic Gagnon-Lebrun. 2004. The CDM Portfolio: Update on Non-Electricity Projects. Paris, France: OECD Environmental Directorate, International Energy Agency.

Ellis, Jane and Katia Karousakis. 2006. The Developing CDM Market: May 2006 Update. Paris, France: OECD Environmental Directorate, International Energy Agency.

Ellis, Jane. 2006. Issues Related to Implementing "Programmatic CDM." Paris, France: OECD Environmental Directorate, International Energy Agency.

Federal Energy Management Program. 2004. Biomass Co-Firing in Coal-Fired Boilers. US Department of Energy Efficiency and Renewable Energy.

Fenhann, Jørgen. 2006. Overview of the CDM pipeline. (20 October). http://cd4cdm.org/Publications/CDMpipeline.xls. Accessed 12 November 2006.

Fenhann, Jørgen. 2007. Overview of the CDM pipeline. (1 April). http://cd4cdm.org/Publications/CDMpipeline.xls. Accessed 9 April 2007.

Gentry, Bradford. 2000. Private capital flows and climate change: Maximizing private investment in developing countries under the Kyoto Protocol. In Climate Change and Development, edited by Luis Gomez-Echeverri. Connecticut: The Yale School of Forestry and Environmental Studies.

Gold Standard. 2006. The Gold Standard Manual for CDM Project Developers. Ver. 3. Basel, Switzerland: The Gold Standard. http://cdmgoldstandard.org/uploads/file/DeveloperManual_GS-CER.pdf

Goodward, Jenna. 2006. The Potential of the Clean Development Mechanism to Promote Renewable Energy in Developing Countries. Senior thesis, Scripps College, Claremont, CA.

Hassing, Pual and Mathew Mendis. 1998. Sustainable Development and Greenhouse Gas Reduction. In Issues and Options: The Clean Development Mechanism, edited by Jose Goldemberg, 147-162. New York: United Nations Development Programme.

Heller, Thomas and P.R. Shulka. 2003. Development and Climate: Engaging Developing Countries. In Beyond Kyoto: Advancing the International Effort Against Climate Change, 111-140. Arlington, VA: The Pew Center on Climate Change.

International Energy Agency (IEA). 2006. World Energy Outlook 2006. Paris, France: OECD Environmental Directorate, International Energy Agency.

International Emissions Trading Association. 2006. 2006 State of the CDM. IETA Position on the CDM for COP/MOP2.

Intergovernmental Panel on Climate Change (IPCC). 2006. Climate Change 1995: The Science of Climate Change. Cambridge, U.K: Cambridge University Press.

Jackson, Mike, Sarah Joy, Thomas Heller and David Victor. 2006. Greenhouse Gas Implications of Large Scale Infrastructure Investments in Developing Countries: Examples from China and India. Stanford, CA: Stanford Program on Energy and Sustainable Development.

Katzer et al. (2007). The Future of Coal: Options for a Carbon-Constrained World. Cambridge, MA: Massachusetts Institute of Technology.

Logan, Jeffery. 2007. China's Emissions Conundrum. *Climate Change Science and Policy* (forthcoming). Currently available http://www.wri.org/climate/topic_content.cfm?cid=4301. Accessed 24 March 2007.

Mann, Margaret and Spath, Peter. 2001. A life cycle assessment of biomass cofiring in a coal-fired power plant. *Clean Production Processes* 3: 81-91.

Michaelowa, Axel. 2005. CDM: Current Status and Possibilities for Reform. Hamburg, Germany: Hamburg Institute of International Economics.

Olsen, Karen. 2005. The Clean Development Mechanism's Contribution to Sustainable Development. (27 October). Denmark: UNEP Risø Centre: Energy, Climate and Sustainable Development.

Percival, Robert, Christopher Schroeder, Alan Miller and James Leape. 2003. *Environmental Regulation: Law, Science, Policy*. 4th edition. New York: Aspen Publishers, 2003.

Samaniego, Joseluis and Christiana Figueres. 2002. Evolving to a Sector-Based Clean Development Mechanism. In Building on the Kyoto Protocol: Options for Protecting the Climate, edited by Kevin Baumert, 89-108. Washington DC: World Resources Institute.

Samson, Roger, Sudhagar Mani, Robert Boddey, Shahab Sokhansanj, Diego Quesada, Segundo Urquiaga, Claudia Lem. 2005. The Potential of C_4 Perennial Grasses for Developing a Global BIOHEAT Industry, *Critical Reviews in Plant Science* 24: 461-495.

Stern, Nicholas. 2006. The Economics of Climate Change. Cambridge, U.K: Cambridge University Press.

Thomas, J.A. et al. 2004. Comparative Losses of British Butterflies, Birds and Plans and the Global Extinction Crisis. *Science* 303: 1879-1881.

Trexler, Mark, Derik Broekhoff, Laura Kosloff. 2006. A Statistically Driven Approach to Offset-Based GHG Additionality Determinations: What Can we Learn? *Sustainable Development Law and Policy* 6 (2):30-40.

Victor, David and Thomas Heller. 2007. Political Economy of Power Sector Reform: The Experience of Five Major Developing Countries. Cambridge, U.K: Cambridge University Press.

Winkler, Harald, Randall Spalding-Fecher, Stanford Mwakasonda, and Ogunlade Davidson. 2002. Sustainable Development Policies and Measures: Starting From Development to Tackle Climate Change. In Building on the Kyoto Protocol: Options for Protecting the Climate, edited by Kevin Baumert, 61-87. Washington DC: World Resources Institute.

World Bank. 2006. An Investment Framework for Clean Energy and Development: A Progress Report. Washington DC: World Bank.

Yergin, Daniel and Michael Stoppard. 2003. The Next Prize. Foreign Affairs November/December 8(6).

Annex A. Summary of Interviews with US Pellet Manufacturers

Company	Contact	Scale of Operations	Domestic/ International	Notes
California Pellet Mills	Ron Fuller (319)232-8444 and Scott Anderson (AndersonS@ cpmroskamp.com)	• Large Scale • 33,600 tons/yr (4 tons/hr) • Starting a plant= $1.5 million	• Has started 130 pellet mills in Europe. Largest success is in the European market. • International office in Amsterdam, sales representatives worldwide • In Latin America, "a lot of inquiries but very few sales, so no trends have emerged."	• Latin America interested in exporting pellets to European market. "My guess at this time is that inquiries are driven by the potential to export biomass pellets to Europe rather than a domestic market." • Timber companies in countries like Venezuela, Chile and Brazil are viewing Europe as a potential revenue stream • Not co-firing power plants
M-E-C	Michele Zhang (620)325-2673	• Large scale • 80,000-100,000 tons/yr • Supply mostly dryers commercial power plants • Dryer alone approx. $2 million	• 40% of business overseas (includes non-biomass equipment) • Especially active in Europe and Canada (because of Kyoto targets) • Don't sell to developing countries. "It will take them a while to start."	• Believes companies in Europe are generating carbon credits, but not US companies. • Wood based equipment works with about any type of biomass. Most US companies are focusing on wood. • Very interested in EcoSecurities and potential credit opportunities. • Plant consists of pellet mills, dryers, coolers, packing equipment
Kesco Inc.	Jason Kessler (803)802-1718	• 25,000 tons/yr of raw material- smallest • $4 million to set up	• Sell internationally throughout Europe and Pacific-Rim.	• Europe doesn't have enough wood to co-fire their coal plants. Don't have the resources in European nations to

		average plant	• Most business is selling equipment to US manufacturers, who then export the pellets (not the equipment) to Europe.	support demand. • Huge growth potential in export business. • Kyoto is the best thing that has ever happened for my business. • "Wont solve energy problem by taking tax money and giving to a company that is using it for a losing venture."
Industrial Turn-Around	Steve Gordon (804)414-1101	• 40,000 tons/yr to 500,000 tons/yr	• Majority of business is in US. Owner will contract plants for Europe, but this is rare. • Owners contract plants to their own personal needs. This owner is typically the one to ship afterwards. • "No one is trying to buy this for the developing world."	• System must be specially designed if intended for export. Europe typically uses larger pellets (9-10mm) than US plants (6-7mm). • Knows very little about carbon credits ("can't do that in the US") • Knows that some European countries give a "tax credit for recovering more than 40% of the waste"
KS Equipment Sales	Kevin Schultze (316)744-9547	• All scales. • Small plant (2tons/hr) costs about $250,000-$400,000. • If material needs to be dried, dryer is very expensive ($150,000). • Approximately 10% added cost for exporting equipment. • Smaller scale equipments runs on a	• Only worked with feed companies internationally (China and Chile 10 years ago) • Almost entirely domestic business (North America), but interested in exports.	• Sells used equipment. • Services the feed and bioenergy business. Same equipment does much of the same work. Doesn't think of himself as a renewable energy company. • To make a profit on new equipment, need lots of raw material and a machine that can process at least 6 tons/hr • Most plants use more than one mill. Capacity is determined more by

		belt-drive. This is much cheaper to repair than gears.		resource availability rather than plant cost. • Pelleting machines require lots of maintenance. Usually one machine is always broken. It's therefore helpful to have more than one machine. • Very interested in potential business opportunities abroad.
Continental Agra Equipment	Elisabet Livengood (316)283-9602	• Buy used equipment in area needed. Scales varies widely depending on needs.	• All 8 wood pelleting plants they have set up have been in the US. • Sell feed mills internationally, especially in Latin America (Elisabet is from Ecuador). • "There is no interest in Latin America in generating electricity with these pellets."	• Sell feed mills, densifying food for poultry, shrimp, dog-food, etc. Technology is very similar to that required for making biomass energy pellets, only its driven by gears instead of belts. This makes it more susceptible to breaking while processing wood (KS). • "Wood pellets are for stoves and heaters. They don't need that in the warmer South American climate."
BHS Energy	Adam Reggie (570)696-3754	• Low horsepower, on-farm pelletizing machine. • Individual based	• Plan on selling to boiler distributors and individual farmers in Northeast Pennsylvania.	• Still developing the technology. • Switch grass = best fuel • "We are among the first (if not the first) to produce a small scale pelletizer."
Wendling Bioenergy Consulting	Averill Cook	• Large scale, upfront cost of $7-10 million.	• "Densification of biomass has not yet taken hold in developing countries. The technology requires electricity and a lots of it to refine biomass into pellets. No trading as of yet"	• Equipment can process any type of biomass. Dry material reduces cost and scale of the operation.

Bliss Industries	Chad Cook		• No equipment sold outside of North America in the last 3 years. • Have worked in L. America	• Feed industry and wood pelleting
Andritz Sprout	Gary Crick- Manager of Orders (570)546-1021	• Large variety of scales available. Size of plant depends mostly on the number of pellet mills (called the number of lines). Andritz makes plants with anywhere from 1-15 lines. • $1/2 million for a 1 line plant, $7 million for 15 lines.	• North American division of Andritz sells only to Canada and the US (which then export their pellets). • Office in Denmark sells to Australia, Brazil and Europe.	• Never heard of carbon credits.